

Tank Designer

User Manual

Version V 5.2

English (UK) edition II.7-14



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Attention!

This manual refers to the current valid Tank Designer Version 5.0 + 5.1. This can be downloaded on the Internet at www.tankdesigner.com. This version 5.0 5.1 contains new material characteristics, additional fill media, modified factors, reworked calculation formulas, and new methods of calculation. All previous versions are, with this version which has already been published, no longer valid and do not reflect the state-of-the-art. The programme manufacturer disclaims all liability for any new calculations made using older versions.

Before using Tank Designer software packets, we recommend each user to:

**Thoroughly study
this manual as well as all listed writing
material in Chapter 6, Bibliography!
Please pay attention to the marginal
conditions and recommendations needed
to fulfil the theoretical basics!**

Table of contents

Topic	Page
0. Basic information / Rules, important to know	5
0.1 Basics of tank construction	6
0.2 Rectangular tanks	7
0.3 Circular tanks	8
1. Information on the use of Tank Designer	9
1.1 Software updates	9
1.2 Consulting / Helpline	9
2. Register and key assignment	10
3. Download / Installation with WINDOWS XP / VISTA / 7	
3.1 Download	11
3.2 The licensing process / implement TAN	16
3.3 The licensing process / activation / product key	18
3.4 Integrate Tank Designer in your network	21
3.5 Installation of language packs	22
4. Tips and tricks for programme application	
4.1 General	
4.1.1 Launch window	23
4.1.2 Commission	24
4.1.3 Confirm TAN	24
4.1.4 Material selection/reliability/ welding processes	25
4.1.5 Thermal load	27
4.1.6 Fill medium	28
4.2 Rectangular tanks	
4.2.1 Tank construction designs	30
4.2.2 Tank dimension and marginal values	31
4.2.3 Calculate	35
4.2.4 Print calculations report	38
4.2.5 Edit table of stiffener profiles	39
4.2.6 Tanks made of twin wall sheets (hollow core panels)	40
4.3 Circular tanks	
4.3.1 Tank construction designs	42
4.3.2 Entry of the roof design and the setup location	44
4.3.3 Notes on analysis of stability in the event of an earthquake	46
4.3.4 Tank dimensions and marginal values	50
4.3.5 Entry of nozzles and access openings	52
4.3.6 Calculate	53
4.3.6.1 Confining pressure stability	54
4.3.7 Print calculations reports	56
4.3.8 Conical bases with spoke-shaped support	57
4.3.9 Conical bases with ring support (in preparation)	58
4.3.10 Sloped base with parallel support structure (in preparation)	59

Topic	Page
4.4 Ventilation ducts	
4.4.1 Rectangular ventilation ducts	59
4.4.2 Round ventilation ducts	61
4.4.3 Calculate	62
4.4.4 Print calculation reports	63
4.5 Individuelle Kostenanalyse	
4.5.1 Basic informationen	64
4.5.2 The database für price and times	64
4.5.3 The dashboard for rectangular tanks	65
4.5.4 Optimise rectangular tanks according cost	66
4.5.5 The dashboard for cylindrical tanks	67
4.5.6 Optimise cylindrical tanks according cost	68
5. Errors and error messages	
5.1 General remarks	69
5.2 Through data input	69
5.3 Communicating with non-disclosed error messages	70
6. Bibliography	71
8. Calculation values and abbreviations	
8.1 Generally abbreviations	74
8.2 With rectangular tanks	75
8.2.1 additionally for tanks made of twin wall sheets	76
8.3 In cylindrical tanks	77
8.3.1 With flat roofs	78
8.3.2 Additionally for earthquake safety analysis	80
8.3.3 Additionally for cylindrical skirt-type tanks (in preparation)	82
8.4 Additionally for cost analysis	83
9. Guarantee and liability	84
10. Attachment	
10.1 Orientation guide: Earthquake zones in Europe / Mediterranean (*see Chap. 4.3.3, Legal notice!)	85
10.2 Listing of integrated sheet thickness variants (metric / imperial)	86
10.3 step by step claculation guide for rectangular tanks	88

0. Basic Information / Rules, important to know

This software was developed as engineering software. It supports the experienced plastic tank manufacturer in the design and dimensioning of plastic tanks, devices, and similar products. In this case, design means the dimensioning of the wall thickness as well as the reinforcement system of thermoplastic or steel (not for circular tanks). To this end, the programme uses calculation methods from guidelines / recommendations and standards. In the event of missing information, it falls back on the experience of the manufacturer or other experts and specialists.

This product is not intended as a replacement for human understanding or to cast doubt on technical principles. Results which do not appear to be reasonable or realistic are to be scrutinised. In such cases, please contact the programme manufacturer (see here too Section 5.5 Communication for non-mentioned error messages).

Basic rule 1

The calculations carried out with the programme only apply if pre-products are used for the tank construction which have been produced according to the relevant DVS / EN / ISO guidelines and standards and correspond to these.

Basic rule 2

The calculations can only be used if the products to be manufactured are produced with machines and equipment which operate according to the relevant DVS guidelines.

Basic rule 3

The calculations are only to be used in products if the production staff adheres to the associated DVS / EN / ISO processing guidelines, are trained accordingly and document the production correspondingly.

Basic rule 4

Statics provided using these calculation programs can only be considered valid after the entered application data (e.g. dimensions, temperature, life expectancy, composition of the filling material, influence of the filling material, welding process, material, setup conditions and required level of safety) correspond exactly to the application that has to be fulfilled by the product under analysis.

Basic rule 5

The responsibility of certain legal areas (e.g. construction law, water rights, occupational reliability law, etc.) is to be observed!

The existing programme is based on the publications of the Deutschen Verbands für Schweißtechnik e.V., Düsseldorf [German Welding Society] and the European Directive EN 12573. The directives of the DVS as well as the European standards (EN) which were not mandated, apply only as recommendations, i.e. these are not normative. These publications were prepared by a group of experienced experts serving on a voluntary collaborative team. The user of Tank Designer must examine to what extent the contents of the corresponding directive/recommendation applies to his particular case and if the version available to him is still applicable. Apart from that, the guarantee and liability conforms to the provisions of the law.

Each programme user is obliged to examine all information on the tank statics for correctness using the relevant standards before manufacturing a tank. If errors exist in the calculation, these are to be reported immediately to the software manufacturer. No liability is assumed for damages which result from erroneous entries by the programme user. For errors in the software resulting from improper transport or faulty installation or a faulty PC, no liability is assumed. For errors which are caused by computer accessories or TAN files, no warranty will be honoured.

0.1 Basics of tank construction

The static calculation of the component calculable with this programme is based on the following assumptions which must be considered when executing the component:

General design basics:

The existing tank calculation is based on a theoretical consideration of a design corresponding to the guidelines of the Deutschen Verband für Schweißtechnik (DVS). To fulfil the theoretical basis and operands, the following points must be required at least:

Design details: The design of the welding seams, the arrangement of the flange connections or braces and those for the attaching of the reinforcement beams should be done according to the DVS directives DVS 2205 T2, 2205 T3, DVS 2205 T4, 2205 T5 and DVS 2205 T5 Supplement. These take the important design features such as stability, strength, and thermal length modifications into account.

Pre-products: The used plastic pre-products must meet the characteristic values according to DIN 8075 (PE-63 /-80/-100/-HD), DIN 8078 (PP), DIN 8061 (PVC), DIN 8080 (PVC-C) and ISO 15014 (PVDF), as well as the supplements to DVS 2205 for the individual materials. A positive evaluation of the chemical resistance as per the DIBt media lists (9/2011) or DVS 2205 for the mould compounds used in the pre-products are required. The pre-products are subject to a constant quality monitoring according to DVS 2201 Part 1 and must undergo a positive weldability test according to DVS 2201 Part 2 before use. Only welding consumables are to be used which correspond to the requirements of the DVS 2211.

The steel profiles chosen as reinforcements must meet the resistance moments (W_x) and area moments of inertia (I_x) which are accepted in the programme-internal steel table. With deviations, please correct the values in the steel table.

Welding and plastics processors: Experience has shown that the handworker who is assigned to the manufacture of the calculated tank should have a valid welding license according to DVS 2212 Part 1 and Part 2. With all other processors, the achievement of the underlying welding seam strength or the prevention of a negative change of pre-product characteristics through the processing is not adequately assured.

Processing guidelines and parameters: In long-term studies, it was shown that for compliance of the characteristics adopted in the calculation, processing corresponding to the Directives 2207 T 1, T 2, T 3, T 4, T 4 Supplement, T 11 and DVS 2209 T 1 is implicitly recommended. As an alternative, the recommendations of the relevant pre-product manufacturer are available.

Machines and equipment: A prerequisite for the achievement of the best processing results are machines which correspond to the quality demands of the DVS 2208 T 1 and T 2.

Components and construction-related inspections: Before a tank calculated with theoretic characteristic values and designed mostly for the storage of environmentally hazardous liquids is introduced to its intended purpose, it should be subject to thorough testing. It is recommended that during the production, processing samples such as e.g. welding samples be prepared. These should be subject to a quality assessment according to DVS 2203 T 1, T 2, T 3, T 4 and T 5. For finished products, an optical examination is recommended according to DVS 2203 Part 1, which, however, is only carried out by experts trained in this. Furthermore, a density and stability inspection using water filling is recommended on the finished tank.

Intermittent temperatures: When inputting to a temperature field, i.e. from several operating temperatures, the useable life to be expected is determined by the programme by the addition of the damage rates according to "Miner". The calculation of the useable life is done here according to the calculation processes for cumulative damages according to DIN/ EN/ ISO 13760 Miner's rule.

Plastic ribs and plastic supporting plates: Please make sure when using massive thermoplastic plastic ribs / stiffeners or plates / stiffeners which serve for support, that a "thickness / height ratio" of a maximum of 1/8 (e.g. thickness 25mm / height maximum 200mm) is not exceeded. Exceeding the ratio of 1/8 leads to the situation that the supporting element bends / twists or buckles due to the material flexibility thus losing the desired effect.

0.2 Rectangular tanks

The individual fields of a tank are to be consecutively numbered from top to bottom.

Tanks with reinforced edges, circular reinforcements, yoke reinforcements or cross ribbing: The horizontal stiffener are calculated as a beam between suspended and firmly clamped bending beams. This statement is, however, only applies to rigid edge joints (e.g. welded reinforcement design). Please make sure that the corresponding frames are produced as rigid designs!

Tanks with yoke reinforcement or cross ribbing: Here you can select the general construction from 6 different variants. This can also include tierod or tie profile. The number of vertical reinforcements with cross-ribbed tanks is the same as the number of the required tie rods at upper or lower end. In both construction designs, a minimum number of 2 vertical reinforcements applies. The distance of the vertical ribs to the tank edge must be a maximum of $\frac{1}{2}$ of the panel width.

Variable deflection of the reinforcement beams: According to DVS 2205-5 or EN 12573, the tolerable deflection is 1% of the panel height supported by the respective beam. You have the possibility in this programme with tanks of the Type B), C), E) to adjust this deflection to 2%, 3%, 4% or 5% in the window "tank size". We expressly state here, however, that the responsibility and liability lies with the programme user. Before you make a change in this value which is a deviation from the specifications of the directive, you should make certain that the end users, the testing institution or the (local) law or the regulation position allows this or makes this possible.

Attaching the reinforcements with protective profiles: Steel profiles are, as a rule, attached to the tank wall, position determined by the programme using plastic protective profiles. These protective profiles of plastic also serve as corrosion protection. Furthermore, an all-over mounting prevents vibration movement of the wall caused by filling height fluctuations. These vibrations can lead to brittle fractures in the tank corners.

Welded-in tops as reinforced edges: The calculation of the top thickness is done without consideration of the top deflection. In each case, an adequate top stiffener is provided. Tops cannot be walked on. In the calculation, it is assumed that the welding process, with which the top is attached, is also used as a basis for the tank calculation. The welding seams must correspond in their force-transmitting areas at least to the plate thickness. A double fillet weld (T-joint) is ideal weld geometry.

Tanks with tie rods: The number of the tie rods corresponds to the number of the crossing points between circular and vertical reinforcements. Here the vertical beams are replaced by the tie rods. Please implicitly observe that at the place where the tie rods are attached to the steel beams, the steel beam must be adequately reinforced. This is done to prevent the tie rods being pulled through the steel beams (through enormously high point loads). If the tie rods are covered (e.g. with a plastic pipe), the cover must be so designed that it can compensate for a length change of the tie rods or movement of the sidewall (e.g. through fill level fluctuation) without damages.

0.3 Circular tanks

The individual fields of a tank are consecutively numbered from top to bottom.

Limitations of the main dimensions:

Tank diameter: $d \leq 4\text{m}$
 Ratio: $h/d \leq 4$
 Minimum thickness: 4 mm

Out-of-roundness:

The calculations are based on the prerequisite that the out-of-roundness of the cylinder casing is a maximum of 0.5 %. The out-of-roundness is determined according to

$$U = \frac{2 \cdot (d_{\max} - d_{\min})}{d_{\max} + d_{\min}} \cdot 100 \leq 0.5\%$$

If these marginal values are exceeded, the existing tank statics are invalid!

Permitted flexural stress:

In the manufacturing of the cylinder covers from panels, stresses are created which are caused by the bending process. The residual stresses may be neglected if the tolerable flexural stresses (according to Table 1 from the DVS 2205 T1 Page 5) $\varepsilon = s/d \cdot 100\%$ is not exceeded. The marginal values determined according to the directive for the flexural stress have been provided with a tolerance of 5% ($\varepsilon \cdot 1.05$) based on practical experience collected. This means that e.g. with tanks of PP-H, a maximum flexural stress of 0.525% is allowed by the programme. Please clarify whether your customer or the evaluating authority agree to the exceeding of this marginal value before the construction of the tank. PVC-U plates are always moulded using heat.

If the tolerable marginal values are exceeded, the existing tank static is invalid!

Welded joining of base/casing:

The calculations listed only apply for the following prerequisites:

- Welded seam thickness $a \geq 0.7 \cdot S_B$
- Long-term welding factor $f_s \geq 0.6$

If the tolerable marginal values are exceeded, the existing tank static is invalid!

Double layer tank, double skin retention tank:

Caution! The following special construction regulations are to be observed:

Only a maximum of two layers is allowed

The outer skin should be shrunk so that both skins have full-surface contact.

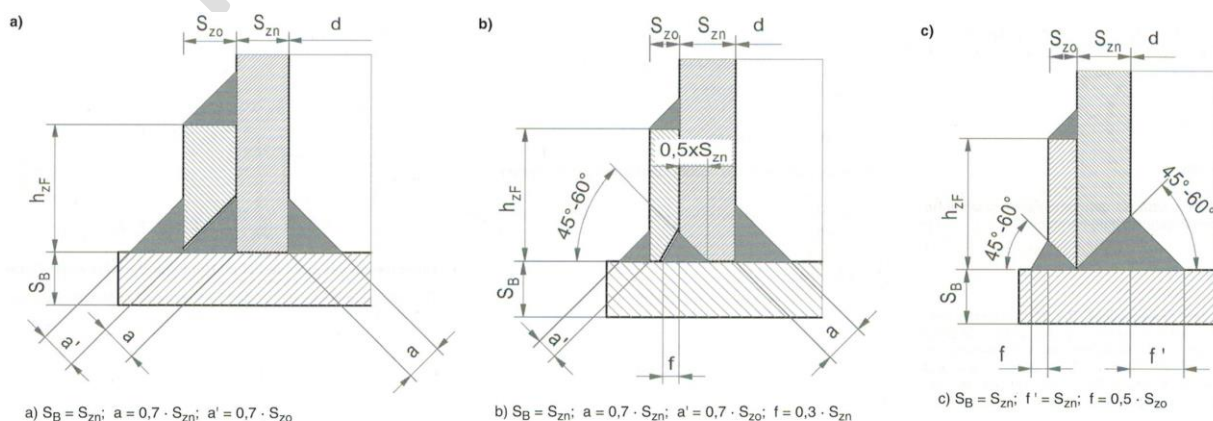
Skins are to be welded according to Figure 7 of EN 12573-2 to the base (see drawings below).

The properties of both skins should be identical (same raw material and pre-product manufacturer).

The thickness of the outer skin should correspond to 0.5 to 1.0 times the inner skin.

The thickness of the base must be identical with the thickness of the inner skin of the lower panel.

The inner skin must be 100mm higher than the height of the shrunken outer skin.



1. Information on the use of Tank Designer

We offer you the following possibilities for the use of Tank Designer software:

Full version:	You purchase the software and have lifelong user rights
1-year version:	You purchase the right to use the software for 365 days in its complete scope for all intended purposes. The software has no restrictions other than the limitation of use of 365 days.
7-day version:	You purchase the right to use the software for 7 days in its complete scope for all intended purposes. The software has no restrictions other than the limitation of use of 7 days.
1-day version:	You purchase the right to use the software for 24 hours in its complete scope for all intended purposes. The software has no restrictions other than the limitation of use of 24 days.
1-static version:	You purchase the right to use the software to calculate a static of your choice. The calculation and the data print are done in complete scope without any restrictions.
24h offer version:	You purchase the right to use the software for 24h. In doing so, you can carry out a complete calculation, but only print it out for estimations. The information on the data printout is enough for the user for the generation of an offer.
1 offer version:	You purchase the right to use the software for one calculation. In doing so, you can carry out a complete calculation, but only printout for estimation purposes. The information on the printout is enough for the user for the generation of an offer.

Please request prices for these possibilities at info@tankdesigner.com

1.1 Software updates

The version designation: **V A.bbb.cc** (e.g. V 5.000.12) means:

A = Basic version **b** = Development step **c** = Update number

New standards/directives or innovations are valid on the software basis with Microsoft®, we offer reworked basic versions or development steps for purchase. Additionally we work on fundamental improvements or extensions and offer these in regular intervals as new development steps for purchase (see too Sect. 7 Information on updates). If there are errors/bugs in the programme, you will receive a free update.

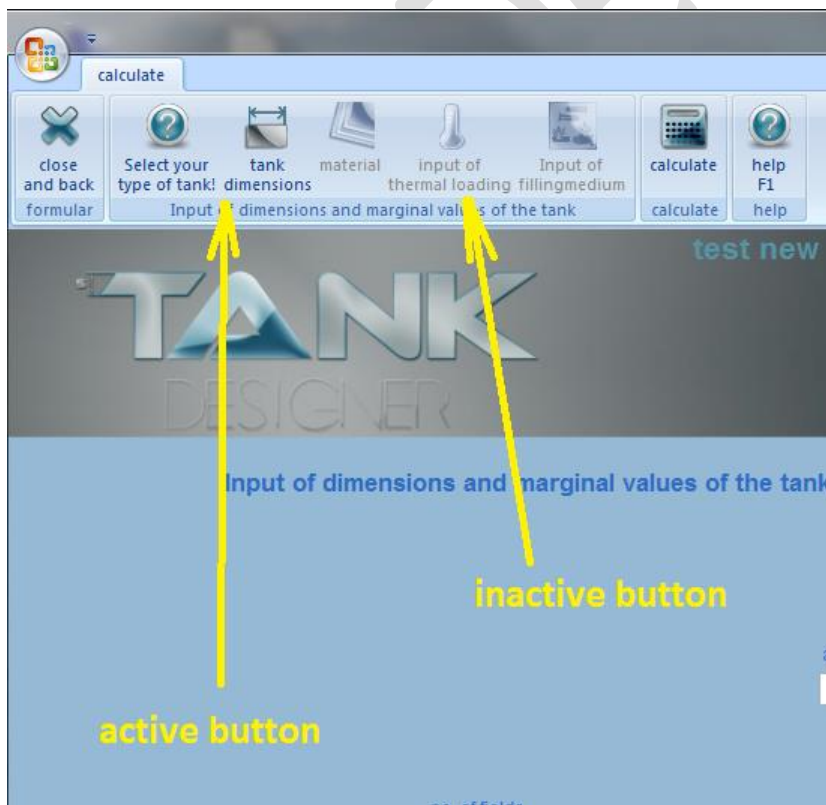
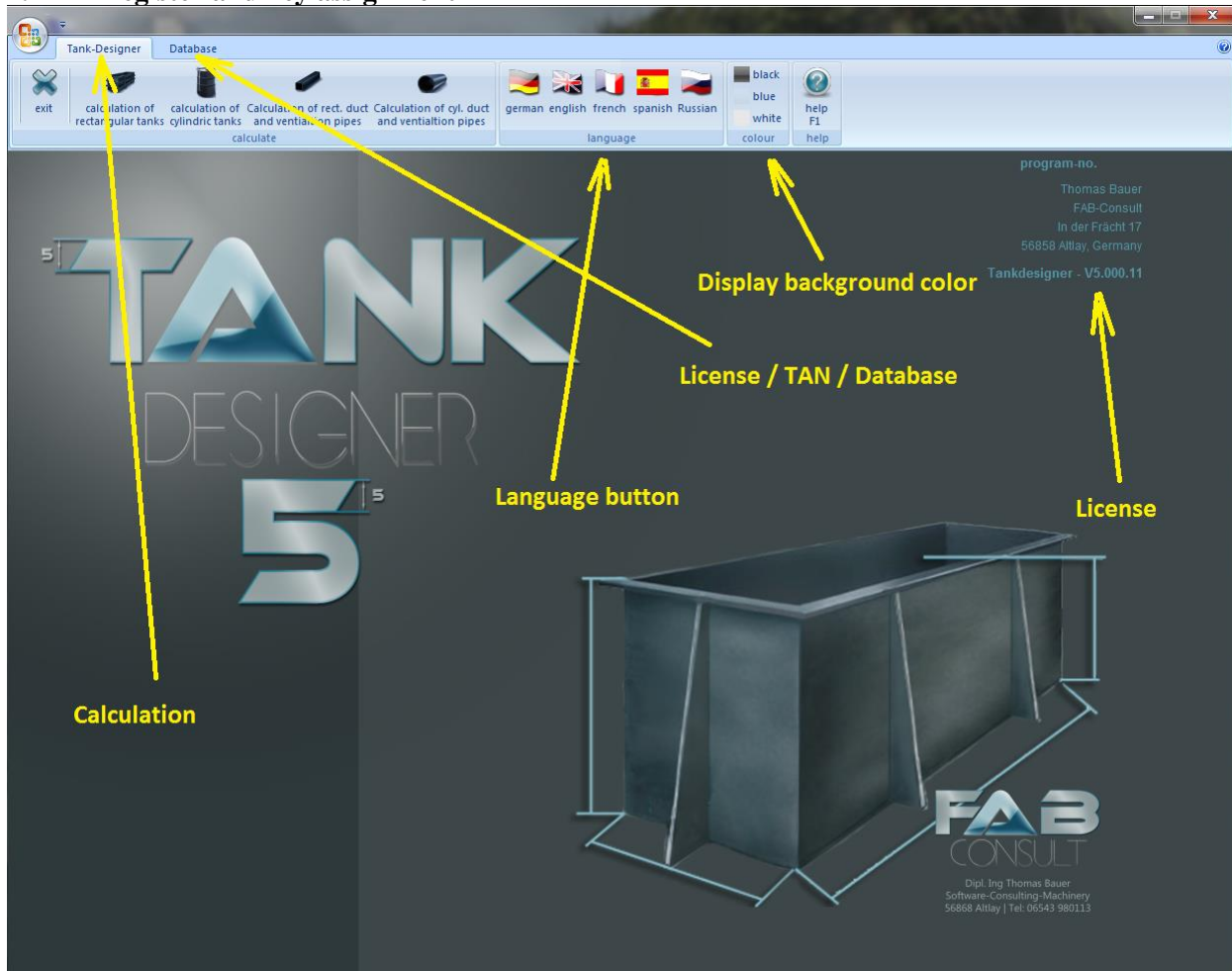
We thus recommend that you visit our website www.tankdesigner.com in regular 4-week intervals. Here you will find the current version designation. If there are deviations to your installed version, we recommend that you update with a download. Please observe here that with modified version designations in Parts **A** or **b**, the update is subject to a charge; with changed designations in Part **c**, it is free-of-charge!

1.2 Consulting / Helpline

You have questions now and then about tank construction, calculation methods, directives, materials or the like. You need support time and again in the calculation of tanks? For a flat rate of 185.-- Euros once a year, we are at your disposal at any time with advice and assistance.

If you are interested in this service, please call the telephone number listed. Included in the price is one complete standard calculation per year.

2. Register and key assignment



It is entirely possible to enter data if a window is active. If you want to move from one folder or window to the next but the programme does not allow doing so, than at least 1 value / selection is missing in the current entry form . Check thus the current folder and enter the missing value or activate a possibly missing selection. As soon as the missing information is entered, the programme activates the next folder and you can jump on with a click on this folder!

It means: **“ESC”**
The Escape key on your keyboard

“DEL” key Delete on your keyboard

3.1 Download / Installation with WINDOWS XP / VISTA / 7

To install Tank Designer 5.0, you will need at least 120 MB of free memory on your hard drive (Partition C :)

1. Connect to the Internet.
2. Open the website: www.tankdesigner.com
3. Select the installation language (Click on the corresponding flag)
4. Please decide whether you want a full version or a demo version. For owners of older/previous versions, the downloading of an update, a step with the corresponding costs appears for your confirmation and you will be sent the corresponding invoice in the next days. Please ask about the current version number which you can find on the current download page (see next figure)
5. For the installation of a new programme (previously not available on the computer). Please download the DEMO. In doing so, it does not matter whether you purchase the complete or demo version.

TANK DESIGNER 5
V5.000.07

update
demoversion
imprint

demoversion

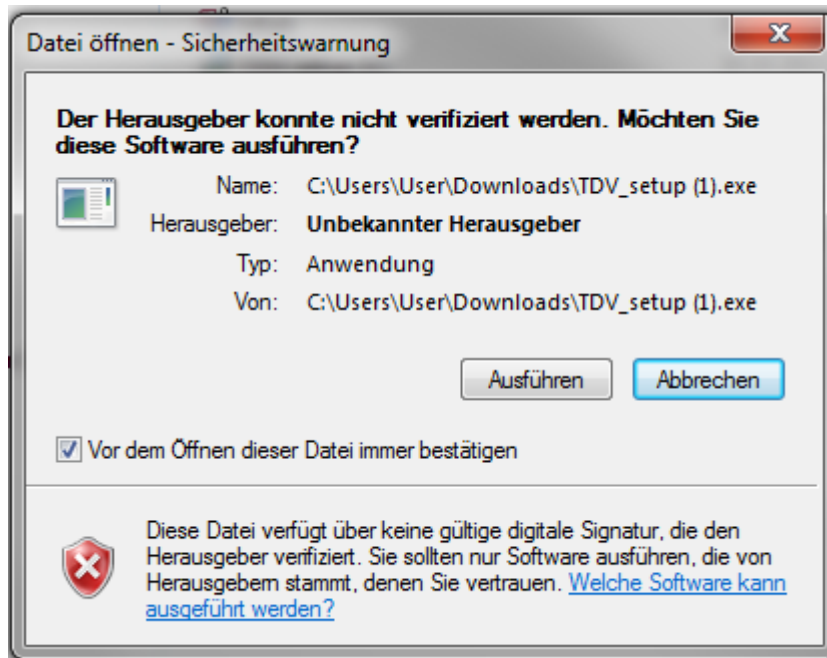
company: _____ surname: _____
name: _____ address: _____
citycode & city: _____ country: _____
tel: _____ fax: _____
email: _____ internet: _____
valid: _____

We are distributors of:
1) TNGENIA
2) Jacob Köhne
3) Hexadux

6. Please fill in all fields completely and correctly because the information given here serves as a license reference.
7. Click on "continue" to start the installation.

8. To start download without saving the software to your computer, click on “Run” as shown in the next picture.

Recommendation: Make a copy of the programme (before installation starts), click first on “Save”. Normally you will find the setup file (**TDV_setup.exe**) in the file “Downloads”. Double click on this file.

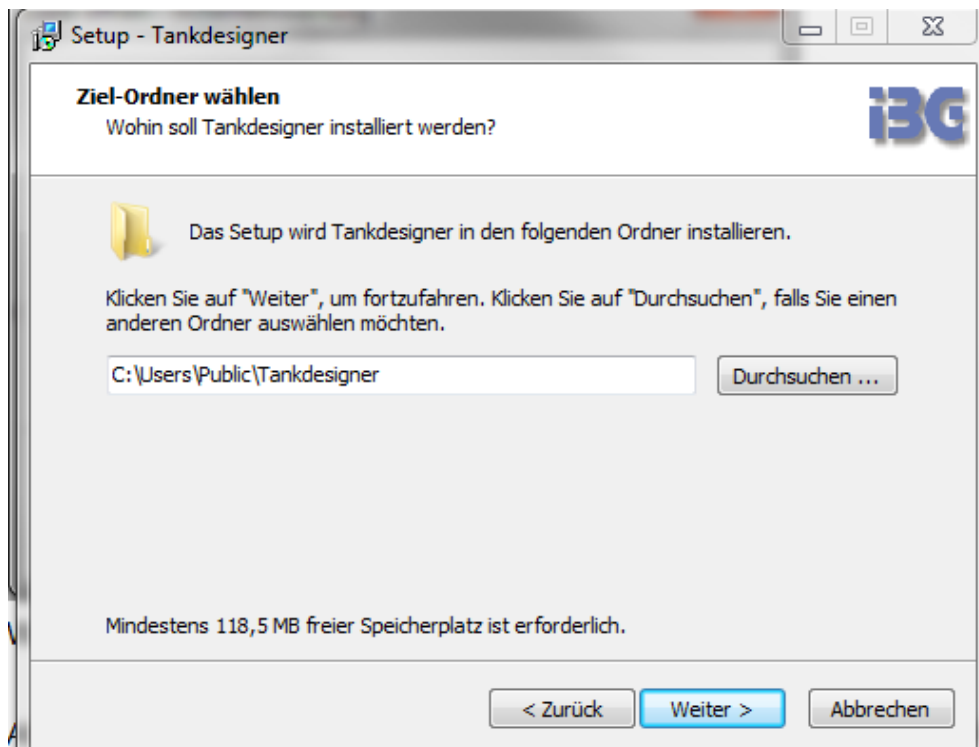


9. To start the installation, the following window will open. In doing so, you will be informed that the manufacturer of the programme is not known. Continue with the installation after this and click on “Run” nevertheless.
10. At the start of the installation, the following window appears:



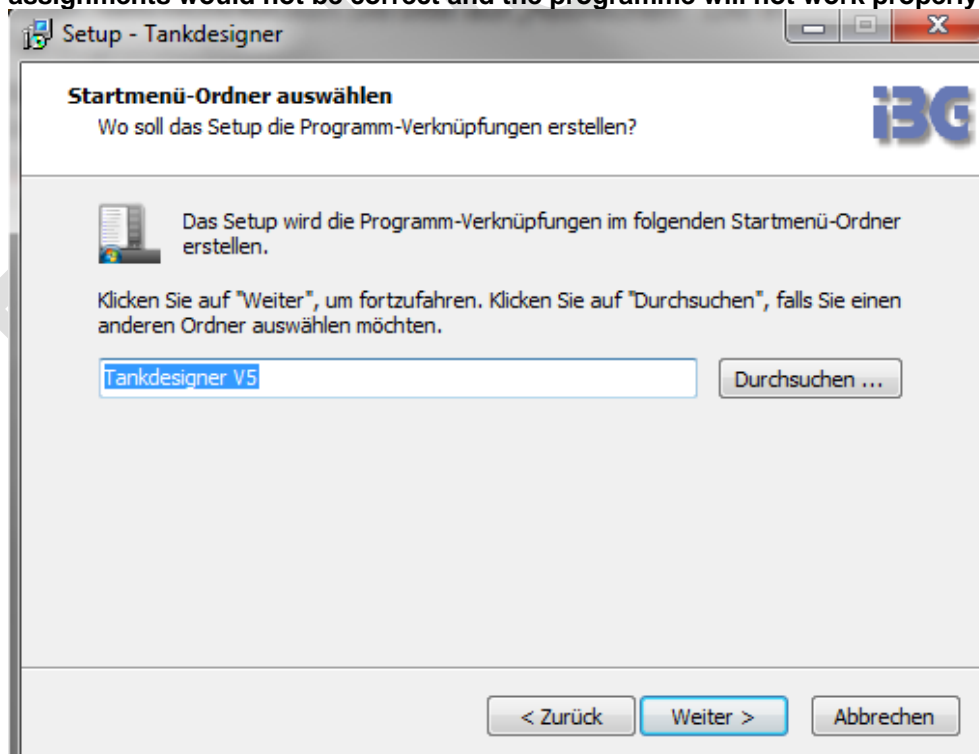
Click on “Continue”>“

11. A legal notice appears. If you accept this, click on "Continue", otherwise click on "Cancel". The installation will be aborted in the latter case.
12. If you chose "Continue", the notice now appears regarding the file to be created. Please do not change this and allow the directory to be created by clicking on "Continue":

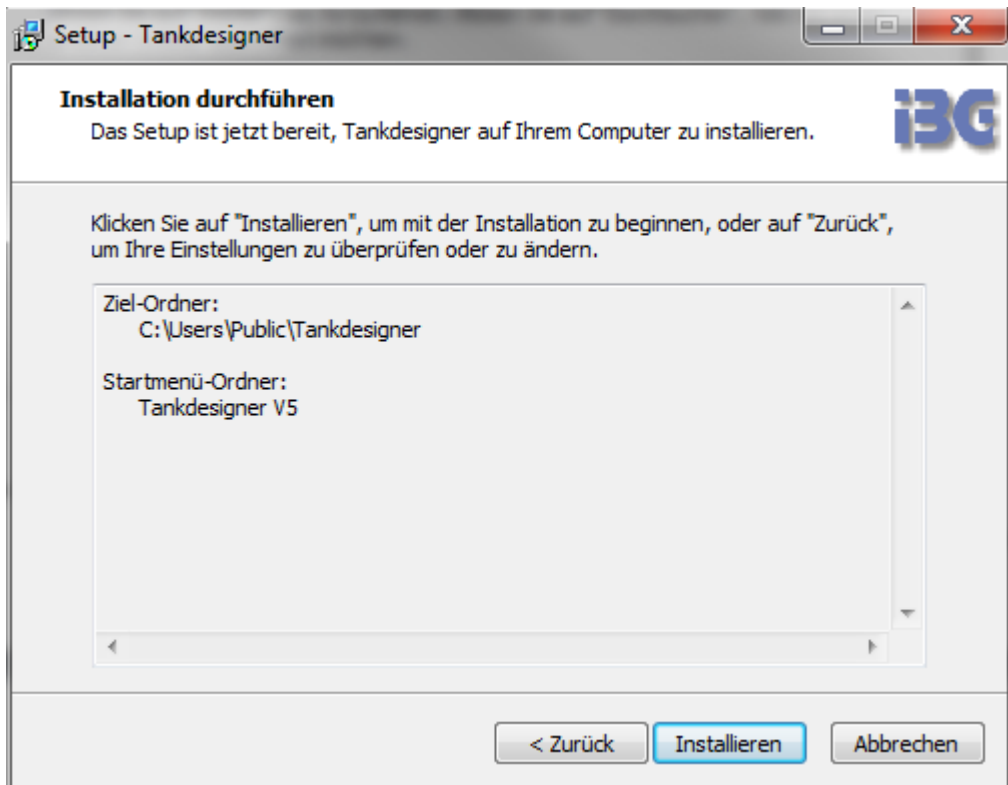


13. Now, the program will inform you that it will create a folder in your menu bar. Proceed with this by clicking on "Continue>" (Weiter>)!.

