AUTOMATED HYDROCARBON TREATMENT MACHINE DESIGN

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ПРОЕКТИРОВАНИЕ АВТОМАТИЗИРОВАННОЙ УСТАНОВКИ ДЛЯ РЕГЕНЕРАЦИИ УГЛЕВОДОРОДНОГО СЫРЬЯ

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Аннотация. *Современное развитие нефтяной отрасли предполагает наличие ресурсоэффективных технологий, которые базируются на технических, экономических и экологических принципах. Их нарушение может привести к невосполнимым потерям ресурсов и нанести существенный экологический ущерб. Поэтому международные экологические стандарты ИСО 14000 предполагают повышенные виды ответственности к предприятиям, допустившим указанные нарушения. Тем не менее, нефтяные компании ежегодно несут серьезные финансовые затраты, связанные с аварийными или чрезвычайными ситуациями при транспорте нефти и нефтепродуктов. В связи с вышеуказанным, возникает необходимость в совершенствовании существующих и разработке новых эффективных и быстрореализуемых технологий локализации и утилизации нефтяных разливов.*

Ежегодный объём, поступающих на утилизацию углеводородов с загрязнениями, требует развития высокоэффективных, недорогих и экологически безопасных технологий, которые базируются на различных физико-химических методах разделения.

В настоящее время существуют как зарубежные, так и Российские аналоги по очистке/утилизации нефтезагрязнений или нефтешламов. Проведённый литературный анализ позволил выявить наиболее востребованные технологии, разработанные российскими производителями.

Исходя из достоинств проектов разных компаний и учитывая их недостатки, авторами была предпринята попытка создания конкурентоспособной технологии импортозамещения (моделирование новой установки), с учётом требований конечного потребителя.

The oil industry’s continued progress advances the application of resource-efficient technologies based on technical, economic, and environmental principles. Violation of the above principles generally causes the loss of irreplaceable natural resources and, as a result, environmental damage. Therefore, the international ecological standards ISO 14000 aim to persuade companies to take more responsibility for violation of these principles and regulations [1]. However, financial costs annually incurred by petroleum companies because of oil and gas transportation accidents do not decline [2]. This necessitates improvements in the existing technologies and

development of new ones which would be effective in oil spill detection, elimination, and further treatment of oil sludge.

The treatment machine produced by Swedish company «Alfa Laval» has been chosen as one of the most highly positive examples (LLC «Avantage», LLC «Spetzautocom», ZAO «RusEcoProject») and foreign manufacturers (LLC «Alfa Laval», AG «MOG») [3-5] for oil sludge processing. Main characteristics of the machine are listed in Table 1. All calculations were made per one month of machine operation given that it was a five-day working week and 8-hour work day. Calculations involved the current price for oil sludge treatment (1250 rub/m^3).

Table 1

"Alfa Laval" machine characteristics

Company	Power	Cost	Processing capacity	Treatment methods
LLC «Alfa Laval»	45 kW	13 000 000	9 m^3/h	Phys-Chem-Bio
Price for a block	Cost of operation (network)	Cost of operation (field)	Total profit	Payback period
	34 560		1 800 000	7,5 months.

The advantages of Swedish project are as follows: high utilization quality of any oil products, compliance with modern environmental standards, high reliability and technical support guaranteed by the manufacturer. However, the facility discussed has some limitations: impossibility of feedstock reprocessing due to high performance and need for consumables (filter cartridges and chemical reagents).

Having considered all the advantages and limitations of "Alfa Laval" technology, authors have made an attempt to develop a new machine within import substitution framework with due regard to the listed characteristic features (Table 2).

Based on calculations which involve costs related to the proposed facility operated from different power sources, it has been revealed that one of the most effective methods to cut utilization cost is the possibility to carry out all works stationary. Depending on the operating conditions, autonomous field work will be 3-4 times more expensive.

Table 2

Characteristics of the proposed machine

Company	Power	Cost	Processing capacity	Purification methods
The proposed machine	15 kW	1 545 200	2 m^3/h	Physical
Price for a block	Cost of operation (network)	Cost of operation (field)	Total profit	Payback period
300 000 - 450 000	11 520	47 232	400 000	4 months

Due to physical treatment methods, it has become possible to recover good quality oil from waste oil sludge with its composition being the same. This cannot be achieved in other ways. Therefore, it can be stated that the proposed treatment machine is resource-efficient and it enables to partially reprocess waste oil sludge prior to reuse or disposal. Authors have carried out the feasibility study in terms of short-term perspective (3 years) and

long-term perspective (10 years) of the proposed machine implementation including Swedish analogue if using only physical methods of treatment (Table 3).

Table 3

Profit and work volume comparison for short- and long- term perspectives

Parameters	«Alfa Laval» (1 machine)	Proposed machine (4 machines)
Processing capacity (m3/hour)	9	8
Expenses (facility assembly and energy, 3 years)	14 244 160 rubles	6 595 520 rubles
Total profit (3 years)	25 920 000 rubles	23 040 000 rubles
Volume of processed material (3 years)	51 840 m^3	46 080 m^3
Expenses (facility assembly and the energy, 10 years)	17 147 200 rubles	7 563 200 rubles
Total profit (10 years)	86 400 000 rubles	76 800 000 rubles
Volume of processed material (10 years)	172 800 m^3	153 600 m^3

The most significant findings to emerge from this study are as follows:

- ✓ the proposed project is of low cost in comparison with European analogues;
- ✓ due to high mobility and small number of staff required to operate the facility (up to 3 persons including an operator), it is possible to eliminate oil spills in-situ which, in its turn, contributes to significant cost reduction as compared with the ex-situ methods;
- ✓ having a proper financing the further development and serial production of the proposed facility will provide qualified specialists with new workplaces and contribute to addressing the issue concerning small local spills far from big refineries;
- ✓ the equipment performance is enough to utilize the wastes of a small refinery.

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