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DETERMINATION OF FACTORS THAT INFLUENCE ON AMOUNT OF LOSSES OF LIGHT GASOLINE HYDROCARBNONS FROM EVAPORATION IN HST

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Abstract. Horizontal steel tanks (HST) are considered as the source of emission of light hydrocarbons. Identified groups of factors and factors that influences the magnitude of losses of light hydrocarbons by evaporation from the HST.

Keywords: value of losses, significant factors, predicting losses, source of pollution.

Problem statement

Today losses of oil product at objects of fuel supply are determined as ratio between delivered oil product and actual stored residue. Such calculation is done every quarter of the year. Difference between these values, taking into account oil products issue is considered as natural losses (Instrukcija... 2008).

Additional processing of exploitation data will allow developing of new methodology for estimation of oil products losses from evaporation. From the above mentioned we can make a conclusion that determination of the most valuable factors influencing evaporation of light hydrocarbons and their interconnections is an important scientific-practical task.

Object of reseach

Object of research is evaporation of gasolines during fulfilling of technological operations. Subject of research is factors that influence on the intensity of gasolines evaporation at HST. Literature analysis (Abuzova *et al*, 1970) has shown that chemical composition and temperature regime of tanks are the most important factors. Aim of the research is determination of factors and group of factors that act during the process of light hydrocarbons evaporation from gasolines during technological operations. Nowadays it is an important scientific-practical task, because there are no works describing complex impact of factors on gasolines losses from evaporation.

Problem analysis

Well known methodologies developed by Konstantinov M. M. (Konstantinov 1961), Korshak A. A. (Korshak *et al.* 1999), Gizzatov M. A. (Gizzatov, 1987), Prohorov A. D. (Prohorov, 1977), Ashkinazi M. I. (Ashkinazi *et al.* 1969), Budarov I. P. (Budarov, 1961), Boichenko S. V. (Boichenko *et al.* 2007) are applicable for one-time calculation of losses and do not allow estimating impact of certain factors.

Today tanks are equipped with temperature, pressure, density detectors, automatic level controllers, etc. It allows constantly monitor the parameters of petroleum products. But these means of automatization are used for registration of parameters of oil product discharging and reception operations. Modern parameters control systems can be used for both registration of oil product parameters and obtaining data about equipment state.

Data about oil product state that are collected via these detectors can be accumulated by the system and can be used for volume of losses forecasting. It will make possible determination of the most valuable factors and interconnections between them as well. Application of available data will simplify task fulfillment.

Technological regimes of horizontal steel tanks (HST) use

HST of volume from 3 to 200 m^3 are used for state accounting operation with oil, oil products, their storage

and payments between supplier and consumer (GOST, 2000). Excessive pressure foreseen for most of these tanks is not more than 0,07 MPa. These tanks may be either ground or underground (GOST, 2010).

Main technological operations with HST are discharging, reception, storage and pumping. During pumping gasoline changes it's temperature and density. It happens because temperature and density of gasoline in tank and pumped one may differ.

During discharging level of gasoline, temperature, pressure of saturated vapors in gaseous medium (GM) of tank decrease. During gasoline pumping out from the tank suction of air and addition evaporation of light hydrocarbnons take place. It is accompanied by pressure rise up to the adjusted value of breathing valve (BV). If the pressure in GM exceeds adjustment of the BV than the "backward breathing" will take place.

Gasoline storage is accompanied with changes of temperature, density, level and pressure in GM. Gasoline level changes during storage due to evaporation of light hydrocarbons, variation of density and temperature. Density changes in a result of light hydrocarbons evaporation and daily temperature variations. Gasoline temperature changes because of daily temperature variations as well. When pressure in GM reaches the adjusted level in BV, the emission of light hydrocarbons take place. It is known as „small breath".

During acceptance gasoline's temperature changes (pumped gasoline mixes with the residue in tank). Amount of emitted vapor-air mixture (VAM) in this case and concentration of light hydrocarbons in it will be determined by closed or open kind of stream of the filling process. In case of open-stream filling the higher turbulization of surface is observed. Process of evaporation is intensified and concentration of emitted light hydrocarbons in VAM increases. During closed-stream filing only internal medium of liquid are subjected to turbulization. Evaporation from surface is less intensive in this case.

Factors that influence on volume of light hydrocarbons evaporation during technological processes

According to (Kuznecov 2010) we can determine four groups of factors that influecne significantly on hydrocarbons evaporation:

- Economic;
- Ecological;
- Technic;
- Technological.

Economical factors include the following:

- Expenses for implementation of systems or means of environmental protection from volatile hydrocarbons evaporation and thus increasing of gasoline prices;
- Economical effect from implementation of environmental protection systems;
- Increase of incomes that be stipulated by optimization of technological processes and use of modern effective equipment;
- Amortization costs;
- Costs of technological processes;
- Prices for oil products.

Considering these factors we can decide that today conclusion about rationality and efficiency of application of means for losses prevention, means of losses forecasting, their monitoring will be made basing on results of these factors analysis. In case of negative economical effect there is small probability that decision about use of means of losses minimization will be taken. So, one of the main aspects to be considered is effectiveness and initial price. For example, even if systems for volatile fraction adsorption are of high efficiency they will not be popular because of the high price.

