Modern efficient methods of steel vertical oil tanks clean-up

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Abstract. The legislative base of the Russian Federation operating in the field of operation of tanks and tank parks is considered, and consecutive stages of technological process of cleaning of vertical steel tanks from oil ground deposits are presented. In work shortcomings of existing most widespread electromechanical mixers are described when using a hydraulic method of removal and prevention of formation of ground deposits in tanks with oil and oil products. For the purpose of increase of efficiency, reliability and decrease in power consumption of washout of oil ground deposits in tanks the new design of system of funneled washout and prevention of formation of deposits is offered.

1 Introduction

The sludge is generated and accumulated in the tanks while storage and transportation of oil or oil products resulting in loss of up to 1/4 of tank storage capacity. Besides, the accumulation of sludge leads to complications while utilization of tank, quality/quantity monitoring of oil volume, and reduction of technical and economical characteristics of oil storage tanks and transportation system in overall.

2 The object of study and methods

The requirement to keep the storage capacity of the tank is strongly followed while creating the design of construction and regulated by authorized documents, such as: GOST 1510-84 «Oil and oil products. Labeling, packing, transportation and storage», guidelines RD 153-39.4-078-01 «Regulations on technical utilization of tanks in oil pipeline», RD 153-39.4-057-00 «Workflow on elimination of generation of tank bottoms and cleaning», RD 153-39TH-012-96 «Regulations on safe cleaning of oil tanks» etc. [1]

Tank bottoms removal is a complex procedure including the following:

- Pumping out of hydrocarbons from the tank till the level required for work of cleaning nozzles and de-sludging by the standard cleaning devices, if available;
- Preliminary degassing by forced ventilation until the concentration of oil vapors is below maximum allowed concentration; and making-up of cleaning equipment;

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- Oil vapor saturation of gas space in the tank exceeding the maximum allowed concentration;
- Cleaning of the tank walls and bottom by oil stream generated by cleaning device along with simultaneous monitoring of gas space saturation by the hydrocarbons and the level of static electricity;
- Pumping out of dissolved and dispersed sludge together with flushing oil into a special container (or pipeline);
- Cleaning of the tank by stream of water or cleansing agents from cleaning devices;
- Pumping out of emulsified water from the tank;
- Degassing by sorption and (or) forced ventilation and (or) airing;
- Quality monitoring of pumped sludge;
- Monitoring of cleaning quality of internal surface and degassing [2].

At the same time it's required to minimize the generation of sludge in the tank. It will allow decreasing the number of cleaning cycles and increase the storage capacity of tanks and oil transport system in overall.

For the time being the various methods are used to decrease the generation of tank bottoms; the essential of which are classified into mechanical, hydromecanical, thermal and sonic. However, the most power-and-economically effective is the hydraulic method. It's an exposure of the oriented drowned stream of oil at determined velocity to bottom sediments, as a result, separating them into parts and holding them in suspension. [3,4,5,6,7]

