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Research Article

Analysis of Natural and Technological Losses of Products in the Collection, Preliminary Preparation and Storage Systems at the Kokdumalok Umid and South Kemachi Mines

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Abstract

This article examines and analyzes the collection and preparation systems in oil fields. It explores the conditions under which various technological schemes are applied during the process. The establishment of large centralized collection points greatly simplifies the collection schemes of oil and liquid hydrocarbons from separate deposits and creates favorable conditions for their integration into large objects. It is more profitable to separate oil and gas in large centralized facilities than in small facilities. Such centralization allows to reduce the loss of light oil fractions, to improve oil production, to provide deeper processing of gas, and to ensure maximum extraction of raw materials for the chemical industry. Today, in the oil and gas regions of many countries, great work is being done on the development of oil and gas gathering systems, and the technical and economic basis of oil and gas gathering and preparation and shipping is being analyzed. In the future, the development of optimized oil collection and preparation systems is planned, with the goal of integrating these systems into national budgets. This article was prepared on the example of a mine as part of the research and includes the application of the results in these mines. The technological losses in the fields during the initial preparation of the extracted oil in the fields were analyzed. In this process, losses of oil with associated gas, together with separated water and by evaporation in the reservoir are considered. The article also calculates the amount of oil that could be recovered by mixing with satellite gas, specifically for the Kokdumaloq and Southern Kemachi fields, and provides recommendations for reducing these losses.

Keywords

Layer, Loss, Deposits, Separation, Pressure, Temperature

1. Introduction

Technological loss of oil in fields is divided into 3 classes:

a) in mining and gathering - well surface equipment; measuring devices; initial gas extraction device; pumps for driving well products; measuring vessels; traps; res-

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ervoirs and capacities for disposal of primary drainage water; oil storage tanks; oil traps; sealing device and so on;

b) in the preparation of oil - a clarifier or reservoirs for the preliminary dehydration of oil; technological reservoirs; electrodehydrators; clarifiers and reservoirs for preparation and treatment of product groundwater; buffer capacities; separators of the first and next stage of separation;

c) storage and transportation of oil - oil feed and product reservoirs; transport capacities; temporary oil storages; pumps; sealing device and so on.

Let's consider the types of technological loss of oil:

1) leaving the separation step with oil and gas flow;
2) Evaporation from pressure devices below 0.105 MPa;
3) leakage through sealers of pumps, flange connections and sealers of sealing devices;
4) removal of residual oils with drainage water under the product.

The technological loss of oil from evaporation includes the loss of oils saturated with gas or containing gas, and oils containing a specified amount of residual gases in accordance with the requirements of GOST 9965, TSh 39.0-176, TSh 39.2-136 is divided into losses [1-3].

The technological loss of oil from the flow of oil gas during the separation stage includes:

1) oil in a droplet or vapor state, which comes out from the oil separator, drop trap or gas separator to the gas transmitter of the torch line with the flow of oil gas, when the liquid collected from the condensate collector is released into the atmosphere or burned;
2) companion gas containing $C_{5+\text{ higher}}$ components directed to the flare system without disposal or technological use.

The technological loss of oil as a result of the removal of the product with groundwater consists of the following losses:

1) from evaporation of light hydrocarbons;
2) from the departure of the oil that formed the residual emulsion;
3) from the removal of residual emulsion-formed oil with drainage water, which is transferred directly to the absorption well or to the formation water pressure storage system without purification.

It will be necessary to collect the technological loss of leaking oil through the condensers of the technological equipment, taking into account the part of the evaporated oil in the period before disposal of the leakage [4].

2. Materials and Methods

Loss of oil from evaporation is determined by direct and indirect (comparative) methods.

Direct methods include direct calculation or measurement of the volume (mass) of hydrocarbon vapors displaced from the container during the evaporation process of oil. The advantage of direct methods is sufficient measurement accuracy, but the disadvantage is that it requires a lot of work to perform measurements in devices, apparatuses, reservoirs operating in industrial conditions [5-7].

