ISSN: 2350-0328

International Journal of Advanced Research in Science, Engineering and Technology

Vol. 8, Issue 11 , November 2021

On Oil Loss from Evaporation from Open Surface

RustamShafiev

PhD, Consultant - Secretary of The Scientific and Technical Council, JSC «O'ZLITINEFTGAZ», Tashkent, Uzbekistan

ABSTRACT: In modern conditions of oil production, special attention is paid to reducing oil losses in the processes of its preparation, which is associated with ensuring environmental protection and increasing the technical and economic efficiency of oil and gas operations. Today, oilfield technologies are used, which are designed to dehydrate emulsions that do not have complex structural and mechanical properties. At the same time, oil production from hard-to-recover reserves requires large energy resources, which affects the efficiency of oil treatment. It has been revealed that during the transition to the operation of fields with hard-to-recover reserves, the growth of complex dispersed systems and intermediate emulsion layers in sedimentation tanks occurs, which requires taking measures to prevent malfunction of oil treatment units and thereby avoid additional oil losses. The problem of oil losses during the active phase of oil production from hard-to-recover reserves will remain relevant due to the accumulation of trapped oil and oil sludge. The article presents the materials of scientific research of oil losses from evaporation from an open surface. Losses are determined for the main types of oil and various degrees of water cut. The results obtained make it possible to more fully assess the emissions of hydrocarbons into the atmosphere during accidental emissions and to correctly determine the components of the environmental load on the soil, air and water basins. A formula is given for the balance between the mass of oil lost during the release and the mass of collected and lost oil (impregnation into the soil, deposited at the bottom of the water basin, evaporation). To reduce the burden on the environment, a scheme of improved oilfield technology has been proposed, by supplementing it with specialized production units for additional processing of complex dispersed systems and an ecological workshop.

KEYWORDS: Oilfield Technology, Trap Oil, Oil Sludge, Emergency Oil Release, Oil Evaporation, The Amount of Oil Losses from The Duration of Oil Storage in The Open State

I. INTRODUCTION

The operation of oil fields with hard-to-recover reserves is accompanied by the introduction of innovative technologies to increase oil recovery and stimulate oil flow to the well for forced production, when they switch from the natural mode of reserves drainage to artificial methods. Under these conditions, from the reservoir along the flow lines of the filtrate fluids spontaneously flow to the well - oil, dissolved gas, formation water, solid particles of organic and inorganic origin with the formation of their mechanical mixtures combined into complex-multiple emulsions, which differ depending on the method of oil production being introduced.

II. REFERENCE INFORMATION

By research on thermochemical dehydration and special rheological studies of oil, we have established the key dependences of changes in the composition and structural and mechanical properties of complex emulsions during oil production from fields confined to various types of in terms of the complexity of extracting geological reserves, after applying geological and technical measures (GTM) and well workover (workover). Changes in the composition and properties of extracted complex dispersed systems in prevailing cases lead to complications in the collection, preparation, transportation and storage of oil. Therefore, one should strive to improve the safety of oil and gas production [1]. Failure to take into account production complications leads to multiple expenditures of raw materials and energy and can often provoke an oil spill accident.

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 8, Issue 11 , November 2021

III. METHODOLOGY

Proceeding from the principle of the unity of purpose of the created oilfield technology for the effective management of the oil economy with the provision of high values of oil recovery factor, they resort to multivariate consideration of energy and resource savings in individual oil and gas operations [2]. The main condition here is the increased requirements for production, which implies a revision of the initial characteristics of the processes incorporated in the technology due to the failure to ensure their functions in full in the rapidly changing conditions of oil production from complex deposits [3]. However, for a number of reasons, this revision with the modernization of oil and gas operations in the existing oilfield technology is lagging behind and then the loss of raw materials is inevitable.

The article deals with the general problem of the accumulation of trapped oil and oil sludge, including emergency emissions at oil production facilities and its solution.

Trapped oil and oil sludge are formed as a result of the extraction, collection, preparation, transportation, storage and processing of hydrocarbon raw materials (oil, natural gas, gas condensate and oil products), as well as in the process of emergency and repair work in production due to the imperfection of the current technology.

First of all, it is necessary to understand that trapped oil and oil sludge do not exist in nature and this refers to an artificially created object of research. And from this it follows that at each stage of the development of civilization and the environmental safety requirements put forward for production, the amount of trapped oil and oil sludge can increase or reach its minimum. Ideally, one should strive for their complete eradication when creating the technologies of the future. In the research, we will adhere to the following definitions for trapped oil and oil sludge.

