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TECHNOLOGIES FOR HYDROCARBON STAIRS TO REDUCE ENVIRONMENTAL POLLUTION AT FUELING STATION OPERATION

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Abstract. *The article provides with information on hydrocarbon loss, as well as economic and environmental problems, and fuel energy is a necessary factor in saving resources. The analysis of losses in the current state of technological processes of transportation and storage of hydrocarbons is presented. Detailed information on the role and functions of collars and gas station and the types of petroleum products stored in them is provided. The article provides information on the physical and chemical properties of pure petroleum products. It also provides analytical information on the amount of product lost during evaporation of gasoline products. It is shown that the parameters of gasoline products change with increasing temperature. The composition of petroleum product vapors during storage is indicated in the gas station, and it is shown that the loss of products by these vapors causes environmental problems. At petrol stations, petroleum products are represented by their technological parameters and their values from the point of view of fire danger. The concentration values between the lower and upper limits of explosion hazard are indicated in the range from 0.76 to 8.4% for gasoline products, for kerosene products - from 1.4 to 7.5%. All technical parameters of AI-80 gasoline fuel are analyzed. There are analyses of the amount of product lost during evaporation when filling gasoline in cars. As aresult of the analysis, with an increase in the boiling point of the fractions, the difference in the mass of the molecules also increases, the molecules become heavier. For the lightest oil products, the fractionation properties of fractionated substances are described, and the properties of the compound according to the physical parameters of pentane C5H12 are analyzed. The preservation of gasoline joints is an urgent problem and the methods currently used to eliminate them are presented. A new technology for capturing hydrocarbon vapors using a thin condenser for capturing petroleum vapors was also proposed. The advantages of the technology of absorption and separation of steam-air mixture based on the technology of absorption and separation in the process of filling and storage of petroleum products are presented for gas stations. As a result of the conducted studies, it is shown that the amount of hydrocarbons in the form of a vapor-air mixture depends on the temperature. The amount of oil product vapor released into the environment by bears is 0.09 ... It is proved that the ratio of 0.12% is based on the results obtained.*

Keywords: *Petroleum products, losses, physicochemical properties, evaporation, gas station-filling stations, component composition, molecular weight, vapor recovery, thin-walled condenser.*

INTRODUCTION. Elimination of losses of hydrocarbons is one of the important ways to save fuel and energy resources, which are a necessary component in the development of the economy. The main type of loss of oil and oil products, which cannot be completelyeliminated at the current level of development of means of transport and storage of hydrocarbons, is losses from evaporation from tanks and other containers. The damage caused by these losses is both economic and environmental.

At all the most important nodes of the technological chain of production, transportation, storage and sale of petroleum products. At the refinery, these are racks for transshipment of oil products to railway and truck tanks.

At tank farms, where oil products are supplied from the refinery for subsequent distribution to filling stations (gas stations), tank farms are equipped with recuperation units.

The filling station is the final point of distribution of fuels to consumers. The most common filling stations that fill vehicles with traditional types of hydrocarbon fuel - gasoline and diesel fuel (petrol stations).

MATERIAL AND METHODS. The main physical and chemical properties of petroleum products, which in one way or another affect the technology of their reception, storage and dispensing, include density, viscosity, pour point, volatility, fire and explosion hazard, electrification and toxicity.

The density of various oil products at 20 ° C (293 K) is within (kg / m3): gasolines - 700- 780, diesel fuels - 830-860, jet fuels - 755-840, boiler fuels - 870-900, oils - 880 -915, fuel oils - 940-970 [1, 4, 6, 15, 16, 17,18].

For low-viscosity Newtonian fluids, it is sufficient to know the kinematic and dynamic viscosity at the corresponding temperature. These liquids include light oil products, as well as fuel oils and oils at high temperatures.

Evaporation of a hydrocarbon liquid occurs at any temperature until the gas space above it is completely saturated with hydrocarbons.

Table 1 shows the component composition of vapors of petroleum products.

