

INSPECTION AND TECHNICAL DIAGNOSIS OF STEEL VERTICAL CYLINDRICAL TANKS

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The vertical cylindrical steel tanks (here in after they are called tanks) for storing oil and oil products are dangerous facilities. During the long period of their exploitation the different process decrease tank security and increase the risk of accidents – settlement of foundation, corrosion, fatigue of material, deviation of the construction in comparison of project form etc.. The tanks accidents cause big financial loss (the product stored in the tank is much more expensive then the facility itself), the pollution of environment, the risk of fire and victims.

The periodical inspection and diagnosis is a must in order to decrease the risk of partial or full distraction of tanks and to avoid all the problems that are the consequences of destruction. The inspection and diagnosis include several activities, related to the inspection of tanks assessment of the fitness of different elements for further exploitation, determination of zones joints, connections or construction elements in which the repairing works are a must, determination of safe way of exploitation assessment of residual resource. They are several ways of tanks inspection:

a) **external inspection** – it must be done by personnel who exploits the facility and who is especially trained for this purpose. It includes examination of external surface of tank for discovering of leaks, damage in the wall, and symptoms of settlement of the foundation. The period between two external examinations must not exceed one month.

b) **partial examination** – it must be done by qualified persons – inspectors, at least at every five years.

The stop of the tanks exploitation is not obligatory. The inspection includes:

- visual control of construction of tanks and welding joints;
- determination of the kind and the degree of corrosion damages upon the surface of the wall that is available supporting joint and tank roof;
- measuring of the real thickness of elements of roof and wall;
- measuring of deviations of geometrical form of the wall;
- check of status of foundation;
- measuring settlement of the foundation;

c) **full inspection** – it must be done by qualified personal least at every ten years. The tank must be out of service. The facility must be empty. Gas must be cleaned with the control of concentration of carbon vapors and cleaned.

The following kind of works must be done:

- inspection of the surface outside and inside of all constructive elements.
- measuring of real thickness of all constructive elements of the tank
- measuring of geometrical characteristic of all constructive elements of tank which measure exceeds the determined limits
- check of status of foundation
- determination of kind and value of settlement.

The technical report and conclusion must be prepared according to the results of inspection and it must be integral part of the documentation of the tank. Referring to this report the repairing work must be carried out aiming to increase the safety and to make longer the period of their exploitation.

One of the characteristic phenomena is the settlement of the foundation. When it is even there are not the additional tensions in tank construction except in the zone of the joint of the pipeline. When the settlement of the foundation is not even the tank declines and the liquid level in some zone exceed the design one. The additional tensions appear in the shell. When there is settlement of the foundation, because of the flexible construction, the shell has being deformed and the deviation from project form can be enormous.

After the analysis of the settlement of the foundation there are two basic solutions of the problem:

a) the tank continues to work even in the deformed status. The possibility for this must be proved through calculation. The difficulty of the work of the floating roofs is possible and also their going to key is possible.

- b) repairing and leveling of the tank foundation. Those operations require lifting of tank which must be done according to the individual project. Big forces are concentrated in the points of support and they can cause crushing in the shell. The damages of the bottom are dangerous because for discovering them and for repairing them, the exploitation of the tank must be stopped, the facility must be emptied and cleaned. The leaks of bottom must not exist. Because of it the inspection of the bottom is absolutely necessary. The rest thickness on the next inspection must not be less than 2 mm, when the system for leaks discovery is missing. The period between the two inspections depends on the status of the bottom. It also depends on velocity of the corrosion, thickness, the small damages etc.
- c) During the process of exploitation of the tank the damages appear inevitably. The damages are discovered through the inspection. The degree of their influence must be assessed individually for every case.

Referring the results the elements of the tank must be repaired or replaced. When the damages are especially serious or irreparable, the exploitation must be stopped.

The most broadly used standard for inspection and diagnosis is API653. This document says that during the inspection and analysis of tanks the specialist must use the law under which the facilities are constructed.

Our typical and individual project of tanks are constructed under the Bulgarian and Soviet Union rules and because of it the “Положение о системе технического диагностирования сварных вертикальных цилиндрических резервуаров для нефти и нефтепродуктов -РД – 08-95-95. According to the above mentioned document if the data, for calculated by legislation term for tanks, are missing, inspectors accept that this term is equal to the 20 years. Almost all the tanks for oil and oil products in Bulgaria (in “Лукойл-Нефтохим”, в “Нова Плама”) are constructed before more than 20 years. So the stipulated by rules term for their exploitation is expired and their further exploitation without complete inspection complete analysis and repairing hides very big risk.

The possibility of the tank for further exploitation depends on proved resistance of every element by itself and all elements together. For bearing all future load. For this purpose the complete analysis must be done and this analysis must include the following items: slope of the foundation, real thickness of elements, inclination, geometrical deviation in the shell and roof etc. The calculation must be made toward the toughness and toward the loss of stability when loaded by wind, snow, earthquake, weight of the stored product.

Conclusion

Steel tanks are not eternal facilities. They must bear the continuous corrosion caused by external atmosphere conditions and stored product which decrease thickness and damage wholeness of the construction.

Settlement of foundation geometrical deviation has negative impact which must be registered by qualified persons. The correct analysis and competent repairing of the tank decrease the risk of accidents and environmental pollution and lengthen the period of their exploitation.