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REDUCTION OF LOSSES OF HYDROCARBONS IN THE TANK FARM OF THE FILLING STATION «SOLNECHNOGORSKAYA» PAO «TRANSNEFT» (RUSSIA) (OVERVIEW)

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Combating the loss of petroleum products is one of the most important areas of resource conservation, playing a leading role in the development of the economy and ecology. The generalization of literature data on the main types and sources of hydrocarbon losses in the tank farm is presented. Methods for reducing losses of hydrocarbons are considered. The indicators characteristic for various stages of the reservoir operation process are analyzed. The calculation of technological losses during storage of petroleum products is carried out depending on the temperature and pressure conditions of the environment, density, technological conditions of filling and emptying the tanks.

Introduction. Reducing the loss of oil and oil products is one of the important ways in saving fuel and energy resources, which plays a significant role in the development of the organization's economy. An essential task in the operation of tank farms is maintaining the quantity and quality of oil products. For this, it is necessary to ensure maximum sealing of all processes of unloading, filling and storage.

Research part. The filling station "Solnechnogorskaya" was commissioned in 1977, it is a structural subdivision of Joint-Stock Company "Transneft Upper Volga".

The main functions of the Solnechnogorskaya FS are the storage of oil products in tanks, the delivery of petroleum products to consumers by filling them into tank trucks, ensuring the safety of petroleum products, both in terms of quantitative and qualitative indicators.

The tank farm of the Solnechnogorskaya FS includes 5 tanks with a capacity of 5000 m^3 for storing motor gasoline and 3 tanks with a capacity of 5000 m^3 for storing diesel fuel. All tanks are steel, vertical and cylindrical. The annual capacity of the «Solnechnogorskaya» filling station is 450 m^3.

In the process of delivering oil products to the storage site, there are operations of filling and emptying the tanks of the warehouse of the filling station, as well as the stationary storage of oil products, as a result of which large losses from evaporation are allowed. This causes economic damage to the enterprise and significant air pollution occurs. Therefore, reservoirs for storing hydrocarbons are equipped with means to reduce losses.

It is necessary to select a means of reducing losses specifically for each reservoir. To determine the effectiveness of the use of loss reduction means, it is necessary to compare the amount of evaporated oil product from the reservoir without established means of loss reduction with a similar value in the reservoirs on which the loss reduction means are installed.

Based on the literature review, the loss of oil products can be classified according to two approaches, which have some similarities and some differences.

First, we will consider the first group of classification. It includes quantitative, qualitative-quantitative and qualitative losses.

Quantitative losses occur as a result of leaks, overflows, incomplete draining of transport tanks and reservoirs. These losses become possible in the event of leakage of the walls and bottoms of tanks, malfunctioning valves, non-observance of the technology of operations and malfunctioning of instrumentation [1, 2, 3, 4].

Qualitative and quantitative losses occur during the evaporation of oil products. Due to evaporation from petroleum products, light hydrocarbons are lost, which are valuable components. Losses of light fractions reduce the quality of petroleum products. This applies to the greatest extent to gasolines, to a lesser extent to diesel fuels [3].

In gasoline, due to the loss of light fractions, the octane number and the pressure of saturated vapors decrease, the temperature of the initial and final boiling points of various fractions increases, which worsens the starting qualities of gasoline, increases fuel consumption and engine wear.

With losses from "small breaths", part of the liquid oil product, evaporating, turns into a gaseous state, thereby reducing the volume occupied by the oil product, and increasing the volume of the GS reservoir.

Losses at "big breaths" mean that while pumping out the product from the container, the released volume of the GS is filled with atmospheric air. In this case, the partial vapor pressure of the oil product in the GS decreases, and the evaporation of the oil product begins until the GS saturation.

The next time the tank is filled, the air-vapor mixture in the GS is displaced from the tank.

Losses from "big breaths" depend on the frequency of injection and pumping out and are proportional to the volume of oil injected into the reservoir [4].

Next are quality losses. A decrease in the quality of petroleum products as a result of compounding occurs during sequential pumping through one pipeline of petroleum products of different properties, as well as when filling tanks containing residues of petroleum products of a different type. In this case, it is possible to transfer part of the oil product to a lower grade.

For petroleum products that change quality quickly, the minimum storage time is recommended. The recommended storage periods for oil products have been increased in the middle and northern zones, in semi-underground and underground reservoirs, due to lower storage temperatures.

Losses of light fractions from evaporation from tanks are divided as follows [5]: from "big breaths" - 80.2%; from ventilation of GP - 19.05%; from "small breaths" - 0.8%.

The second approach to the classification of oil or oil product losses includes: natural, operational, accidental losses.

Losses from evaporation belong to natural losses, which depend on natural and climatic conditions, the physicochemical properties of the oil product and the design of the technological equipment of tanks of oil depots and warehouses.

These losses at the modern level of technical equipment of facilities intended for the storage of petroleum products are practically not amenable to complete liquidation, however, they can be significantly reduced as a result of the implementation of appropriate technical and organizational measures [6,4].

Operational losses resulting from malfunctions or improper operation of oil storage equipment include losses from spills, leaks, incomplete discharge, pollution and watering of oil products [6,4,7,8].

This type of loss can be completely eliminated provided that the necessary measures are observed:

- technically competent organization of storage of petroleum products;
- timely and high-quality performance of periodic maintenance and preventive maintenance of tanks;
- clear planning and correct implementation of loading and unloading operations.