Technical factors that influence on volumes of losses from evaporation include characteristics of additional equipment (technical characteristics of pumps) and parameters of tank. The most valuable among them are geometrical size of tank, quantity and type elements stop valves, heat isolation.

Data given in (Abuzova *et al*. 1981), allows considering that net volume of losses during „big breathing" increases with decrease of tank content. Net average losses in middle climatic zone are 1.42 kg/m^3. This data can vary depending on the grade of investigated gasoline, conditions of storage and climatic zone, where researches were done. Great role is also played by the technical state of equipment.

Technological factors include those, influencing on tank operation or those considered as characteristics of oil proguct (gasoline in our case).

Special attention must be paid to factors that influence on volume of losses from evaporation:

- Atmospheric pressure, P_a;
- Temperature of environment T_{Env};
- Adjustment of breathing valve for excessive pressure or vacuum;
- Coefficient of tank use;
- Coefficient of tank negotiability;
- Temperature regime of tank;
- Presence or absence of means for losses prevention;
- Quantity of holes and their mutual disposition.

Atmospheric air influences mainly on losses of volatile hydrocarbons during storage. Impact of environment temperature is revealed greatly in regions with increased temperature background. Adjustment of breathing valves of the tank may depend on technical conditions of use and may vary in a range 1800–2000 Pa. When the coefficient of tank use increases (level of tank filling) the volume of GM decreases. It will stipulate decreasing of vapor-air mixture emissions into atmosphere. The most valuable factor in this group is temperature regime of tank. It is influenced by geographical position, tank painting and temperature isolation (Abuzova 1975). Decreasing of temperature variation gradient will contribute to reduction of emissions. That is why building of underground reservoirs is seemed to be the most rational for providing optimal temperature regime. At the same time building of ground reservoir with heat insulation may be

in 10 times more expensive (spending on the type of oil product).

Technological parameters that determine such property of gasolines as evaporation include:

- Fractional composition of gasoline;
- Hidden heat of evaporation;
- Gasoline liability to formation of vapor locks;
- Coefficient of vapors diffusion;
- Surface tension;
- Chemical composition of gasolines;
- Density.

Modern raw material base for gasoline production is characterized by increased content of products of catalytic oil processing. It leads to high content of components with low boiling temperature and decreasing of initial boiling temperature. Components with low boiling temperature (hydrocarbons $C_1 - C_6$) make the most part (up to 98–99 %) of evaporating components. These components are contained usually in gasolines (Budarov 1961). It should be mentioned that vaporability of gasolines is in almost 1000 times higher than of dark oil products. Results of light fractions evaporation are the following: heavier fractional composition, density and viscosity increase, decrease of saturated vapors pressure.

It may be also determined a group of technological factors that will be defined by interaction between tank itself gasoline and parameters of technological process:

- Temperature of VAM in GM of tank, $T_{ППС}$;
- Mass of VAM in GM of tank, kg;
- Oil product density in GM of tank, g/cm^3;
- VAM density in GM of tank, g/cm^3;
- Level of gasoline in tank, H;
- Volume of gasoline in tank, V_g;
- Volume of GM in tank, V_{GM};
- Expenditure of oil product, pumped into tank, Q;
- Expenses of oil product, pumped out of tank, Q_{Ex};
- Excessive pressure in VAM of GM, P;
- Concentration of light hydrocarbons vapors in GM of tank C;
- Quantity of VAM emitted into environment, kg;
- Quantity of air coming into tank during pumping out operations, kg.

Ecological factors that have impact on quantity of losses from evaporation are limit acceptable concentration of light hydrocarbnons in area of tank placement. Today there are no norms for pollutants emissions into atmosphere at objects of oil products supply. That is why harmful impact of these losses is not considered properly. Peculiarity of this kind of pollution is that emissions are concentrated at the height of 2–3 m above the ground. It is a working zone, other words it has direct negative impact on personnel health at oil depots. Situation becomes worse due to the escalates increasing number of objects thair distribute gasoline. Today there are more than 7000 filling stations in our country and this number is growing constantly. The situation becomes more complicated in a result of old, out of date equipment. At the same time filling stations are not equipped with any means for losses decreasing.

It should be also mentioned that except individual impact of each factor it is necessary to take into account interaction of group of factors. This will determine the final result. Choice of optimal decision (for example method of losses decreasing or environmental protection technology) will depend on general analysis of all factors.

Conclusion

Exploitation information collected by means of automatization may be a basis for solving this question. This is the most appropriate variant because fulfillment of planned experiment in conditions of oil depot or filling station is impossible due to peculiarities of its functioning.

Practical realization of these researches will give possibility to create new measures for estimation industrial and ecological safety of horizontal tanks, consider them as a source of environment pollution. In it's turn it will give possibility to develop and implement in our country norms for emissions of volatile hydrocarbons into atmosphere. Later it will stimulate modernization of existing equipment and introduction of means for losses decreasing.

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