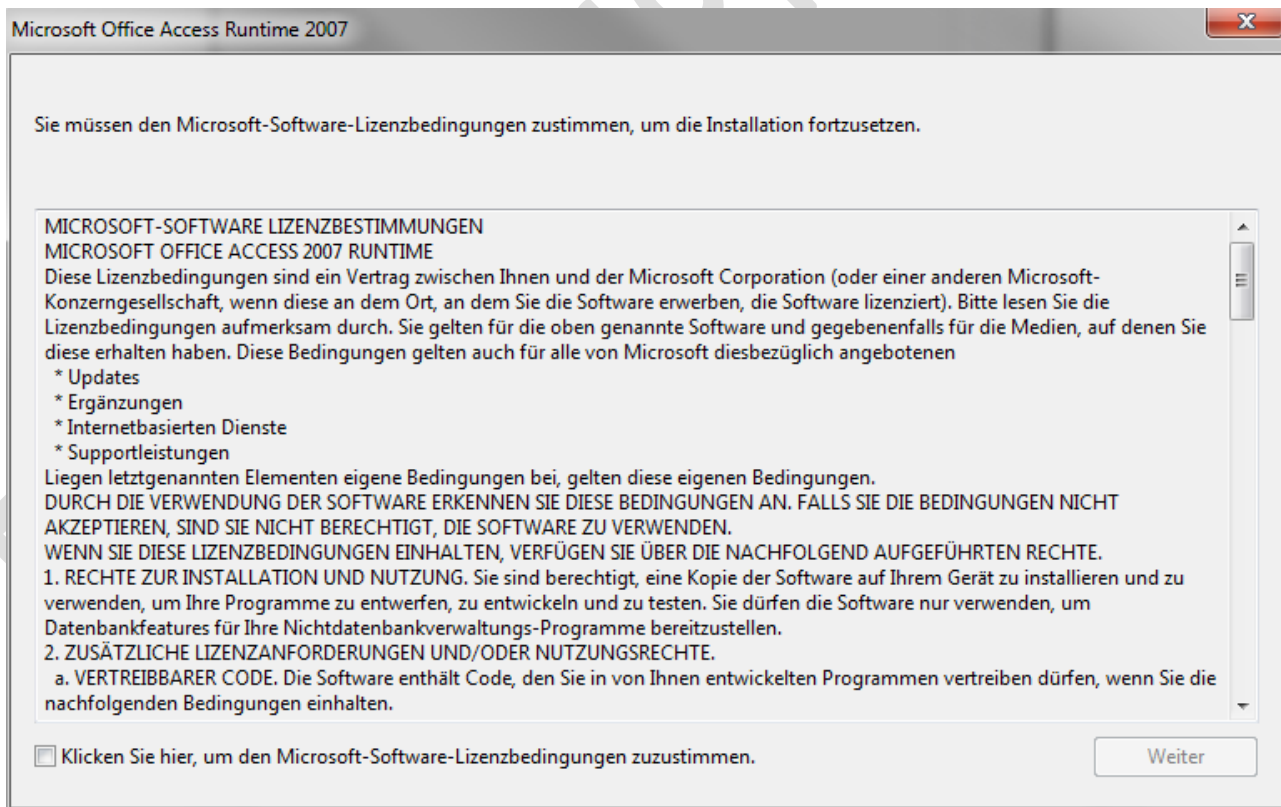
Please do not change this assignment! Otherwise, the internal programme database assignments would not be correct and the programme will not work properly!



14. To confirm, the programme notifies again you of the target file and start menu folder. Please click on "Install" now.

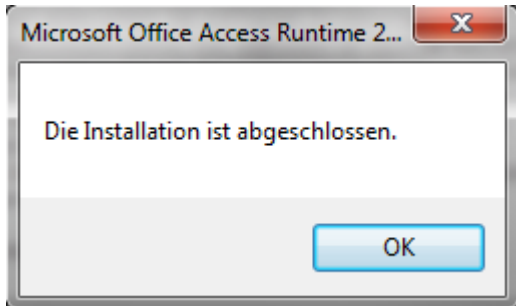


13. Now you will be asked if you accept the Microsoft user terms:



Check the box (by clicking on the square box) and then on “continue”. If you do not accept the Microsoft terms, the installation is aborted.

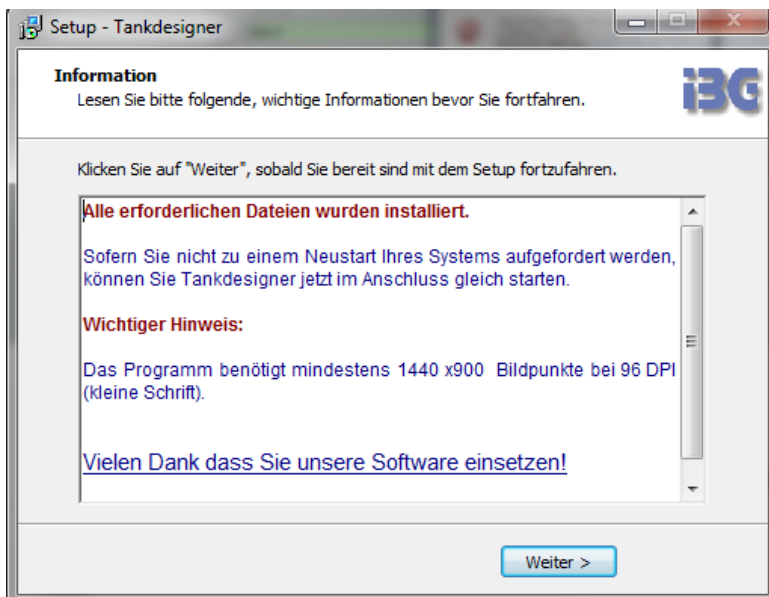
14. Now several installation pictures follow in passage. After completion of the installation, the following remark appears



Click on ok.

Now zip files are unzipped. When this is done, the following window appears:

15. Click "continue >"



16. At the completion of the installation, the following picture appears:



17. Click on "Finish"! The installation is thus finished/

3.2 Licensing process, TAN (TransActionNumber)

In the attachment of the license e-mail sent to you, you will find an Excel file with the name (TAN.....xls). This file contains so-called "Trans Action Numbers" (TAN). One of these TANs will be needed for each future calculation. The Tan file contains several TANs. Each of these TANs is valid for 1 year. (unless you ordered a 1 x TAN or a 7-day TAN). The TANs are activated with the first click and run for exactly 365 days. Therefore, please activate the first in the first year, the second in the second year, etc. If the TANs have expired, the owner of the full version will, of course, receive new TANs.

Copy the TAN file into the directory Tank Designer.

For this, click on the right mouse on the appendix of the license e-mail and then on "save as" and choose the folder:

C://user/public/Tankdesigner (Vista or WIN 7) or

C://Dokument und Einstellungen/all users/Tankdesigner (WIN XP)

The exact location of the directory is dependent on your version of Windows or the setting.

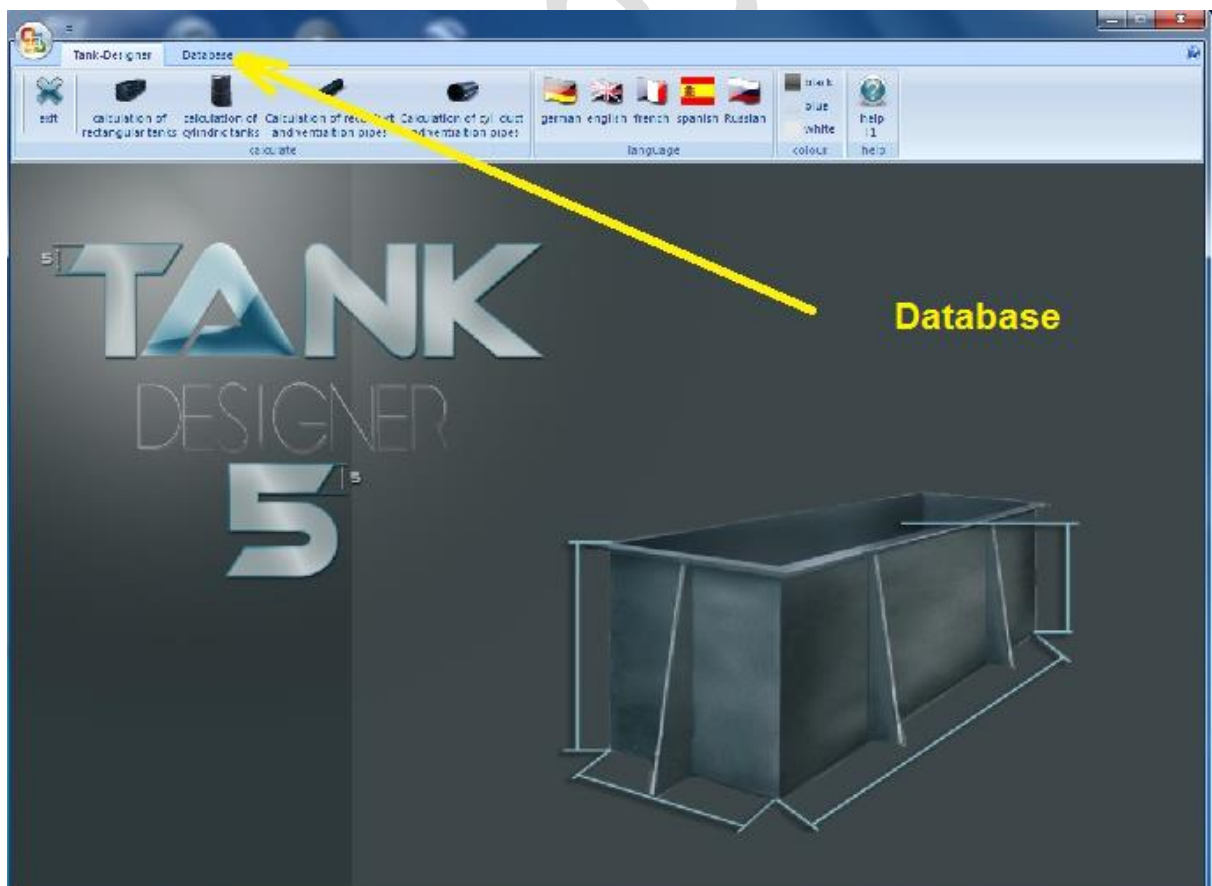
You will then return to your desktop:

1) Start the programme now with a double click



If the programme module cannot be opened now, and if the text "Optimisation >1" appears in the upper menu bar instead of the buttons "circular tanks" and "rectangular tanks", the database references can be considered false. In such a case, please uninstall Tank Designer and reinstall the demo or update version in the suggested default path (c:/....)!

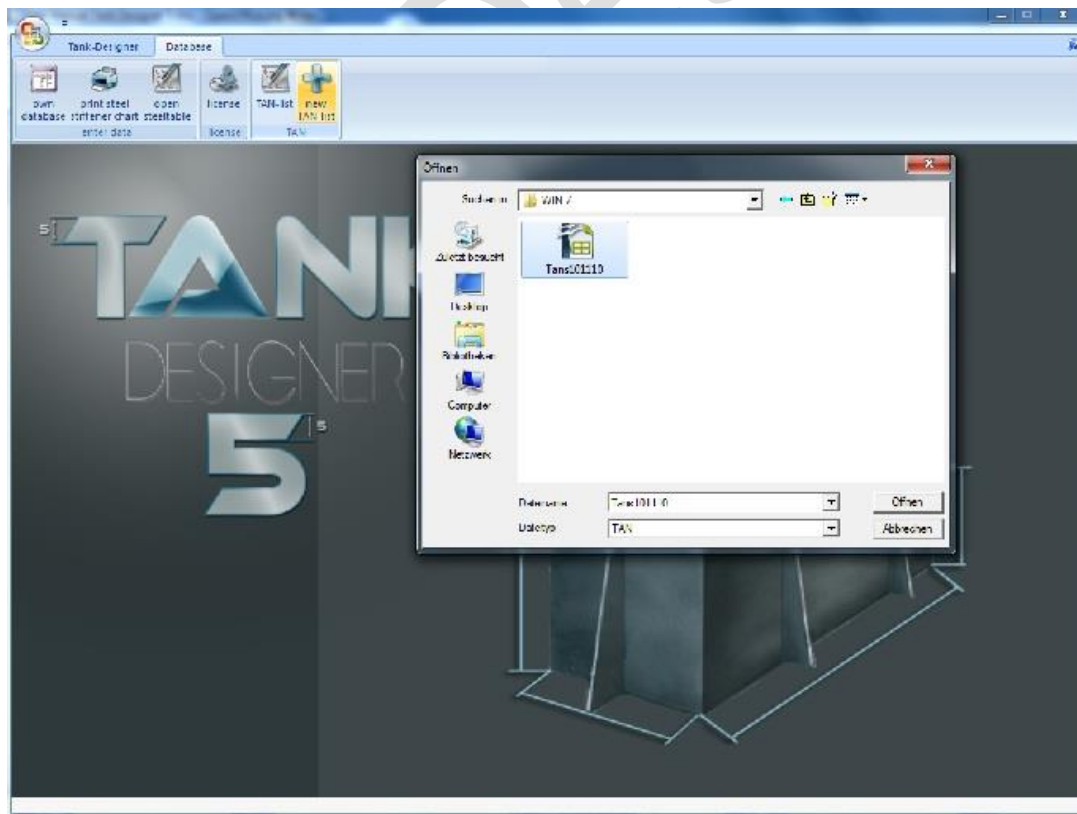
2) Afterward you can open the "Database" by clicking on the folder



3) Click on "New TAN list"



- 4) Search through the directory "Tankdesigner", choose the previously copied TAN file and click on "open"



- 5) The TAN list is now active!!

3.3 The licensing process / activation / product key

To convert the software from the demo version to a full version, enter the following:

Before doing so, please make sure:

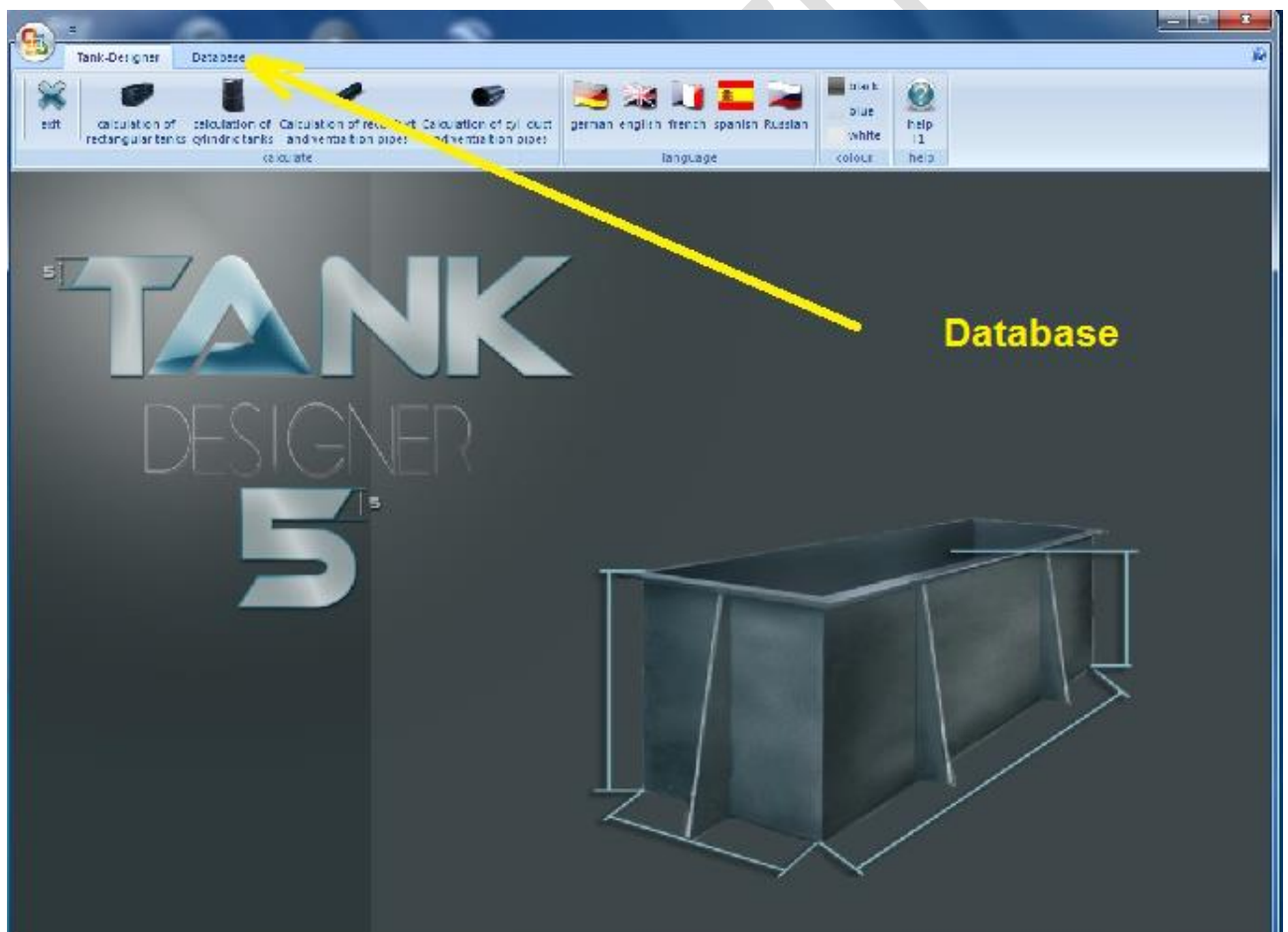
If your PC / laptop is part of a network:

**For this activation, the relevant computer must work in the
“Administrator” mode!**

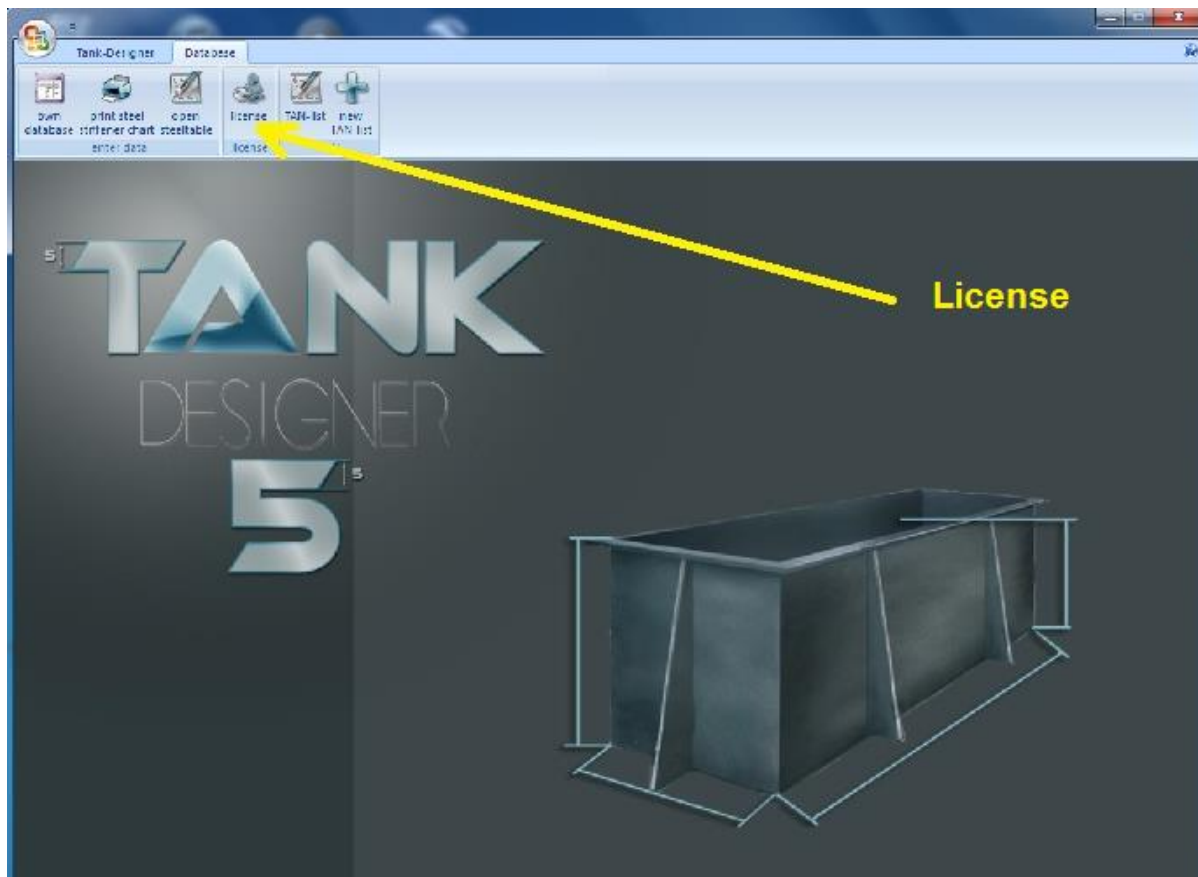
- 1) Start the programme by double clicking:



- 2) Then click on “Database”



3) Click on "License"



4) Please fill in this field as displayed and deactivate the demo

license holder

company: FAB-Consult

company: Thomas Bauer

street: In der Frächt 17

town: 56858 Altlay

Tel.: +49-6543-980113

Fax: +49-6543-980115

Prog.-Nr.: IN95000

208 621 535

key

fill in key here

☐ DEMO-Version

☒ Rechteck

☒ Rund

☒ RundRohre

☒ Rechteck Rohre

☒ earthquake safety

☒ Verst. Tr.

☒ Network

untag!

must be filled out completely!

stated in the invoice

tag purchases modules only

requested numbers

Please enter a maximum of 21 characters per field as license holder!

- 5) After you have filled in the “License number” fields and deactivated the box in the demo version, please make a copy of your desktop (screenshot):

--> Press: CTRL + print (on your keyboard)

and send this copy to the following e-mail address:

info@tankdesigner.com

We establish the programme key from this and send it to you via e-mail. Enter the key as shown in the “programme key” and close the window with “OK”

While you are waiting for the programme key, please do not close the current window. By closing and opening a new window, the numbers which are used in the transmitted key will be changed and become invalid!

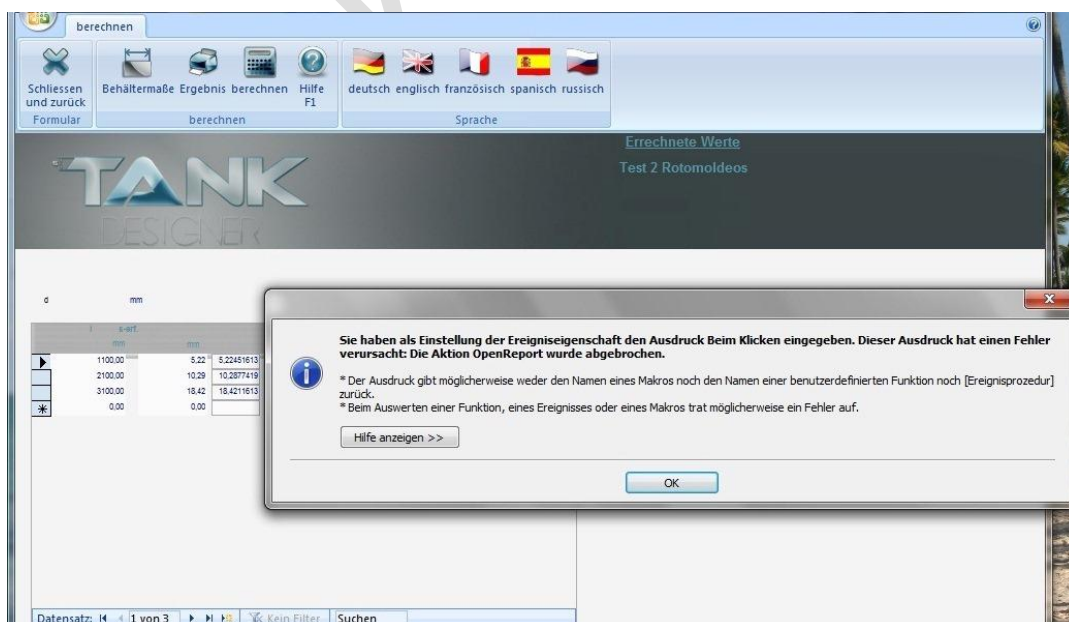
Alternative: Call us at: +49-6543-980113

We will then ask you for the “requested figures” and tell you the key over the telephone.

- 6) This licensing process from Section 3 must be done for each computer on which Tank Designer will be used.

Please note, important message: For proper functioning of the programme, a functional printer must be installed. Without an installed printer (or PDF Generator) the programme will not display any results!!!

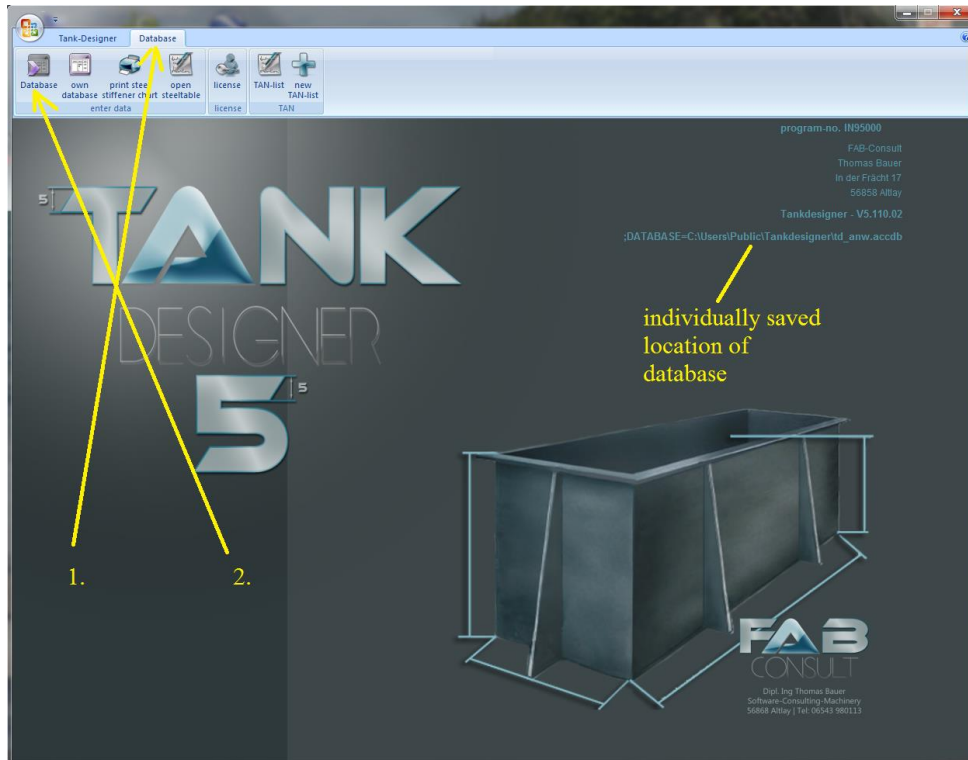
In this case, the following error message will appear after clicking on “Result”:



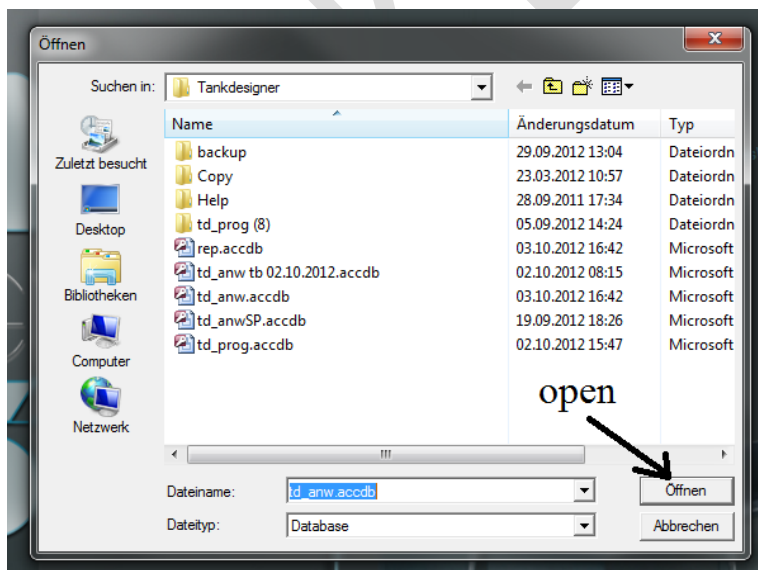
3.4 Integrate Tank Designer in your network

Presubposition to use this network function is that you have purchased the key for additional module N 0.1!

First open following folder in your windows explorer: **C:/user/publik/Tankdesigner**. Please „copy“ the file (using right mouse button) the file **TD_ANW.accdb**. Insert this file into your expected folder e.g. on your server. To realize the connection and data exchange with this file (Tank Designer database), on each PC used for Tank Designer please start the Tank Designer program once and click two times on the menu (folder button) „Database“ (see next picture).



After the 2. click the following window will pop up:



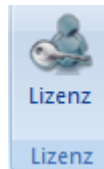
Now please search the before integrated file TD_ANW.accdb on your server and activate it by clicking to „open“. Tank Designer will automatically create a link to that database and store it program internal. For your orientation, the chosen folder/ file now will be shown in the address field of the start page (see upper picture)! This operation of connection with the server/ database you have to realize with each PC / Notebook that is using Tank Designer 5 software and should have access to the TD database.

3.5 Installation of language packs

You can download language packs directly via the license window from the Internet. To do this, you need a different password for each available language. Those you may either purchase online through our web shop (with PayPal payment) or through pre-payable invoice received from us.

After receiving your password, proceed as follows:

- 1) Start Tank Designer
- 2) Open the Tab: database
- 3) Open the menu: License
- 4) Perform the following steps:



Please note the order in any case!

1. Enter the related password
2. Tag chosen language
3. Click to „dnl“ (behind the chosen language)

After step 3 Please wait until the download is complete!

4. Close the window

Lizenznehmer

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825 550 405

Schlüssel Vollversion

TAN:

DE ☒
GB ☒
FR ☒
ES ☐
PT-BR ☐
RU ☒ XXXOOOYYY
CZ ☐
PL ☐
TR ☐
ZH ☐
NL ☐

1. 2. 3. 4.

DEMO-Version ☐ Rechteck ☒ Rund ☒ RundRohre ☒ Rechteck Rohre ☒ Erdbebensicherheit ☒ Verst. Tr. ☒ Kostenanalyse ☒ Network ☒

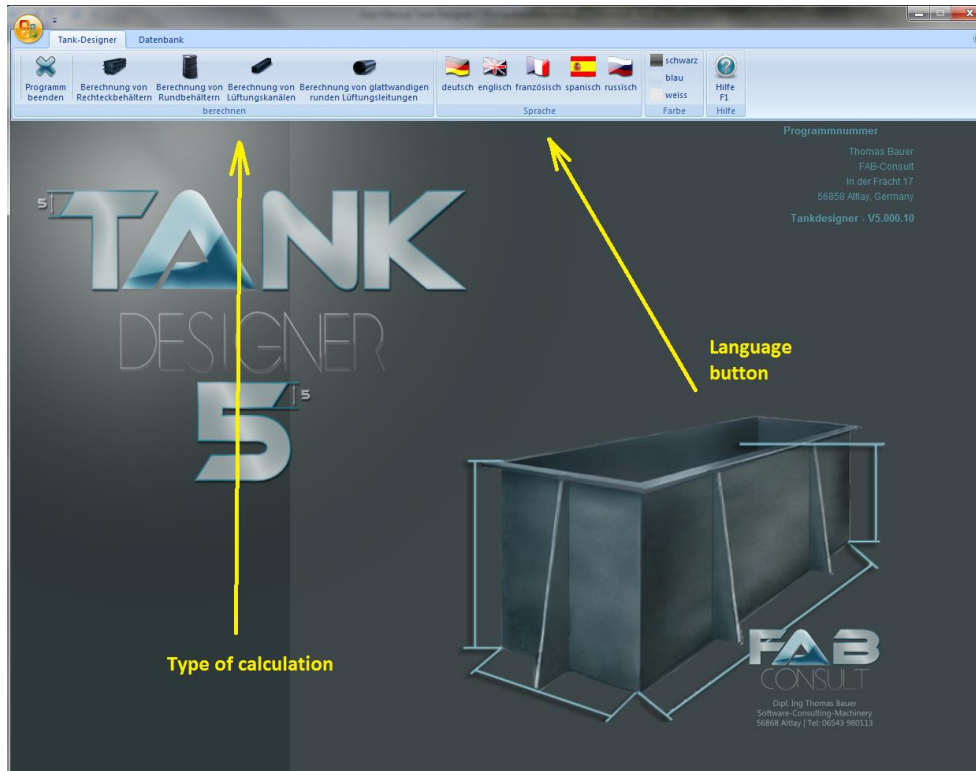
4. Tips and tricks for programme application

This Section provides the untrained tank designer with tips and tricks which will simplify the generation of a tank static.

