STEEL VERTICAL CYLINDRICAL TANKS FOR OIL AND OIL PRODUCTS STORAGE WITH DOUBLE BOTTOM

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1. Introduction in the problem

During repairing works of the bottom, if the complete bottom replacement is necessary, the implementation of systems for leaks detecting is recommended and those systems assure drain for pouring out the liquids to the place where the liquids can be easily found and the result can be shown out the of tank.

These systems are obligatory for tanks where dangerous for the nature products are stored.

During the period from 1994 to 1995 company KZU Holding constructed four tanks with floating roofs according to the project of NOELL, Hamburg. All tanks have steel catching basin with double bottom with vacuum system for leak detecting on the bottom. The used system is specified, developed and improved by KSU Holding and can be implemented in new and exploited tanks.

2. Solution of the problem.

The modern trends suppose the second (new) bottom and vacuum system to be put even when the old bottom is not spare all its resource. The pressure between the two bottoms is decreased through vacuum pump and the pressure level should be watched uninterruptedly. Every increase of the pressure between two bottoms is a signal for violence of their hermetic status.
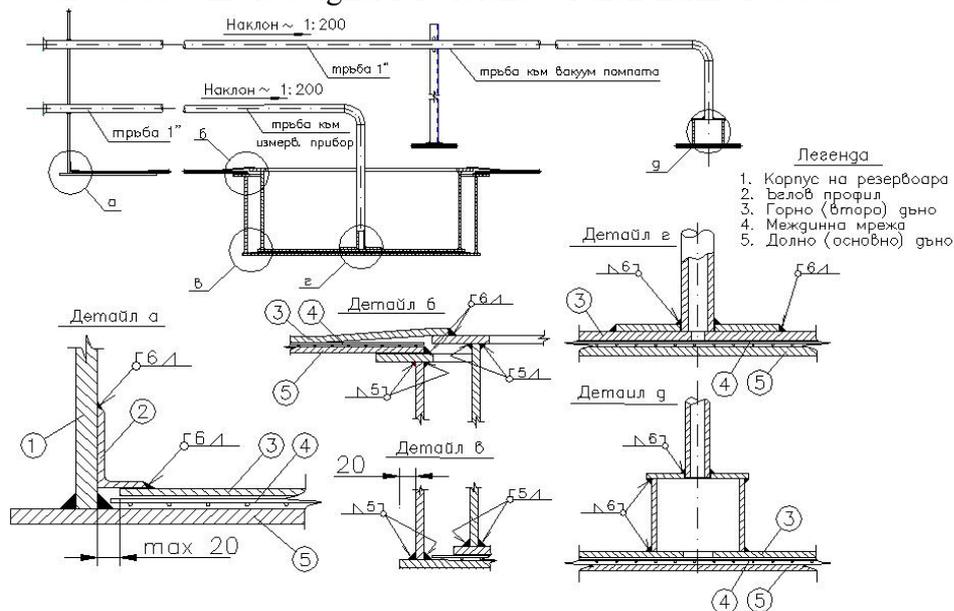

fig.1 Double bottom of tank with vacuum system on it

It is recommended that the thickness of the sheets of the new (upper) bottom to be equal or more than 6 mm. The sheets of the two bottoms are separated through steel net put between them which net is constructed by point welded smooth rods with diameter Ø3-Ø6 mm. The net does not allow the full contacts of the sheets and appearance of the areas when the free liquids movement is impossible. The distance between two parallel rods depends on dimensions of the load of the bottom, thickness of the rods and thickness and strength of the sheets on the bottom. It is necessary also that the complete inspections on the tank have been done at some period. For the above mentioned operations the tank must be emptied, cleaned and treated with steam. The period between two complete inspections must not exceed 10 years. This is the way for watching the status of the tank and respectively status of the bottom.

3. The research for determination of the net between the two bottoms.
3.1 The research carried out under the following conditions:

a) the sheets are made from steel BСт3 analogue of S235 , yield strength R_y = 215 MPa;
b) coefficient of overloading γ_f =1,2 and is equal for hydrostatic loading and overpressure in the tank;
c) the net between two bottoms has the diameter Ø3 or Ø4 mm;
d) for surveying better the security problem, the research are carried out when one part of the bottom is consumed by corrosion and the bottom thickness is only 2mm;
e) it is accepted that the upper bottom is a thin sheet rested on the rods in the net below this sheet.
The reinforcing steel does not have the even level and because of it the support of the formed fields is two sided, elastic near the rods which simulate girders.

