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# ANTICIPATED ECONOMIC RETURN FROM APPLICATION OF THE EJECTOR HEAT EXCHANGER FOR LIGHT FRACTION HYDROCARBON CONDENSATION ON THE PETROLEUM STORAGE DEPOT

*Prevention of oil product losses is the one of the relevant way of fuel and energy resources saving that play a substantial role in economy development. Nowadays a lot of various procedures for choice of oil and petrol losses from evaporation reduction means are known. However on the one hand they do not include the cost of these funds and expenditures for their maintenance, on the other hand they do not account different timing of losses reduction means introduction or use outdated at the present day criterion. In the conditions of petroleum storage depots, as a rule, usage of ejector systems of light fraction trapping is more preferential than other losses reduction hardware's. The positive effect from ejector heat exchanger application for preventing of petroleum products losses is calculated.*
*Keywords: Annual losses of petroleum products; System of vapor recovery of oil products; Price of ton of oil product; Ejector heat interchanger; High-grade petrol; Economic benefit.*

## INTRODUCTION

At organization of saving of petrol comprehensive learning are suppose, and then decrease and the next removal are more any than losses of a light hydrocarbon at all phases them delivery to a user. The negative influencing, call by evaporation losses, consisted not only in decrease of fuel resources and, as consequence, cost of products, was loses, but also in negative ecological impacts on an environment.

In this connection decrease of losses of petrol from evaporation are relevant not only with the point of view of economic benefit, but also for security of nature preservation. Petroleum and products of its processing could to influence negatively air, water, the soil, a plant and animal life and the human.

For the exact choice of a means of reduction of losses of vapor of petrol from evaporation, it are necessary to know, on how much percent it has reduced them. This value is call the degree of reduction of losses. In exist procedures these values for miscellaneous hardware's was accept by the stationary values, which are not dependent on operation conditions of reservoirs. However, it did not represent the facts. Unlike traditional means of reduction of losses, references on prediction of a datum for ejector systems of vapor recovery of petrol is not present.

Decrease of losses of petroleum products - one of the major directions of an energy saving. In requirements when oil reserves was confine, and her production required the increasing efforts, rushing are natural to save that are already procured and manufactured in a commercial product.

In the conditions of market economy it are necessary to approach to a choice of modes of decrease of losses of petroleum products with the registration not only the reach positive effect (in this case - decrease of hydrocarbon emissions in an atmosphere), but also a fabrication cost (acquisition) and exploitation of this means. At present for determination of cost efficiency of elaborate events, such comparison methods of alternatives was possible:

− on an actual pay-back period of investments, it are compare with a normative pay-back period;

− on a minimum of reduced cost.

In Ukraine determinations of losses of oil product, it are regulate according to the normative document. According to him the total losses of oil products consist of a natural wastage at storage, reception, tempering, haul was define. Also in total losses, it are switch on one-trip losses at emergencies, reconditioning has, etc. A natural wastage was define as a variance between the common and one-trip losses. Magnitude of a natural wastage are adjust with rates of natural loss who was specific in process.

## FORMULATION OF THE PROBLEM

Allow for a singularity of realization of technical and economic accounts we will consider that comparative cost efficiency of modernizing of system define for determination the performance evaluation as from the point of view of decrease of losses, and cost efficiency of means of modernizing are.

Some authors executed technical and economic accounts on the cost value of storage of one ton of oil products, and some - on the cost value of storage of oil product in 1 м³ operation bulk of the reservoir. Thus:

$$C_{\text{н}} = \frac{E}{Q}, \qquad C_p = \frac{E}{V} \qquad (1)$$

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where Cн, Cр – the cost of storing 1 т of oil products, and oil products in the 1 м³ operational volume of the tank respectively; E – operational cost in a year; Q – turnover rate of the tank in a year. As the cost value of storage are peer to creation of the cost value of an unit measure on amount of such unities irrespective of a method it a payback period can be define evaluations, as:

$$T = \frac{K}{E_1 - E_2} \qquad (2)$$

K – capital investments on the modernizing, stipulate by the estimate; E1 and E2 - annual maintenance cost before modernizing accordingly.

Technical and economic accounts at value of storage of unity of operation bulk of the tank can be execute in that event when a turnover rate (annual traffic) of tanks, was compare, it are equal. At different cargo turnovers, similar accounts should be execute on the cost value of storage of a mass unit of oil product.

Calculate value of losses of engine fuel, it are desirable to allow for them quality. As the prices for indexes of saturation pressure, was more other than octane number, availability of valuable fractions done not allow, such value calculated in wholesale prices of the industry without the receipts tax.

The normal value of depreciation expenses on renovation from investments on modernizing depended on normative life expectancy of engineering betterment. However, there are a series of means of the modernizing which one normative life expectancy are peer to normative useful life of tanks.