Indirect methods include methods for determining the amount of loss due to changes in the hydrocarbon composition due to evaporation, changes in the physical and chemical properties of oil. In indirect methods, the most common method is to compare the hydrocarbon content and to determine the loss of oil by evaporation based on the change in the saturated vapor pressure of the oil samples taken at the beginning and end of the process or the source under investigation. The advantage of indirect methods is that the detection of loss is carried out on the basis of sample analyzes carried out in laboratory conditions (in some cases, part of the analyzes can be carried out directly in industrial conditions), simultaneously how many consecutive sources or the entire technological process can be evaluated for loss [8, 9].

Table 1. *Types of technological loss of oil in oil fields.*

Name of the loss source	Leaving the separation stage with the flow of oil and gas	Evaporation (boiling) of oil	Leakage through condensers, free gas release	Removal of residual oils with product water
Working wells				
Overhead device of oil wells	-	+	+	-
Raw material pumps	-	+	+	-
Well production measurement device				
Measuring vessels, traps (in the oil and gas industry)	+	+	+	-
Measuring devices	+	+	+	-
Raw material pumps	-	+	+	-

Name of the loss source	Leaving the separation stage with the flow of oil and gas	Evaporation (boiling) of oil	Leakage through condensers, free gas release	Removal of residual oils with product water
Distribution nodes				
Separation devices	+	-	-	+
Initial gas extraction device	+	-	-	-
Devices for disposal of primary layer drainage water	-	-	-	+
Buffer tanks	-	+	+	-
Raw material pumps	-	+	+	-
Oil collection points				
Separation devices	+	-	-	+
Devices for disposal of primary formation water	-	-	-	+
Storage capacities, buffer tanks, warehouses, oil traps	-	+	+	+
Raw material pumps	-	+	+	-
Compressor pump station				
Separation devices	+	-	-	+
Buffer tanks	-	+	+	-
Pumps	-	+	+	-
Oil processing equipment				
Separation devices	+	-	-	+
Initial gas extraction device	+	-	-	-
Primary product wastewater disposal facilities	-	-	-	+
Raw material capacities, process and product reservoirs, warehouses, oil tanks	-	+	+	+
The high-temperature stage of separation	+	-	-	-
The last stage of separation	+	-	-	-
Technological pumps	-	+	+	-
Under-product drainage water preparation device				
Tanks for preparation of sub-product drainage water and intermediate emulsions	-	+	+	+
Warehouses, oil tanks	-	+	+	+
Extraction pumps	-	+	+	-
Product tank parks, opd, oil pipelines, oso				
Product reservoirs	-	+	+	+
Reservoirs for preparation and collection of groundwater.	-	+	+	+
Product pumps	-	+	+	-
Trading centers for accounting for oil, automobile and railway tanks	-	+	+	-

Name of the loss source	Leaving the separation stage with the flow of oil and gas	Evaporation (boiling) of oil	Leakage through condensers, free gas release	Removal of residual oils with product water
Oil pipelines	-	-	+	-
OSO	-	+	+	-

Note: "+" is the presence of this type of loss; "–" non-existence of this type of loss

The disadvantage of indirect methods is that it is difficult to provide average samples of oil taken for analysis at the beginning and end of the studied system and relatively reduces the accuracy.

A method of determining the loss of oil by evaporation by measuring the volume of the air-steam mixture displaced from the reservoir.

A method of determining the loss of oil by evaporation, which involves direct measurement of the volume of the air-vapor mixture, is used in reservoirs downstream of constant or oscillating level OAQ. The meter measures the volume of the released steam-gas mixture of hydrocarbons [10, 11].

The amount of loss of oil from evaporation is determined by the following formula.

$$G = V \cdot C \cdot \rho, \quad (1)$$

where G-is loss of oil, kg; V - normalized volume of the air-steam mixture coming out of the tank during the measured time interval, m^3, ρ - is the normalized average density of the air-steam mixture being squeezed out of the tank, kg/m^3; S is the volume fraction of hydrocarbons in the air-steam mixture leaving the reservoir, in parts of one [12, 13].