You can find information on the use of the function keys in Section 3; Function key assignment. Information on general key assignment and use of the windows, switch **strips** and input fields can be found by clicking on the online tool (? F 1).

4.1 General

4.1.1 Launch window



You can change the language at any time. In order to get a data printout in another language, it is possible to enter the data in German (or another language) and change over to another language in this window before printing out the data. After printing, choose the original language again.

Under the **Help** tool, you will find explanations for several steps of the programmes. With the F1 key, you can call up the Help tools at any point in the programmes (**Is currently being revised**).

When calculating **rectangular tanks** / **circular tanks** / **round ventilation ducts** / **rectangular ventilation ducts**, you reach the actual calculation programme.

By calling up the folder **Database** you can access and modify the chemicals database. Here you can enter a media yourself or check which of your own media are already contained in the programme.

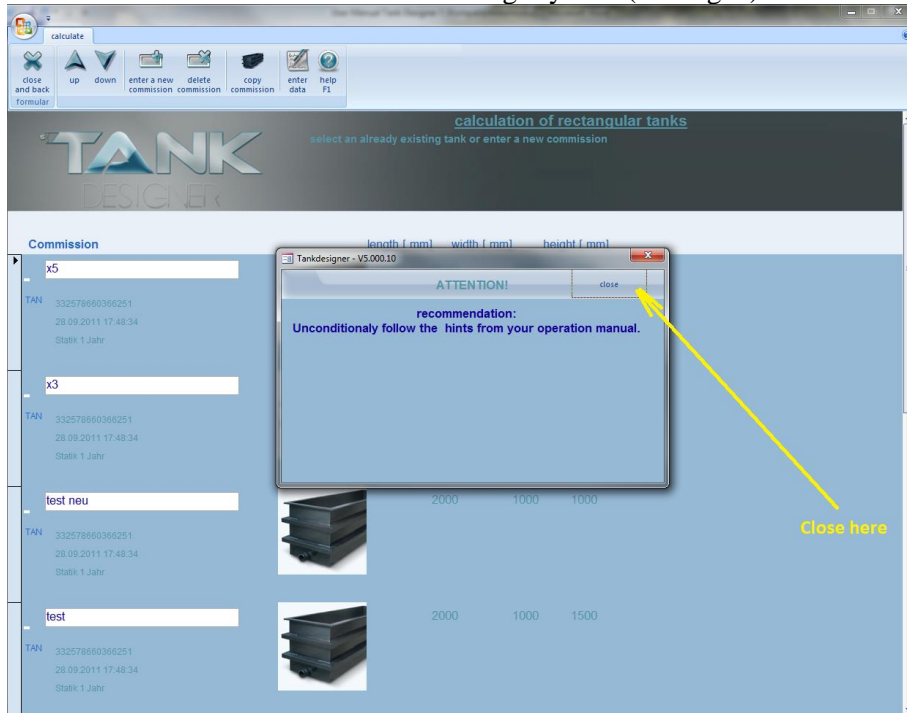
In the database, you can print out all beam shapes and sizes contained in the database with “**print steel table**”. **Process steel table** opens the steel table for you for further processing. You can enter here your own profile shapes with the corresponding beam sizes. It is also possible e.g. to generate a table with preferred profiles.

Help in starting display? It gives you several tips and tricks for programme use with each new start up of the programme. You can switch this help off permanently by clicking on it. This function is currently deactivated!

Close the programme with **end**.

4.1.2 Commission

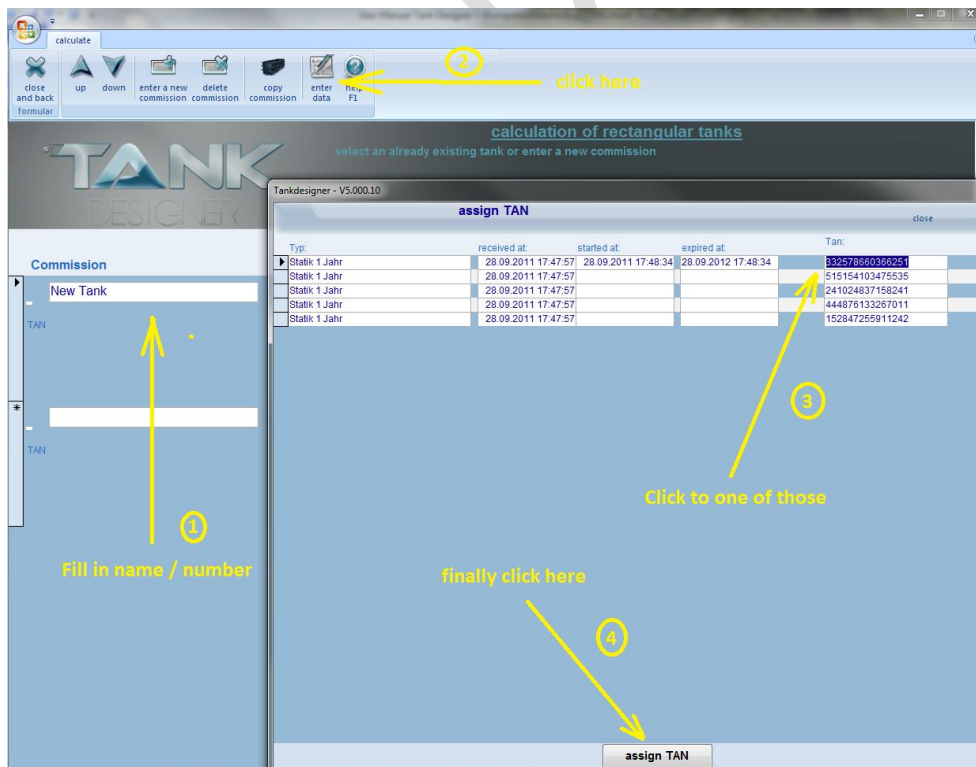
The window commission serves as a storage system (catalogue) for calculated tanks.



Initially you will be reminded to thoroughly read through and observe this manual. Acknowledge this with a click on “close”. The dialogue window then closes automatically.

Enter only the **commission name or number** or a combination in this commission window where you will find the tank again later. The dimensions of the tank (**length, width, height**) are automatically inserted by the programme. The corresponding commission name appears on the data printout as a footnote on each side. You can move to the next screen by clicking on the folder “Enter tank data”.

4.1.4 Confirm TAN



4.1.3 Material selection / reliability/ welding processes

In this window, you select the *material* from which the tank will be produced as well as the *reliability factor* and the *welding process* whereby you will attach the pre-products.

Material

marginal values

material ☐ Approved Material

PE 100	High Density (MRS 100)
PE 63	High Density (MRS 63)
PE 80	High Density (MRS 80)
PE-HD	High Density
PP Alpha Plus	PPH Simona, modifiziert
PP-B (Typ 2)	Block
PP-H (Typ 1)	homo
PP-R (Typ 3)	Random
PVC (U / NI)	normal impact
PVC-C	Chlorinated
PVC-HI	Raised impact
PVC-RI	Raised impact
PVDF-C	Copolymerisat
PVDF-H	

The following points should be taken into account in the pre-selection of the design material:

- Operating temperature
- Stiffness
- Impact resistance
- Thermal length changes
- Chemical resistivity
- UV exposure
- Desired welding process

Information on the above-listed points can be obtained from your pre-product manufacturer or supplier.

Caution! With the material PE- HD: Officially, this material has not been available since 01/2000. It was replaced with PE 63/ 80/ 100 which has other stability and strength characteristics. We have only left PE-HD in this list so that older tanks which were manufactured from PE-HD, could be retroactively recalculated. **Do not use this material for new projects!**

Note! For SIMONA PP-Alpha Plus: This material can only be obtained from SIMONA AG. This is a P-H with increased creep modulus (E_c). According to the details provided by SIMONA AG, this E_c lies around 140% in contrast to a standard PP-H. In this programme, the creep modulus is calculated on the safer side with 125% and according to DVS 2205-1 in contrast to the corresponding standard PP-H types. SIMONA AG alone bears the responsibility for this. All other values remain unchanged and identical with standardised PP-H according to DVS 2205-1 and the supplementary sheets!!

Authorised material yes/no: If the material used for construction of the tanks are semi-finished products produced using raw material with authorisation according to the material reference lists of DIBt Berlin, please mark this field by clicking on it! On basis of their proven properties, this material with authorisation provides the opportunity to apply the material partial safety factor $\gamma_M = 1.10$. For material without authorisation of DIBt, the value $\gamma_M = 1.25$ has to be used which might cause some difficulties in calculating certain parameters for component design (components are expected be thicker!). Although the material you are using has been authorised by DIBt, please reaffirm this from your semi-finished product supplier or manufacturer!

Global safety/ reliability

The reliability to be determined here refers to the useful life of the tank. The basis of the calculation according to DVS 2205 Part 1 is that the reliability coefficient given with the load case should still be available at the end of the useable life to be calculated.

The following reliability coefficients are provided:

I) Static load at room temperature and constant conditions. In case of damage, no hazard of people, property and environment is possible. $S = 1.3$

II) Load under changing conditions (for example, temperature, fill level). In the case of damage, risks to people, property and the environment are possible, for example, plans or plant parts subject to monitoring and inspection. $S = 2.0$

III) Open, non-DVS 2205 compliant safety factor. The value corresponds to a local requirement or standard of another directive (e.g. EN 12573) or has been defined by the program user. The liability for this value will be taken from the program user. $S \geq 1.0$

The designer has to decide in individual cases which classification applies to the component to be designed. If applicable, intermediate values may be appropriate. We only recommend load type I for tanks used to store water at room temperature. The programme manufacturer assumes no liability in the use of III.

Only for circular tanks (partial safety concept)

The following weighting coefficients are provided:

IV) Static load at room temperature and constant conditions. In case of damage, no risks for people, property and environment is possible. $\gamma = 1.0$

IV) Load under changing conditions (for example, temperature, fill level). In the case of damage, risks for people, property and the environment are possible, for example, plans or plant parts subject to monitoring and inspection. $\gamma = 1.2$

The following partial safety factors continue to apply for effect of:

Intrinsic weight, filling and assembly	$\gamma_{F1} = 1.35$
Pressure, wind load and snow load	$\gamma_{F2} = 1.50$
Tension lowering intrinsic weights	$\gamma_{F3} = 0.90$
Influence of earth quake	$\gamma_{F4} = 1.00$

The calculation of the stability during earthquakes is only possible with the two variants of the partial safety concept (IV + V)!

Welding processes

With the welding processes listed in the programme, the following materials contained in the programme can be processed according to DVS 2205 Part 1:

Heating element butt welding	(HS): PE-HD; PP-H; PP-B; PP-R, PVC-U, PVC-HI, PVDF	$f_s = 0.8$
Hot gas extrusion welding	(WE): PE-HD; PP-H; PP-B, PP-R, PVDF ($f_s = 0.5$)*	$f_s = 0.6$
Hot gas welding	(W): PE-HD; PP-H; PP-B; PP-R, PVC-U; PVC-HI; PVDF	$f_s = 0.4$
Unwelded	(N): PE-HD; PP-H; PP-B, PP-R,	$f_s = 1.0$

If you should verify, through the corresponding testing, that your welding seam qualities lie above the listed values of the DVS, you can thus change the corresponding welding factors in the right factor field by overwriting. The liability for such a static lies with the programme user. The programme manufacturer assumes no liability in the deviation of the characteristic values from the recommended benchmarks.

It is recommended that the welding process be entered with each calculation which is actually used in the tank construction and which shows the lowest welding factor.

4.1.4 Thermal load, useful life

input of thermal loading

lifetime in years

3

aver. temp. [cels. degr]

25

calculate

3

long term value (miner)

8,9

	temperature cels. degr	period in %	period in h	period in years	
▶	25	100	26280	3	delete
*	0	0	0	0	delete
sum		100			

Initially, the programme asks you to enter the desired *useful life in years*. The following listed, theoretical design time periods is available according to DVS directives. We recommend the use of the offered useful life for the following application areas:

- | | |
|--------------|--|
| - 0.25 years | Retention tanks (load case filling) |
| - 10 years | Process tanks and retention tanks for process tanks |
| - 25 years | Storage tanks, plants and plant parts subject to monitoring and inspections, retention tanks for storage tanks |

Retention tanks are always designed according to basic guidelines for the same period as the associated tank. Only the strength calculation (verification of rigidity) is done in cases of leakage (load case filling) over a period of 6 months (0.5 years). We recommend that you choose the same useable life for retention tanks as with the associated tank in the programme. The programme automatically calculates the verification of rigidity for a period of 3 months. The programme additionally offers calculations for the periods of 0.25; 0.5; 2; 3; etc. years which however do not meet the German directives and laws. The programme user must here decide himself if he should deviate from the legal provisions and laws of the Federal Republic of Germany with regard to the warranty and liability. The liability for the corresponding static lies with the programme user. The programme manufacturer does not assume any liability for deviations from the characteristic values of the recommended standard values.

Now enter the **operating temperature** or the operating temperatures and the **duration** (period) in % at which these temperatures occur. Please note that the total period must be exactly 100 %.

The programme determines your information on the useable life duration in hours (h). With several temperatures, the programme determines the mean operating temperature and the material strength according to the “Miner’s” rule (see too Section 0.1).

If you forget to input the life time duration, a warning appears which now pops up repeatedly. You can leave this routing by deleting the last two entries with the **“Esc” key (poss. press several times)!!!**

4.1.5 Fill medium

In this window, you determine the chemical load of the component to be calculated.

First, choose between the *internal or variable media catalogue* (Explanations on this in the following Section). By activating the >F4 key, you go to the corresponding catalogue. By entering the name or the first 3-4 letters of the medium needed and then pressing the Enter key, the programme searches for the desired chemical. If the medium needed is found, you must move the mouse to the corresponding medium to acknowledge the choice (Medium is a blue background). Close the screen page with <F11. You will find yourself back in the screen which contains the medium and the corresponding calculated characteristic values. Now begin the calculation of the tank by leaving this page with >F12. The programme automatically now begins the calculation of the desired component.

Internal media catalogue:

This media catalogue only contains media tested and published by official institutions (Deutsches Institut für Bautechnik [The German Institute for Building Technology] and Deutscher Verband für Schweißtechnik [the German Welding Society] and the corresponding factors of “chemical resistance”. Unfortunately, not all catalogued media has been tested in connection with each possible operating temperature and/or each offered material. Different factors could thus not be given. In these cases, we refer to the *variable media catalogue*.

The data contained in the *internal media catalogue* cannot be changed by the user!

Columns A_{2k} and A_{2l} contain the corresponding factors of chemical resistance. Here with a plastic, the influence of the chemical can increase with rising application temperature. That is why the values are assigned to the corresponding temperatures.

Depending on the resolution of your screen, there can be some shifting of the number runs. If a number arrangement is not clear, observe the following colour assignments:

Green: PE- HD, PE 63, PE 80 PE 100	20, 40, 60, 80°C
Blue: PP- H, PP- B, PP- R	20, 40, 60, 80, 95°C
Purple: PVC- U	20, 40, 60°C
Red: PVDF	20, 40, 60, 80, 100, 120°C

In the data printout (Page 2 of the static), you can find the following lines:

Fill medium

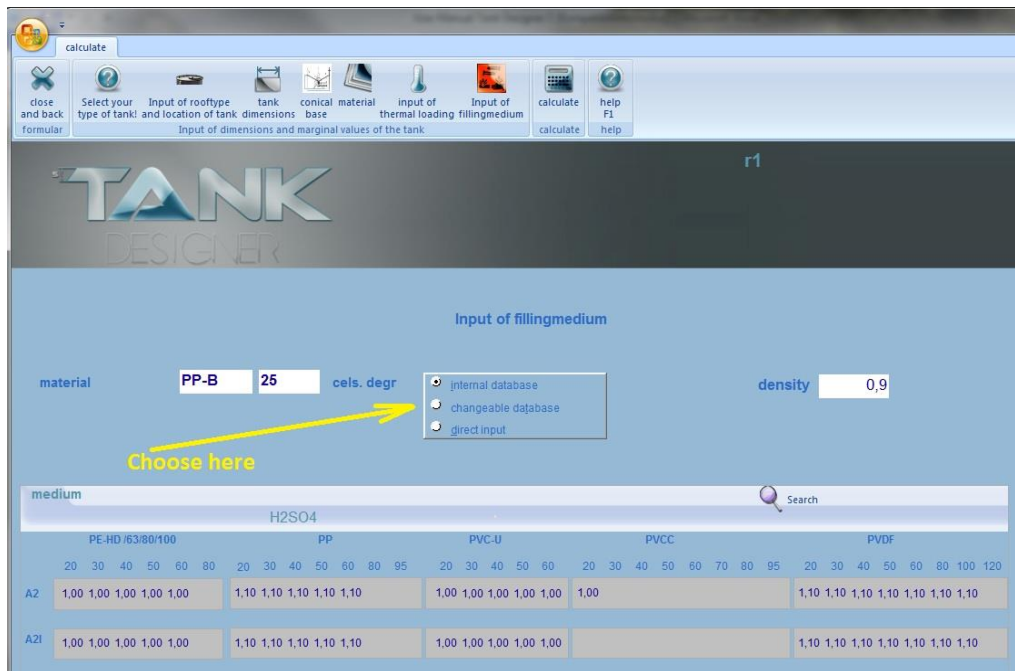
Medium	Formula	Concentration	Comments
e.g. Nitric acid	HNO₃	<= 55 %	G5

- The column Medium contains the trivial name of the mediums.
- The column Formula represents the chemical formula of the medium.
- The column 3 contains the respective max. allowable concentration of the medium.

It means:	%	=	volume percent
	GL	=	gesättigte Lösung [saturated solution]
	VL	=	verdünnte Lösung ≤ 10% [diluted solution]
	TR	=	technisch rein [technically pure]
	H	=	handelsüblich [commercially available]
	S	=	suspension
	Fg	=	Feststoffgehalt [solid content]

- Column Comments contains warnings which should be implicitly observed:

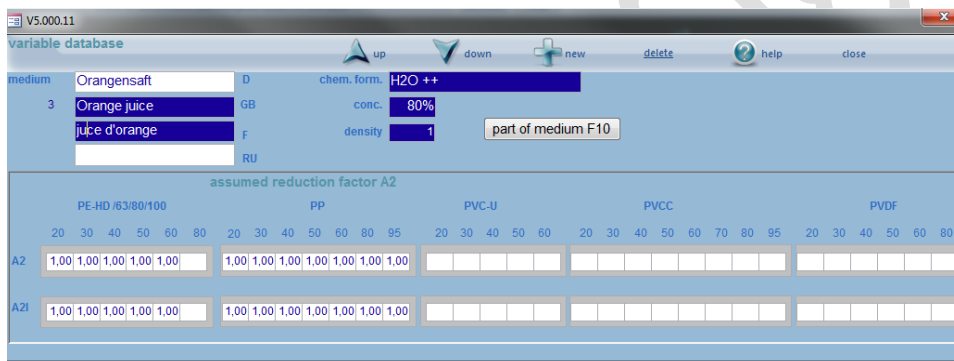
WP	=	wiederkehrende Prüfung nach Zulassungsbescheid des DIBt [Repeated inspection after note of authorisation by the DIBt]
G5	=	Gebrauchsdauer ist auf 5 Jahre begrenzt [The service life is limited to 5 years]
G10	=	Gebrauchsdauer ist auf 10 Jahre begrenzt [The service life is limited to 10 years]



Variable media catalogue:

With the first installation of the programme, this catalogue does not hold any data.

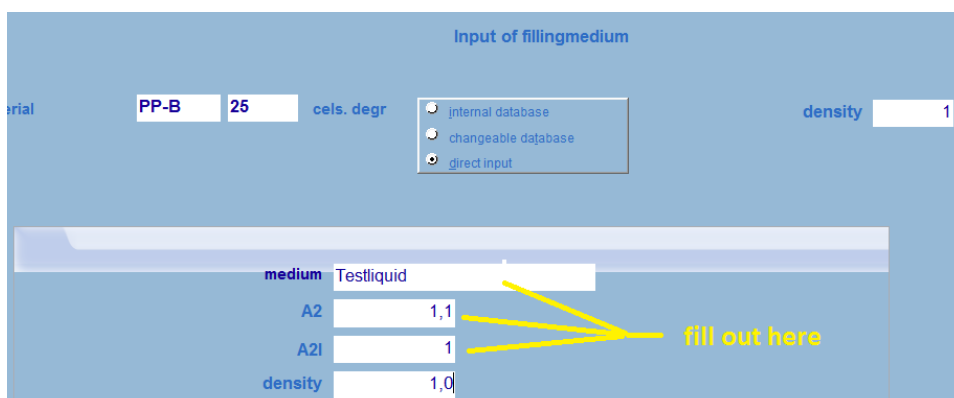
The *variable media catalogue* provides the programme user the option of saving all media, **including mixtures**, not contained in the *internal media catalogue* (see following figure). Column A_{2k} contains the values which represent the effect of the chemicals on the solidity of plastic. Column A_{2I} refers to the stability of the material.



Generally, the values are identical in both cases. Significant differences only occur with solvents. You can get the factor “chemical resistance” by estimating in comparison to already known media, by enquiring at your pre-product supplier or from the corresponding expert and engineering office.

Direct input:

With this variation, the input values are not saved in any retrieval database. They only remain in memory for this calculation and are thus not retrievable for other calculations (commissions). See figure on the next page!



4.2 Rectangular tanks

Observe the following when constructing rectangular tanks with reinforcement profiles:

All connections of steel profiles must be produced in an absolute flexurally rigid manner because the based calculation theories do not apply and larger deflections result on the product than calculated.

Make sure in the detailed design therefore that all welds will be designed accordingly and connections are so braced with bulkhead and gusset plates that the stability and rigidity of the connection equals its profile and even the bending of single pipe walls or bars are prevented at the connection points. This rule also is valid for aluminium system profiles!

4.2.1 Tank construction design

In this window, you choose the later construction shape of the type of the reinforcement system. You already decide here whether you can influence the wall thickness (*C*), (*D*), (*E*)) or not (*A*), (*B*)). Typical tank construction shapes are:

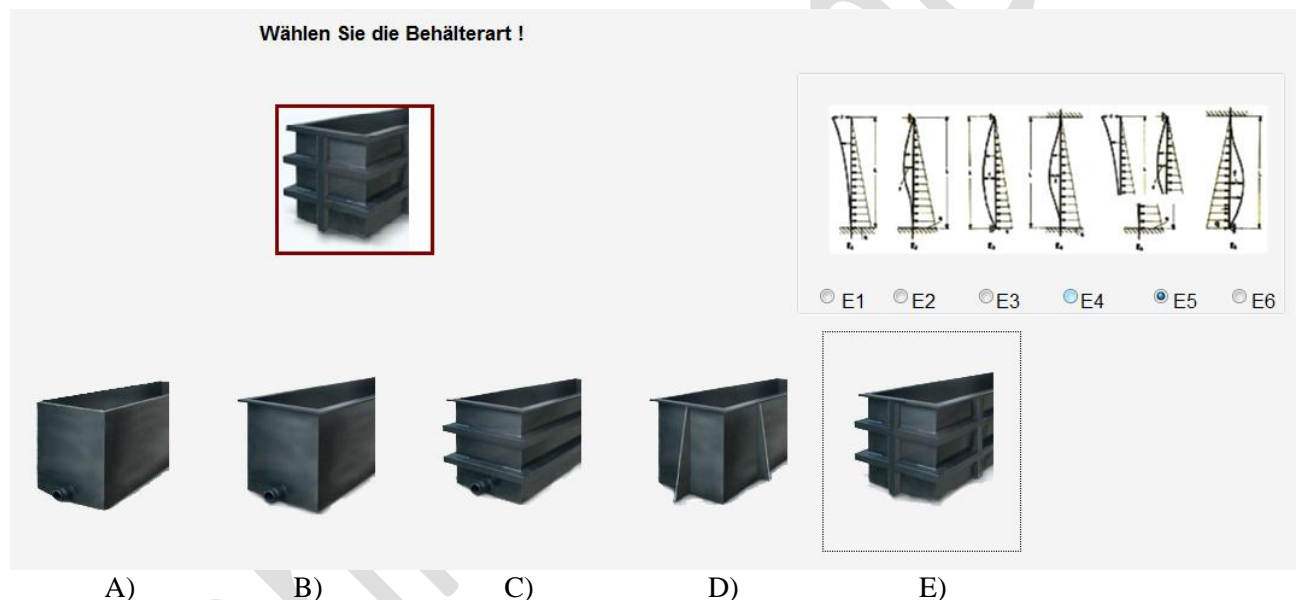
A) Tanks without reinforcement

B) Tanks with reinforced edges

C) Tanks with circular reinforcement

D) Tanks with yoke reinforcement

E) Tanks with cross ribbing and/or tie rods, choose out of 6 different variations (only with module Z 11.)



Based on long years of experience in tank calculation, we recommend the following pre-selection criteria:

Tanks up to a length of approx. 500 mm :

Type A

Tanks up to a length of approx. 1000 mm and a height of approx. 500mm:

Type B

Tanks up to a length of approx. 2500 mm and a height of approx. 2000mm:

Type C

Tanks from a length of approx. 2500 mm with max. height of approx. 1000 mm:

Type D

Tanks up to a length of approx. 4000 mm from a height of approx. 1000 mm:

Type E

This recommendation applies as a rough pre-selection. If wall thicknesses result with certain tank dimensions which do not agree with your expectations, please simply choose the next highest construction type and let the programme recalculate.

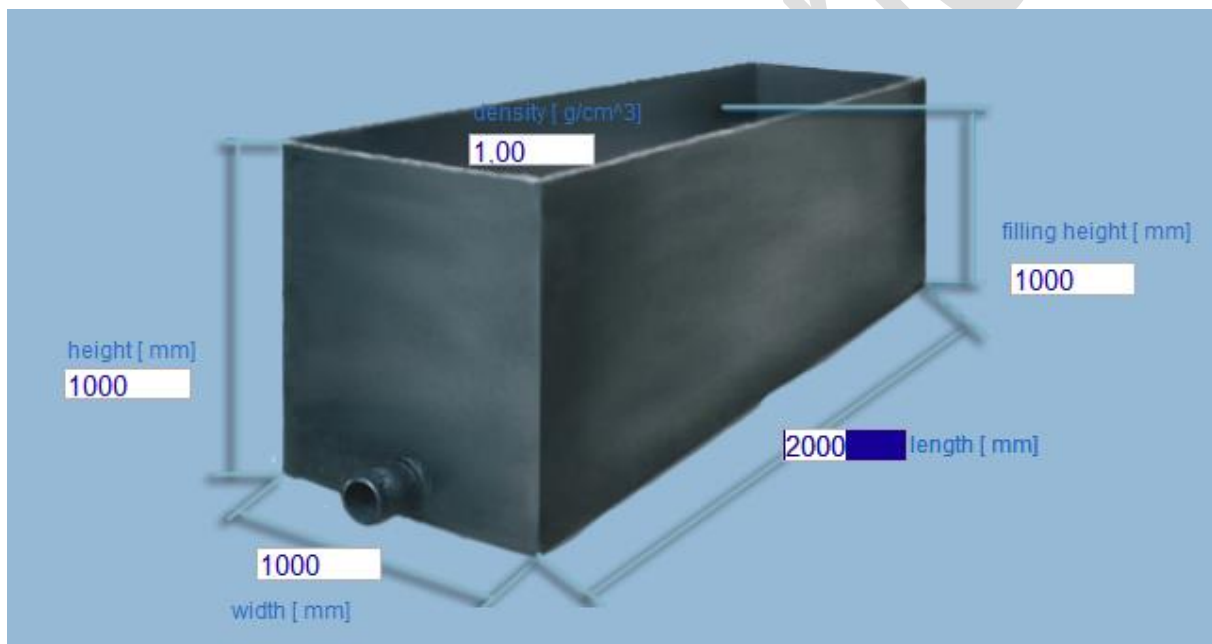
4.2.2 Tank dimensions and marginal values

For rectangular tanks of type B), C), D) and E) Tank Designer module Z 1.1 is offering you the possibility choose the stiffener material out of 5 different metalls (in the TD basic version only the material standard carbon steel St 37-2). For tie rods or tie profiles Tank Designer is offering additionally 3 different types of screws (in the basic version only type 4.6).

N°	Trivial	EU/ ISO	Alloy	ASTM/AISI	UNS	Type /Form
100	M12 – M64	DIN 267-3	4.6	ISO 898-1		Screw
101	M12 – M64	DIN 267-3	8.8	ISO 898-1		Screw
102	M12 – M64	DIN 267-3	12.9	ISO 898-1		Screw e
103	ST 37-2	1.0037	S235JR+AR	A283 C		Profile / Rod
104	ST 52-3N	1.0570	S355J2+N	A572 50		Profile / Rod
105	V2A	1.4301	X5 CrNi 18-10	304	S 30400	Profile / Rod
106	V4A	1.4401	X5 CrNiMo 17-12-2	316	S 31600	Profile / Rod
107	Aluminum	3.3206.1(2)	AlMgSi 0,5 F25			Profile / Rod

In this field, you determine the tank dimensions. When inputting, please observe the following information:

A) Tanks without reinforcement



Enter the *length*, *width*, *height* and *fill level* of the tank and the *density* of the medium to be stored here.

B) Tanks with reinforced edges

Input of dimensions and marginal values of the tank

shape of stiffener sq. and rect. tubing

allowable deflection [%] 1

carrier height[mm] 40

density [g/cm³] 1.00

filling height [mm] 1000

height [mm] 1000

length [mm] 2000

width [mm] 1000

Enter the **length**, **width**, **height** and **fill level** of the tank and the **density** of the medium to be stored here. Choose the **shape of the reinforcement profile** which is to be used as a reinforced edge. You have here the choice of: U, L, IPE, IPB middle-beam, IPB L, flat bar and rectangular **hollow profile**. For reasons of stability and cost, we recommend rectangular **hollow profile** because these show high stiffness at low weight. After choosing the reinforcement profiles, you determine the **beam height** (flange width), i.e. the wall contact surface (load-bearing surface) of the profile. Please observe, with the pre-dimensioning that the steel profile is attached to the upper tank wall as a rule using protective profiles of plastic. These plastic protective profiles also serve as corrosion protection. The programme automatically inserts the determination of the reinforcement profile height and thickness in the “Calculate” window.

C) Tanks with circular reinforcements

Input of dimensions and marginal values of the tank

shape of stiffener sq. and rect. tubing

allowable deflection [%] 1

carrier height[mm] 40

density [g/cm³] 1.00

filling height [mm] 1000

no. of fields 2

desired wallthickn. 0

height [mm] 1000

length [mm] 2000

width [mm] 1000

Enter the **length**, **width**, **height** and **fill level** of the tank and the **density** of the medium to be stored here. Choose the **shape of the reinforcement profile** which is to be used as circular reinforcement and reinforced

edges. You have here the choice of: *U, L, IPE, IPB middle-beam, IPB L, flat bar* and rectangular ***hollow profile***. For reasons of stability and cost, we recommend rectangular ***hollow profile*** because these show high stiffness at low weight. After choosing the reinforcement profiles, you determine the ***beam height*** (flange width), i.e. the wall contact surface (load-bearing surface) of the profile. Please observe, with the pre-dimensioning that the steel profile is attached to the upper tank wall as a rule using protective profiles of plastic. These plastic protective profiles also serve as corrosion protection. The programme automatically inserts the determination of the reinforcement profile height and thickness in the “Calculate” window.

Effect of the wall thickness:

With this tank construction design, you have the possibility to influence the wall thickness. Two methods of computation are available for this:

Calculation of a target wall thickness:

Enter the desired wall thickness in the field ***target wall thickness***. In the field ***number of fields***, please enter the number “2”. The programme will determine the required reinforcement number mathematically which is needed to reach this wall thickness. The programme shows consecutively the number of reinforcements with “Calculate”.

Calculation of the wall thickness with the specified number of fields:

Enter the in the field ***number of fields***, the desired number of the reinforcements (incl. reinforced edges). In the field ***target wall thickness***, keep the number “0” or delete it. The programme will determine the required reinforcement number mathematically which is needed to reach this wall thickness. The programme shows consecutively the number of reinforcements with “Calculate”.

In both cases, the wall thickness is optimised by the shifting of the beam positions. This can lead to the desired wall thickness being overshoot in the calculation for ***target wall thickness***.

D) Tanks with yoke reinforcement

The vertical reinforcement beam is calculated as a device between firmly clamped and suspended rod with one-sided firm clamping according to EN 12573-3. This means that the vertical beams too must be fixed to the lower fixing point (e.g. welded design). It should be so sized that its theoretical deflection does not exceed the upper end of 1% of the tank height. Because practical experience has shown that the calculation according to this directive does not meet the given value for the deflection in every case, the following reliability which exceeds the directive is included in the calculation until the submission of new knowledge or directives: The permitted theoretical deflection is limited to 0.5% of the upper field height. Finite element calculations have shown that due to this, in the total system, an actual deflection of approx.1% is set. The now calculated values for area moment of inertia and resistance moment are multiplied with an additional reliability of $S = 1.5$. In this way, the area moment of inertia is higher by a factor 3-times as well as a resistance moment with 3-times higher reliability ($S = 2 \cdot 1.5 = 3$) as opposed to EN 12573-3!!! This calculation method was checked by an independent expert using finite element calculations. In doing this, it was determined that the requirements in EN 12573-3 with regard to the max. deflection is met here.