In the capacity of an example, we will define operational effectiveness for tanks of types RVS-1000, RVS-2000, RVS-3000, RVS-5000 and RVS-10000 such methods of decrease of evaporation losses:
− metallically buoyant (effectiveness of decrease of losses – 80 %);
− synthetic buoyant (effectiveness of decrease of losses – 92 %);
− gas equalizing system with the accumulator of gas type "a breathing bulb" a capacity 2000 м3 (effectiveness of decrease of losses – 70 %);
− "the breathing flap" type "a tank gas-extraction system" (effectiveness of decrease of losses – 90 %);
− Ejector system (effectiveness of decrease of losses – 98%).

At first economical indexes of basic alternative calculated at storage of a car high-grade petrol at coefficient of a turnover rate of the tank 12 about / year.

The positive economic benefit of application of an ejector means of preventing of losses of oil product are attain only in the event that expenditures on preventing of losses of one ton of oil product was less more its than the generalized value.

Then economical indexes of the compare tank arrange with a means of decrease of evaporation losses defined. Accounts executed at storage of oil product of the same brand in the tank of the same holding capacity, as well as basic alternative.

Annual losses of petrol from evaporation was peer to the total of losses from small and major "breathing", and

them calculated behind a designed procedure for each tank separately.

$$P_1 = xP_6 \qquad (3)$$

where x – part of losses from tanks;
— Investment costs:

$$K_1 = P_1 K_c + C_{м1} + 0{,}35 C_1 \qquad (4)$$

where $C_{м1}$ – assembly cost of system of reduction of evaporation losses (4-5 % from value of system of reduction of losses); uah;
$C_1$ – cost of system of reduction evaporation losses, uah;
$K_1$ – accompany capital cost consist of expenditures on mounting, transportation system, uah;
$K_c$ – specific accompany capital investments, them calculated at the rate of that for obtaining1т petrol it are necessary to spend 5т petroleum crude.

The cost value of storage of petrol in the tank arrange with system of reduction of losses, calculated by formula:

$$C_p^п = \frac{E_1}{V_{rz}} \qquad (5)$$

term of payback:

$$T_1 = \frac{K_1}{E_6 - E_1} \qquad (6)$$

The calculation was performed for the installation, working with larger capacities (PBC-1000, the PBC-2000, the PBC-3000, the PBC-5000 is the PBC-10000) for NPIK LLC "Zirka" in the city of Zaporozhye. The calculation results are summarized in table №1, 2, 3.

Monthly on the petroleum storage depot of a capacity 2 times was space fill and at the unit embayment of loss on a squeezed out steam (as a result of evaporation) constituted about 5,000 L. of a high-grade petrol. The prime cost of such petrol for 1 L. constituted 20 uah. Losses from the embayment of a high capacity in a month constituted 20,000 uah.

The assembly cost and assemblies of installation constituted 8,000-10,000 uah.

After acquiring equipment design and the data are summarized in Table №2

Maintenance cost at plant operation, the data was table №3

The petroleum storage depot daily gained a railroad train with a pool hydrocarbon and sent gas-tank trucks on fuel stations of field.

In the terrain of the petroleum storage depot 5 tanks of a type RVS-5000, RVS-10000 and more than 30 tanks of a type RVS-1000, RVS-2000 was allocated, RVS-3000 and on not the official datum monthly losses on tanks constituted to 110,000 L. of different combustible depending on tank capacity and environmental factors.

**STAGES OF DESIGN TO THE INSTALLATION INSTRUCTIONS**

Operations for loading and unloading of petroleum hydrocarbons from the tank into the tank when pumping pumps and overflow can be used conventional ejector heat exchanger. This could be achieved in the present schematic.

**Figure 1** − *Oil tanks type RVS (RVS-5000, RVS-3000)*



1 - the main trunk pipeline
2 - the reception tank
3 - the working tank
4 - supercharger
5 - ejector heat exchanger
6 - apparatus for inert gas injection
7 - safety device
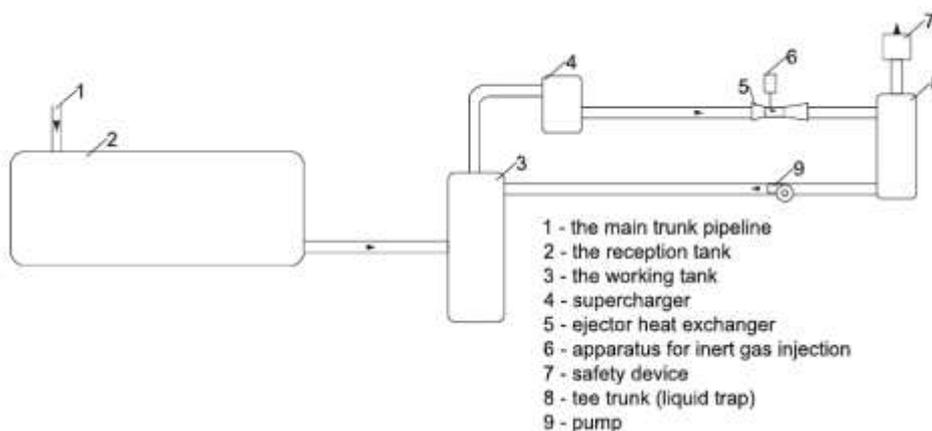8 - tee trunk (liquid trap)
9 - pump