Trapped oil - the term suggests that oil is "caught" in specially equipped tanks or open structures on the terrain, in the booms of water bodies, that is, it is not produced in a traditional way. At the fields, trapped oil is formed as a result of oil discharge and due to imperfections of the existing oilfield technology associated with: emergency situations at the oilfield facility, including due to the discharge of intermediate layers from technological tanks - a highly stable emulsion that exceeded the critical mass; repair - emptying of "dead" or bottom residues from technological devices and pipelines of systems for gathering, preparation, transportation and storage of oil and gas, as well as from oil refining units; trapped oil at water treatment plants and after an accidental spill on the relief and water bodies. Long-term operation of trapped oil facilities generates losses and sludge formation.

Oil sludge is a complex physicochemical mixture, which contains on average (by weight) 10 - 50% hydrocarbons, 30 - 85% water, 0.5 - 40% solid impurities.

Expertly, it can be argued that: a) trap oil can reach 1% of the turnover of crude oil in a single territory where the established environmental standards are observed; b) oil sludge is formed in the amount of 0.1-0.3% of the total productivity of the refinery; c) solid inclusions of bottom sediments may contain up to 0.1% of raw materials (hydrocarbon-asphalt-resin-paraffins) from the gross turnover of oil and oil products.

In total, the volume of liquid and high-viscosity hydrocarbons lost due to the formation of trapped oil, oil sludge and bottom sediments in the production and processing of oil and gas is estimated at 1.25%, which is equivalent to 12.5 thous. tons. These losses multiply in case of accidents in oil production.

The study of literary sources has shown that studies of trapped oil and oil sludge are mainly aimed at: classification and analysis of sources of generated waste [4, 5]; determination of their composition [6, 7]; development of methods for separation, processing and ways of using the separated hydrocarbons [8-12]; creation and use of various devices for their processing [13,14]; as well as exerting a negative impact on the natural environment [15]. However, in the works considered, there is no direction of research related to oil losses due to evaporation in an open surface. The relevance of this area of research is dictated by the practice of eliminating man-made accidents, when it is required to determine the component from emissions of light hydrocarbons into the atmosphere.

Due to technical failures in production systems and pipeline transport, oil is released onto the relief or water basin (accidents). The most large-scale accident can be considered the oil spill in the Gulf of Mexico. The accident that occurred on April 20, 2010, 80 kilometers off the coast of Louisiana in the Gulf of Mexico, on the Deepwater Horizon oil platform in the Macondo field. The oil spill that followed after the accident became the largest in the history of the United States and turned the accident into one of the largest man-made disasters in terms of negative impact on the environmental situation. The results of their elimination are given in [16]. However, it is not clear from the data presented what value was the loss from evaporation, which led to the environmental load on the air. The same can be argued in the event of an accident at the Amplify Energy pipeline in the Orange County area of California, when more than 3 thousand barrels of oil got into the Pacific Ocean due to a leak on October 2, 2021 [17]. This knowledge gap can be filled with the following research result on the rate of evaporation of oil from an open surface.

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 8, Issue 11 , November 2021

IV. RESEARCH RESULTS

For this, the following model studies of evaporation losses from an open surface were planned and carried out on samples of the main types of light, medium viscosity oil, paraffinic, highly resinous (bitumen), oil-condensate mixture and their oil-water emulsions with a storage time from 30 to 800 days at medium temperature intervals for latitude of Tashkent city. Tables 1 and 2 show the results of these experiments.

Table 1. Oil losses from evaporation from an open surface during long-term storage for various types of oil

Oiltype	Temperature conditions on the evaporation mirror, °C	Durationofobservation, days	Loss, % byweight
Light, sample No. 1 density more than 850 kg / m3	20	100 200	10,00 14,00
Light, sample No. 2 density less than 850 kg / m3	from 5 to 30	90 180 365 770	16,50 24,10 30,07 37,20
Average sample No. 1 density from 855 to 880 kg / m3	from 20 to 60	30 60 100	4,0-6,9 5,3-9,0 6,0-10,8
Average sample No. 2 density 870 kg / m3	from 5 to 30	90 180 365 770	6,94 15,77 19,92 24,20
Paraffin, density from 840 to 880 kg / m3	from 5 to 30	30 60 120 180 365	2,32-4,54 3,41-6,16 4,48-7,96 8,38-12-04 17,73-21,60
Heavy, density more than 900 kg / m3	20 from 20 to 40 from 20 to 70	30 60 100	0,55-1,75 2,20-4,80 8,90-9,70