Table 1.

Component composition of vapors of petroleum products

Hydrocarbon group	Content, percentage
C6	<1,0%
C5	2,2%
C4	4,8%
C3	13,7%
C2	70,9%
C1	5,2%

Evaporation of petroleum products at filling stations at the stages of unloading a tanker truck and loading at dispensers not only worsen the ecology of settlements, but also reduce the potential profit of sellers due to losses. In this regard, equipping filling stations with installations for capturing and recuperating fuel vapors looks like an urgent task, especially in the face of increasing environmental requirements, as well as rising gasoline prices.

The fire hazard of petroleum products is determined by the values of the flash points, ignition and self-ignition. The flash point of vapor is understood to mean the temperature at which the vapor of a liquid heated under certain conditions form a mixture with air that flares up when an open flame is brought to it. Hydrocarbon liquids with a flash point of 61 ° C and below are classified as flammable, above 61 ° C - as combustible. The ignition temperature is the temperature at which the liquid burns when exposed to an open flame. Typically, the flash point is 10-50 degrees higher than the flash point [2,5, 18, 19, 20].

RESULTS. Self-ignition temperature is understood as the heating temperature of a liquid at which its vapors ignite without bringing up an open flame. Depending on the ignition temperature, five groups of fire-hazardous mixtures are established: T1> 450 ° C, T2 = 300-450 C; T3 = 200-300 ° C; T4 = 135-200 oC; T5 = 100-135 °C. The self-ignition temperature of some petroleum products is as follows (° C): gasoline - 528-747, diesel fuel - 513-643, kerosene - 489-533 [3].

The explosion hazard of oil products is characterized by the values of the lower and upper explosive limits. The lower explosive limit is the concentration of liquid vapors in the air, below which, when a burning object is introduced into this mixture, a flash does not occur due to an excess of air in it and a lack of vapors. The upper explosive limit corresponds to such a concentration of vapors of oil products in the air, above which the mixture does not explode, but burns. The vapor concentration values between the lower and upper explosive limits are called the explosive range. For some oil products the explosive range is: gasoline - from 0.76 to 8.4%, kerosene - from 1.4 to 7.5%, white spirit - from 1.4 to 6.0% [7,8].

The analysis of previous studies showed that a significant part of the loss of oil products falls on evaporation during storage, transportation and refueling of vehicles. Capturing vapors of petroleum products is an urgent task, because economically feasible.

Complete combustion of 1 kg of gasoline requires 14.45 kg of air or 0.5 kilo moles of air. In the thermal calculation of an internal combustion engine, the required amount of air for combustion of 1 kg of fuel is determined in kg or in kilo moles [2,5].

When determining the loss of oil products from evaporation and "breathing" of tanks, it is necessary to know the density of the evaporated light fractions. To do this, determine the molecular weight of the evaporated oil in kg/kmol. Table 2 shows the change in the molecular weight of petroleum fractions depending on the initial boiling point in ° C.

Table 2.

Change in molecular weight of petroleum product from temperature

Temperature, °C	50–100	101–150	151–200	201–250	251–300	301–350	351–400
Molecular weight, kg/kmol	90	110	130	155	187	220	260

From the analysis of table 2 it can be seen that the light fractions with equal boiling ranges have approximately the same molecular weight. With an increase in the boiling point of the fractions, the difference in molecular weights also increases, since the molecules become heavier [9,10].

For AI-80 gasoline, the molecular weight is 110 kg / kmol, for summer diesel fuel - 206 kg / kmol. [11].

The following table 3 shows the main properties of AI-80 gasoline.

Table 3.