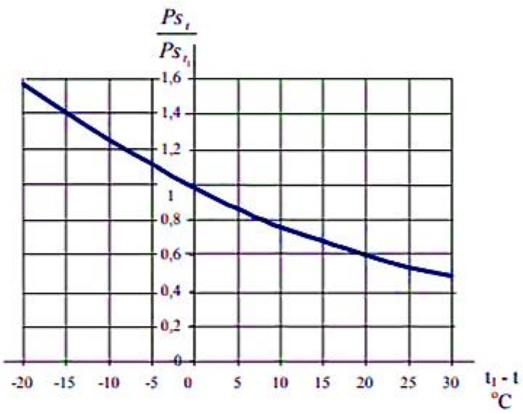

Figure 1. *Temperature dependence of saturated vapor pressure of oil.*

The concentration of hydrocarbons in the air-vapor mixture is determined according to the sample analysis of the air-vapor mixture in a GXP-100 type gas analyzer or gas chromatograph. In both cases, the temperature of the air-vapor mixture sample and the liquid in the closed space should not be lower than the temperature of the vapors in the gas space of the tank in order to avoid errors in the results due to the condensation of hydrocarbons. The concentration of hydrocarbon vapors in the air-steam mixture is determined as an arithmetic mean value [14].

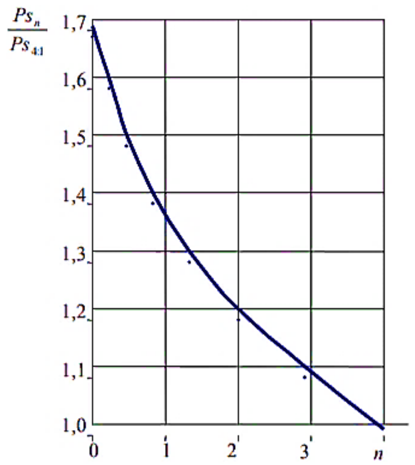

Figure 2. *Dependence of saturated vapor pressure of oil on mutual ratio of vapor and liquid phases.*

The average density of hydrocarbon vapors of oil is determined by the following formula:

$$\rho = \frac{M_n}{22,41}, \quad (2)$$

where M_n is the average molar mass of hydrocarbon vapors of oil in the air-steam mixture, kg/mol; 22.41 - molar volume of gas under normal conditions, m^3/mol.

The average molar mass of hydrocarbon vapors of oil is determined by the following formula:

$$M_n = 0.0043\,(212 + t_{o.b.})^{1.7}, \quad (3)$$

where $t_{o.b.}$ - the initial boiling temperature of oil, ℃ [15, 16].

Table 2. Differential amounts of technological losses of oil in Mubarak OGPD oil fields for 2023 (project) [1].

Mines	Technological loss of oil in %			
	Collection	Preparation	Transport and storage	Everything
Kokdumalok	0.3800	0.5409	0.2025	1.1234
Southern Kemachi	0.3750	0.4968	0.1450	1.0168
Umid	0.3500	0.6729	0.1450	1.1679

Table 3. Actual amounts of technological losses of oil in oil fields of Mubarak OGPD for 2023 [1].

Mines	Annual oil production	Technological loss of oil in %					
		Evaporation			Separation	Dehydration	Everything
		Hot season of the year	Cold season of the year	Average			
Kokdumalok	54829.1	1.2600	0.9450	1.1025	0.0031	0.0178	1.1234
Southern Ke-machi	13338.5	1.0750	0.9000	0,9875	0,0008	0.0285	1.0168
Umid	1502.7	1.0750	0.9000	0,9875	0.1623	0.0181	1.1679