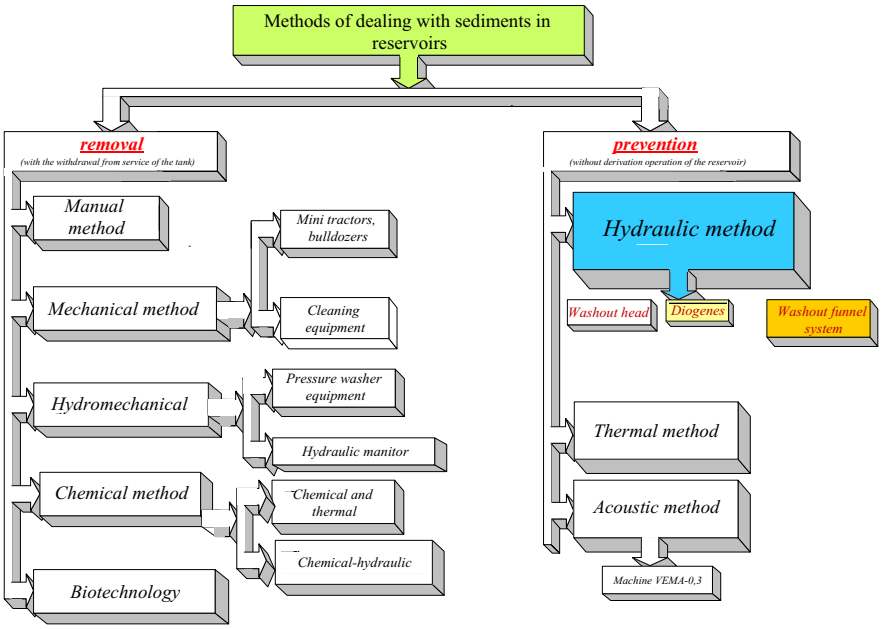

Fig. 1. Methods of tank bottoms generation reduction.

This method is being extensively applied in Transneft Company. In order to create the oriented hydraulic stream for removal of tank bottoms the most widely used are «Diogen»-500/700 and «Taiphun» devices. These are a kind of electromechanical mixers of different design. At the same time they have quite many essential disadvantages.

«Diogen» device is installed on the tanks with 20000 m^3 volume. The operating range of this device at the determined stream velocities is 60º which allows creating so called

"dead" zones in the tank where paraffinic-tar-asphaltenic contents are intensively accumulated and compressed and may occupy up to 50% of tank bottom. [8]

Increasing of the revolutions of the device's screw and increasing of the stream velocity leads to increase of pressure on the tank wall which affects the strain-stress state and tanks operation time.

Worth mentioning, the essential power is consumed by the electric motor. The moving parts negatively affect the reliability of the device.

Long term utilization leads to increased gaps in supporting nodes and shaft eccentricity due to irregular collection of multicomponent sediments on propeller being a cause of the additional vibration and local cyclic load on tank walls. [9]

The additional disadvantages of the electro mechanic mixing machine may be the duration of average washing cycle - 98hr, tank leakage and low reliability of system due to the complex design of device.

All of the abovementioned disadvantages of the utilized nowadays devices are giving evidence of the necessity to create a new design preventing from the generation of tank bottoms. Increasing the efficiency, reliability and decreasing the power consumption while removing sludge out of vertical steel tanks can be achieved with utilization of funnel type cleaning system and by prevention of tank bottoms generation. (pic.2). [10]

The construction consists of incomplete curved pipe (5) installed in the tank base (7) which follows the shape of tank walls (8) and equipped with eight ascending pipes (6) of less diameter with 45˚ angle between them and each of ascending pipes is inclined to tangent circle in horizontal plane at 22˚30′ angle and at angle of 45˚, 40˚, 35˚, 30˚, 25˚, 20˚, 15˚, 10˚ in the direction of oil traffic in pipe in vertical plane accordingly. The construction has a shut off valve (3), Γ-shape bend pipe (2) and S-shape pipe (4) which connect the whole pipe chain with the main tank pipeline (1) (pic.3).