Before the construction of the tank, you should check in any event if the correction of the calculation according to EN 12573-3 mentioned before is recognised by your customer or the experts involved in your case.

The number of the vertical reinforcements in cross-ribbed tanks equals the number of the required tie rods.

With this type of construction, a minimum of 2 vertical reinforcements are necessary. The distance of the vertical ribs to the tank edge must be a maximum of $\frac{1}{2}$ of the panel width.

Input of dimensions and marginal values of the tank

shape of stiffener:

density [g/cm³]:

height [mm]:

width [mm]:

length [mm]:

filling height [mm]:

carrier height [mm]:

carrier height vert [mm]:

side width [mm]:

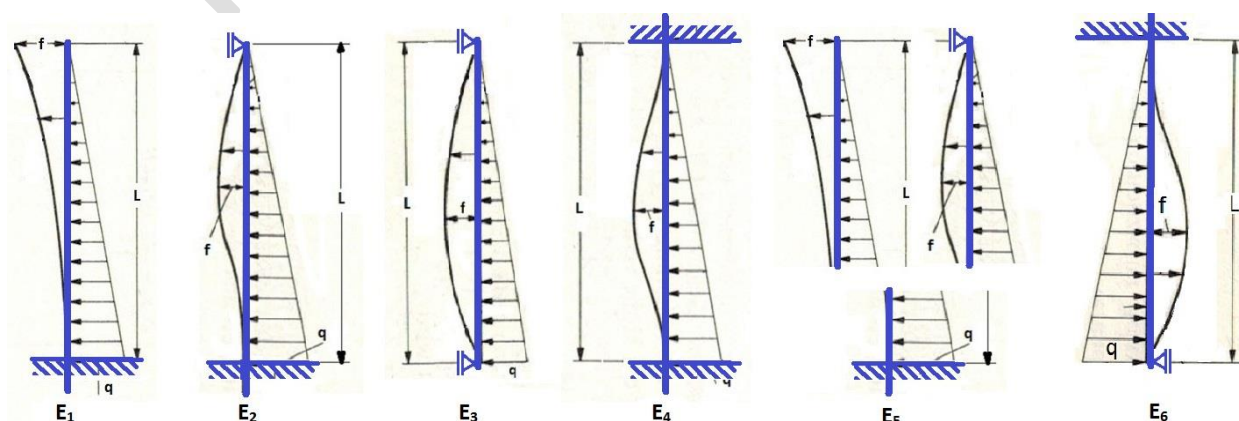
Enter the **length**, **width**, **height** and **fill level** of the tank and the **density** of the medium to be stored here. Choose the **shape of the reinforcement profile** which is to be used for the vertical as well as the reinforced edges. You have here the choice of: U, L, IPE, IPB middle-beam, IPB L, flat bar and rectangular ***hollow profile***. For reasons of stability and cost, we recommend rectangular ***hollow profile*** because these show high stiffness at low weight. After choosing the reinforcement profiles, you determine the **beam height** (flange width), i.e. the wall contact surface (load-bearing surface) of the profile. Please observe, with the pre-dimensioning that the steel profile is attached to the upper tank wall as a rule using protective profiles of plastic. These plastic protective profiles also serve as corrosion protection. The programme automatically inserts the determination of the reinforcement profile height and thickness in the “Calculate” window. The programme then asks you to input the distance of the vertical beams in the field **Panel width**. Through this distance, you affect the panel size. We recommend you enter the number “750” into the input field at your first attempt.

Effect of the wall thickness:

With this tank construction design, you have the possibility to influence the wall thickness. By changing the **panel width** i.e. the distance of the vertical reinforcements, the wall thickness and possibly the dimension of the required beam too are changed in the new calculation.

E) Tanks with cross ribbing and/or tie rods/-pipes/- profiles, main beam = vertical stiffener

This additional module (Z1.1), allows you to choose out of 6 different variations to fix the vertical stiffener (in the TD basic version only the until now known variation E₁ + E₅ (former type 5 + 6)):



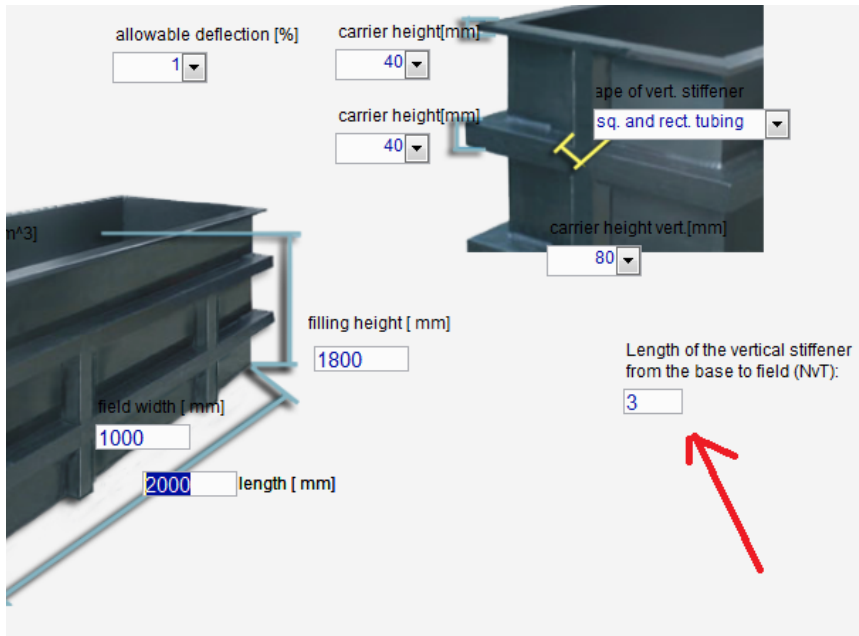
To choose the new mixed design:

This calculation is the content of module Z 1.1! To calculate the new mix design, you choose:

Design: Type E = with cross ribbing

Mounting: E1) = free-standing cantilever (attached below rigidly, top free)

After the selection of container design, TYPE E and E1), you can see a new input field at the free corner of the images to the right. You should enter the number of the field up to which you want to have a vertical support. Please do not enter the actual length! For example, "2", not 1200! Then the Tank Designer can optimise and calculate the length!



The variations E₁ – E₆ do have following meaning (technical basics):

E₁: single standing vertical stiffener, fixed solid at lower end (cantilever arm; **former type F**)

E₂: vertical stiffener, fixed solid at lower end kept in position on top (e.g. by tie rod/ -beam/ -pipe)

E₃: vertical stiffener, kept in position on lower end and top (e.g. by tie rod/ -beam/ -pipe)

E₄: vertical stiffener, fixed solid at lower end and top (e.g. fixed (anchored to ceiling and base))

E₅: Combination of ½(E₁ + E₂): vertical stiffener, fixed solid at lower end kept in position on top by

Horizontal rim stiffener; **former type E**)

E₆: vertical stiffener, fixed solid at upper end kept in position on lower end (e.g. by tie rod/ -beam/ -pipe)

Before the construction of the tank, you should check in any event if the correction of the calculation according to EN 12573-3 mentioned before is recognised by your customer or the experts involved in your case.

The number of the vertical reinforcements in cross-ribbed tanks equals the number of the required tie rods.

With this type of construction, a minimum of 2 vertical reinforcements are necessary. The distance of the vertical ribs to the tank edge must be a maximum of ½ of the panel width.

Enter the **length**, **width**, **height** and **fill level** of the tank and the **density** of the medium to be stored here. Choose the **shape of the reinforcement profile** which is to be used for the vertical and reinforced edges. You have here the choice of: *U*, *L*, *IPE*, *IPB middle-beam*, *IPB L*, *flat bar* and rectangular ***hollow profile***. For reasons of stability and cost, we recommend rectangular ***hollow profile*** because these show high stiffness at low weight. After choosing the reinforcement profiles, you determine the **beam height** (flange width), i.e. the wall contact surface (load-bearing surface) of the profile. Please observe, with the pre-dimensioning that the steel profile is attached to the upper tank wall as a rule using protective profiles of plastic. These plastic protective profiles also serve as corrosion protection. The programme automatically inserts the determination of the reinforcement profile height and thickness in the “Calculate” window.

Input of dimensions and marginal values of the tank

stiffener material ST 37-2
 shape of stiffener sq. and rect. tubing

allowable deflection [%] 1

carrier height [mm] 30

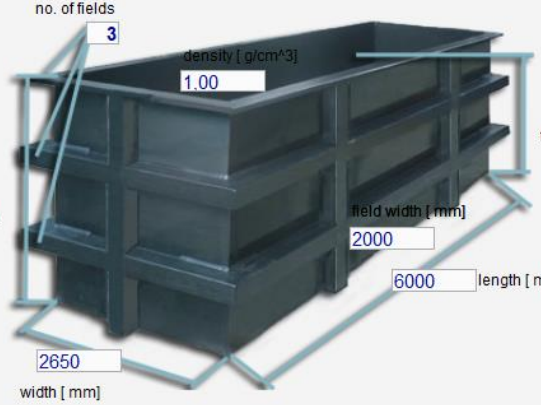
carrier height [mm] 60

age of vert. stiffener sq. and rect. tubing

carrier height vert. [mm] 60

filling height [mm] 1000

material of rod M12 – M64 - 4.6



The programme then asks you to input the distance of the vertical beams in the field **Panel width**. Through this distance, you affect the panel size. We recommend you enter the number “2000” into the input field at your first attempt (see Effect of the reinforcement beam dimensions).

Effect of the tank wall thickness:

With this tank construction design, you have the possibility to influence the wall thickness. Two methods of computation are available for this:

Calculation of a target wall thickness:

Enter the desired wall thickness in the field **target wall thickness**. In the field **number of fields**, please enter the number “2”. The programme will determine the required reinforcement number mathematically which is needed to reach this wall thickness. The programme shows consecutively the number of reinforcements with “Calculate”.

Calculation of the wall thickness with the specified number of fields:

Enter the in the field **number of fields**, the desired number of the reinforcements (incl. reinforced edges). In the field **target wall thickness**, keep the number “0” or delete it. The programme will determine the required reinforcement number mathematically which is needed to reach this wall thickness. The programme shows consecutively the number of reinforcements with “Calculate”.

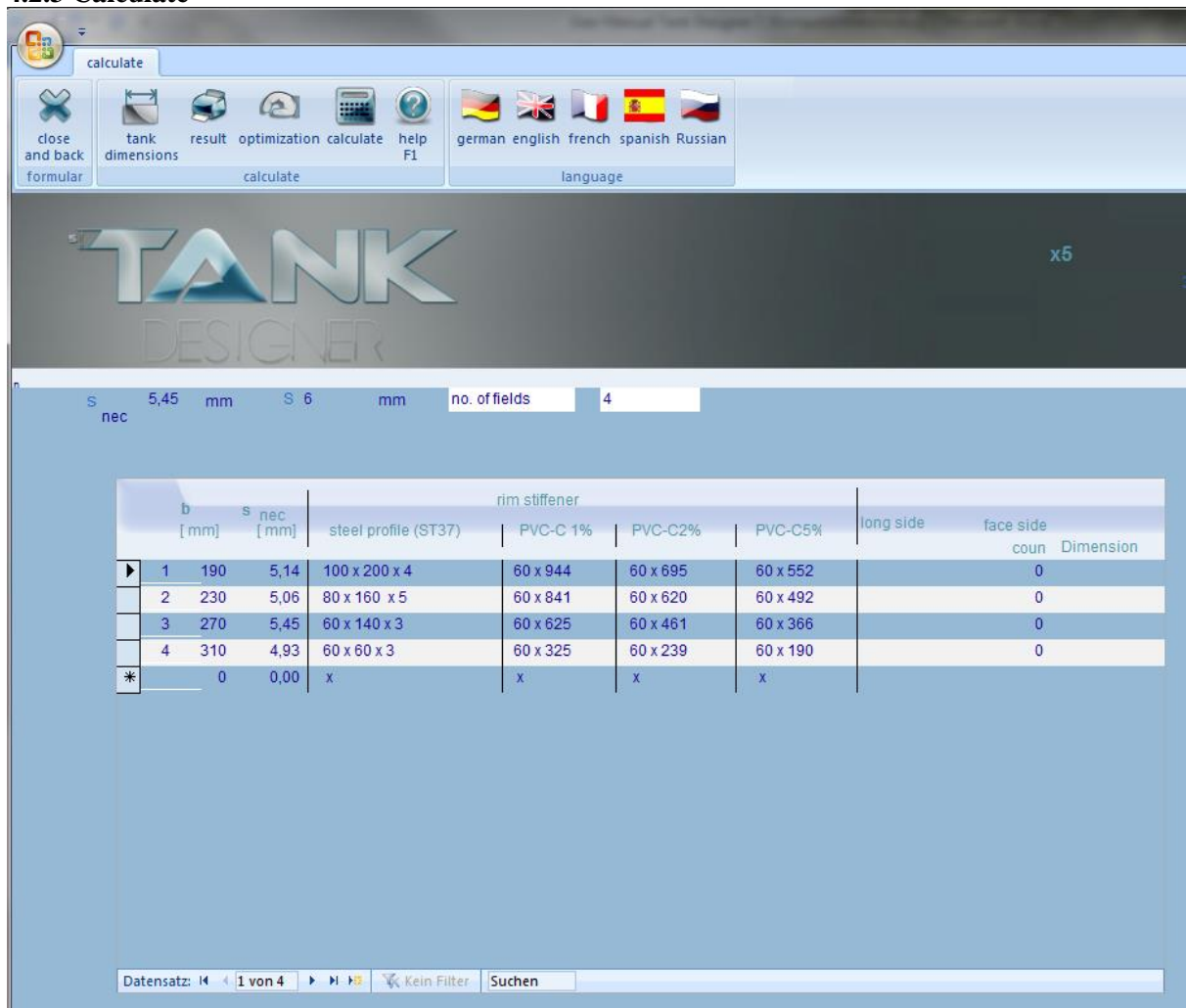
In both cases, the wall thickness is optimised by the shifting of the beam positions. This can lead to the desired wall thickness being overshoot in the calculation for *target wall thickness*.

Effect of the reinforcement beam dimensions:

With this tank construction design, you have the possibility to influence the beam size of the horizontal reinforcements.

By changing the **field width** i.e. the distance of the vertical reinforcements, the required area moment of inertia and the required resistance moment could result in other values in the calculation. By this change, the programme will also change the dimension of the horizontal beams.

4.2.3 Calculate



When the programme reaches the “Calculate” window, the software automatically begins to use the input data in the corresponding formulas and thus generate a static.

During the computation, you can observe the change in the wall thickness and the number of fields (number of the reinforcements) in the tank construction design C) and E) in the upper window area. This change in the value is based on an optimisation programme which varies the beam positions and thus minimises the wall thickness.


After the computational process, the programme shows you the values in a table:

- Panel height (Position of beam) from the bottom to the top
- max. required wall thickness (determined from three calculation methods)
- recommended steel reinforcement

Alternative:

- recommended all-plastic reinforcement (deflection 1% acc. to DVS, 2% and 5% not conforming to standard)
- recommended tie rods (dimensions and screw material, e.g. M 12 4.6)

If a reinforcement beam is located in a position on the tank where another attachment parts are to be

attached, you have to **enter the beam position by hand**. Acknowledge here the function key . By shifting the beam height 25s, the required wall thickness is changed. An optimisation is not possible with this manual shifting. If you leave the “Calculate” window again to change the input, the programme will later automatically begin to optimise again. The previously implemented “manual shifting” of the beam position, is thus erased and must, if applicable, be carried out again.

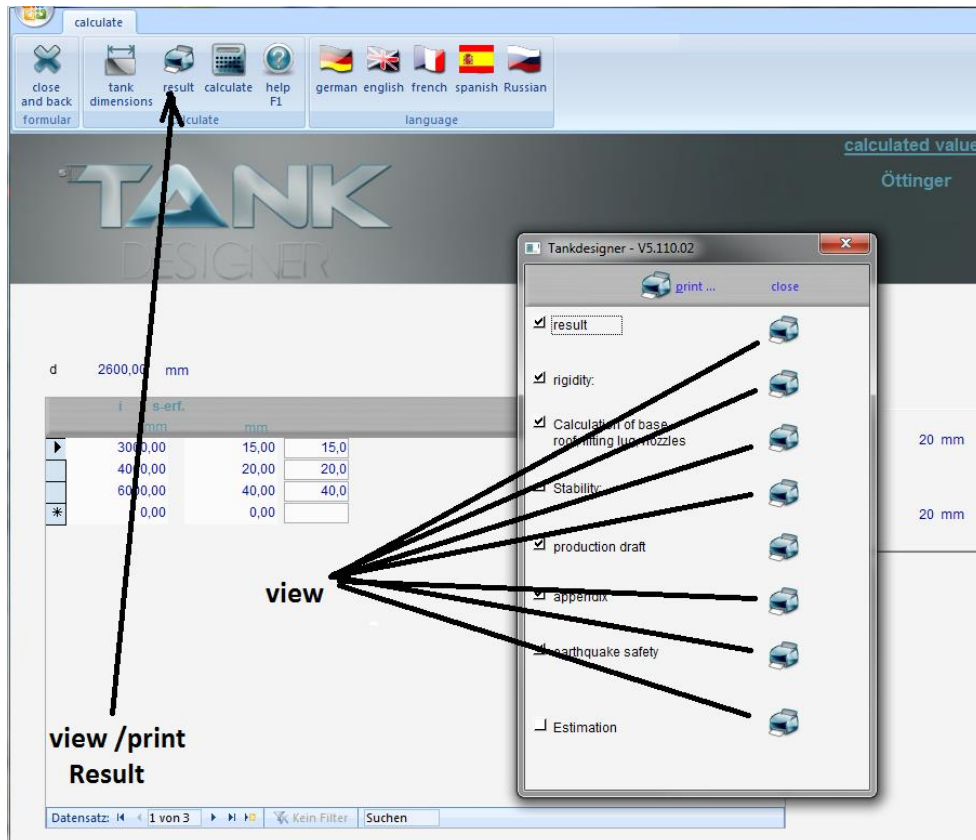
If the calculated tank does not meet your expectations, you can subsequently influence the tank static by changing individual input.

For example, if the calculated wall thickness is too high, go to the window “Tank dimensions and marginal values” by pressing the function key F2 and increase the **number of fields**.

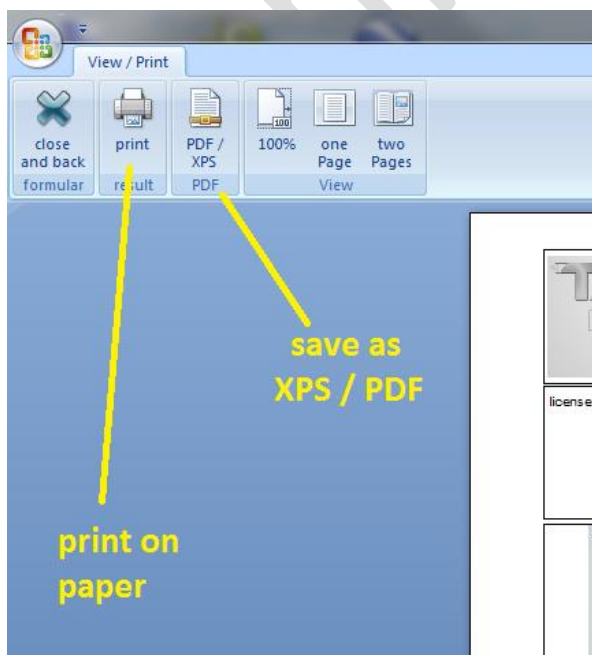
Also, if e.g. the recommended reinforcement beams are too large or heavy, go to the window “Tank dimensions and marginal values” by pressing the function key F2 and reduce the **Panel width** here.

It is also possible to change the tank construction design. To do this, press the function keys F9 or F10 to go to the window “Tank construction design” and choose another type of construction design (usually the next highest). If by changing the construction design, more inputs are required, the programme will take you automatically to the corresponding window.

4.2.4 Print calculation reports



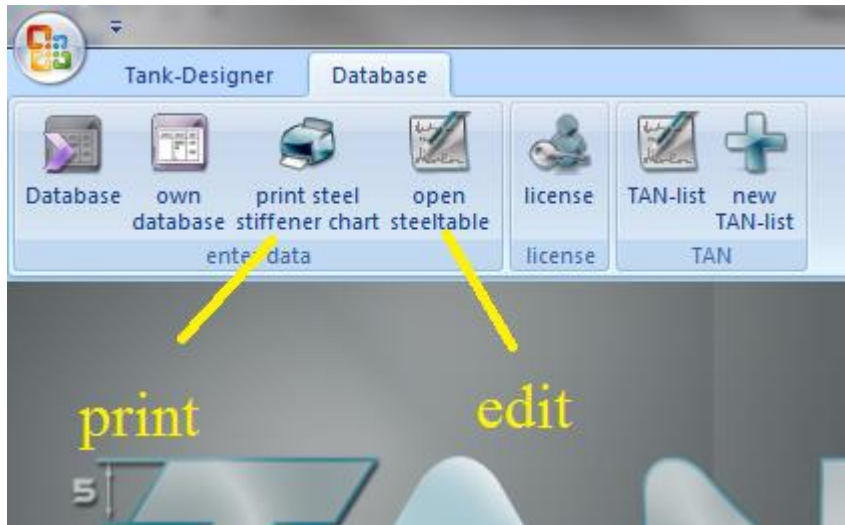
You also have the option of opening a menu with the function key “Print” in which the reports are listed in the very detailed points **Result, Verification of rigidity, Calculation of base, roof, lifting lugs, braces, Stability verification, Production draft, Appendix and Estimation**. It is here possible to output the statics in detail with the complete calculation method on the screen (printer right next to the corresponding point). A new window will open when viewing the documents.



With the function key “Printer”, all selected parts are printed out On the chosen printer. Alternativ save the reports as PDF or XPS file!

4.2.5 Edit table of stiffener profiles

We deliver you Tank Designer 5 inclusive a database for metallic stiffener profiles. The content of this database you may print or edit.



This table includes profiles sorted according to:

- Material
- Type of profile (shape)
- Sizes in mm

carrier height	width	shape of stiffener	theoretical Wx	given Wx	theoretical Ix	103	104	105	106	107
20	x	20	0	0,72	0,0	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
20	x	40	0	2,57	0,0	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
20	x	60	0	5,36	0,0	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
20	x	80	0	9,02	0,0	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
30	x	30	0	1,94	0,0	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
30	x	30	0	2,77	0,0	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
30	x	60	21,22	7,07	0,0	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
30	x	60	29,3	7,77	0,0	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
30	x	120	152,65	25,44	0,0	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
30	x	120	210,94	35,16	0,0	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
40	x	20	1,41	1,41	0,0	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
40	x	40	9	4,5	0,0	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
40	x	40	13,96	6,89	0,0	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

profile dimension in mm

type of profile

profile available in this materials

from chart / theoretically
geometrical moment of inertia cm^4

from chart / theoretically
resistance moment cm^3

Certainly we offer you the possibility, to add new profiles into the database or to delete non accessible with button „delete F9“. To add profiles following steps:

- Please chose type of profile (**System -Profil** = AL extrudet, e.g. ITEM or Bosch)
- Please add the profile dimension into the related fields
- The programm will calculate the theoretical moments (not with system profile)
- Please add the calculated values into the field $I_{X \text{ given}}$ oder $W_{X \text{ given}}$
- Alternative add the values from chart given by the profile supplier (most times 1-2% higher)
- Please tag only those material you are really able the purchase the profile

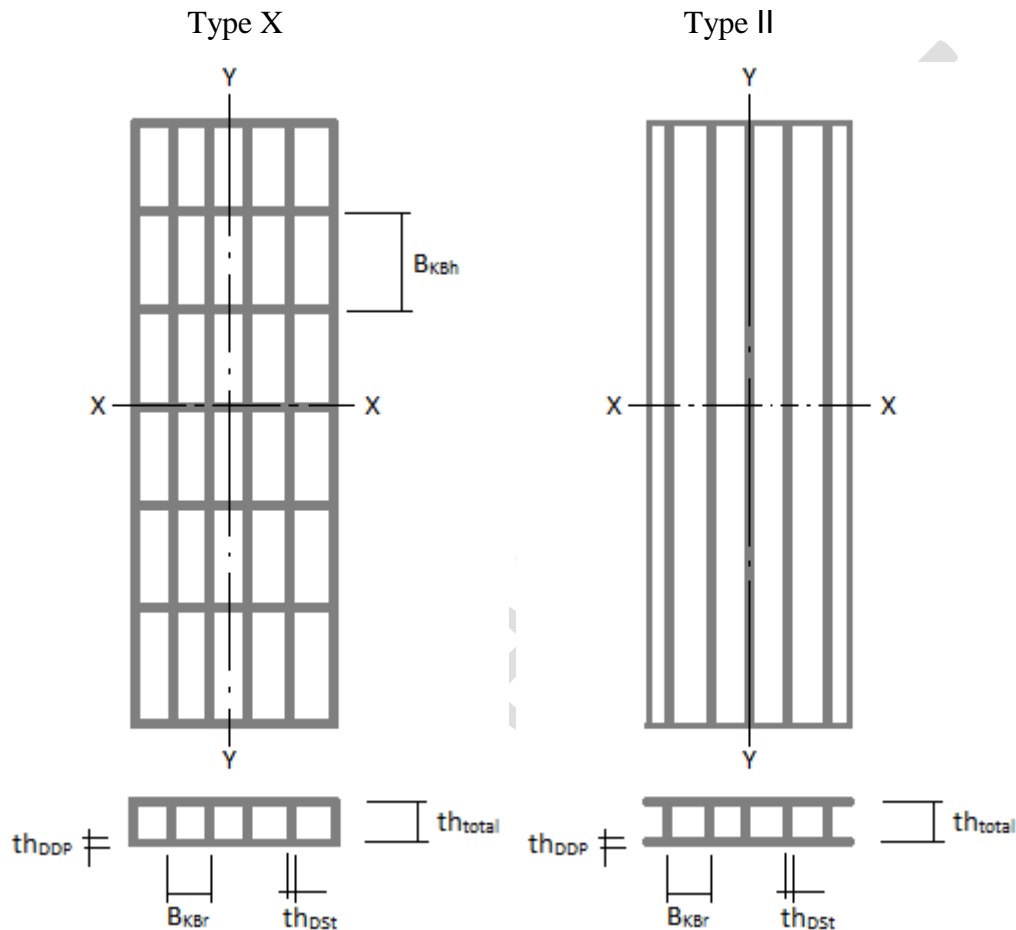
Leave the data base by clicking onto „close“. The changes will be automatically stored!

4.2.6 Tanks made of hollow core panels (twin sheet)

Preparations for program users:

- 1) Please enter the hollow core boards that you use for construction in the HKP database. The technical data relating to the boards is collected and stored here. Information on the thickness of sheets and cover boards and chamber dimensions is available from the manufacturer.

Following types are possible to use:

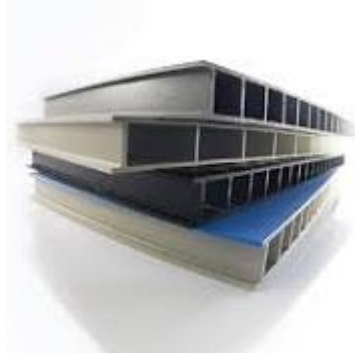
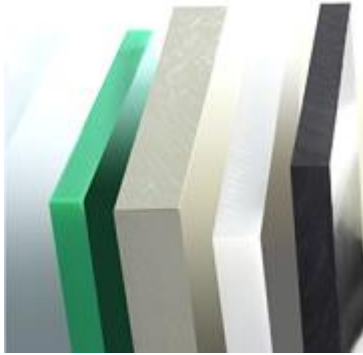


- 2) If you have purchased the right to use the cost analysis module, please enter the cost analysis it in database under "HKP" and also include business data. Data such as the manufacturer, part number and prices are collected and stored here.

Tank Designer module Z7 is now fully operational!

This optional extension for rectangular tanks allows an alternative construction compared to more conventional tanks made from solid panels with steel reinforcement.

In the design window, you can choose from a selection of semi-finished products:



Simply click on the desired type (image) of the semi-finished product!

If you select solid (compact) semi-finished products remain you have five basic designs to choose from. If you select twin wall panels, types C), D), E) will disappear (momentarily). You can choose from:

A) pure thermoplastic tanks, open top, no lid

B) tanks with steel or plastic edge reinforcement. The edge reinforcement can be replaced by an appropriate cover plate.

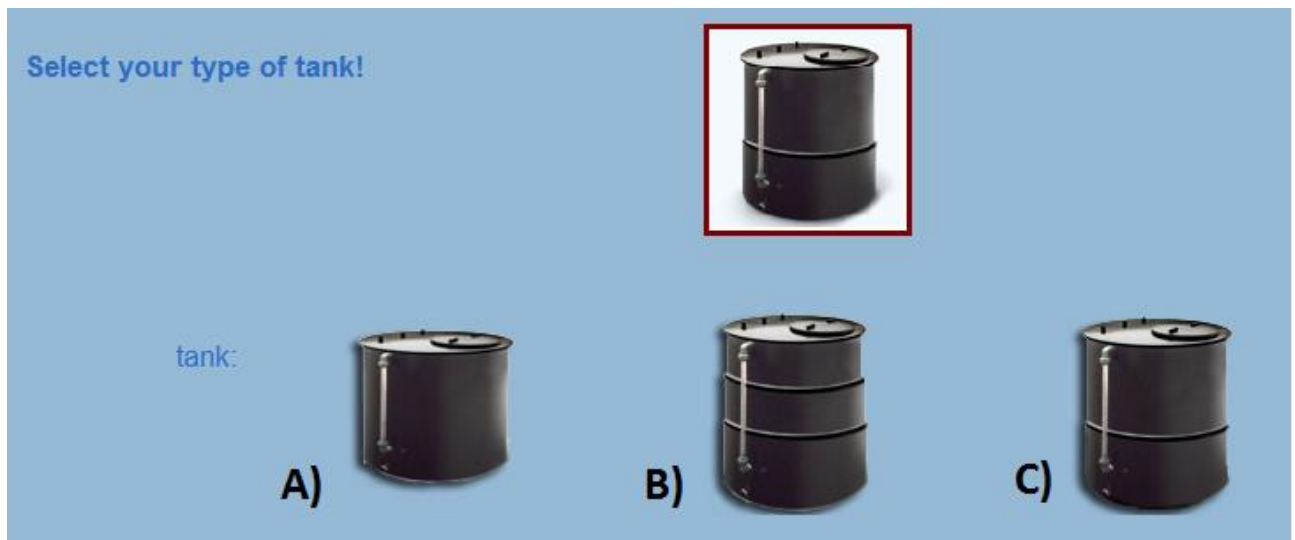
The calculation sequence with the usual steps follows. If you have activated the optional cost analysis, the Results window will display the production costs as well as the material and labour costs. It's worth comparing it with the results from designs using solid panels and it only takes a minute!

The detailed results of the calculation are documented on a separate page in the printing reports (structural analysis)!

4.3 Circular tanks

4.3.1 Tank construction designs

In this window, select the later construction shape or type of overall structure. You already decide here whether you can influence the wall thickness (B, C) or not (A). Typical tank construction shapes are:



A) Tanks with consistent wall thickness

B) Graduated tanks

C) Double layer tanks

Based on long years of experience in tank calculation, we recommend the following pre-selection criteria:

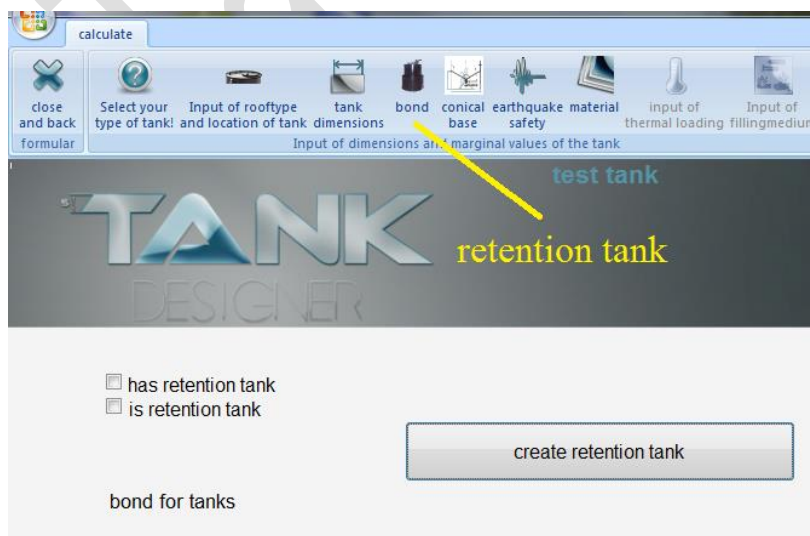
Tanks up to a height of 3000 mm and a diameter of 2000 mm: Type A

Tanks up to a height of 3000 mm and a diameter of beginning at 2000 mm: Type B/C

Tanks from a height of 3000 mm and a diameter of 2000 mm: Type B/C

This recommendation is only a rough pre-selection. If, during tank dimension determination, wall thicknesses do not meet your expectations, please choose another construction design and allow the programme to recalculate.

The option to calculate a **retention tank** is to tag “Tank with bond” in the window “input of rooftop and location of tank”. After entering all data in this window click to “bond” (retention tank). The programme will then ask you to “create a retention tank”. Now the programme takes over all the baseline data. Due to the now acquired tank data, the minimum required diameter of the retention tank and its height is determined by the programme. Even the required tank wall thickness and weight are acquired for the buoyancy calculation!!!





By clicking to retention tank the programm will create such bond. After that you may jump between tank and retention tank at any time to change data here or there. Hence, first finish to calculate a tank which is intended to be the basis for the retention, then create the retention itself!

4.3.2 Entry of the roof design and the installation location:

In this input window, you determine which type of roof the tank should have and whether it is a tank to be set up indoors or outdoors.