Table 2. Coefficient taking into account oil water cut

Oil	Mass fraction of emulsion bound water, %							
	0,0	5,0	10,0	15,0	20,0	30,0	40,0	50,0
Medium, paraffinic, resinous	1,0	0,95	0,900	0,850	0,800	0,710	0,615	0,520
Light, oil-condensate mixture	1,0	0,995	0,990	0,967	0,910	0,750	-	-

As you can see, the losses in the limit reach values comparable to the potential of the light fractions contained in the original oil. Taking into account the laboriousness of accounting for the balance of collection of spilled oil on the relief or water basin, the tables presented can be used to determine the loss of oil from evaporation during the liquidation of emergencies and to make estimates of emissions of light hydrocarbons into the atmosphere.

4.2. Recommendation for application of the obtained results

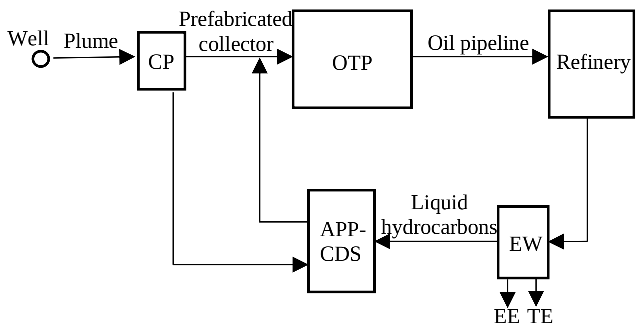
These studies allow us to propose the following formula for the balance of oil accounting when collecting and eliminating the consequences of a blowout:

$$Ml = Mc + Ms + Mw + Me , \qquad (1)$$

where M is the mass of oil, indices “l” are losses (emissions), “c” is collected, “s” is impregnated into the soil, “w” is oil submerged in the water column, “e” is the evaporation of light fractions into the atmosphere. Usually, during the elimination of emissions, the data on the indicators Ml and Mc are presented fairly fully. Me can be determined from the results presented in Tables 1 and 2, then it will be easy to determine the values of Ms + Mw.

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 8, Issue 11 , November 2021

The materials for determining oil losses during long-term storage in open trench storage facilities made it possible to gain new knowledge in the considered problems of oilfield hydromechanics.
The use of this knowledge can be shown on the example of the developed technique and method for determining the loss of high-viscosity oil, for which a patent for an invention of the Republic of Uzbekistan was obtained (IDP # 04597). The invention expands the range of the determined value of oil losses due to evaporation from an open surface at any stage of its long-term storage. Dynamic viscosity and a previously constructed graph of oil viscosity versus losses are used as a control parameter. The invention can be used when it is necessary to establish the time of the oil spill event taking into account the application of the data from Tables 1 and 2.
Thus, trap oil and oil sludge are inevitable products in oil production. Therefore, in the developed oilfield technology, a place should also be allocated for the disposal of these products.
4.3. Technical and technological solution for utilization of trap oil and oil sludge
We see the solution to the problem in the retrofitting of the oil field system for the production, collection, treatment, transportation and storage of oil with special processes:
- additional processing of complex-multiple dispersed systems, including trap oil;
- pyrolysis processing of oil sludge;
- utilization of low-pressure combustible gases with the generation of electrical and thermal energy for the needs of the field.
The general scheme of oilfield technology will then have the following form (Figure 1). And will maximize the energy and resource efficiency of production with minimal impact on the environment.



CP- collection point; OTP - oil treatment plant; OR - Oil refinery; ESh - Ecological shop; APP-CDS - Additional processing plant of complex dispersed systems; EE - Electric energy; TE - Thermal energy.

Figure 1. General scheme of oilfield technology

The main flow of raw materials from the field will not change and will be carried out according to the classical scheme - a well, a collection point (CP), a collection pipeline, an oil treatment unit (OTP), an oil pipeline, an oil refinery (Refinery). An additional flow of raw materials formed from trapped oil (from CP, OTP and spills) is first fed to an additional processing plant for complex dispersed systems (APP-CDS), where the dispersion is brought to the state of an easily disintegrating oil-water emulsion (OWE) with subsequent feeding to the OTP. The ecological workshop (EW) performs the functions of processing oil sludge with the production of liquid and gaseous hydrocarbons by their utilization according to the ORC technology with the generation of electric and thermal energy for the needs of the field.
The advanced construction of the proposed scheme of the improved oilfield technology will allow the systematic production of the formed trap oil and oil sludge without creating an additional load on the natural environment.