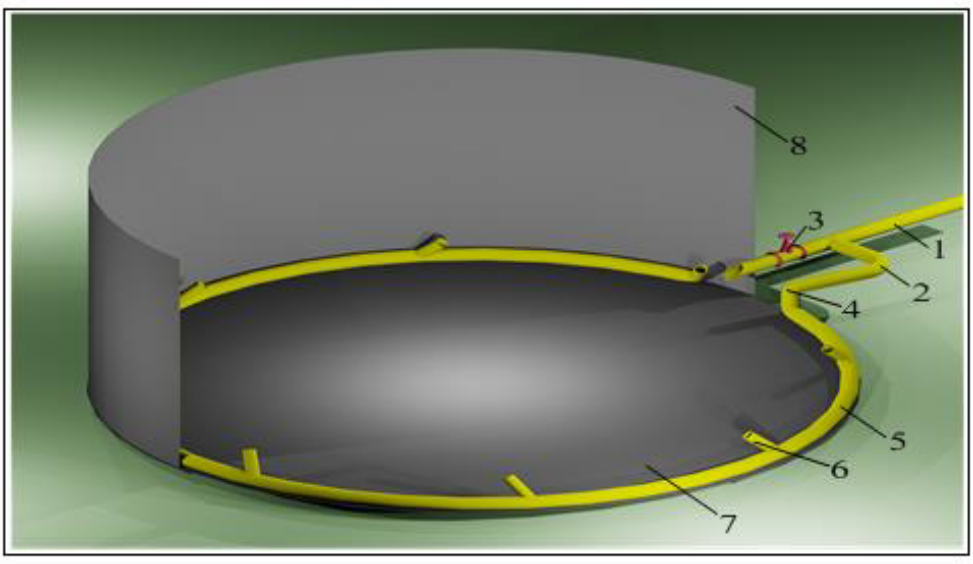

Fig. 2. General view of funnel type cleaning system for sludge removal.

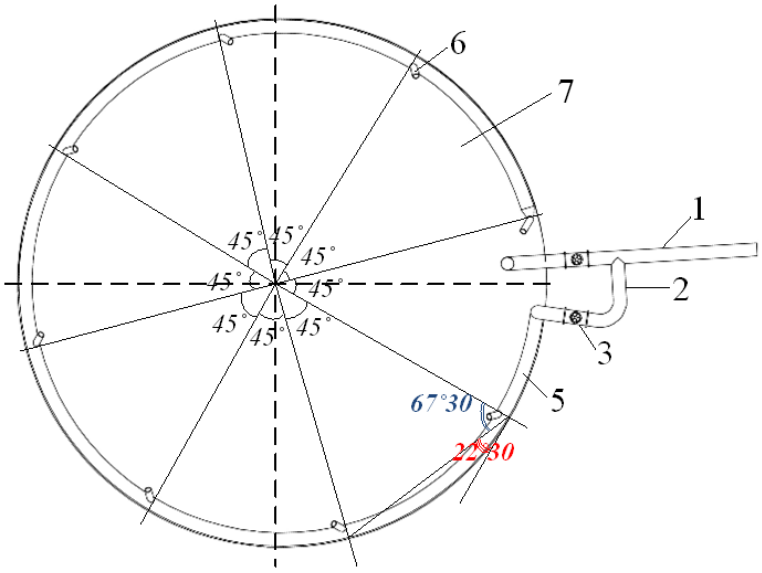

Fig. 3. Design of funnel type cleaning system for sludge removal.

Decreasing of tank bottoms generation and cleaning of the existing ones is done by mixing of oil products. Whereupon the mixing is done by means of energy produced when filling the tank. Some of kinetic energy of the moving oil makes the whole volume of oil in tank circulate as a result of influence of hydraulic drowned streams of oil or oil product.

Location of the pipe at the bottom of tank allows desludging even with low amount of oil or oil products available in the tank. The number of ascending pipes has been chosen on the assumption of the minimum power consumption. As hydraulic pressure is usually lost while desludging due to the resistance of the ascending pipes and during circulation of oil along the length of the curved pipe, the tip angle of ascending pipes in vertical plane is decreased down the direction of oil or oil products in pipe from 45˚ to 10˚ accordingly. As a result, the hydraulic pressure losses are decreased and dynamic residual energy, generated from funnel type mixing, is increased and leads to efficient desludging.

As a result, the desludging and prevention of tank bottoms generation is done without moving them out of tank. Whereas, the method provides high efficiency of desludging regardless the tank volume and type of the stored products.

3 Conclusions

Due to wide use in Russia, the perspective of the hydraulic method of tank bottoms removal from vertical steel tanks is proved by efficient de-sludging.

The method is more economically efficient comparing to other hydraulic methods due to the used energy produced when filling the tank.

Application of this technology allows increasing of operating reliability due to absence of additional solid elements and moving parts.

Proposed system doesn’t require the maintenance saving the time for maintenance checks.

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