Type of roof: 1 = conical roof without ribbing
2 = open tank (without roof)
3 = flat roof, with and without ribbing

Tanks with retention tank?: Choose this field if the tank is intended for setup in a retention tank. The programme automatically prepared all required data for the calculation of the retention tank. For an outdoors installation, the query **wind shielding** is automatically deactivated because the retention tank serves as shielding and the programme takes the expected height of the retention tray (fill level of the tank) as wind protection in the determination of the wind components.

Outdoors installation: For outdoor installations with roof type 1 and 2, a wind and **snow load** component is determined. If a tank is setup in a **snow load zone** in which wind but **no snow** is expected (southern countries), choose the snow load zone "0". The **ground level** affects the wind load according to DIN 1055-4.

Wind shielding: If the tank which is to be installed outdoors is to stand e.g. behind a wall or a concrete tub, this wall can be seen as a wind protection surface. Input here the height of this wind shielding area in meters. The programme automatically then reduces the wind load by the corresponding value.

Tabelle 2. Regelschneelast s_0 in kN/m^2 (kp/m^2)

Tabelle 2. Regelschneelast s_0 in kN/m ² (kp/m ²)					
	1	2	3	4	5
	Geländehöhe des Bauwerkstandortes über NN	Schneelastzone nach Bild 1			
1	m	I	II	III	IV
2	≤ 200	0,75 (75)	0,75 (75)	0,75 (75)	1,00 (100)
	300	0,75 (75)	0,75 (75)	0,75 (75)	1,15 (115)
	400	0,75 (75)	0,75 (75)	1,00 (100)	1,55 (155)
3	500	0,75 (75)	0,90 (90)	1,25 (125)	2,10 (210)
	600	0,85 (85)	1,15 (115)	1,60 (160)	2,60 (260)
	700	1,05 (125)	1,50 (150)	2,00 (200)	3,25 (325)
4	800	1,25 (125)	1,85 (185)	2,55 (255)	3,90 (390)
	900		2,30 (230)	3,10 (310)	4,65 (465)
	1000			3,80 (380)	5,50 (550)
5	> 1000	Wird im Einzelfalle durch die zuständige Baubehörde im Einvernehmen mit dem Zentralamt des Deutschen Wetterdienstes in Offenbach festgelegt.			

In Berlin beträgt die Regelschneelast $s_0 = 0,75 \text{ kN/m}^2$ (75 kp/m^2).

Tabelle 1.

1	2	3
Höhe über Gelände m	Windschwindigkeit v m/s	Staudruck q kN/m^2
von 0 bis 5	28,3	0,5
über 5 bis 20	35,8	0,8
über 20 bis 100	42,0	1,1
über 100	45,6	1,3

Choose the **snow load zone** and the height above sea level of the intended setup location to determine the snow load according to the above table. If there is another snow load at the destination location of the tank, you can adjust the value to the situation.

☐ ventilation outside build

inclination angle of roof

vacuum, constant [N/mm^2]

location of tank
☒ inside ☐ outside building

Indoors installation: If the tank is to be setup inside but has a ventilation duct which leads outside, a vacuum exists from the wind suction in the tank. In this case, click on the field “**Ventilation outside?**”. The programme then automatically sets the value to $p_{US} = 0.00048 \text{ N/mm}^2$ for a vacuum from wind suction according to the DVS directive.

Furthermore, you determine whether a **flat roof** with or without **stiffeners** (reinforcing ribs) is intended. If the flat roof is to be designed without ribbing, set the **number of stiffeners** to “0”. Then the programme provides the least pressure to be considered such as **short-term vacuum and overpressure**, e.g. by emptying and filling. **Constant over and under pressures** are not allowed according to DIBt in this type of roof. If in your application case, the real value exceeds the planned value, you should adjust the value accordingly. The use of flat roofs for outdoor installations is not allowed or intended by the underlying directive.

The calculation of the flat roof is done according to the construction and testing principles of the DIBt as a non-accessible protective cover. If the roof is to be walked on or additions are intended, the corresponding load distribution measures are to be implemented.

If you have chosen the construction design **conical roof**, the programme automatically suggests an **inclination angle** of 15° . This is considered a minimum angle according to the DVS guideline. Furthermore, the programme automatically provides the least pressure to be considered such as **short-term vacuum and over pressure**, e.g. through emptying and filling as well as **constant vacuum and overpressure**. If in your application case, the real value exceeds the planned value, you should adjust the value accordingly.

You also determine whether **lifting lugs** are provided. If yes, notify the programme in the corresponding field **Diameter of the shackles** (through bolts). In the calculation of the lifting lugs, the programme assumes that the lifting lugs are completely (all around) welded to the tank skin using extruder welding ($f_s \geq 0.6$).

lifting lug

☒ yes ☐ no

dia of bolt

You can determine whether the tank that has to be setup shall be anchored to the ground using **claws** or not. On selecting the option “Analysis of the stability in the event of an earthquake (from version 5.1 onwards)”, this takes place automatically. Enter A) the desired width of the claws (**70 mm**) (in the front field, field 2 remains empty) or B) the **maximum width of claws** (in the back field, the front field remains

70 mm)) which you want to use. In the corresponding fields, the programme suggests the minimum required values for the number (4) and width (≥ 70 mm) of claws according to the rules. In case A), the programme calculates the required number of claws using the width provided. In case B), the programme checks whether the required number of claws would be adequate for the selected width range. If not, the number of claws would automatically rise piecewise. Do the claws reach a covering of 50% of the base plate-circumference and its amount is still not enough (this can be especially in earthquake zone 99 of the case), the thickness of the base plate is increased iteratively until the thickness of the lower cylinder thickness (for two-shelled tanks or bonds [type C) or Z]) the thickness of the inner shell) is achieved. Thereafter, the covering area is iteratively increased to 75% and 100%. If this value is still too small, the tank with the selected ground acceleration is not feasible!

4.3.3 Notes on analysis of stability in the event of an earthquake (from Version 5.10 onwards)

The calculation of the stability during earthquakes is only possible with the two variants of the partial safety concept (IV + V)!

Please note: In the absence of complete calculation methods for plastic tanks worldwide, the calculation method used here is based on the only directive present currently DVS 2205-2 supplementary sheet 4, which in turn is based on DIN 4149. This was withdrawn due to a EU directive and not due to false values or formulas. Loopholes in the calculation according to DVS 2205-2 supplementary sheet 4 were taken over through the calculated values and formulas from the withdrawn and hence invalid standard DIN 4149 as well as various formularies of the science of strength of material.

Before using this method of calculation, please check whether your client, end user or the competent local authorities recognise it and the parameters used or not. On refusal of accepting the statics or the product and/or the arising costs, we reject any responsibility and compensation claims for the reasons aforementioned.

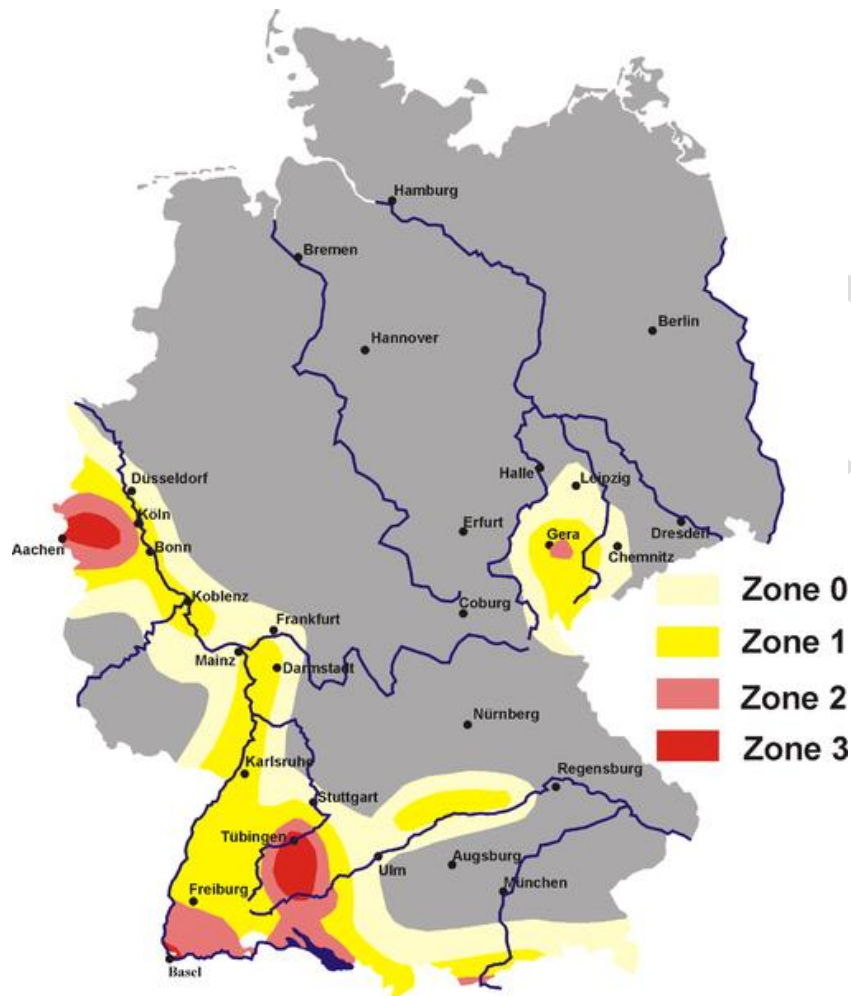
Tanks set up in earthquake prone areas shall always be properly anchored (claws) to the ground. If the tank lies within a collection container (tank in container), the collection container shall be properly fixed to the ground and the tank shall be secured in the catch basin! Therefore, the anchorage and position in the collection container is always considered and dimensioned (where necessary) automatically by the programme!

Here, you can mathematically verify whether the tank would remain safely secured in the ground in the event of an earthquake or not:

For analysis the stability in event of an earthquake, the available horizontal and vertical accelerations as well as the reaction of the whole component against these have to be determined. The following details are required for this purpose:

- **Rated value of ground acceleration depending on the earthquake zone** [a_g]

For Germany, the following earthquake zones apply according to DIN 4149:



Quelle: <http://commons.wikimedia.org/wiki/File:Erdbebenzonen.png?uselang=de>

- | | | |
|---------|---|--|
| Zone 0 | → | $a_g = -$ |
| Zone 1 | → | $a_g = 0.4 \text{ m/s}^2$ |
| Zone 2 | → | $a_g = 0.6 \text{ m/s}^2$ |
| Zone 3 | → | $a_g = 0.8 \text{ m/s}^2$ |
| Zone 99 | → | Value not defined and does not conform to DIN /DVS! Here, you can enter the value for the differing local ground acceleration a_g in m/s^2 (see the next image). Please view Sec. 4.3.3 " Legal Notice " of the manual for this purpose! |

- **Category of importance + Importance factor** [γ_{IE} also referred to as γ_{IE}]

Category of importance	Buildings	Importance factor γ_I
I	Buildings with low importance regarding public safety, e.g. agricultural service buildings and so on.	0.8
II	Ordinary buildings which do not belong to another category e.g. residential buildings	1.0
III	Buildings for which the resilience to earthquakes is an important factor with respect to the large scale consequences of its collapse e.g. large residential complexes, administration buildings, schools, gathering halls, cultural institutes, shopping malls and so on.	1.2
IV	Buildings that must be resilient to earthquakes for protection of general public, e.g. hospitals, important centres of civil protection and security forces, fire stations and so on.	1.4
V	Valid only when placed in the FRG: Structures according DIBt, calculation recommendations 40-B3: If the German competent authority did not permit any other setting, for the worst case in terms of water conservation in the storage of water pollutants the following value becomes valid:	1,6
X	Value not defined and does not conform to DIN / DVS. Here you can enter the importance factor for the differing category of importance applicable at the planned location of setup of the tank! View Sec. 4.3.3 "Legal Notice!" of the manual in this regard	?

For tanks storing water-hazardous fluids, $\gamma_{IE} \geq 1,2$ applies in **Germany** according to DVS 2205-2 supplement 4!!!

- **Effect of local subsurface conditions [S]:**

Geological subsurface classes according to DIN 4149

Subsurface class R

Regions with rocky subsurface environment

Subsurface class T

Transitional area between two regions of the subsurface class U and S as well as areas with relatively flat sedimentary basins.

Subsurface class S

Areas in which there are deep basin structures with thick sedimentary filling.

Subsoil class according to DIN 4149

Subsoil class A

Non-weathered (mountain fresh) hard rocks with great strength

Subsoil class B

Slightly weathered hard rocks or hard rocks with strength or coarse-grained (non-cohesive) and mixed-particle loose rocks with high friction properties, dense material and firm consistency (e.g. glacially preloaded loose rocks)

Subsoil class C

Strong to completely weathered hard rocks or coarse-grained (non-cohesive) and mixed-particle loose rocks with medium-density material and at least stiff and firm consistency or fine-grained binding loose rocks with at least stiff consistency

The subsoil environment can have the following combinations of geological subsurface and subsoil conditions:

A-R	B-R	C-R	B-T	C-T	C-S
(1,0)	(1,25)	(1,5)	(1,0)	(1,25)	(0,75)

You can also enter a different coefficient for the proposed reservoir site subsurface conditions apply! Simply overwrite the number in the back field. Observe, however, necessarily also the following paragraph "Legal Notice"

Legal notice: The programme determines the corresponding values [a_g] [S] [γ_{IE}] according to the information you have provided in the earthquake input mask. For areas lying outside the Federal Republic of Germany, we offer the opportunity to define your own values through direct input (Zone 99/X). However, we do not take any responsibility for this! In any case, we recommend you to ask for corresponding information/values from the client (e.g. buyer of the tank) or from the relevant local authorities or engineering office or to take them from a standard or directive applicable at the installation site.

Earthquake scales (Orientation guide without guarantee)

If the relevant institutions cannot provide you with information regarding the expected ground acceleration at the installation site of the tanks, we will provide you with an orientation guide here, for which we cannot make any guarantee however! The following table provides an overview of the of different intensity levels according to the Mercalli-Sieberg scale, magnitudes according to Richter and the ground acceleration achieved.

The data concerning the average ground acceleration relates to solid surfaces and may vary depending on the source of disturbance. The unit g corresponds to ground acceleration (9.81m/s^2).

In the green background, you will find the data which is technically important here for the analysis! Beyond the Mercalli scale VII (Richter scale 5.5), we recommend setting up roof loads (e.g. agitators) separately from the tank (separate stand) since otherwise, the earthquake moment calculated would be too high! According to our experiences, a tank will become unaffordable in such a case or it will no longer make sense to set it up!

Intensity on the Mercalli scale	Magnitude according to Richter	Ground acceleration in g	Ground acceleration in m/s^2	Effects
I.	around 2.0	< 0.0017	< 0.017	Only detectable with instruments
II.	around 2.5	0.0017	0.017	Can only be detected by a few people who are in a resting state (upper floors of high-rise buildings)
III.	around 3.0	0.014	0.14	Detectable in houses, but usually not identifiable as an earthquake. Vibrations, as in case of a car driving past
IV.	3.5 - 4.0	0.015 - 0.02	0.15 - 0.2	Detectable in houses: plates, windows, doors rattle. Stationary vehicles can be seen swinging
V.	4.0 - 4.5	0.03 - 0.04	0.3 - 0.4	Doors swing open, windows break, at some places, plaster flakes off. People sleeping tend to wake up
VI.	4.5 - 5.0	0.06 - 0.07	0.6 - 0.7	Some heavy pieces of furniture begin to shake, cracks in plaster appear, light damage
VII.	around 5.5	0.10 - 0.15	1.0 – 1.5	People run out of their homes, some chimneys deteriorate, light damage to buildings, motorists detect it
VIII.	6.0 - 6.5	0.25 - 0.30	2.5 – 2.9	Walls and monuments collapse, heavy pieces of furniture fall around, motorists are hindered
IX.	6.5 - 7.0	0.50 - 0.55	4.9 – 5.4	Buildings are lifted from their foundations, cracks appear in the ground
X.	around 7.5	more than 0.60	more than 5.9	Some stable buildings are destroyed, most of the simply built houses collapse, ground cracks up to one meter wide, dams and dykes are damaged, rails get twisted
XI.	>7.5	more than 1.24	more than 12.2	Only a few buildings remain standing, bridges are destroyed, wide cracks in the ground, landslides and soil erosion
XII.	>>7.5			Complete destruction, earthquake waves are visible on the surface of the earth, objects hurl around in the air

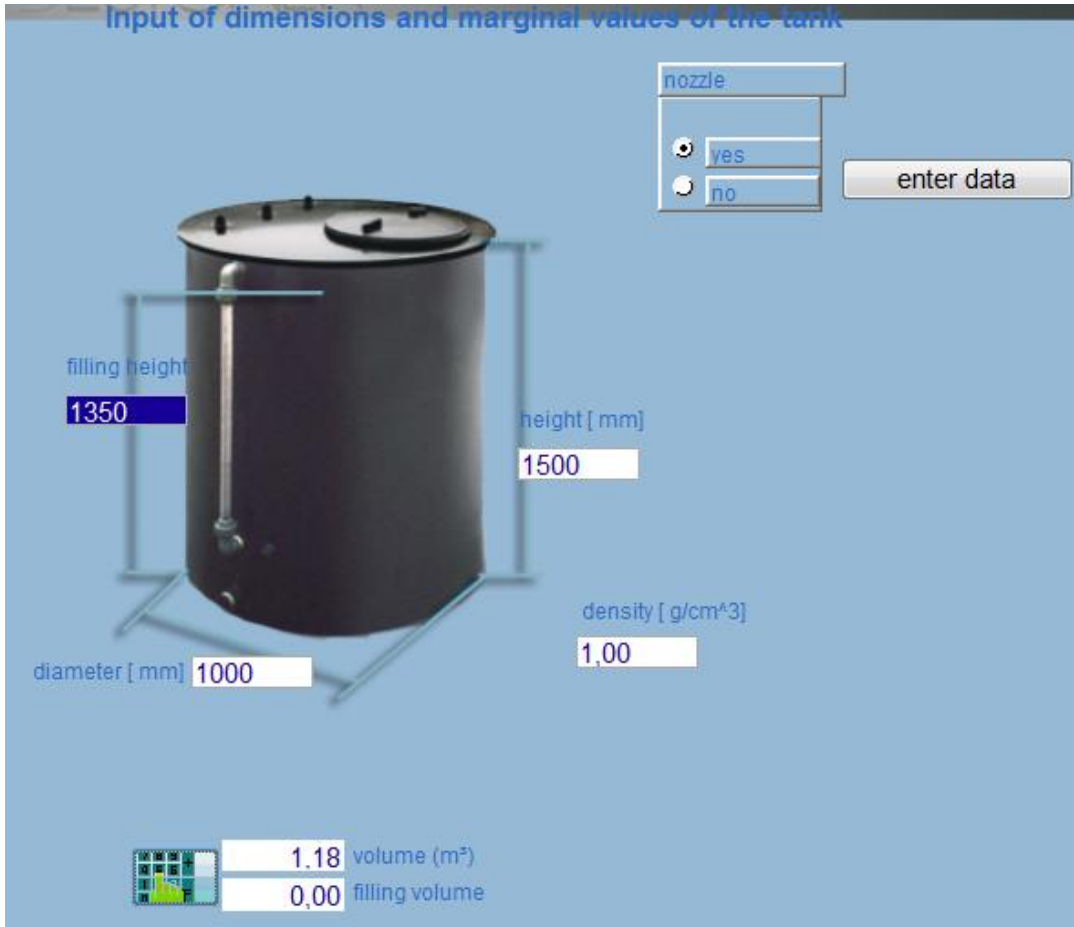
Sources: http://en.wikipedia.org/wiki/Peak_ground_acceleration
<http://www.copernicus-gymnasium.de/eduseis/HTML/skalen.html>

4.3.4 Tank dimensions and marginal values

In this field, you determine the tank dimensions. When entering the details, please observe the following information:

A) Tanks and retention tanks with consistent wall thickness

Input of dimensions and marginal values of the tank



nozzle

☒ yes

☐ no

enter data

filling height

1350

height [mm]

1500

diameter [mm]

1000

density [g/cm³]


1,00

1,18 volume (m³)

0,00 filling volume

Input here the **diameter**, the **fill level** and **height** of the tank and the **density** of the medium to be stored. The fill level is to be so determined that the theoretical fill volume is a maximum of 95 % of the possible tank content.

Volume calculator

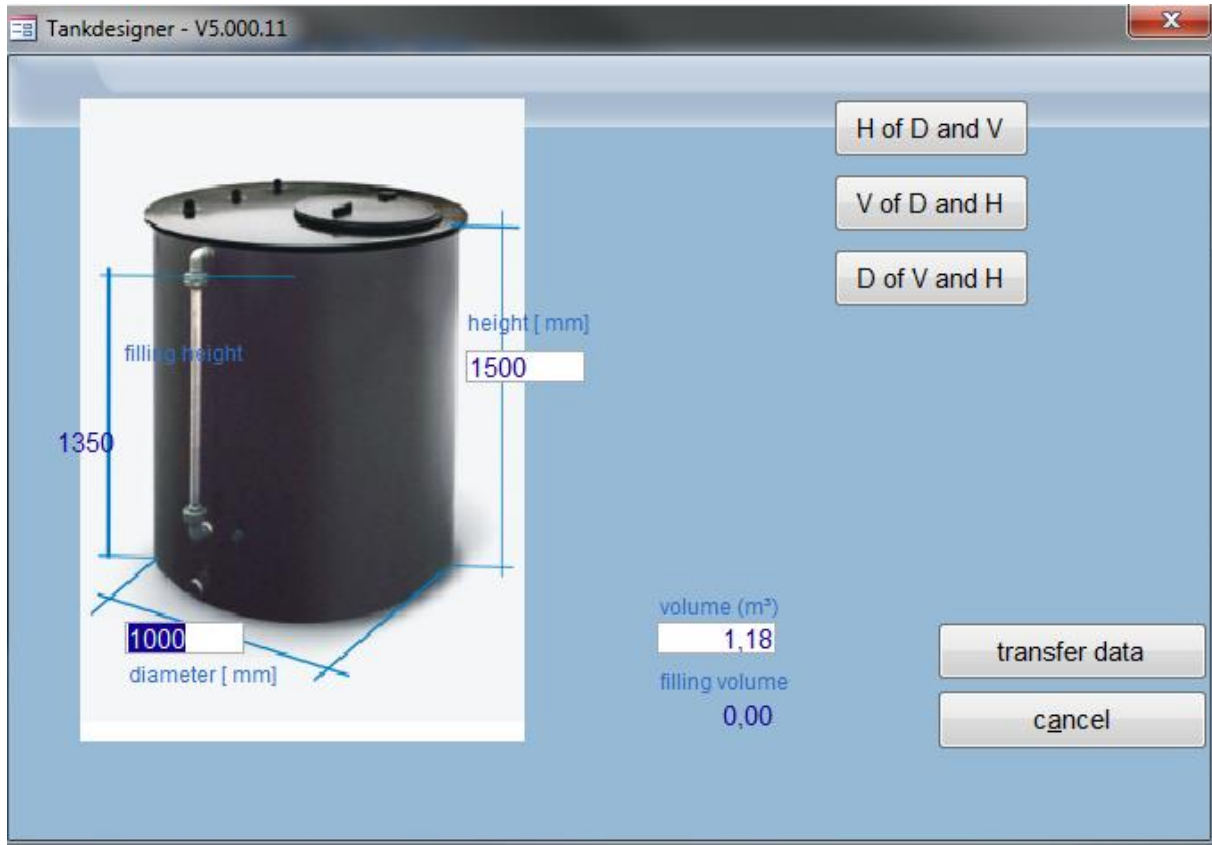


1,18 volume (m³)

0,00 filling volume

In the lower left area of the field “Input of the dimensions and marginal values” you will find the volume calculator button with the data for the total **volume** and **volume**.

When you click on this button with the mouse, the following window appears:

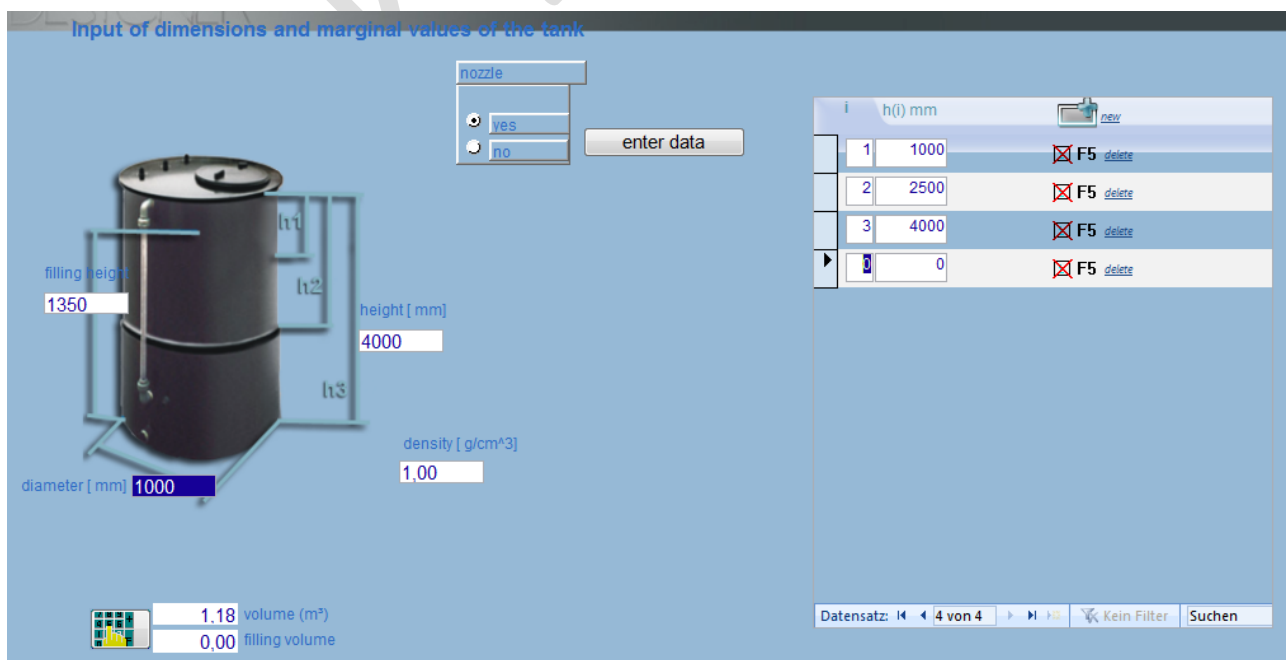


For example, enter the tank diameter and the desired fill volume and click on the field “**H from D and V**” (height from diameter and volume), the volume calculator automatically calculates the fill level, the entire height and the total volume of the tank. You can of course adjust these values to your desired data by simply overwriting the listed number. If you now click on the field “**Transfer data**”, the selected values automatically are transferred into the “Input of the dimensions and marginal values” window. You also have the options of:

V from D and H (Fill volumes from diameter and height) as well as

D from V and H (Diameter from fill volumes and height)

B) Graduated tanks, graduated retention tanks



Input here the **diameter**, the **fill level** of the tank and the **density** of the medium to be stored. The fill level is to be so determined that the theoretical fill volume is a maximum of 95 % of the possible tank content.

Now select the **number of bands** and the **height of the band** which are to be implemented as wall thickness offsets. The input of the band height is done according to standards from the upper edge to the base or to the respective wall thickness offset. For reasons of rationalisation and cost, we recommend that the band height is graduated in the panel format (1000 mm, 1500 mm or 2000 mm). Enter first the number “1” for band 1 and then the height of the first band of the tank tabularly in the input field. Repeat this for other band. The individual bands are thereby to be entered cumulatively (2nd band height = 1st band plus 2nd band etc.). The total height thus corresponds to the last entered field. To simplify the input, observe the visual dimensioning of the tank. Caution, the height gradation of the table has precedence over the total height in the calculation. If you calculate a retention tank to a tank which are have designed in duplicate, you must adjust the height gradation of the entire height. Otherwise, the programme calculates with the wrong tray height.

C) Double layer tanks , double layer retention tanks

The input is done as with **B) Graduated tanks**. In the strength calculation (verification of strength) and in the calculation of the axial stability (verification of stability), a wall thickness increase factor of $C_3 = 1.25$ is, however, intended. This construction design makes the production as panel tanks possible even with higher total wall thickness because the **allowable flexural stresses** for the individual skins are determined and thus can be more easily met. The threshold values for the flexural stress which were established according to the directive based on practical experience collected, is provided with a tolerance of 5%. This means that e.g. in tanks of PP-H, am maximum flexural stress of 0.525% is permitted by the programme. Please check before the manufacture of the tank whether or not your testing institute agrees with this exceeded threshold value.

4.3.5 Entry of nozzles and access openings

If you would like tank braces, select “Yes” in the control panel “Braces” The following window appears:

in the cylinder				
no.	outer Dia (mm)	weight (kg)	position from top	wallthickness
1	500	10	3000	20
*				

in the roof				
no.	outer Dia (mm)	weight (kg)	position from edge	wallthickness
1	160	10	500	10
*				

Starting with version 5.3, the programme can differentiate between nozzles and access openings (manholes \geq DN 500). Beyond this version, the nozzles and cylinder/access openings in the roof are analysed as previously. The dimensioning of the access openings in the cylinder takes place according to the guidelines of DIBt and LGA, Nuremburg. You can find details in this regard in the statics beginning with version 5.3.

Please note: For tanks that have to be setup within the Federal Republic of Germany, the following applies: Recommended minimum dimensions for tank openings: Manholes (access openings) 800 mm diameter or 600 mm diameter, if the nozzle height does not exceed 250 mm.

Enter the **nozzles present in the cylinder** in the **upper part of the table** of the window that now appears. While entering the position of the nozzles, please note that the height shall be taken starting from the upper edge of the tank. The programme automatically gives a warning as soon as a nozzle comes too close to wall-thickness transitions or the ground.

Please note: For nozzles present in the cylinder, the wall thickness shall be at least SDR11 (earlier pressure rating of PN 10).

In the **lower part of the table**, enter the nozzles that are planned for the **roof**. The wall thickness of the nozzles can be estimated and shall at least correspond to the thickness level SDR 11. The weights play an important role in calculating the roof load. Hence, measure them very accurately. The conical roof is analysed according to DVS 2205-2 as a non-passable protective roof. If the roof will be used for walking purposes or if it will be subjected to **heavy loads** (e.g. agitator) or **fittings**, load distribution measures shall taken since roof loads are taken into account as surface load during roof dimensioning. Basically, the roof loads and fittings shall be supported separately.

4.3.6 Calculate

Summary of the results:

D: 1000 mm H: 4000 mm FH: 1350 mm G_E: 830 N
height to erect tank: H_A = 4142 mm roof height h₀ = 0,0 mm

calculated thickness [mm]:

	band	h _i	S _{req}
base:	1	1000	5
cylinder:	2	2500	5
	3	4000	8

roof:

lifting lugs: width: - 137 thckn.: - 4
anchors: width: - 70 number: - 4

edge expansion: allowable ϵ = 0,788 %
existing ϵ = 0,800 %

Attention! The max. allowable edge expansion is exceeded. Please chose a different design method or elevated temperature bending of the sheet is required. Please pay attention that in case of elevated temperature bending the sheets shall be heated up homogenously.

minimum filling level: h_{res} = 0 mm

Nozzle:

Attention! Please note, that the calculation of the nozzle does not take into account any weld in roof or cylinder. From there please locate the nozzles with a minimum distance of 1/2 nozzle diameter + 100 mm away from base, welds and borders of bands.

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Seite: 14 1 Keim Filter

In the field Calculate, you will input the required **wall thickness** of the individual bands the **base thickness** and **thickness of a conical roof** (min. 15° slant). The minimum wall thickness is 4 mm according to the

DVS directive. Furthermore, the programme suggests corresponding wall thicknesses from a standard, pre-product delivery programme.

Flat roof:

If you choose the roof type flat roof, the programme will automatically create and calculate a roof with thermoplastic stiffening system. If you are not satisfied with the result you may click to button “flat roof” and following window will appears. You may use this to optimize manually..

You will be asked at this point of the calculation, to reinforce the flat roof according to your wishes. First, input the desired **thickness** of the **roof**. Than acknowledge it with OK. If the window reappears, the suggested reinforcement is not adequate. At the top left, the **degree of utilisation** ($n =$) is displayed. Increase the **height** of the **stiffener** and/or the **thickness** of the **stiffeners** and /or the **number of the stiffeners** until the degree of utilisation is < 1 . As soon as this condition is met, the query appears: “**Do not optimise further**”. If you choose this field, the programme aborts the roof calculation and continues the total calculation. If you do not acknowledge this query, you can optimise the roof until the value of 1 is exactly met. You will save material costs in this way.

4.3.6.1 Confining pressure stability according to DIN 18800- 4

The determination of the coefficient β is done with a replacement cylinder which is determined as followed according to DIN 18800-4:

5.3.2 Druckbeanspruchung in Umfangsrichtung

(509) Dreischüssiger Ersatz-Kreiszyylinder

Es ist ein gedachter dreischüssiger Ersatz-Kreiszyylinder zu bilden (Bild 19 b). Seine fiktive obere Schußlänge l_0 erstreckt sich bis zum oberen Rand jenes Schusses, dessen Wanddicke die 1,5fache kleinste Wanddicke t_1 überschreitet, maximal bis $l/2$. Die beiden anderen fiktiven Schußlängen ergeben sich aus Gleichung (54).

$$l_m = l_0, l_u = l - 2 l_0, \text{ wenn } l_0 \leq \frac{l}{3} \quad (54 a)$$

$$l_m = l_u = 0,5 (l - l_0), \text{ wenn } \frac{l}{3} < l_0 \leq \frac{l}{2} \quad (54 b)$$

Die fiktiven Wanddicken t_0, t_m, t_u werden durch Mittelung über die fiktiven Schußlängen bestimmt.