V. CONCLUSION

The active development of hard-to-recover oil reserves from complex geological objects is accompanied by a spontaneous increase in the share of complex multiple emulsions in the produced product.
The delay in the introduction of new processes to improve the existing oilfield technology in the rapidly changing conditions of hard-to-recover oil production generates multiple costs of raw materials and energy. In some cases, this leads to emergency situations.
A method is proposed for determining oil losses from evaporation from an open surface after a long time.

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 8, Issue 11 , November 2021

VI. RECOMMENDATION

For oil and gas territories, an important place should be given to the environmental issue in the production of hard-to-recover oil and, in order to avoid the accumulation of trapped oil and oil sludge, the modernization project should include specialized production facilities for their preparation and processing.

REFERENCES

1. Handel G.L., Kleimenov A.V. (2004). The concept of choosing measures to increase the level of safety of oil and gas production. NTZh - Environmental protection in the oil and gas complex, 8, 11-14.
2. Patel S. (2007). Energy saving at each production site of the enterprise. Oil and gas technologies, 4, 75-79.
3. Cusack R. (2009). Koch-glitsch, LP, Weihita, Kansas. Oil and gas technologies, 10, 85-92.
4. HerndonM., SammarcoP. W., NicholsonA., PascalJ., WisemanB., WagenbrennerD. (2013). Decision of the 21st century to eliminate the consequences of oil spills. Oil and Gas Technologies, 2, 4-19.
5. https://neftegaz.ru/news/incidental/699504-u-beregov-sht-kaliforniya-proizoshla-utechka-nefti-iz-nefteprovoda/
6. Mochida I., Sakanishi K., Fujitsu H. (1986). Stored crude-oil sludge components identified. Oil and Gas Journal. XI. - Vol. 84, 46, 58-63.
7. Mazlova E.A., Menshikova I.A. (2010). Sludge waste from oil and gas companies. Environmental protection in the oil and gas complex, 1, 20-23.
8. Patel S. (2007). Canadian tar sands: favorable opportunities, technologies and problems. Oil and gas technologies, 6, 87-93.
9. Khutoryansky F.M. (2010). Trapped water-in-oil emulsions: composition, properties of emulsifiers and mechanical impurities and their effect on the stability of emulsions. World of oil products, 7, 24-31.
10. Khutoryansky F.M. (2010). Trapped water-in-oil emulsions: development of a surfactant composition - an effective demulsifier for the destruction of stable emulsions and the removal of mechanical impurities from them. World of oil products, 8, 31-36.
11. Khutoryansky F.M. (2011). Trapped water-oil emulsions: removal of mechanical impurities and dehydration. World of oil products, 4, 25-28.
12. Garabadzhiu A.V. and others (2012). Cluster of technological units for processing large-tonnage accumulations of acid sludge and oil sludge. Oil refining and petrochemistry, 9, 37-48.
13. Shperber E.R., Bokovikova T.N. Sperber D.R. (2011). Sources of oil sludge formation and methods of their utilization. Chemistry and technology of fuels and oils2, 53-56.
14. Bokovikova T.N. and other. (2013). Classification and system of waste management of primary oil refining. // Oil refining and petrochemistry, 11, 36-40.
15. Egazaryants S.V. and other. (2015). Technological processes of oil sludge processing. Chemistry and technology of fuels and oils, 5, 50-55.
16. Solovyanov A.A. (2012). Processing of oil sludge using chemical and biological methods. Environmental protection in the oil and gas complex, 5, 30-39.
17. Khodzhaeva G.K., Plum E.A. (2012). The impact of oil pollution on the environment of the Nizhnevartovsk region // Omsk Scientific Bulletin, 1 (108), 221-223.

AUTHOR’S BIOGRAPHY

SHAFIEV RUSTAM UMAROVICH

Place of work: JSC «O'ZLITINEFTGAZ».
Specialist in the field of production, collection, treatment, transportation and storage of oil.
Education:
Diploma of the Azineftekhim University (Baku, 1974) in the specialty of machinery and equipment for oil and gas fields.
Degree of Candidate of Technical Sciences (2007) in specialty 05.15.06, dissertation on the topic: “Methodological foundations of field preparation of oil at various stages of field development”.
Directions of scientific work
- Rheological studies of oil and water-oil emulsions;
- Oil dehydration and desalination;
- Technologies for collection, preparation, transportation and storage of oil;
- Oil losses.