WIDTH OF ANNULAR BOTTOM PLATES

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Abstract: *During the exploitation empty steel tanks could be exposed to loads that can provoke overturning or sliding. Usually tank's movement do not leads to destruction but it could tear shell in connections with external pipelines. Therefore all steel tanks should be assured against uplift, overturning or sliding.*

Peripheral part of bottom with its thickness, width and yeld strength participates in forming of stabilizing forces that hold the tanks in design condition.

Key words: *steel tanks, overturning stability, annular bottom*

During their exploitation, the empty tanks can be exposed of the impacts which can change tank's position. Tank's dislocation from their foundation usually does not cause their destruction but it can provoke tearing of shell in the place of joint with technological pipelines and the tanks will go out of service. In that reason all tanks must be secured against the change in their position i.e. stabilizing efforts must be bigger than the dislocating one.

The peripheral bottom part (annular bottom plates) also takes part in the calculations, as a part of stabilising forces, depending on its thickness, width, strength.

1. Foreword

During their exploitation the tanks may not be completely emptied. The product layer which remains inside of tank have a height ***h*** (fig. 1) equal to the distance between upper surface of bottom and lower edge of outlet pipeline. This remaining product and tank's over pressure have been engrossed by the part of the bottom where the bottom is very close to the shell and facilitate the tank's stability

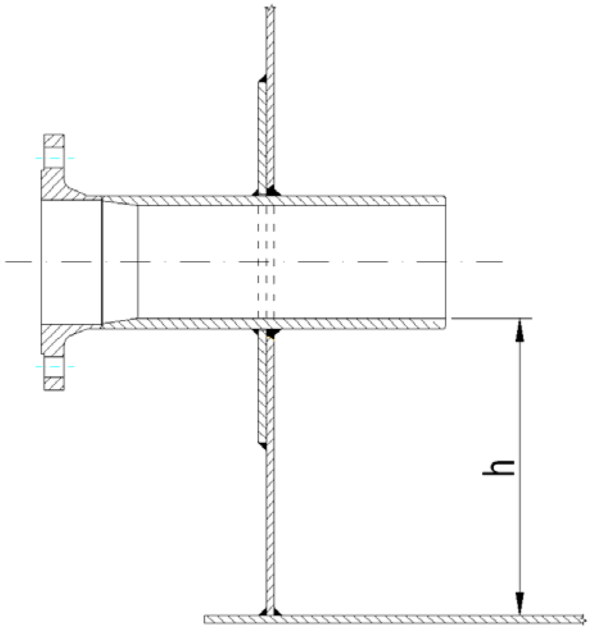


fig. 1 Outlet pipeline and height of remaining layer of liquid

According to [1] and [2], the calculated width ***L*** of the assisting bottom part always is 500 mm, independently on the steel, thickness and the real width l_e of the annular bottom plates. It is necessary to point out that according to [4] and [5], the minimum distance between the shell and the central bottom part l_e (fig. 2), is 500 mm, so the accepted in [1] and [2] value of the calculated width ***L*** has its logic explanation.

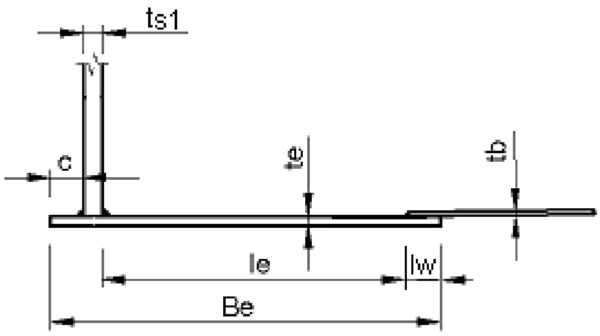
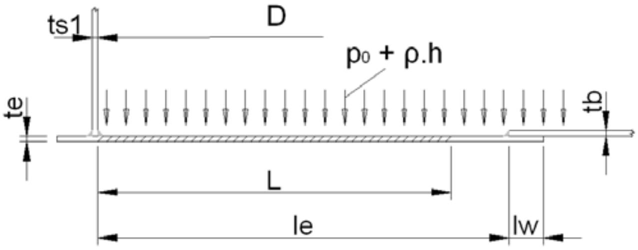


fig. 2 Thickened annular bottom plates

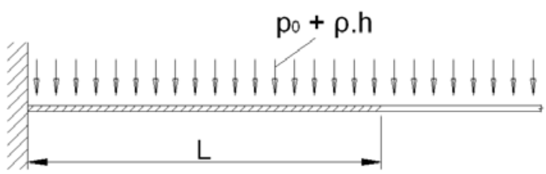
Actually the modification of the thickness t_e of the annular bottom plates and/or yield strength of steel modify also the calculated width ***L*** of the assisting bottom part. When these two indexes are changed the value of the calculated width ***L*** is influenced respectively the part of stored product which can be engrossed by the bottom and will stabilize the tank.

2.Calculated bottom width

The bottom part, near to the shell which assists the stabilizing of the tank can be seen as a cantilever which is fixed to the shell (fig. 3). The maximal value of the calculated width ***L*** of the assisting bottom part is determined by condition that the cantilever can bear the pressure of the column of remaining product with height ***h*** and over pressure p_0 inside when the tank begin to fill.



а) конструктивно решение



б) изчислителна схема

fig. 3 Computing scheme of the annular bottom plates

Bending moment for the unit width which appears in the place of joint between the bottom and the shell as a result of over pressure p_0 and a column of remaining product with height ***h*** is determined by the equation:

(1)

$$M = \frac{1}{2}.(h.\gamma_{fp}.G_n + \gamma_{fa}.p_0^n).L^2 ,$$

where:

G_n e normative value of density of the liquid;

h – height of the liquid layer from the bottom to the lower edge of outlet pipe;

γ_{fp} = 1,1 – coefficient of overloading by the stored product;

p_0^n - normative value of over pressure in the tank

γ_{fa} = 1,2 – coefficient of overloading by the over pressure in the tank.

The maximum bending moment of annular bottom plates for unit of its width when the steel works in elastic stage shall be calculated by:

(2)

$$M = \frac{1}{6}.R_y.t_e^2 ,$$

where:

R_y is the design resistance of steel in annular bottom plates;

t_e – width of the annular bottom plates.

When equation (1) is equal to (2) and elementary transformations are done, for calculated width ***L*** of the bottom assisting part the following is valid:

(3)

$$L = \sqrt{\frac{R_y}{3.\left(h.\gamma_{fp}.G_n + \gamma_{fa}.p_0^n\right)}}.t_e$$

The method of approach in [3] and [5] is analogous when the minimal width $\boldsymbol{l_e}$ (fig. 2) of the annular bottom plates is calculated during the bottom construction and which participates in stability verification. The equation is calculated for the bottom's plastic section modulus, yield strength R_y = 230 MPa, and security coefficient $k = 2$:

(4)

$$l_e = \frac{215.t_e}{\sqrt{H.G}} ,$$

where:

H is the maximal height of the product stored in the tank.

3. Conclusions

Calculated width ***L*** of the assisting part of the bottom does not have permanent value. When the loading upon it is fixed, it depends on the yield strength $\boldsymbol{R_y}$ and width $\boldsymbol{t_e}$ of the annular bottom plates. Changing these parameters we can provide total stability of the tank when bigger quantity of the product is engrossed. In this way we do not need to increase the thickness of the shell and/or anchoring the tanks.

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