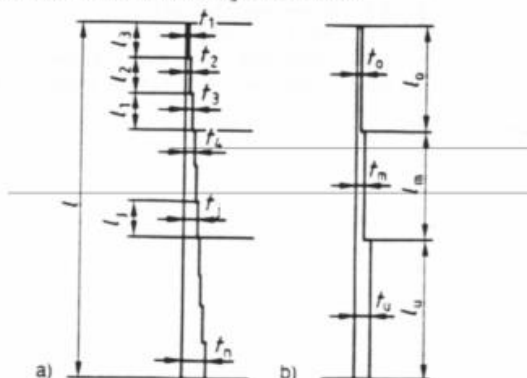


Bild 19. Kreiszyylinder mit abgestufter Wanddicke (a) und dreischüssiger Ersatz-Kreiszyylinder (b)

After determination of the replacement cylinders, the coefficient is determined from the following diagrams.

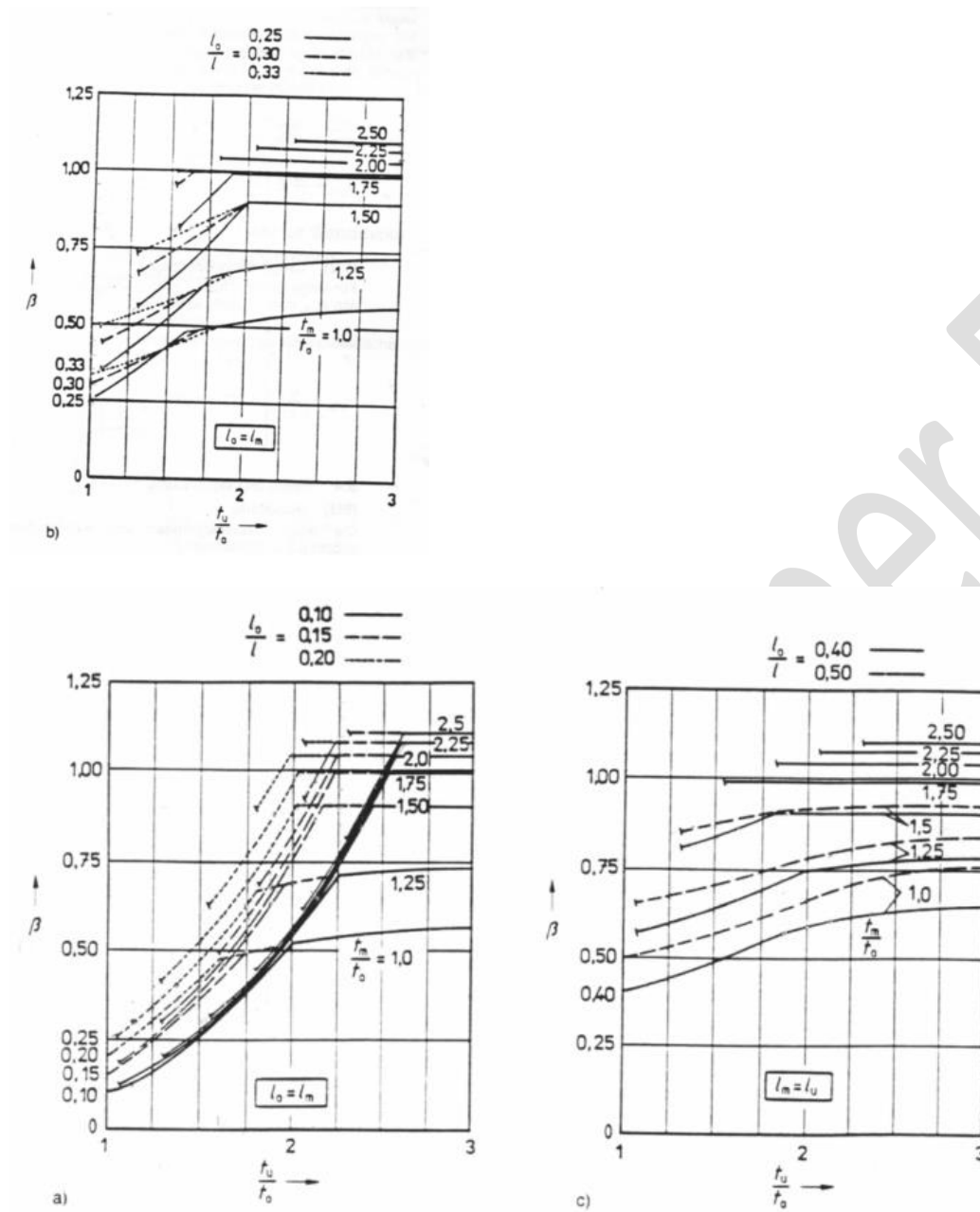
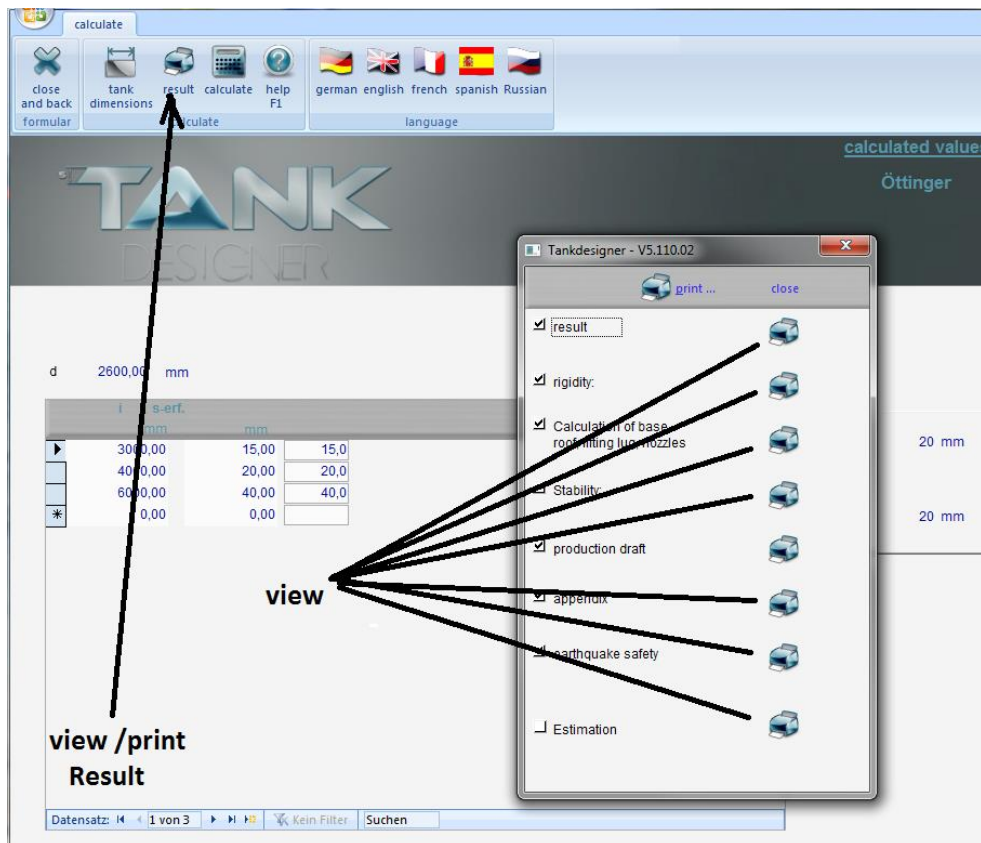


Bild 20. Beiwert β zur Ermittlung der idealen Umfangsbeulspannung eines abgestuften Kreiszylinders

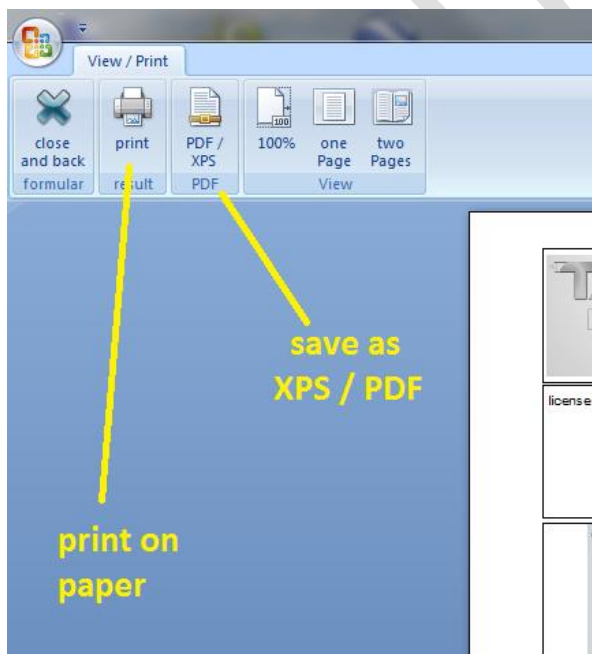
The programme does this determination automatically!!!

4.3.7 Print calculation report



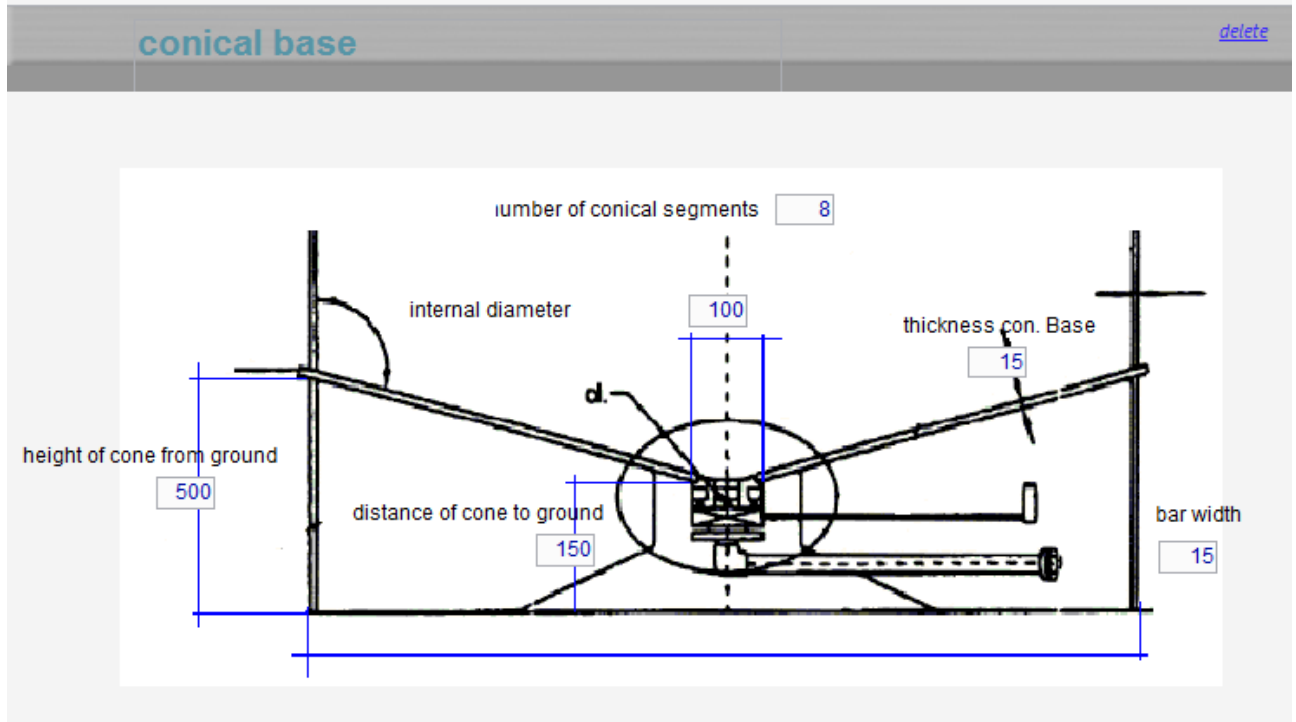
You also have the option of opening a menu with the function key "Print" in which the reports are listed in the very detailed points **Result, Verification of rigidity, Calculation of base, roof, lifting lugs, braces, Stability verification, Production draft, Appendix and Estimation**. It is here possible to output the statics in detail with the complete calculation method on the screen (printer right next to the corresponding point). A new window will open when viewing the documents. With the function key "Printer", all selected

parts are printed out On the chosen printer. Alternativ save the reports as PDF or XPS file!



4.3.7 Conical bases with spoke-shaped support

With this base variation, the statics done are not based on DVS directives or EN standards but rather on a calculation method developed by the University of Hanover. Tanks with this conical base form have been designed hundreds of times in the last fifteen years and approved by testing institutions. Nevertheless, you should check with your customer and the responsible testing authority to see if the calculation method listed here will be recognised before manufacturing this type of tank.



The following information is needed from you for the calculation:

- Diameter of the inner braces (inner diameter)
- Distance of the cone tip from the base (ground clearance)
- Distance of the upper conical base edge from the floor (height conical base)
- Desired thickness of the cone (thick conical base)
- Number of the segments or ribs (numbers of cone segments)*
- Thickness of the support ribs (bar thickness)**

*The minimum number is 4. These are designed as supports standing on the base. If you raise the number, further ribs as stiffeners (not standing) are calculated.

**Now the maximum thickness / height ratio of 1/8 (see Section 0.1 Paragraph "Plastic ribs and plastic support plates").

If you have carried out a calculation of the conical base and the result does not meet your idea, e.g. conical base is too thick), increase the number of the segments or lift the conical base height or reduce the distance to the base (the steeper the conical angle, the thinner the cone) and before each new calculation, correct the thickness of the base to the desired value and first then recalculate the conical base.

4.3.8 Conical bases with ring support (in preparation)

Tank Designer 5

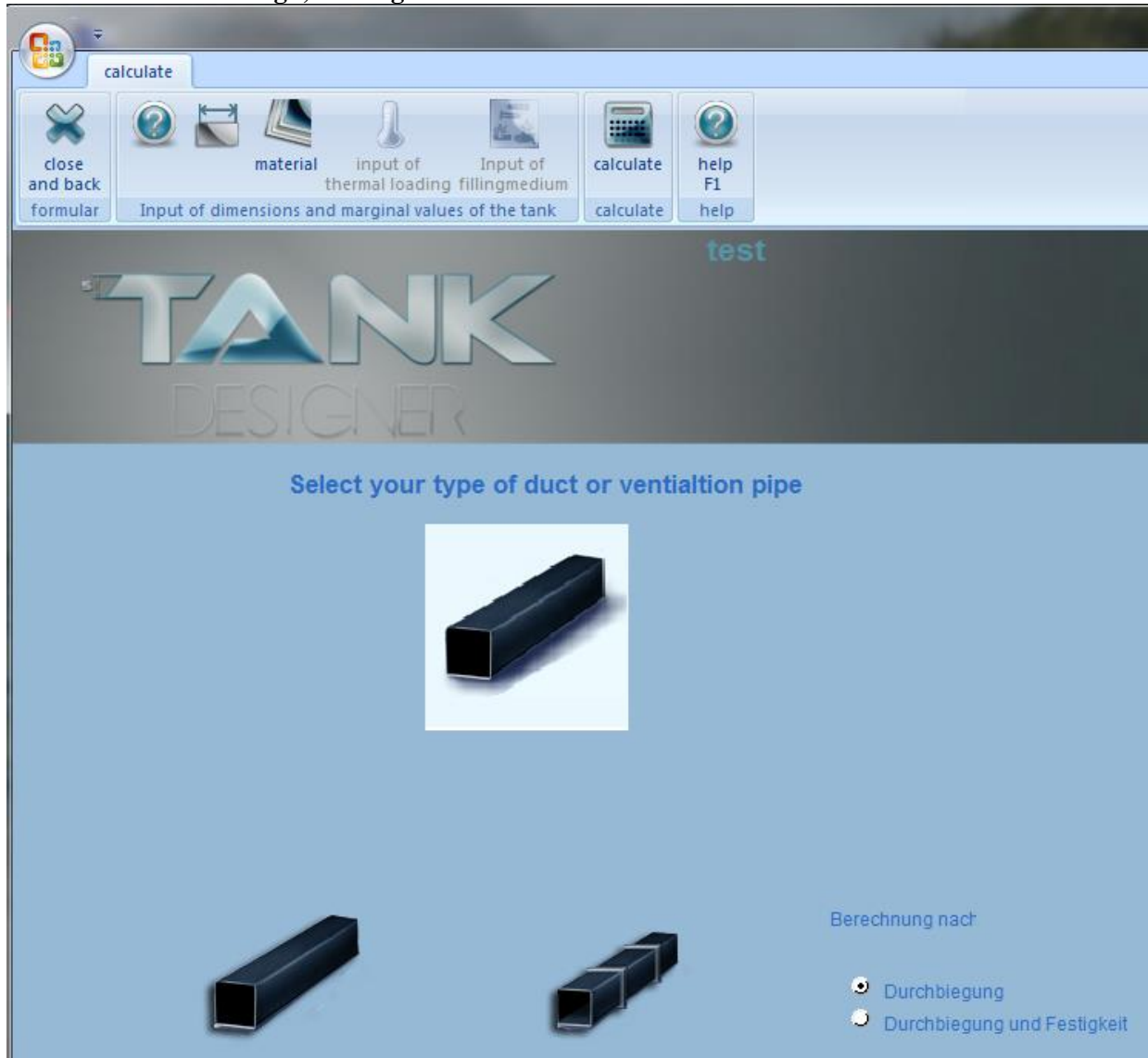
4.3.9 Sloped bases with parallel support (in preparation)

Tank Designer 5

4.4 Ventilation ducts

This programme module is only designed for a calculation with vacuum. The input of a minus symbol before the value of the vacuum is Pa (Pascal) is thus not required and leads to a programme error!

4.4.1 Construction design, rectangular



In this window, you select the *construction design* as well as the *calculation method* of the determining ventilation ducts.

4.4.1.1 Construction designs:

A) Rectangular ventilation ducts without reinforcements

Recommended for ducts up to a max. of 500 mm larger width

B) Rectangular ventilation ducts with reinforcements

Here, the reinforcements are designed as welded on ribs or as flange bars. Observe here that the reinforcing ribs first exert influence on the wall thickness when distances are the same or smaller than the width of the ventilation ducts.

4.4.1.2 Calculation method

1. Deflection:

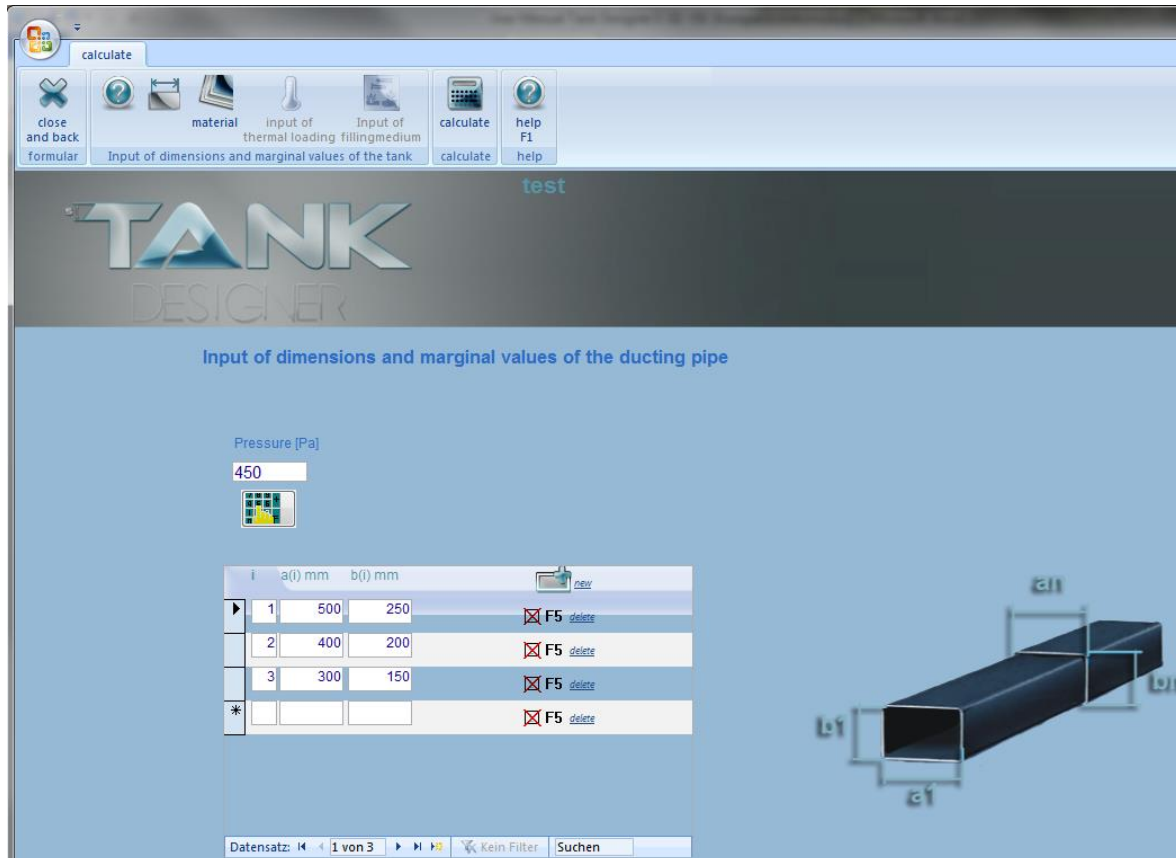
The calculation for deflection only considers stability criteria. According to the calculation as per P. Jacobs which this programme is based on, a deflection of the largest ventilation duct side of max. 1% is permitted here. This deflection can first be reached following the calculated useable life according to the underlying calculation.

2. Deflection and stability:

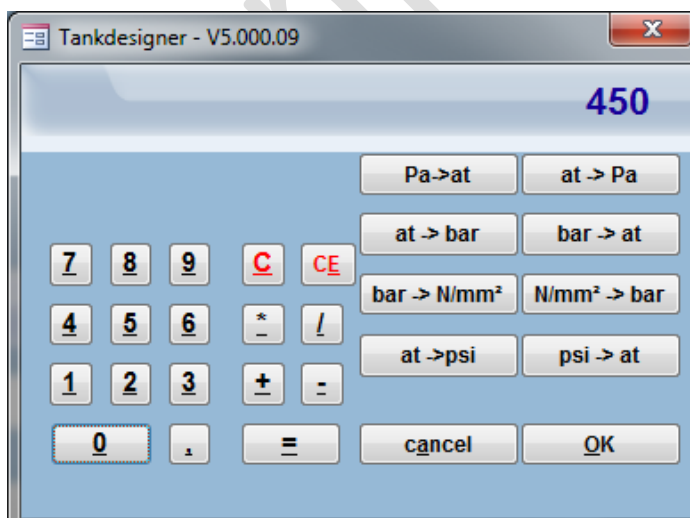
This calculation considers the max. 1% of the largest side length (see previous paragraph) as well as the effect of the manufacturing method and aggressiveness of the gas to be transported. Through the additional strength analysis, the durability of the welding seams is calculated in the dimensioning of the ducts influenced by the temperature and the reduction factor of chemical resistance.

4.4.1.2 Duct dimensions and marginal values

4.4.1.2.1 Rectangular ducts without reinforcing ribs



If you have a different pressure specification, you can convert it to Pa using the installed calculator. For this, just click on the switch symbol underneath the pressure input field. The calculator appears (see next figure).



Enter the value appearing before you. Calculate now by selecting the corresponding unit fields until the value in Pa appears. If you confirm this value with “ok”, the value will automatically be inserted in the pressure field.

Now enter the dimensions of the different duct sizes into the table field.

In the field i: Enter the consecutive duct number.

In the field a(i): Enter the base side length of the duct here.

In the field b(i): Enter the height of the duct here. This should usually be 50% of a_i .

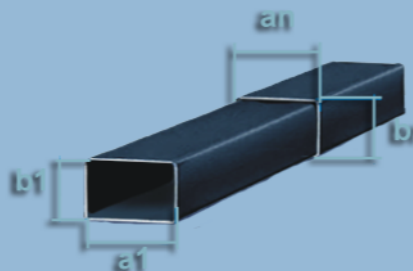
4.4.1.2.2 Rectangular ducts with reinforcing ribs

Eingabe der Abmessungen und der Randwerte für die Lüftungsleitung

Druck [Pa]
450

i	a(i) mm	b(i) mm	
1	500	250	<input checked="" type="checkbox"/> F5 Löschen
2	400	200	<input checked="" type="checkbox"/> F5 Löschen
3	300	150	<input checked="" type="checkbox"/> F5 Löschen
*			<input checked="" type="checkbox"/> F5 Löschen

Datensatz: 3 von 3



The input is done according to Section 4.2.2.1! Here, however, the input of the rib distance l (i) into the table field is also required.

In doing so, the reinforcements can be planned as welded on ribs or as flange bars. Observe here that the reinforcing ribs first exert influence on the wall thickness when their distances become smaller than the width of the ventilation ducts.

The programme asks you here for the intended rib thickness and then calculates automatically the required rib height. This is so dimensioned that the ribs can be seen as solid outer edges between the individual pipe sections.

4.4.2 Round ventilation ducts

calculate

close and back formular material input of thermal loading fillingmedium calculate help F1

TANK DESIGNER

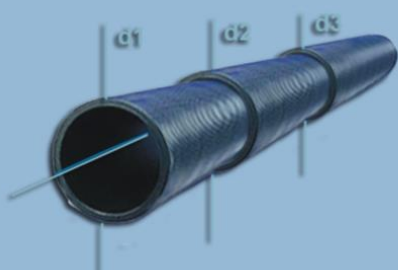
Test

Input of dimensions and marginal values of the ducting pipe

350

i	h(i) mm	
1	1000	<input checked="" type="checkbox"/> F5 delete
2	750	<input checked="" type="checkbox"/> F5 delete
3	500	<input checked="" type="checkbox"/> F5 delete
4	400	<input checked="" type="checkbox"/> F5 delete
*		<input checked="" type="checkbox"/> F5 delete

Datensatz: 1 von 4



First, enter the pressure as Pa. If you have a different pressure specification, you can convert it to Pa using the installed calculator. For this, just click on the switch symbol underneath the pressure input field. The calculator appears (see next figure).

Enter the value appearing before you. Calculate now by selecting the corresponding unit fields until the value in Pa appears. If you confirm this value with “ok”, the value will automatically be inserted in the pressure field.

Now enter the dimensions of the different duct sizes into the table field.

In the field i: Enter the consecutive duct number.

In the field d(i): Enter the diameter of the duct here.

4.4.3 Calculate

In the field Calculate, the resulting recommended wall thicknesses which were calculated are tabularly displayed according to corresponding panel delivery programme.

The calculation is done according to DIN 4071 for PP- H or 4076 for PVC- U. The calculation of lines from other materials is done based on DIN 4071!

4.4.4 Print

The result of the calculation can be printed with the F6 key.

4.5 Cost analysis

4.5.1 Basic information

The cost calculation is based on the values, calculated from the respective tank, the settings you have made in the dashboard (to set up the tank) and from the data that you have entered in the database. The module of cost analysis determines the necessary materials and work steps from these data and multiplies them with the material and working speeds and working hours that you must store in the database. The more accurately you determine and enter them, the more accurate is the calculation result.

The program manufacturer made the assumptions or specified the conditions as follows:

- 1) The cost per working hour is based on the calculated "average hourly rate"! This is calculated from:
(total cost - purchase of goods) / productive working hours
- 2) The processing rules according to DVS guidelines and all other applicable guidelines and standards apply.
- 3) The calculated technical data of the tank are implemented consistently.
- 4) The prices for the average hourly rate can be entered in any currency. This must only be followed consistently. However, only the dollar sign appears in the database as well as the data printout!
- 5) The program user is responsible for updating the prices and working hours and/or working speeds!
- 6) The program does not perform any optimisation of the weldseam count and of the blank cut.
- 7) During the first application of a specific design, please check all the calculated number values thoroughly or at least compare them with your own (previous) cost calculation. This calculation module is the first edition of such a calculation; this is implemented without any guideline as a template. Due to the enormous complexity and number of choices, errors cannot be ruled out! If you find such an error, please report it to us immediately.
- 8) The following definitions, which you would like to consider when entering the working hours, continue to apply. If any of the steps do not occur, then set the appropriate times to 0 (zero).
 - The panels are trimmed (cut) due to non-angularity and/or oxide layer. Select the number of cuts in the dashboard.
 - In the calculation of production cost for the reinforced section and safety section frame, semi-finished products with a length of 6 m are required.
 - Each panel / each safety section / reinforcement section is transported from the warehouse to the sawing machine, from there to the welding machine or the welding site.
 - The tank body is moved from the welding machine to the welding site or from one welding site to the next.
 - The finished tank is transported out of the hall.

4.5.2 The databases

The databases can be found at: Database / master data cost analysis

Here, the following databases are stored with the following units for the input values:

Butt welding (HS)	min	
Bending (BI)	min	only possible for PVC + PVC-C
Angular welding (AK)	min	only possible for PE + PP + PVDF
Extrusion welding (WE)		m/min
Automated extrusion welding (A-WE)	m/min	
Hot gas welding (WZ)	m/min	
Straight blank cuts	min	
Milling / chamfering / cutting	m/min	
Internal logistics	min	

TIP: If you have 2 or more staff on duty for some operations, then you simply double or multiply the relevant time. You may also apply this when one employee works, e.g. only half the time as one hundred percent of other staff, then take the time to be entered simply times 1.5!

Panel prices	\$/kg
Wire prices	\$/kg

Connecting piece prices	\$/piece
Safety section (U) prices	\$/m
Special accessories prices	\$/piece
Prices of rolled laminated tube	\$/kg
Prices of extruded tube	not activated yet
Clamping claw prices	not activated yet
Anchor bolts prices	not activated yet
Square pipes	\$/m
Edit steel table	\$/m or kg/m

These databases can be supplemented arbitrarily by you! Namely, you can, for example, create your own sections!

More information required is:

Cost per working hour (K-MA)	\$
Working length of panel welding machine	mm
Loss per weldseam	mm
Loss per saw cut	mm
Working length of bending machine	mm
Working length of folding machine	mm

Please check all of these values for relevance to your company, and correct them, if necessary!

4.5.3 The dashboard for rectangular tanks

Cost analysis

DB ☒ Cost analysis ☐ Store data as default?

Preferred sheet size: 3000 x 1500

All stiffener same (max) size: ☒

Cover stiffener with protective U-profile: ☒

Cove with complete sheets instead profiles?: ☐

Baseplate overlaps?: ☒ 40 mm

Planning with roof plate?: ☐

Roof stiffener according calculation?: ☐ Recommended

Roof plate replace rim-stiffener: ☐

Rim additional thermoplastic stiffener: ☐

Rim pure thermoplastic stiffener: ☒ 30 Thickness [mm] 75 Width [mm]

Weld account for cylindrical tanks:

	Pre-milling	2-times	HE	AK	BI	WE	A-WE	WZ	WZ x-times
Base welds	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	1
vertical corner connection	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	1
Welds for roof or rim-folding	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1
Umlaufende Nahte	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	0
Welds for rim cover profile	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	0
Vertical stiffening	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	0
Welds for roof stiffener	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Roof stiffener	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Corner welds full cover	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	0

percentage safety margin (onto PC): 10 %

percentage surcharge for margin (onto PC): 35 %

onto contract for discount (out of SP): 8 %

Diameter of weld rod for root pass: 3 mm

Diameter of weld rod hot gas weld: 3 mm

Diameter of weld rod extrusion weld: 5 mm

Addition to labour costs: 10 %

Addition to material costs: 10 %

Material surcharge for waste?: 10 %

The dashboard is used to adjust the (individual) design - commonly used in your company - in the program prior to calculation. These can then be saved as default parameters (default setting). The following information is required for this purpose:

Preferred panel size	Select the preferred (present in the warehouse) panel size from the dropdown menu
Apply material surcharge for offcuts?	Enter a percentage value from 0 to 100

Reinforcement sections all in one size?

Currently unchangeable. All steel sections are the same! The largest (bottom) of the horizontal sections is selected.

Panel reinforced sections with U sections?

Should the vertical and horizontal steel sections be panelled with U sections?

Complete panels instead of panelling sections?

Should the tank be lined completely? If yes, with what panel thickness? Select from the dropdown menu!

Bottom plate protruding?

Is the bottom plate larger than the tank? If yes, by how many mm is it protruding?

Cover plate provided?

Should the tank be provided with a cover? Only possible for type B / C / D / E! And is the cover plate larger than the tank? If yes, by how many mm is it protruding?

Is the cover ribbing based on structural engineering calculation?

Should the cover plate be supported by the rib spacing determined in the structural engineering calculation?

Does the cover replace the upper horizontal reinforcement?

The edge reinforcement can be dispensed with. Following design:

Additional thermoplastic rib on the upper edge?

The steel reinforcement is applied below the edge:

Only thermoplastic rib on the upper edge? is dispensed with:

The steel reinforcement

If none of the above versions is selected, the following design is regarded as the basis for calculation:

Where:

Tank body set up as U ☐

Face plate ☐ Added onto ☒ Added into

Rim / top stiff ☐ Added onto ☒ Added into

Roof plate ☐ Added onto ☒ Added into



A = mounted onto (added onto)

E = inserted into (added into)

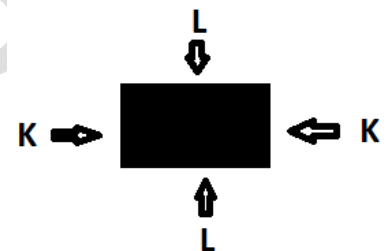
You choose here:

No. of cuts **LKL**

LKLK	long-short-long-short
LKL	long-short-long
KLK	short-long-short
KL	short-long
KK	short-short
LL	long-long
L	long
K	short

Number of blank cuts (incl. trimming)

With the drop down menu shown, select the number and position of the blank cuts or trimmings. Refer to the diagram shown next in case of doubt.