Analysis of motor gasolines AI-80 K2-L according to O'zDSt 3031: 2015

No.	The name of indicators	ND for test method	O'zDSt standard norm summer	Actual
1.	Research octane number, not less	GOST 8226	80,0	82,0
	Octane number according to the motor method, not less	GOST 511	76,0	76,0
2.	Mass concentration of lead, mg/dm3. no more	GOST 28828	10	4,7
3.	Fractional composition: distillation start temperature, °C, not lower	GOST 2177	35	42
	Distillation limits, 10%, not higher, °C		75	60
	Distillation limits, 50%, not higher, °C		120	101
	Distillation limits, 90%, not higher, °C		190	160
	Boiling end, °C, not higher		215	190
	Volume fraction of the remainder in the flask, %, not more		2,0	1,4
	Remaining and losses,%, (by volume) not more		4,0	2,5
4.	Gasoline saturated vapor pressure, kPa, no more	ASTM D 323	66,7	46,8
5.	Volume fraction of benzene,%, no more	ASTM D 4053	5	4,8
6.	Mass concentration of solvent-washed resins, mg/100 cm^3, no more	ASTM D 381	5	4,4
7.	Gasoline induction period, min, not less	ASTM D 525	450	961
8.	Mass fraction of sulfur, mg / kg, no more	ГОСТ 19121	500	400
9.	Copper strip test (3h at 50 °C)	ASTM D 130	Class 1	Class 1
10.	Density at 15 °C, kg/m3, not less	GOST 3900	725,0	758,4
11.	Content of water-soluble acids and alkalis	GOST 6307	absence	absence
12.	Content of mechanical impurities and water	Visually	absence	absence
13.	Appearance	Visually	Clean, transparent	Clean, transparent
14.	Mass concentration of manganese mg/dm^3 no more	ASTM D 3831	absence	absence
15.	Mass concentration of iron g/dm^3 no more	GOST 32514	absence	absence

Losses of oil products occur from the evaporation of the lightest fractions, for example, pentane C_5H_{12}. Its density at 20 °C is 626 kg / m3, its boiling point is plus 36 °C, and its molecular weight is 72 kg / kmol.

Gasoline consists of various hydrocarbons from pentane C_5H_{12}, hexane C_6H_{14} to decane $C_{10}H_{22}$. Pentane, hexane, decane pass into a gaseous state, respectively, at a temperature of 36 °C, 69 °C and 180 °C. The composition of gasoline can contain benzene (C_6H_6), toluene (C_7H_8), but their boiling point reaches 80 °C and 110 °C. During storage, discharge, filling, gasoline losses will occur from the evaporation of light fractions and, first of all, pentane [6].

As has long been known, the profitability of any business directly depends on the algorithm for its construction, on how the funds are spent and the resources involved are used. A gas station (petrol station) today is a fairly profitable business, which, with a competent approach, brings significant income by today's standards.

Even at the design stage, a number of mandatory requirements are imposed on the filling station, for example, environmental requirements, requirements for equipment explosion protection, etc.

One of the ways to solve this problem is to install equipment at filling stations for capturing and returning (recuperating) vapors. This not only helps to overcome environmental barriers in the design of gas stations, but also allows you to save a lot.

Currently, there are two gas return systems (recirculation):

• vacuum - using a vacuum electric pump and is widespread due to the availability of proposals from equipment manufacturers;

• balance sheet - unique in its simplicity, the essence of which is the displacement of vapors of petroleum products from the gas tank by the pressure created by the fuel entering it.

The system meets all modern requirements, but has no application due to the lack of appropriate equipment [3, 12].

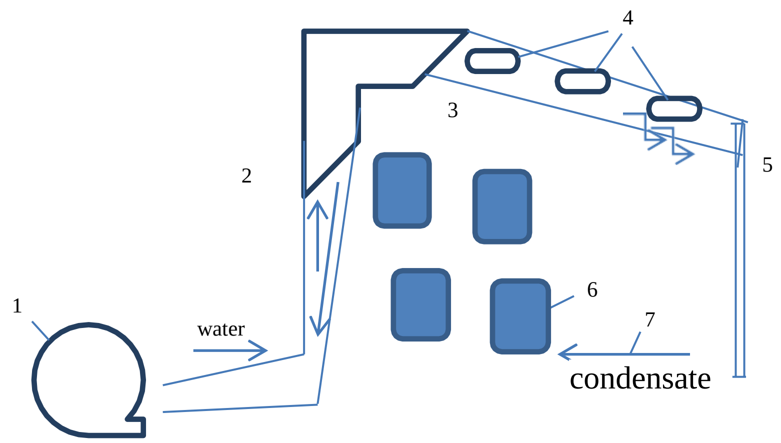

Figure 1. Technological scheme for capturing hydrocarbon vapors on a thin-walled condenser