3.2 Analysis of the obtained results.
The essential thing for this case is that the plastic deformations began as a result of increased efforts. The criteria for plastification in one point are presented by formula of von Misses:

$$\sigma_{red} = \sqrt{\sigma_1^2 + \sigma_2^2 + \sigma_3^2 - \sigma_1.\sigma_2 - \sigma_1.\sigma_3 - \sigma_2.\sigma_3} = R_y$$

As it was expected the bigger density is calculated when the net has diameter Ø 3. The biggest pressures are on the places where the rods cross each other (stiff support). Due to the little resistance of bending of the reinforcing rods, the efforts in the fields and above the reinforcing steel which touch the upper bottom are several times smaller. For bigger security sheets can be accepted as a point rested. The density of the net is registered on the fig. 2 depending on the pressure and the diameter of the reinforcing rods. The use of the nets with bigger diameters of the rods is possible, and the density of the nets is registered on fig. 2, depending on the expecting diameter of the rods after continuous exploitation.
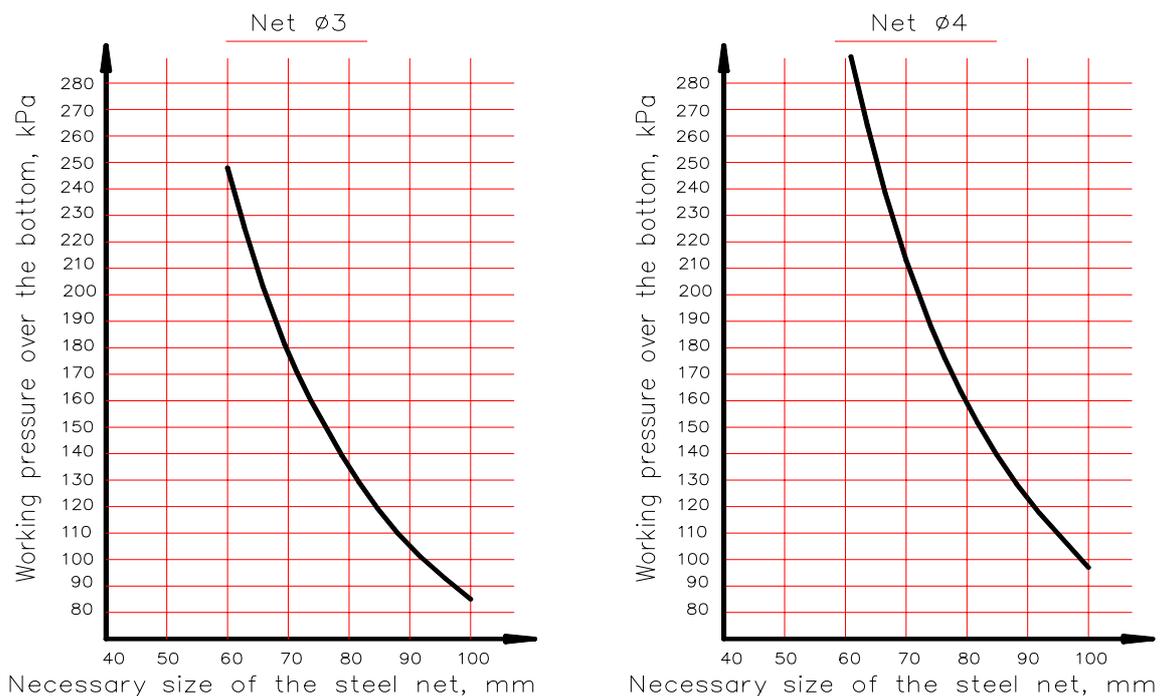

Fig.2 Necessary number of rods in the net depending on the pressure.

If the calculated minimal thickness of the bottom t_b in the end of the term to the next insider inspection is smaller than 2 mm the bottom must be repaired or the period between the two inspections must be decreased.

4. Determination of the dimensions of the angle section.
The angle section which joints new bottom and shell must meet the following requirements:
- minimal thickness of the section is equal to the thickness of the bottom t_b;
- minimal lap of the section of the upper bottom is five time the thickness of the sheets in the bottom t_b;

-   minimal height of the web toward the wall is 100 mm aiming to make bigger the distance from supporting welding joint.

The welding joint which joints the angle section wall and bottom must be executed with minimal weld thickness but not less than thickness of the bottom or section. The purpose is to make the joints denser and tougher by entering the minimal quality of thermal power in the construction.

5. Conclusion

It is known that 10 % from new constructed tanks, in the moment of their introduction to exploitation have holes on the bottoms and respectively leaks.

The thickness of the bottom decrease as a result of the aggressive action of the stored product and continuous exploitation. All bottom damages are potential reasons for leaks and it is possible that the leaks remain hided for many years.

The use of the double steel bottom and vacuum system for uninterruptible detecting is a modern solution which although the high expenses of its implementation increases the security. If it is combined with double shell (steel catching basin) the occupied area by tanks will be smaller (we will economize area) and we will meet the last requirements for environmental protection.