The dashboard offers you the following processing options (work steps):

Pre-milling	Machining the weldseam surface or creating a groove / bevel
2-fold	The work steps are valid for inside / outside, up / down and left / right
HS	Hotplate / butt welding
AK	Angular welding (folding welding) → semi-crystalline materials
BI	Bending → amorphous materials
WE	Hot gas extrusion welding
A -WE	Automated hot gas extrusion welding
WZ	Hot gas extrusion welding (WZ x-fold = 1 \triangleq root of the weldseam is set automatically)
WZ X-fold	Multilayer hot gas welding (WZ x-fold >1 \triangleq multilayer main weldseam)

You have this assortment (with manufacturing constraints) for the following tank elements:

Circumferential bottom weldseams	V and/or fillet weldseams (WE/ A-WE/ WZ)
Vertical corner joints	Inside / outside corner joint (all work steps)
Weldseams for cover or fold	As T-joint or inside/ outside corner joint
Horizontal safety section weldseams	Fillet welds: top/ bottom (WE/ A-WE / WZ)
Weldseams for safety sections at the upper edge	Fillet welds: top/ bottom (WE/ A-WE/ WZ)
Vertical safety section weldseams	Fillet welds: left/ right (WE/ A-WE/ WZ)
Weldseams for cover reinforcement	Fillet welds: left/ right (WE/ A-WE/ WZ)

Weldseams for bottom part reinforcement	Fillet welds: left/ right (WE/ A-WE/ WZ)
Weldseams for full lining	All work steps possible
Weldseams of connecting pieces or manholes	Fillet welds (WE/ WZ) or sleeves/ paddings (HS)

To calculate the production cost or the offer price, you have the following additional charge variables:

Percentage safety margin (on HK) is calculated as the additional charge on the HK

Thereupon percentage additional charge for income (on HK) is calculated as the additional charge on the HK

Thereupon additional charge for discount is calculated as a deduction from the VK

Additional charge for labour cost	Additional charge on all labour cost (total)
-----------------------------------	--

Additional charge for material expenses	Additional charge on all material expenses (total)
---	--

Add material surcharge for offcuts	Serves as lump-sum surcharge on panel material
------------------------------------	--

4.5.4 Optimisation of rectangular tanks by cost

If the program has determined the technical data for the tank, it shows you the production cost in the "Result" window. Alternatively, you can view cost details also below **Print / cost analysis**. Now change the design type of the tank or the number of fields or the material or you can immediately see the change in production cost. You can now change the tank data as long as it is technically meaningful, and thus reduce the production cost. Always allow the program to "calculate" twice. If a cost reduction is no longer given, return to the penultimate configuration. You have now reached the optimum relationship between labour and material cost!

4.5.5 The dashboard for round tanks

Explanation follows with the release of this update

4.5.6 Optimisation of circular tanks by cost

Explanation follows with the release of this update

5. Error or error messages

5.1 General notes

A) On the printout or the display of the paper pages, there are only numbers, text/ drawings and formula symbols are not displayed.

You are using Norton Antivirus. The scrip blocking prevents the displaying of the text/ drawings and formula symbols. Deactivate the script blocking.

B) **If you get caught in a loop:** Press “ESC” on your keyboard (poss. several times). The programme will reset and you can enter your input again.

5.2 Through data input

1) The creep modulus for the given material cannot be specified because the calculated Sigma is outside the allowed range for the material selected. Press CTRL + F1 for further information.

2) Value... *Change the corresponding value.*

3) The required moment of inertia 2nd degree is too high. *Choose the next highest beam height from the steel table in the form dimensions and recalculate.*

4) No reduction factor for the desired environmental medium can be determined for the given material. *Please enter the reduction factor into the variable media catalogue or via direct input. If no values are available, get in touch with your suppliers for thermoplastics pre-products.*

5) The ratio of the fill level for the total height results in fields which are not loaded by the fill medium. *Please change the fill level, the height or the number of the fields.*

6) Number of fields too high. *Go to the tank dimensions  window and change the number of fields.*

7) Target wall thickness cannot be reached because too many fields are available. *Change the number of fields in the window “Dimensions and marginal values”.*

8) The material is only useable in the above-given temperature interval.

9) No information for the material time interval in years for this material of XX- XX. *Choose a different material or shorten the selected useful life.*

10) Total life time is incorrect (< >100%). *Return with “ESC”, choose the erroneous lines with the mouse and delete these with “X” or “DEL” on your keyboard.*

11) The total of the mixture proportion is incorrect (<>100%). *Return with “ESC”, select the erroneous lines with the mouse and delete these with “X” or “DEL” on your keyboard.*

12) 100 % not reached or exceeded. *Return with “ESC”, select the erroneous lines with the mouse and delete these with “X” or “DEL” on your keyboard.*

13) No panel thickness can be calculated for the required wall thickness and no information can be made on the maximum base area.

14) The creep modulus is only determinable to the above temperature for this material. *Change the temperature or use a different material.*

15) The thermal load is too high for this given material. *Change the temperature or use a different material.*

16) In the DEMO version, only up to 350 mm is permitted. *The value is automatically corrected!*

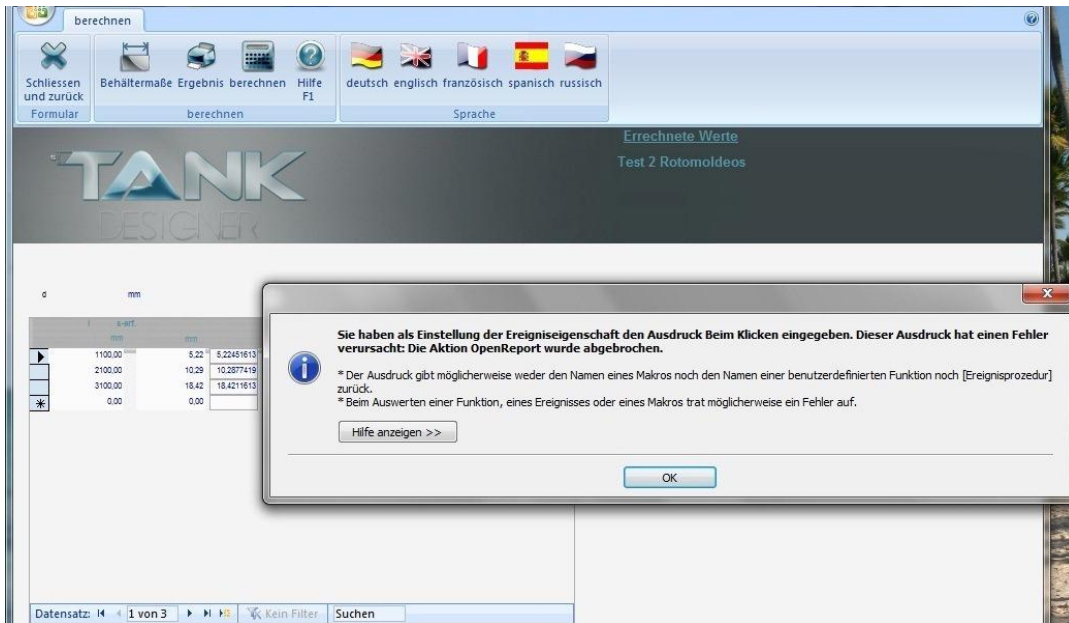
17) The ratio of the fill level for the total height results in fields which are not loaded by the fill medium. *Please change the number of fields to the above value.*

18) Readjust first heights. *Please choose again  and correct the beam distances to the tank height.*

19) The larger side must be defined as length! *Exchange length and width.*

20) The fill level must be smaller or be the same as the height. *Is automatically corrected!*

21) After clicking on “Result”, the following error message will appear:



A functional printer has not been installed. Install a printer and then start the application again!

5.3 Communicating with non-disclosed error messages

- A) If you discover an **error** when using Tank Designer which is **not included in this list**, we ask you to let us know.

Make a copy of your desktop (screenshot) for this:

➔ **Print: CTRL + print (on your keyboard)**

Attach this graphic file to an e-mail and please send it to the following e-mail address:

info@tankdesigner.com

We will send you a solution to this as soon as possible.

- B) You get an **illogically appearing result** or the programme show you a lot of “zeroes” (after calculate) in the result.

Please send us your database

- ➔ Copy the file: TD_ANW.ACCDB (in the directory “Tank designer”)
- ➔ Let us know whether it is rectangular or circular tanks
- ➔ and give your name and the designation (the name) of the tank

Send the file with the relevant information to the following e-mail address:

info@tankdesigner.com

With this file and your information, we can see where the error is in the developer programme. If necessary, we will provide a free update.

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PVC-C	40-1.5

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8. List of abbreviations and calculation variables

8.1 General abbreviations

E-CTFE		Ethylene-Chlorinetrichlorineethylene (e.g. Halar)
PE-HD		Polyethylene, high density
PE 63		PE-HD _(20°C, 50a) $K(A_1, A_3) = 6,3 \text{ N/mm}^2$ (a PE-HD type)
PE 80		PE-HD _(20°C, 50a) $K(A_1, A_3) = 8,0 \text{ N/mm}^2$ (a PE-HD type)
PE 100		PE-HD _(20°C, 50a) $K(A_1, A_3) = 10,0 \text{ N/mm}^2$ (a PE-HD type)
PE-el		Polyethylene, elektrical conductive ($\leq 10^{-6} \Omega$) based on PE 100
PP-H		Polypropylene, homopolymere
PP-B		Polypropylene, blockcopolymer
PP-R		Polypropylene, random-copolymer
PVC-U		Polyvinyl chloride, non- plasticized
PVC-NI		Polyvinyl chloride, normal impact resistant (a PVC-U type)
PVC-RI		Polyvinyl chloride, raised impact resistant (a PVC-P type)
PVC-C		Polyvinyl chloride, post- chlorinated
PVDF		Polyvinylidene fluoride
PVDF-C		Polyvinylidene fluoride, Copolymer
HS	-	Heated tool butt welding
N	-	Non- welded
W	-	Hot gas welding
WE	-	Hot gas, extrusion welding
σ_{zul}	N/mm ²	permissible stress
E_C	N/mm ²	modulus of creep (from DVS 2205 -1)
$K(A_1, A_3)$	N/mm ²	Creep strength in dependence of time (A_1) and temperature (A_3)
A_1	-	Dependence of the reigidity and stability of the service live
A_2	-	Reduction factor for the medium in the case of the proof of the strength
A_{2I}	-	Reduction factor for the medium in the case of the proof of the stability
A_3	-	Influence of temperature on the strength during the calculated service live
A_4	-	specific toughness as function of temperature
f_s	-	Long term welding factor
f_z	-	short term welding factor
S	-	Total safety coefficient $\triangleq \gamma_g$
s	mm	Thickness of sheets (roof, cylinder, base, ...)
γ_g	-	Total safety coefficient determine of partiela safety values $\triangleq S$
γ_I	-	partial safety concept, basic safety value
γ_M	-	partial safety coefficient for thermoplastic material
i.A.a.F	-	In accordance with formula (###), Formel
Formel	-	Digit of determined equation related to given condition
Typ	-	Digit or letter of chosen type of design (construction)

8.2 For rectangular tank calculation

A,B,C,D	-	operands
A_S	-	stressable cross section of a thread
a	mm	length of tank or of panel
a', b'	mm	lengths and heights of panels assigned to strengthening
b, b_n	mm	heights of tank or panel
B x H x s	mm	Flange width, height, thickness of metallic stiffener
c	mm	width of tank or of panel
E	N/mm ²	elastic modulus of the beam material (with plastics, corresponding to E_C)
E_{St}	N/mm ²	Elasticity modulus of the chosen stiffener material
$E_{I-} E_6$	-	type of fixation of the vertical stiffener
E_{Vn}	-	Calculation value for type of fixation
F_{An}	N	Force to be taken by the tie rod/ tie profile
f_{zul}	mm	maximum allowable deflection
F	N	force
H	mm	total internal height of tank
J	mm ⁴	moment of inertia of edge strengthening
k	-	coefficient
Light	-	Extruded Aluminum profile of light design (thin wall)
M	Nmm	bending moment
M_{Vn}	-	Coefficient related to type of vertical fixation for $W_R / W_H / W_V$
M_{Zn}	-	Coefficient related to type of vertical fixation for F_o / F_u taken by tie rod
N	N/mm ⁴	stiffness
NvT	-	number of the field (of the horizontal reinforcement) up to which the vertical reinforcement should extend upwards! Count the fields from the bottom up! Do not enter the height in mm here!
p, p_{max}	N/mm ²	excess pressure on tank bottom
p_m	N/mm ²	mean value of excess pressure for calculation of wall thickness
p_n	N/mm ²	mean value of excess pressure for calculation of beam
W	cm ³	moment or resistance of edge stiffening
W_R / I_R	cm ³ /cm ⁴	resistance and geometrical moment of horizontal edge stiffening
W_H / I_H	cm ³ /cm ⁴	resistance and geometrical moment of intermediate horizontal stiffening
W_V / I_V	cm ³ /cm ⁴	resistance and geometrical moment of vertical stiffening
$W_{X ist} / I_{X ist}$	cm ³ /cm ⁴	resistance and geometrical moment of chosen stiffening profile
Z_{VL}	-	Amount vertical stiffener on the long side of tank
Z_{VK}	-	Amount vertical stiffener on the short side of tank
Z_{ALo}	-	Amount tie rod on the long side of tank upper tank end
Z_{ALu}	-	Amount tie rod on the long side of tank lower tank end
Z_{AKo}	-	Amount tie rod on the short side of tank upper tank end
Z_{AKu}	-	Amount tie rod on the short side of tank lower tank end
$\alpha_1 \dots \alpha_5$	-	coefficient for calculation of deformation
$\beta_1 \dots \beta_5$	-	coefficient for calculation of wall thickness
$R_e / R_{0,2}$	N/mm ²	tensile yield point of metallic stiffening profile
σ_{St}	N/mm ²	permissible stress of metallic stiffening profile
γ_{MSt}	-	partial safety coefficient for material of metallic stiffening profile

8.2.1 additional for tanks made of twin wall sheets

a_{Kehl}	mm	weld thickness of fillet welds based on th_{min}
B_{KBh}	mm	height of a twin wall
B_{KBr}	mm	width of a twin wall
D_{DRip}	mm	recommended distance of cover ribs (under its own weight, without consideration of additional transport loads)
$E_{c\sigma}$	N/mm ²	creep modulus calculated from the existing tension
f_{zul}	mm	permissible deflection (based on the total thickness of the sheet)
I_{Ycross}	cm ⁴	area moment of Inertia, based on the height of a twin wall (in the Y axis)
I_{Xaxial}	cm ⁴	area moment of Inertia, based on the width of a twin wall (in the X axis)
N_{HKP}	-	coefficient of rigidity from the calculation with th_{equi}
th_{Bod}	mm	recommended thickness of a compact (solid) base plate
th_{DDP}	mm	thickness of the cover plates
th_{Deckel}	mm	recommended thickness of a compact (solid) cover plate
th_{DSt}	mm	thickness of the cross pieces
th_{equi}	mm	equivalent thickness, resulting from the comparison of the area moments of inertia of a compact (solid) and the twin wall sheet.
th_f	mm	required thickness from the bending for the cover plate of a twin wall
th_{min}	mm	smaller thickness of the two elements to be welded
th_{total}	mm	total thickness
th_{σ}	mm	required thickness from the tension for the cover plate of a twin wall
W_{Ycross}	cm ³	section modulus, based on the height of a twin wall (in the Y axis)
W_{Xaxial}	cm ³	section modulus, based on the width of a twin wall (in the Y axis)
σ_{Xaxial}	N/mm ²	existing tension, determined with the section modulus W_{Xaxial}
σ_{Ycross}	N/mm ²	existing tension, determined with the section modulus W_{Ycross}

8.3 For cylindrical tank calculation

a	mm	Thickness of weld
A_B	m^2	Area of the bottom
A_D	m^2	Area of the roof
A_j	m^2	Area exposed to the wind (partial area)
A_Z	m^2	Shell area of the cylinder
A_1	-	Reduction factor for the influence of the specific toughness (Corresponds to A_4 according to the DVS 2205-1 technical code)
A_2	-	Reduction factor for the medium in the case of the proof of the strength
A_{2K}	-	Reduction factor for the media influence in the case of the proof of the strength with an effect for three month
A_{2I}	-	Reduction factor for the medium in the case of the proof of the stability and the deformation
$b_{\bar{O}}$	mm	Width of the lifting lug
b_{PR}	mm	Width of the claw
c	-	Force coefficient according to DIN 10554
C	-	C1 • C2
C_1	-	Stress-increasing factor
C_2	-	Material-specific design factor
C^*	-	Coefficient for the circular cylinder subjected to external pressure loads
d	mm	Nominal inside diameter
d_A	mm	Outside diameter of the nozzle
d_L	mm	Whole diameter in the lifting lug
d_{max}	mm	Maximum cylinder diameter
d_{min}	mm	Minimum cylinder diameter
d_{Sch}	mm	Diameter of the shackle
$E_K^{T^{\circ}C}$	N/mm^2	Elastic modulus in the case of short-time loading for $T^{\circ}C$
$E_K^{20^{\circ}C}$	N/mm^2	Elastic modulus in the case of short-time loading for $20^{\circ}C$
$E_K^{30^{\circ}C}$	N/mm^2	Elastic modulus in the case of short-time loading for $30^{\circ}C$
$E_L^{20^{\circ}C}$	N/mm^2	Elastic modulus in the case of long-time loading for $20^{\circ}C$
f_s	-	Long-time welding factor
f_{sD}	-	Long-time welding factor for the roof
f_z	-	Short-time welding factor
f_{zD}	-	Short-time welding factor for the roof
g	m/s^2	Acceleration due to gravity ($9.61 m/s^2$)
g_A	N/mm^2	Equivalent area load for the nozzles and similar items on the roof
g_D	N/mm^2	Area-related weight of the roof
G_B	N	Dead load of the bottom
G_D	N	Dead load of the roof
G_E	N	Total dead load
G_F	kN	Load of the filling material
G_S	N	Snow load
G_Z	N	Dead load of the cylinder
h_F	mm	Filling of the tank
$h_{F,i}$	mm	Filling height of the course i
h_{RF}	mm	Residual filling height

h_z	mm	cylindrical height
$h_{z,i}$	mm	Height of the course i
h_{zF}	mm	Height of the lowest course
K_K^{vorh}	N/mm ²	Stresses effective for a short time
$K_{K,d}^{vorh}$	N/mm ²	Dimensioning value of stresses effective for a short time
$K_{M,d}^{vorh}$	N/mm ²	Dimensioning value of stresses with a medium effective duration
$K_{L,d}^{vorh}$	N/mm ²	Dimensioning value of stresses effective for long time
K_K^*	N/mm ²	Creep strength for 10 ⁻¹ hours
K_L^*	N/mm ²	Creep strength for the computational working life at the mean effective temperature
$K_{M,d}^*$	N/mm ²	Dimensioning value of the creep strength for the medium effective duration (e.g. in the case of snow for three months at 0°C)
$K_{K,d}^*$	N/mm ²	Dimensioning value of the creep strength for 10 ⁻¹ hours
$K_{L,d}^*$	N/mm ²	Dimensioning value of the creep strength for the computational working life at the mean effective temperature
l_o	mm	Length of the upper course of the equivalent cylinder
l_m	mm	Länge des mittleren Schusses des Ersatzzylinders
l_u	mm	Länge des unteren Schusses des Ersatzzylinders
M_W	Nm	Bending moment in the case of a wind load
$n_{Z,d}$	N/mm	Dimensioning value of the tensile force on the diaphragm at the lower edge of the cylinder
$\Sigma p_{DK,D}^{vorh}$	N/mm ²	Short-time dimensioning value of the effects on the roof according to Table 5 or 6
$PD_{L,M,d}^{vorh}$	N/mm ²	Dimensioning value of the effects on the roof according to Tables 5 + 6
p_{eu}	N/mm ²	Radially symmetrical equivalent loading caused by wind pressure
$p_{kM,d}$	N/mm ²	Dimensioning value of the critical shell buckling pressure
p_{stat}	N/rnm ²	Overpressure at the tank bottom due to the filling medium
p_{max}	N/rnm ²	Auxiliary variable
p_s	N/rnm ²	Snow load on the roof
$p_{stst,i}$	N/mm ²	Overpressure per lower edge of the graduation due to the filling medium
p_u	N/rnm ²	Continuously effective external pressure (or internal partial vacuum)
p_{uK}	N/rnm ²	External pressure (or internal partial vacuum) effective for a short time
p_{us}	N/rnm ²	Partial vacuum due to wind suction
$p_{\bar{u}}$	N/rnm ²	Continuously effective internal pressure
$p_{\bar{u}K}$	N/rnm ²	Internal pressure effective for a short time
$p_{W,d}$	N/rnm ²	Auxiliary variable
p_l	N/rnm ²	Auxiliary variable
$p_{\sigma,d}$	N/rnm ²	Auxiliary variable
q_j	kN/m ²	Impact pressure on the partial area A_j
q_{max}	kN/m ²	Maximum impact pressure at the tank
r	mm	Radius of the cylinder
R_d	N/mm ²	dimensioning value of the stresses
s_a	mm	Executed wall thickness of the basic component
s_B	mm	Wall thickness of the bottom
s_D	mm	Wall thickness of the roof
S_d	N/mm ²	Dimensioning value of the stresses
s_M	mm	Wall thickness of a non-graded cylinder due to under pressure
$s_{\bar{O}}$	mm	Wall thickness of the lifting lug

s_Z	mm	Wall thickness of the cylinder
s_{ZF}	mm	Wall thickness of the lowest course
s_{ZFC}	mm	Statically required wall thickness resulting from the longitudinal stress
s_{ZFR}	mm	Statically required wall thickness resulting from the ring tension
s_{ZF}^*	mm	Statically required wall thickness of the lowest course
s_{Zm}	mm	Mean wall thickness of the cylinder
$s_{Z,1}$	mm	Wall thickness of the highest course
$s_{Z,i}$	mm	Wall thickness of the course i
$s_{\bar{O}}$	mm	Wall thickness of the upper course of the equivalent cylinder
T_A	°C	Mean ambient temperature
T_D	°C	Mean roof temperature
T_D^*	°C	Mean roof temperature for the summer load case
T_M	°C	Mean media temperature (according to Miner, see DVS 2205-1)
T_W	°C	Mean temperature of the bond wall
T_Z	°C	Mean temperature of the cylinder wall
u	%	Permissible out of roundness
V	m ³	Filling volume
v_A	-	Weakening coefficient
w_{gr}	mm	Tolerable lifting path
W_j	kN	Wind load
z	-	Number of anchors
α	-	Auxiliary value
α_D	-	Pitch of the roof
β	-	Coefficient
δ	-	Coefficient
δ_A	-	Coefficient to determine A_{2K}
δ_B	-	Coefficient for the calculation of the bottom
δ_W	-	Coefficient
δ_S	-	Coefficient t für die Dachberechnung
ε	%	Tolerable edge fiber expansion
$\eta_{A,i}$	-	Utilization of the axial stability in course i
η_M	-	Utilization of the shell pressure stability
γ_F	-	Partial safety coefficient of the effect/stresses
γ_I	-	Weighting coefficient depending on the loading type
γ_M	-	Partial safety coefficient of the resistance/stress ability
κ	Grad	Angle of the roof in relation to the perpendicular
λ	-	Coefficient for the shell pressure stability
ρ	g/cm ³	Density of the material
ρ_F	g/cm ³	Density of the filling medium
σ_G	N/mm ²	Compressive stress on the diaphragm resulting from the dead weight
σ_d^{vorh}	N/mm ²	Dimensioning value of the crucial compressive stress in the conical roof
$\sigma_{i,d}^{vorh}$	N/mm ²	Dimensioning value of the crucial axial compressive stress in the course i
$\sigma_{k,d}$	N/mm ²	Dimensioning value of the critical buckling stress in the conical roof
$\sigma_{k,i,d}$	N/mm ²	Dimensioning value of the critical axial buckling stress in the course i3
σ_W	N/mm ²	Compressive stress on the diaphragm resulting from the wind load

8.3.1 Additional for flat roof calculation

b_m	mm	Width also bearing load
f_{sD}	-	Long-time welding factor for the weld of the roof plate
f_{sD}	-	Short-time welding factor for the weld of the roof plate
β_F	-	Coefficient for roof calculation
β_S	-	Coefficient for roof calculation
g_D	N/mm ²	Area load resulting from dead weight of the roof plate
g_{Steife}	N/mm ²	Uniformly distributed area load resulting from stiffeners and bulkheads
h_S	mm	Height of the stiffeners
I_S	mm ⁴	Moment of inertia
k	-	Buckling value
p	N/rnm ²	Effect on the roof
$p_{DK,d}$	N/rnm ²	Dimensioning value of the short-time effects on the roof
$p_{DL,d}$	N/rnm ²	Dimensioning value of the long-time effects on the roof
p_E	N/rnm ²	Equivalent load (for a short time)
m	Nmm/mm	Bending moment
n	-	Number of stiffener and bulkheads
s_S	mm	Wall thickness of the stiffener
z_S	mm	Distance away from the center of gravity
μ	-	Poisson's ratio
$\sigma_{k,d}$	N/mm ²	Dimensioning value of the compressive stress
σ_d^{vorh}	N/mm ²	Dimensioning value of the compressive stress in the roof plate

8.3.2 Additionally for earthquake safety analysis

a_g	m/s ²	Ground acceleration
a_h	m/s ²	Horizontal ground acceleration
a_v	m/s ²	Vertical ground acceleration
A_{Erd}	N	Horizontal force component of ground acceleration
A_R	m/s ²	Cross section area of the open annular cross section
A_S	m/s ²	Shear area of the replacement beam
$A_{SW,i}$	mm ²	Shear area of the section i in collection container
b_{Blo}	m/s ²	Width of the blocks
B_{Erd}	m/s ²	Horizontal force of the upper nozzle
e_i	-	Eccentricity of section i
f_{ai}	-	Reduction factor of eccentricity
g	m/s ²	Ground acceleration
$G_K^{T^\circ C}$	N/mm ²	Shear modulus for short term stress at T°C
h	mm	Height of the replacement beam
$h_{A,j}$	mm	Height of the axis of the section j
H_{Blo}	N	Horizontal force in the block
H_{Erd}	N	Total horizontal force resulting from the earthquake
H_F	N	Horizontal inertial force resulting from the filling
h_g	mm	Total height of the tank
H_{GA}	N	Horizontal inertial force from G_A
H_{Sch}	N	Horizontal force in the bulkhead
h_{St}	mm	Height of the upper nozzle measured over the container base

I	mm^4	Moment of inertia of the replacement beam
$I_{W,i}$	mm^4	Moment of inertia of the section i in collection container
k_f	-	Concentration factor according to the supplementary sheet 7
l_{Blo}	mm	Length of the blocks
l_{Sch}	mm	Length of the bulkheads
M_{Erd}	Nmm	Earthquake moment in height x for tanks without collection container
$M_{\text{Erd,B}}$	Nmm	Earthquake moment in height x for tanks in the collection container
$M_{\text{Erd,B,i}}$	Nmm	Earthquake moment at the lower edge of section i of the tank in the collection container
$M_{\text{Erd,i}}$	Nmm	Earthquake moment at the lower edge of section i of the tank without collection container
$M_{\text{Erd,j}}$	Nmm	Earthquake moment in height of the support j
$M_{\text{Erd,W}}$	Nmm	Earthquake moment in height x for the collection container
$M_{\text{Erd,W,i}}$	Nmm	Earthquake moment at the lower edge of section i of the collection container
m_k	kNs^2/m	Mass of roof load
n_{Blo}	-	Number of blocks
n_{Sch}	-	Number of bulkheads
$N_{\text{R,d}}^{\text{Füllung}}$	N	Rated value of the global compressive force resulting from the filling in the nozzle
q	-	Behaviour coefficient = 1.5
S	-	Subsurface parameters
$s_{1/3}$	mm	Wall thickness of the cylinder in lower third of the tank
s_j	mm	Wall thickness of the cylinder at the level of nozzle j
T	s	Period of oscillation
$T_{\text{Bieg,mk}}$	s	Period of oscillation of the filled tank
T_{F}	s	Period of oscillation of a weightless bending cantilever beam with head mass
$T_{\text{Schub, mk}}$	s	Period of oscillation of a weightless sliding cantilever beam with head mass
w_{bieg}	mm/N	Bending deformation of the collection container at level of the nozzle for 1N
w_{Schub}	mm/N	Shear strain of the collection container at level of the nozzle for 1N
W_{R}	mm^3	Resistance moment of the open annular cross section
x	mm	Height of the examined section starting from the container base
z_s	mm	Centroidal distance of the open ring from the cylinder axis
β_o	-	Reinforcement coefficient of spectral acceleration = 2.5
η	-	Attenuation correction coefficient = 1.0
γ_{F4}	-	Partial safety factor of impact stress (earthquake) = 1.0
γ_{IE}	-	Importance factor according to DIN 4149 table 3 referred to as γ_1 there
λ	-	Reduction factor for ripples
ω	1/s	Angular frequency

8.3.3 Additionally for cylindrical skirt type tanks (in preparation)

Tank Designer 5

8.4 Additionally for cost analysis

th	mm	Panel thickness
Ø	mm	Diameter
H _n	mm	Horizontal safety section on the upper edge (plastic U section)
H _{n-1 bis 1}	mm	Intermittently horizontal safety section (plastic U sections)
V	mm	Vertical safety sections (plastic U sections)
L	mm	Total length of a connecting piece
n _{zs}	piece	Number of blank cuts
n _{BH}	piece	Number of movements / transports of the panels
m _{V-SCH}	m	Milling work on the weldseam required for a length of one metre
m _{W-SCH}	m	Number of weldseam roots required for a length of one metre
m _{E-SCH}	m	Load-bearing weldseams required for a length of one metre
n _{TE}	piece	Number of loading and unloading operations of a welding or bending machine
n _{HE-S}	piece	Number of hotplate welds on the container body
n _{AK-BI}	piece	Number of corners or bends on the container body
n _{BH}	piece	Number of movements / transports of the container body
m _{S-SCH}	m	Number of weldseams required for one-metre length of the safety section
n _{HE-S}	piece	Number of hotplate welds on the safety section
n _{TE-S}	piece	Number of loading and unloading operations of a welding machine for safety sections
pos / fix	piece	Number of sections that should be fixed and itemised
\$		Currency as preferred (depends on the entry in the database)
HK	\$	Production cost
VK	\$	Selling expense (offer price)

9. Warranty and liability

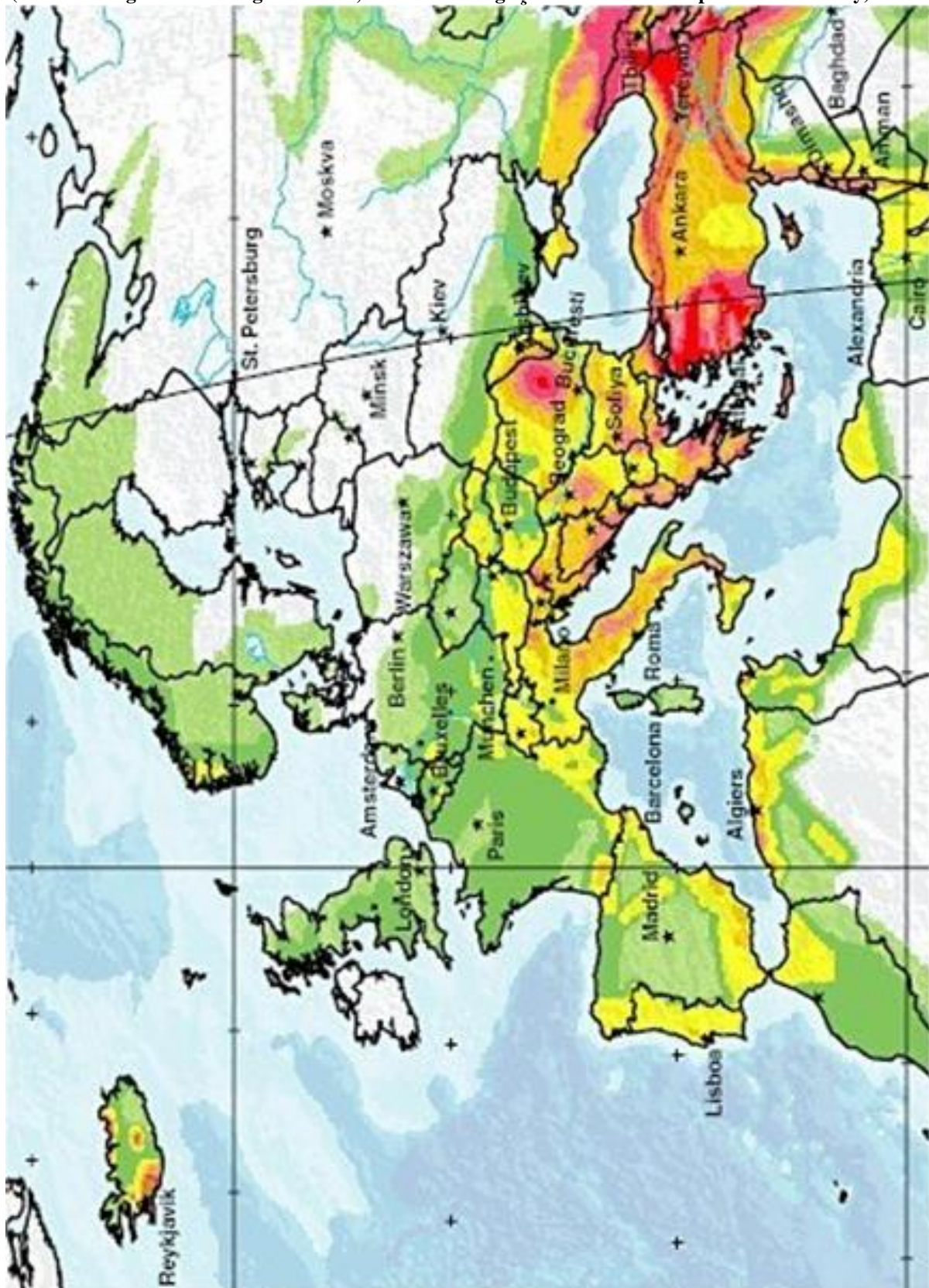
The existing programme is based on the publications of the Deutschen Verbands für Schweißtechnik e.V., Düsseldorf [German Welding Society] and the European Directive EN 12573. The directives of the DVS as well as the European standards (EN) which were not mandated, apply only as recommendations, i.e. these are not normative. These publications were prepared by a group of experienced experts serving on a voluntary collaborative team. The user of Tank Designer must examine to what extent the contents of the corresponding directive/recommendation applies to his particular case and if the version available to him is still applicable. Apart from that, the guarantee and liability conforms to the provisions of the law.