**Figure 2** − *Schematic diagram of the connection of the ejector heat exchanger in the system drain from the tank*

The designed device allowed to reduce almost completely losses of a hydrocarbon at a spillover from a tank in a tank, transporting. Usage of this device allowed to refine system of draining and fullness and to increase energetic effectiveness which one played a crucial role in preservation of a hydrocarbon.

Value of 1 L of pool not cleared nitrogen in the city of Zaporozhye constituted 12 uah, and the large wholesale are peer 10 uah.

Designing the installation with an ejector heat exchanger made according to the rules and budgets of composite heat exchange equipment.

**Table 1** *– Expenditures on projections of installation*

| № | Activity category | Value of the perform operation (uah) |
|---|---|---|
| 1 | Account and matching of the equipment | 4,000 |
| 2 | Expert judgment | 500 |
| 3 | Design of the detail design | 6,500 |
| 4 | Compilation of the budget documentation | 2,000 |
| Total: | | 13,000 |

**Table 2** *– Expenditures on the equipment of installation*

| № | The equipment from the design | Cost (uah) |
|---|---|---|
| 1 | The ventilator in defensive embodiment | 22,000 |
| 2 | Ejector heat interchanger as an assembly | 3,000 |
| 3 | Tank for feeding of nitrogen | 5,000 |
| 4 | Pipe ducts as an assembly | 2,000 |
| 5 | Valve and gears of automation, and guard | 7,000 |
| Total: | | 39,000 |

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*Table 3 – Maintenance cost at plant operation*

| № | Maintenance cost | Cost (uah / year) |
|---|---|---|
| 1 | Servicing of installation (in combination) | 3,000*12= 36,000 |
| 2 | Value of liquid nitrogen | 80 uah. / 1l. petrol<br>800*12=9,600<br>9,600*12=115,200 (uah) |
| 3 | Expenditure of an electrical power | 75 kWt*12=900<br>900*1.5=1,350 |
| Total: | | 152,550 |

## CONCLUSION

Sum up it are necessary to mark that value on design and acquisition of the equipment, and it mounting had constitute 53,000 uah. Annual maintenance cost had constitute 152,550 uah. Ground on the accounts it are possible to state that installation paid for itself less than in a year.

Application of installation with an ejector heat exchanger for condensation of trapping of light fraction hydrocarbon completely on the petroleum storage depot will allow will gain economic benefit much more promptly.

In the territory of the petroleum storage depot, and also in radius of 5 kilometers from the petroleum storage depot a gas pollution vapors of a hydrocarbon exceeded admissible normal value in ten times. The disturbed ecosystem, people suffered affliction industrial diseases.

Application of installation with an ejector heat interchanger for condensation the trapping of light fraction of a hydrocarbon on the petroleum storage depot will allow advocating a surrounding medium from hit of vapor of a hydrocarbon in it.

The conclusions with regard to the efficiency of the ejector vapor recovery units of the system are valid in the case when it is connected to the 5 tanks with gasoline. If they will be less, it will expand the scope of the pontoons or gas piping. When the number of connected tanks larger than 5, ejector vapor recovery units system can be out of competition.

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## ПРОГНОЗОВАНИЙ ЕКОНОМІЧНИЙ ЕФЕКТ ВІД ВИКОРИСТАННЯ ЕЖЕКТОРНОГО ТЕПЛО-ОБМІННИКА ДЛЯ КОНДЕНСАЦІЇ ЛЕГКО КИПЛЯЧИХ ВУГЛЕВОДНІВ НА НАФТОБАЗІ

*Боротьба з втратами нафтопродуктів – один з важливих шляхів економії паливно-енергетичних ресурсів, що грають важливу роль в розвитку економіки. В даний час відома велика кількість різних методів вибору засобів скорочення втрат нафти і бензину від випаровування. Однак, одна частина з них не враховує вартості цих коштів і витрат на їх експлуатацію, інша – не враховує різночасності впровадження засобів скорочення втрат, третя – використовує застарілий, в даний час, критерій. В умовах нафтобаз, як правило, використання ежекторних систем уловлювання легких фракцій більш переважно, ніж інших технічних засобів скорочення втрат. Розраховано позитивний ефект від застосування ежекторного теплообмінника для запобігання втрат нафтопродуктів.*
***Ключові слова:*** *Річні втрати нафтопродуктів; Система уловлювання парів нафтопродуктів; Ціна тони нафтопродукту; Ежекторний теплообмінник; Високооктановий бензин; Економічний ефект.*