1-refrigeration unit with a pump; 2-cold water pipelines; 3-adjustable porous canopy; 4-thin-walled condensers; 5,7-pipeline for condensed oil product; 6-fuel dispensers

The technological scheme of the work of the trap developed by us consists in cooling the emissions of PVA in a thin-walled condenser, followed by separation (separation) of the gas-condensate mixture of the developed design. The condensation and absorption process is carried out in condensate-separation devices (heat exchanger-condenser and centrifugal separator combined in a single housing). During the separation of the gas-condensate mixture, the processes of mass transfer and heat transfer, as well as dissolution of the non-condensed part on cold condensate, additionally occur. The resulting condensate (recovered product) also absorbs hydrocarbon vapors, is collected and drained by gravity into a storage tank. The rest (2÷3%) of the emission, the air-vapor mixture (PVA) is injected and dispersed into the atmosphere at speeds up to 30÷40 m/s.

DISCUSSION. The main advantages of the condensate absorption and separation technology developed by us for recovering PVA emissions during unloading and loading operations and storage of hydrocarbons are:

- high safety of the recuperation technology;
- ease of installation and operation;
- independence from the composition of PVA emissions;
- there are no costs for the purchase and disposal of absorbents;
- in the course of recovery, we obtain commercial quality condensate;

- minimum hydraulic resistance of the installation;
- automation of the main technological process;
- a wide network of service and maintenance of refrigeration equipment in the regions and high reliability to failure [8,10].

Figure 2 shows the Layout of a condensate separation unit for recuperating oil vapors at a gas station.

Estimated amount of recovered products (liters of hydrocarbon vapors/liters of bottled gasoline):

The average concentration of hydrocarbon vapors is 30% by volume (winter-summer) and a molar weight of 65, i.e. 2900 g / m³.

- input of hydrocarbon vapors	- 2900x30% = 870 g / Nm³
- density of hydrocarbon vapors	- 630 g / m3
- recovered vapors of hydrocarbons in bottled gasoline	- 870/630 = 1.38 l / Nm³

Figure 2. Layout of a condensate separation unit for recuperating oil vapors at a gas station.

Thus, it is possible to recover 1.38 liters of gasoline from the vapors generated by pouring 1 Nm³ of gasoline.

Vapors are captured from tanks when loading petroleum products. It is quite difficult to capture steam due to the very large proportion of light ends - in the provided chemical composition over 75% of the hydrocarbon in the steam is C_1 and C_2. These light ends require very low operating temperatures for condensation [13, 14, 19, 20].

CONCLUSION. Thus, using the most modern calculation method, taking into account all the above factors, and operating with the mass flow density of evaporating gasoline, it is possible to calculate the gasoline losses during warehouse operations. Moreover, the calculation error is about 16%, which is not bad, given the complexity and multi-parameter nature of the processes occurring during the discharge/filling and storage of oil products.

Researches have shown that there is a dependence of the amount of displaced fuel in the form of a vapor-air mixture on temperature. Losses of oil products from evaporation displaced into the environment when refueling vehicles is 0.09 ... 0.12% of the amount of refueling oil product. Analysis of the chemical composition of the air on the territory of gas stations showed that the main components of light fractions of petroleum products (gasoline) are: hexane, acetone, carbon disulfide, benzene, decane, ethylbenzene. Diesel fuel losses from evaporation areless than that of gasolines, but they pose a threat to the environment.

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