Each programme user is obliged to examine all information on the tank statics for correctness using the relevant standards before manufacturing a tank. If errors exist in the calculation, these are to be reported immediately to the software manufacturer. No liability is assumed for damages which result from erroneous entries by the programme user. For errors in the software resulting from improper transport or faulty installation or a faulty PC, no liability is assumed. For errors which are caused by computer accessories or TAN files, no warranty will be honoured.

10. Attachment

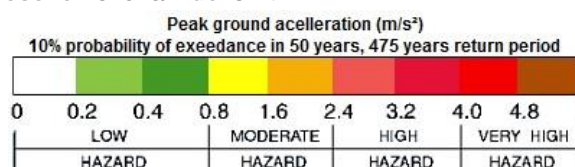
10.1 Orientation guide: Earthquake zones in Europe / Mediterranean region

(Orientation guide without guarantee *, for determining a_g outside Federal Republic of Germany)



Quelle: <http://www.balkanforum.info/f37/erdbeben-kosovo-131019/index8.html>

(*see Chap. 4.3.3, Legal notice!)

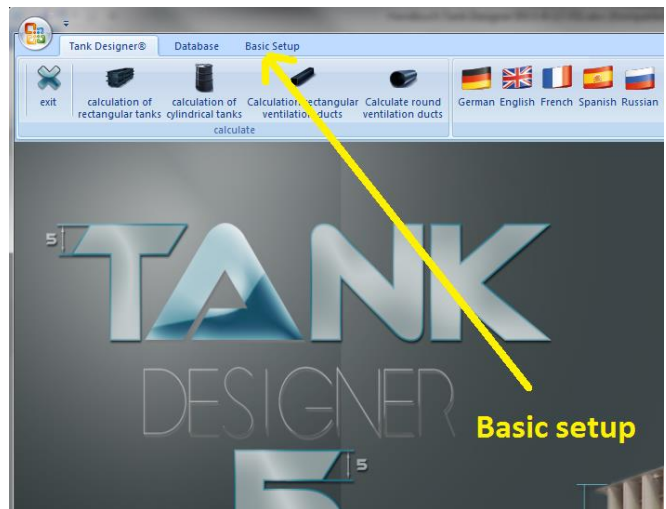


10.2 Listing of integrated sheet thickness variants (metric / imperial)

metric = Basis setup:

17.5 mm only if activated in tab „basic setup“

Sheet thickness in mm	
thickness mm	max. tolerance
3	3,17
4	4,2
5	5,23
6	6,26
8	8,32
10	10,38
12	12,44
15	15,53
(17,5)	(18,105)
20	20,68
25	25,83
30	30,98
35	36,13
40	41,28
45	45,43
50	51,58
55	56,73
60	61,88
65	67,03
70	72,18
75	77,33
80	82,48
85	87,63
90	92,78
95	97,93
100	103,08
110	113,38
120	123,69
130	133,98
140	144,28
150	154,58



Imperial:

Only if activated in the tab „basic setup“

Sheet thickness inch (if activated)			
thickness inch	thickness mm	max. tolerance	displayed thickness mm
3/16	4,7	4,92	5
1/4	6,4	6,67	6
1/2	12,7	13,16	13
3/4	19,1	19,75	19
1	25,4	26,24	25
1 1/2	38,1	38,32	38
2	50,8	52,4	51
2 1/2	63,5	65,49	64
3	76,2	78,57	76
3 1/2	88,9	91,65	89
4	101,6	104,73	102
4 1/2	114,3	117,81	118
5	127	130,89	131
5 1/2	139,7	143,97	144
6	152,4	157,05	157

10.3 step by step calculation guide for rectangular tanks

Example:

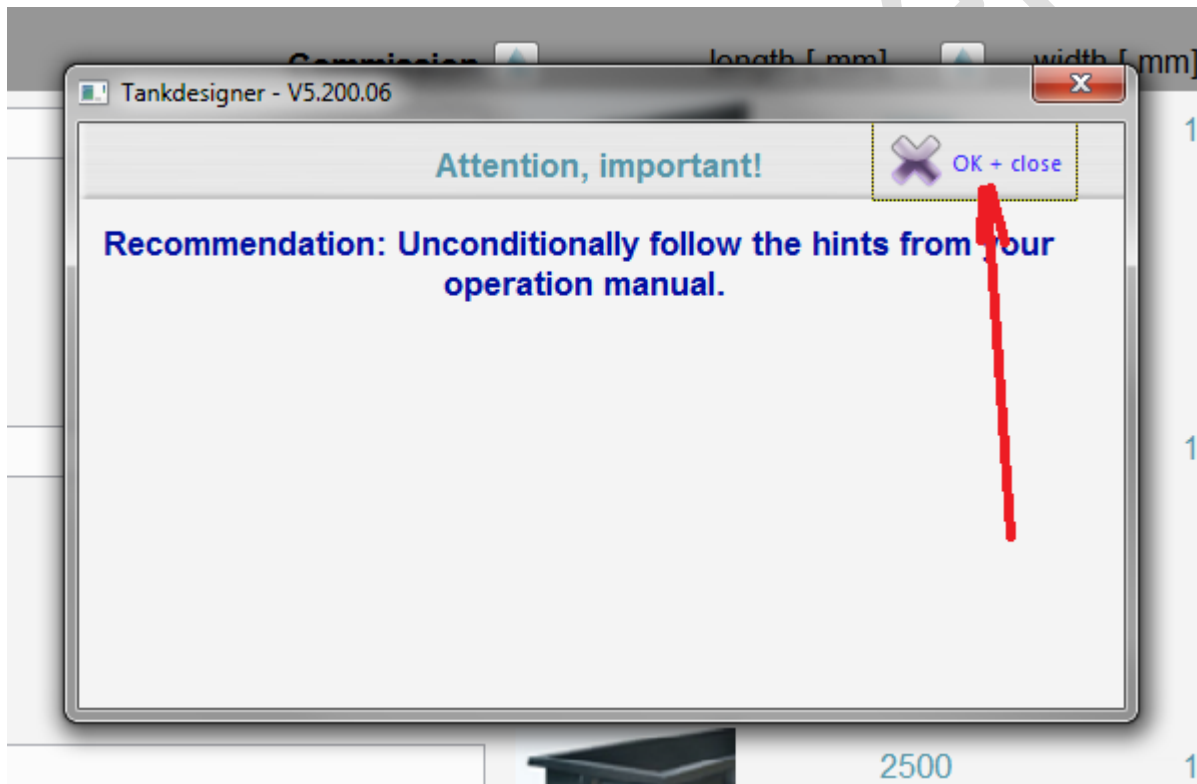
Dimension (L x W X H):	3200 x 1000 x 1400 mm
Requested material:	SIMONA Alpha Plus (PP-H)
Innerwall welding process:	heated tool butt welding (HE)
Operation temperature:	60°C
Expected service life:	10 years
Density:	1,3 g/cm ³
Liquid to handle / store:	HCL ≤ 37%

Explanation:

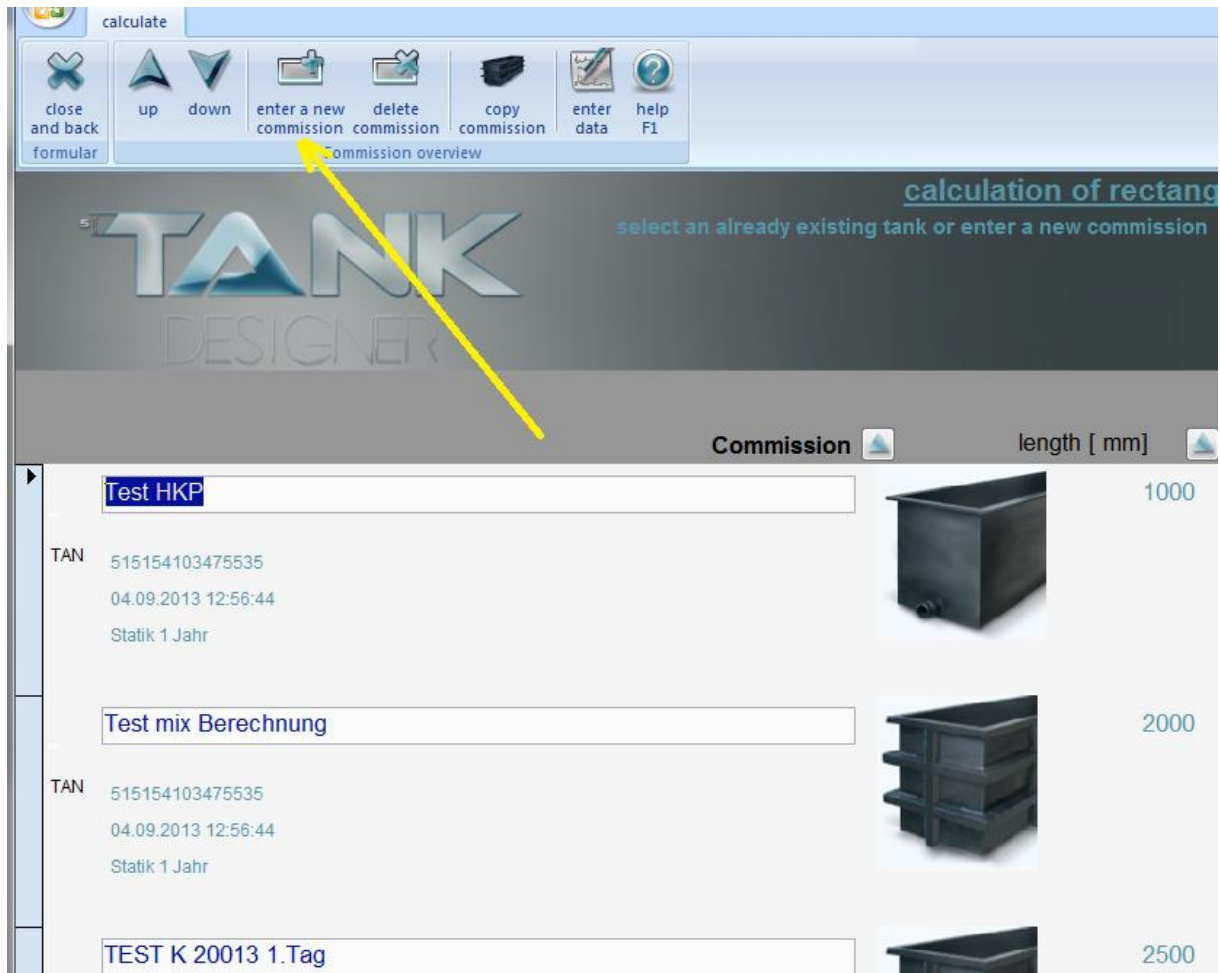
If you find the hint (e.g.): see chapt. 4.2.1 please study the user manual

The calculation process:

Start	Tank Designer software	double click onto the logo
Start	rectangular tanks	click onto "calculation of rectangular tanks"
Confirm	You have read the user manual	click onto "OK + close"

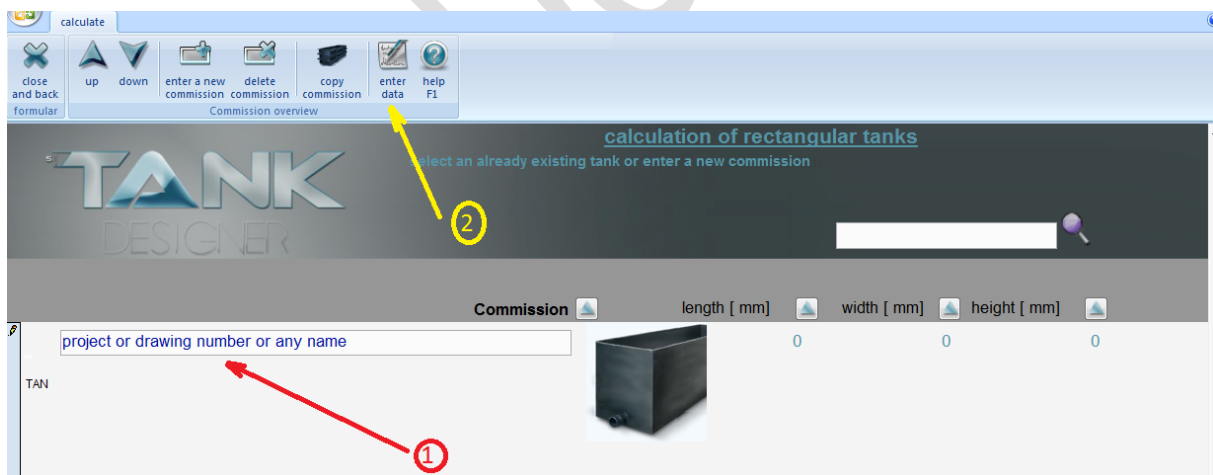


Choose register the calculation in the catalog click onto "enter a new commission"



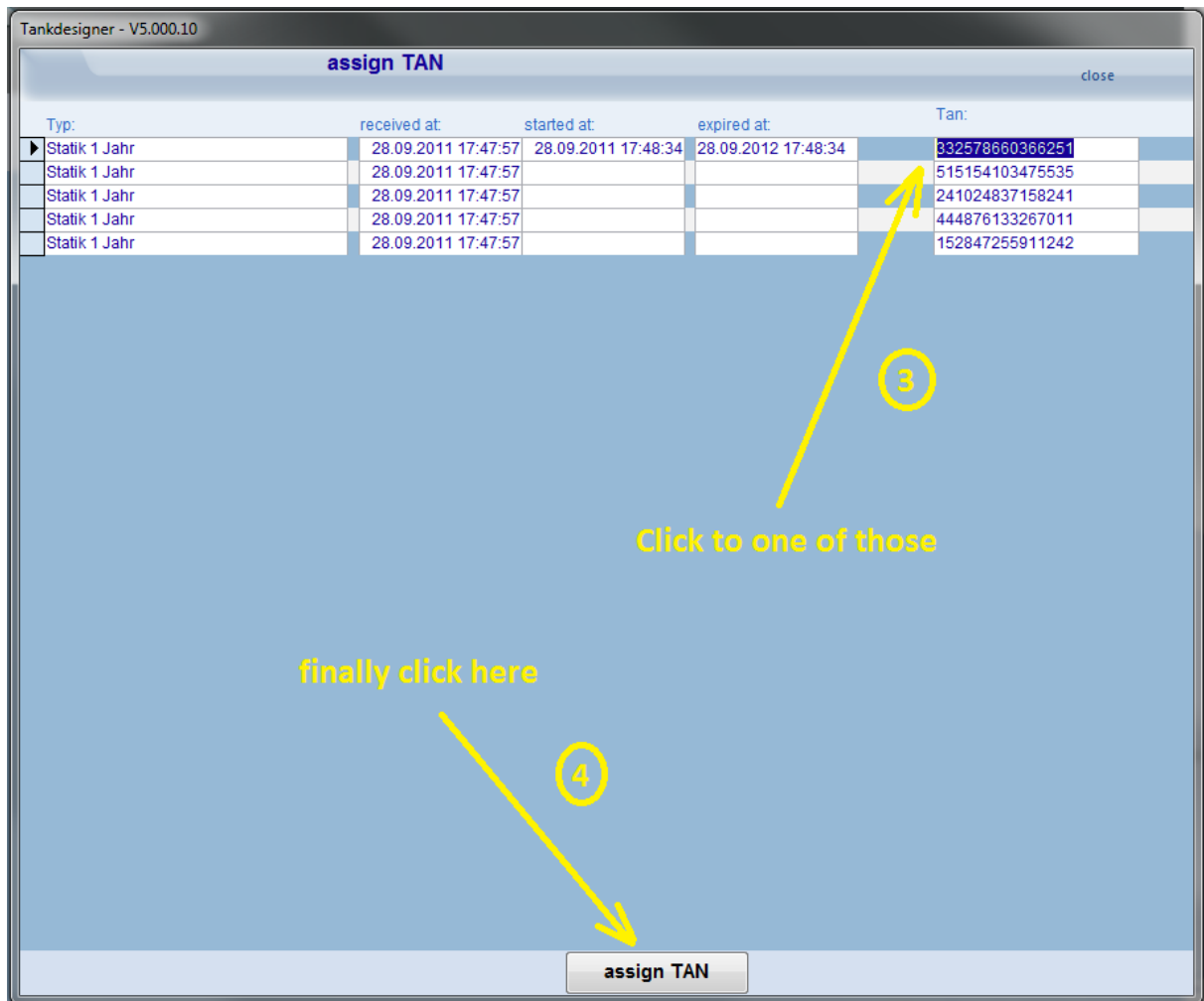
Enter 1 name of your commission
Move 2 continue to insert data

Choose anything you will remember
click onto "enter data"

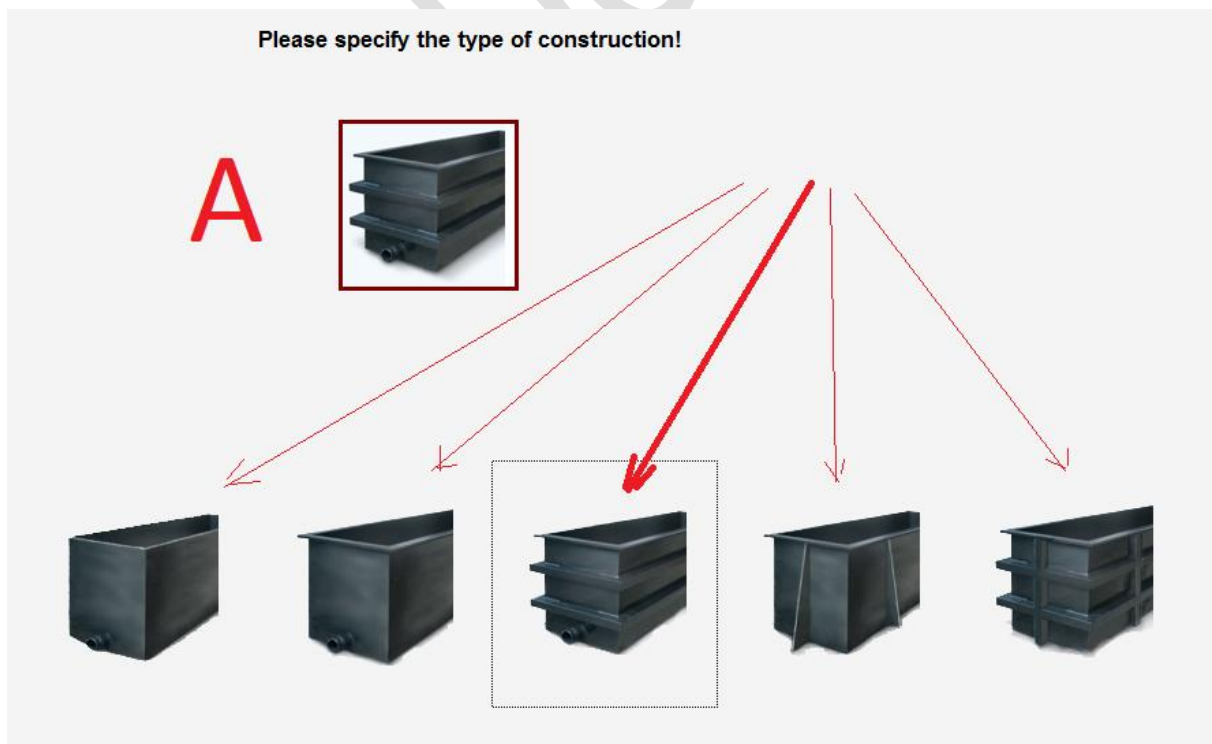


Choose 3 select a started TAN
Move 4 continue to insert data

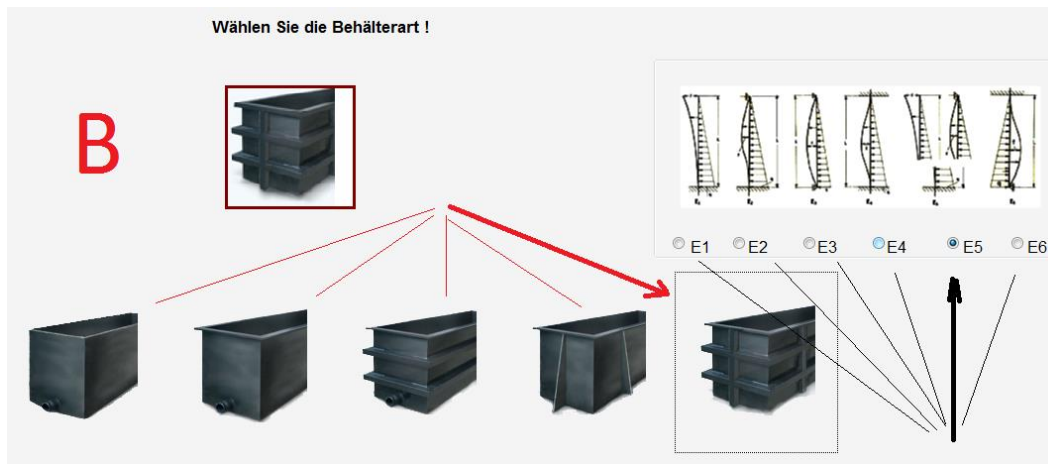
(each TAN is valid for one year)
click onto "assign TAN"



Choose basic design of the tank (A) click onto expected design (see chapt. 4.2.1)



If you have chosen type E) and purchased module Z 1.1 following window will pop up instead (B):

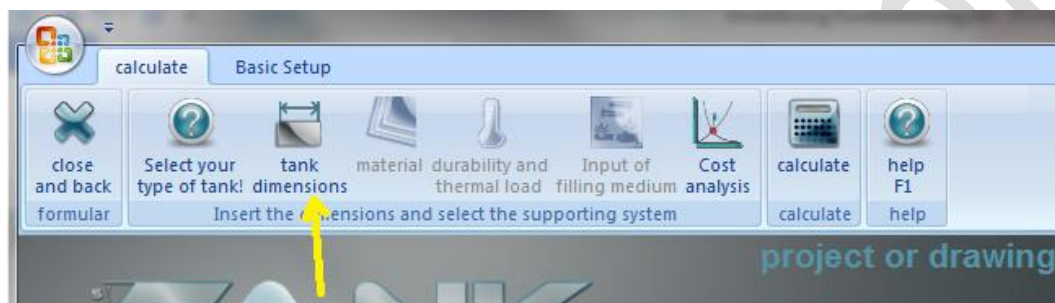


In this case you should also choose the design of the fixation of the vertical stiffener (see chap. 4.2.1)
If you have not purchased Z 1.1 only E and E is available (see chap. 4.2.1)

Continue with (A)

Move 4 continue with insert data

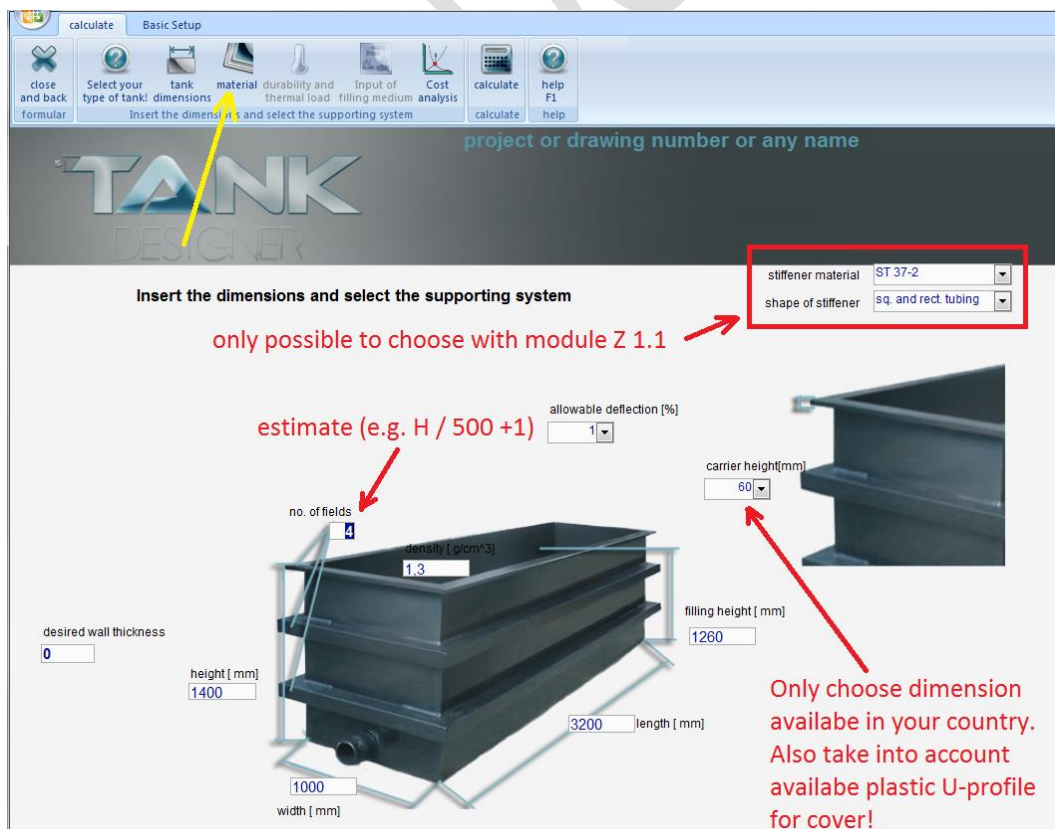
click onto "tank dimensions"



Enter
Move

data as requested
continue with insert material

see example values on page one
click onto "material"



Enter

requested data

please study the picture (see chap 4.1.3)

Move

continue with application data

click onto "durability and thermal load"

Basics for the construction

Construction material: PP Alpha Plus

Global safety factor: Loading under alternating conditions (e. g. temperature, filling level). Possible danger to person, objects and environment in the event of failure.

Welding (tank wall): HS

Approved material, DIBt listed? ☒

Remarks: Here you could enter any design related remark you need to tell your customer.

Please always study the definition of each safety factor (see chap. 4.1.3)

Please ask your material supplier for approval!

Tank corners and base connection are save if the weld factor is $\geq 0,6$! Hence choose factor for innerwall joining process.

Enter

requested data

please study the picture (see chap 4.1.4)

Move

continue with application data

click onto "Input of filling medium"

durability and thermal load

Ignore (only used for calculation by hand)

lifetime in years: 10

Aver. temp. [cels. degr]: 0

long term value (miner): 0,0

calculate

temperature cels. degr	period in %	period in h	period in years
60	100	87600	10
0	0	0	0

Choose 5

select a database (see chap. 4.1.5)

only internal database comes including data

Choose6

filling liquid (see chap. 4.1.5)

search in internal (or changeable) database

project or drawing number or any name

TANK DESIGNER

Input of filling medium

Construction material: **PP Alpha Plus**
 60 cels. degr

medium: internal database, changeable database, direct input

density: 1,3

medium table:

	PE-HD /63/80/100	PP	PVC-U	PVCC	PVDF
	20 30 40 50 60 80	20 30 40 50 60 80 95	20 30 40 50 60	20 30 40 50 60 70 80 95	20 30 40 50 60 80 100 120
A2					
A21					

Choose

find the liquid by its chemical name

only internal database comes including data

enter first letters of liquid then press enter

search: hydro

medium	chemical formula	conc	PEHD20	PEHD30	PEHD40	PEHD50	PEHD60	PEHD80	PP20	PP30
1,1,1-Trichlorethane	CH3CCl3	TR								
1,3,5 Trimethylbenzene	C8H3(CH3)3	100	1,11	1,11	1,11	1,11	1,11			
4- toluenesulphonic acid	CH3CH6H4SO2Cl	TR								
6-Hexanol chlorine -(1)	HO-(CH2)6-Cl	TR								
Acetic Acid	CH3COOH	<=80	1,6	1,6	1,6				1,4	1,4
Acetic Acid	CH3COOH	<=60	1,2	1,2	1,2				1,4	1,4
Acetic Acid	CH3COOH	<=50	1,2	1,2	1,2				1,4	1,4
Acetoacetic ethyl ester	CH3CO CH2 COO C2H5	100	1	1	1	1	1			
Acetoacetic methyl ester	CH3CO CH2 COO CH3	100	1,18	1,18	1,18	1,18	1,18			
Air	N2/O2	100	1	1	1	1	1		1	1
alkaline solution		100	2	2	2	2	2			
Alum (Me(I) Me(III) sulphate)		S	1	1	1	1	1		1	1
Aluminium chloride	Al Cl3	<=GL	1	1	1	1	1		1	1
Aluminium fluoride	Al F3	S								

Choose 7

find the liquid by its chemical name

make sure there are data (values) available!

Move 8

continue with application data

click onto "OK + close"

search: hydro*

medium	chemical formula	conc	PEHD20	PEHD30	PEHD40	PEHD50	PEHD60	PEHD80	PP20	PP30
Hydrobromic acid	HBr	<=50								
Hydrochloric acid	HCl	<=37	1,2	1,2	1,2					
Hydrochloric acid	HCl	<=30	1,2	1,2	1,2			1,75	1,75	
Hydrofluoric acid	HF	<=85								
Hydrofluoric acid	HF	<=40	1,4	1,4	1,4			1,4	1,4	1,4
Hydrofluoric acid	HF	<=10	1,4	1,4	1,4			1,4	1,4	1,4
Hydrofluoric acid	HF	<=75	1,4	1,4	1,4			1,4	1,4	1,4
Hydrogel emulsion (pH value = 9,5)		100								
Hydrogen peroxide	H2O2 (PE+ PP max. 30°	<=70	1,4	1,4						
Hydrogen sulfide	H2S	<=GL								
Hydroiodic acid	HI	<=GL								
Hydroxyethylethylenediaminetri-		H	1,4	1,4	1,4				1,4	1,4
Hydroxyl ammonium sulfate	(NH2OH)2 * H2SO4	<=12	1	1	1	1	1		1	1
Hydroxyl ammonium sulfate	(NH2OH)2 * H2SO4	<=12	1	1	1	1	1		1	1

make sure you'll find values for requested material and temperature

Move

continue with calculation

Ignoring “cost analysis” (see chap. 4.5)

The screenshot shows the 'Basic Setup' window of the TANK DESIGNER software. The interface includes a menu bar with 'calculate', 'Basic Setup', and 'language'. Below the menu bar are icons for 'close and back formular', 'tank dimensions', 'result', 'optimization', 'calculate', and 'help F1'. The 'language' section shows flags for German, English, French, Spanish, Russian, Portuguese simplified, Turkish, Polish, Dutch, and Czech. The main area displays 'project or drawing number or any name' with the value '3'. Below this, there are input fields for 's nec' (17,15 mm), 'S 20' (circled in red), and 'no. of fields' (4). The 'S 20' field is labeled 'recommended thickness'. The 'no. of fields' field is labeled 'info about tie rod (if needed)'. The main table shows dimensions for stiffeners. The first column is 'b [mm]' with values 240, 300, 380, 480. The second column is 's nec [mm]' with values 16,50, 16,46, 17,15, 14,97. The third column is 'rim stiffener' with values 80 x 160 x 5, 80 x 160 x 4, 60 x 120 x 4, 60 x 40 x 2. The fourth column is 'PP/Al/Steel' with values 60 x 1027, 60 x 928, 60 x 710, 60 x 393. The fifth column is 'PP/Al/Steel' with values 60 x 757, 60 x 684, 60 x 523, 60 x 290. The sixth column is 'PP/Al/Steel' with values 60 x 601, 60 x 543, 60 x 415, 60 x 230. The seventh column is 'long side' with values 0, 0, 0, 0. The eighth column is 'face side' with values 0, 0, 0, 0. The ninth column is 'dimension' with values 0, 0, 0, 0. The tenth column is 'count' with values 0, 0, 0, 0. The eleventh column is 'dimension' with values 0, 0, 0, 0. The 'Cost analysis' section shows 'manufacturing cost (MC) [\$]' as 5457, 'Net Weight [kg]' as 521, and 'working hours [h]' as 25,7. Annotations include: 'to change e.g. amount of stiffener' pointing to the 'b' column; 'to view or print detailed results' pointing to the 'result' button; 'to move stiffener position manually' pointing to the 's nec' field; 'position of stiffener' pointing to the 'b' column; 'dimension of horizontal stiffener / info about vertical stiffener in the printed documents' pointing to the 's nec' column; 'alternative dimension for solid plastic stiffener (alternative to steel)' pointing to the 'rim stiffener' column; and 'info about tie rod (if needed)' pointing to the 'no. of fields' field.

	b [mm]	s nec [mm]	rim stiffener	PP/Al/Steel	PP/Al/Steel	PP/Al/Steel	long side	face side	dimension	count	dimension
1	240	16,50	80 x 160 x 5	60 x 1027	60 x 757	60 x 601	0	0	0	0	0
2	300	16,46	80 x 160 x 4	60 x 928	60 x 684	60 x 543	0	0	0	0	0
3	380	17,15	60 x 120 x 4	60 x 710	60 x 523	60 x 415	0	0	0	0	0
4	480	14,97	60 x 40 x 2	60 x 393	60 x 290	60 x 230	0	0	0	0	0

Cost analysis

manufacturing cost (MC) [\$]	5457
Net Weight [kg]	521
working hours [h]	25,7

If you are not satisfied with the result:

Move back to “tank dimension” and change values, e.g. number of fields (more fields = thinner wall, less fields = thicker wall), or change basic design e.g. to Type D or E. Then you have to enter distance between the vertical stiffener (field width) as well as vertical stiffener flange width additionally! You may also change material of sfety factor or whatever leads to better result.