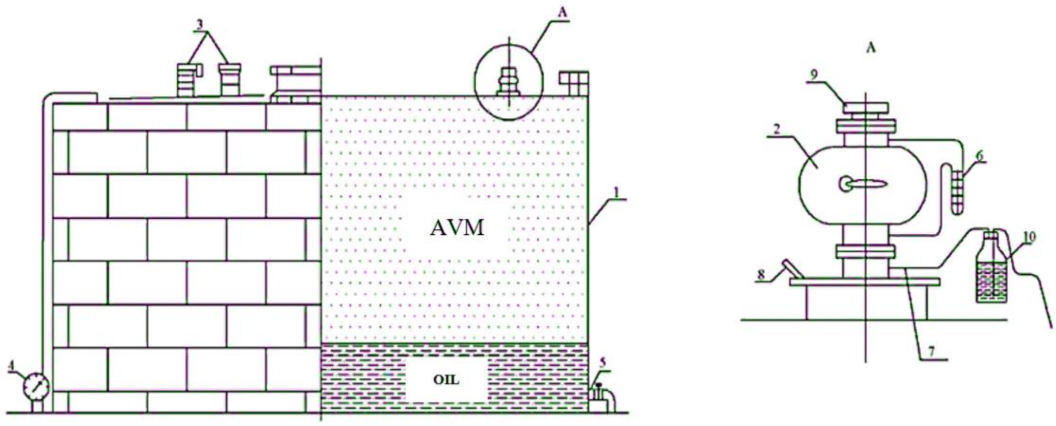

Figure 3. Installation scheme of the RG type counter in the reservoir: 1 – reservoir; 2 – RG type counter; 3 – breathing device; 4 – level gauge; 5 – inlet pipe; 6 – U-shaped manometer; 7 – a nozzle for taking a sample of the air-vapor mixture; 8 – manometer installation device; 9 – reverse valve; 10 – container for air-vapor mixture sample; AVM – air vapor mixture.

3. Results and Discussion

According to the data obtained on the basis of the results of the study of oil loss in the Kokdumalak field, it can be seen that 0.0005% may occur during gas separation, 0.33% during water separation, and 1.0015% due to evaporation. Based on these data, the maximum loss in the mine was determined to be 1.332%. Total process loss was predicted at the mine using 2023 production figures.

As a result of the studies carried out on the Kokdumalak field, the oil loss was predicted to be 728,367 tons when the wells were watered at 85-87%. This was 1.332% of the total oil produced in the Kokdumalak field. The loss of the total extracted oil from the field during the year is expected to be 1.1234%, and according to the results of the study and practical work, it is predicted that an additional 0.2086%, that is, 151,937 tons of oil may be lost.

4. Conclusions

The choice of the method of determining the loss of oil depends on the expected amount of oil loss, the analysis of its measurement error, the specific features of the technological process and technical structure specific to the type of mine equipment, laboratory techniques and means of controlling process indicators. subject to availability.

It is recommended to use the method of determining the loss of oil based on the change in its hydrocarbon composition, when a relatively large amount of technological loss is expected for a single source or for the entire mining facilities, which include several sources of loss.

Loss of oil from reservoirs due to free gas release is included in the total loss, which is determined by measuring the volume of the air-steam mixture squeezed out of the reservoir, as well as by comparing the hydrocarbon content of oil samples taken before and after the source of loss.

Abbreviations

OGPD	Oil and Gas Production Department
GOST	State Standard of the Russian Federation
TSh	Technical Standards
MPa	Megapascal
C5+	Hydrocarbons Containing Five or More Carbon Atoms
OGP	Oil and Gas Processing
RG	Rotary Gas
AQ	Automatic Quotation
GXP	Gas-Xylol-Probe
Kokdumalok	KDM (for Shorthand Reference)
Umid	UMD (for Shorthand Reference)
SKM	Southern Kemachi Mine
MP	Measuring Point
CFA	Comparative Flow Analysis
OEM	Original Equipment Manufacturer
TPA	Technological Process Analysis
HP	Hydrocarbon Pressure
EVP	Evaporation Pressure
VLP	Vapor-Liquid Phase
MPT	Molar Pressure Temperature
LFL	Loss of Fuel Liquids
RF	Reservoir Fluid

Author Contributions

Xabibullayev Saidaziz: Conceptualization, Investigation, Resources, Software, Supervision

Abdukarimov Mirzohid: Data curation, Formal Analysis, Funding acquisition, Methodology, Validation

Norqulov Shohbozbek: Project administration, Resources, Writing – original draft

Mamatova Nigora: Software, Visualization, Writing – review & editing

Conflicts of Interest

The authors declare no conflicts of interest.

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