Methods for reducing the loss of oil products from evaporation can be divided into 5 groups [9, 10, 11]:

Group 1 - reducing the volume of the GS reservoir. From the analysis of the loss equation, it follows that the smaller the GS volume, the lower the losses, and at V1 = V2 = 0 in the reservoir, theoretically, there should be no evaporation losses.

This condition is implemented in tanks with floating roofs or pontoons, which allow to reduce losses from "large breaths" and "reverse exhalation": by 70-75% with an annual turnover rate of up to 60 times a year; by 80-85% with an annual turnover rate of over 60 times a year, and from "small breaths" - by 70%.

Group 2 - overpressure storage.

According to the loss equation, if the design of the reservoir is designed to operate under excess pressure, then losses from "small breaths" and partly from "large breaths" can be completely eliminated in such a reservoir.

Group 3 - a decrease in the amplitude of the temperature fluctuation of the GS.

To create conditions for isothermal storage of oil products or to significantly reduce fluctuations in the temperature of the gas space and the surface of the oil product, thermal insulation of tanks is used, they are cooled in summer with water and painted white, as well as underground storage.

Group 4 - capturing vapors of petroleum products displaced from the tank.

For this, gas equalizing piping is used, which are separate pipelines or a system of pipelines connecting the gas spaces of tanks or transport tanks. The use of a gas equalizing piping allows to reduce losses from "big breaths".

Group 5 - organizational and technical measures.

Correct organization of the operation of tanks is one of the most important means of reducing the loss of oil products.

The main reason for technological losses of valuable raw materials and harmful emissions into the environment during storage in tanks is the volatility of light hydrocarbon fractions. When storing liquids in tanks, emissions of vapors and gases into the atmosphere occur periodically at certain intervals associated with the injection and pumping of liquid and daily fluctuations in the ambient temperature. When the tanks are connected to the atmosphere, emissions occur when the vapor-air mixture is displaced from the gas space through the ventilation pipes or breathing valves. The level of air pollution is an important indicator of the negative impact on the environment.

Prevention of such situations involves: legal, organizational, economic, engineering and technical, environmental protection, sanitary and epidemiological and social measures that ensure observation and control of the state of the environment and potentially dangerous objects, forecasting and prevention of sources of emergency situations, preparation for these situations [13].

Most of the methods for assessing and analyzing properties and quality are standardized and for their intended purpose. They are subdivided into acceptance, control, full, arbitration and special.

Losses of oil products from "big breaths" over a long (week, month, quarter, season of the year) period of time are usually defined as:

$$G_{БД} = \left[V_н - V_г \cdot \left(\frac{P_2 - P_1}{P_2 - P_{Y\,зак}}\right)\right] \cdot \frac{P_{Y\,зак}}{P_2} \cdot \rho_Y$$

Where:

$V_н$-volume of the injected oil product;

$V_г$-volume of the gas space of the reservoir before injection;

P_2- absolute pressure of the overpressure valves;

P_1-the absolute pressure of the vacuum valves;

$P_{Y\,зак}$-average partial vapor pressure of petroleum product;

ρ_Y-the density of the oil product.

In accordance with the guidelines for determining the technological losses of hydrocarbons from "small breaths", the calculation is made according to the formula:

$$G_{МД} = \sigma \cdot V_п \cdot ln\left[\frac{(P_A - P_{КВ} - P_{min}) \cdot T_{г.max}}{(P_A + P_{КД} - P_{max}) \cdot T_{г.min}}\right]$$

Where:

σ-- the average mass content of vapors of petroleum products in the steam-air mixture;

$V_п$- -volume of the vapor phase;

P_A--barometric pressure;

$P_{КВ}$- - absolute pressure of the vacuum valves;

$P_{КД}$- - absolute pressure of the breathing valves;

P_{min}, P_{max}- -minimum and maximum partial pressure;

$T_{г.max}$, $T_{г.min}$- the maximum and minimum temperature of the GS.

Based on the necessary data, the following indicators were determined:

– fractional composition according to GOST 2177-99 (method A)
– density at 20 ℃ according to MVI 2302-13M-2007
– saturated vapor pressure according to GOST EN 13016-1-2013 with the addition of p. 8.4 GOST 32513-2013.

And it was also determined the type of tank; injection performance; maximum and minimum filling height; downtime; average air temperature; vacuum valve data; pressure valve data; atmosphere pressure.

Having performed tests and calculations according to these formulas, the total losses of hydrocarbons in motor gasoline and diesel fuel in the tank farm of the filling station "Solnechnogorskaya" are equal to 55 thousand m^3 / year.

Reducing the loss of hydrocarbons during the evaporation of motor gasoline can be achieved by introducing gas equalization systems (GES) into the tank farm scheme. GES is called a gas piping, to which a gas collector is connected, where the vapor-air mixture is displaced when the reservoir is filled, and from where it is re-supplied to the GS of the reservoir when it is emptied.

To reduce the loss of hydrocarbons during the evaporation of diesel fuel, pontoons are installed. A pontoon is a rigid floating roof that is placed in a tank with a fixed roof in order to reduce the rate of saturation of the tank's GS with vapors. Tanks with a fixed roof, supplemented by a pontoon, significantly reduce evaporation losses of light fractions.

Conclusion. This paper addresses the issues causing the losses of petroleum products, as well as measures to reduce the loss of petroleum products.

Basically, the loss of petroleum products occurs due to the unsatisfactory technical condition of storage, transportation, pumping facilities, non-observance of the rules for their operation. The problems associated with losses, to varying degrees, affect all links in the functioning of the oil product supply system and are important indicators of the technical improvement of all operations.

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