As a manuscript

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MOBILE INNER TANK CLEANING UNIT

EXECUTIVE SUMMARY

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The thesis defence will take place on the 19th of June, 2017 at 10:00 in FSAEI of Higher Education "Siberian Federal University", Educational Laboratory Building of the Oil and Gas Institute located at 660041 the city of Krasnoyarsk, 82 Svobodny prospect, build. 6, classroom 605.

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INTRODUCTION

In the process of petroleum production, there is a wide variety of hydrocarbon storage tanks used in the oil deposits, on the bottom of which moisture, sediments and solid particles are cumulated during the gravity fluid settling (production fluid). All this has a negative impact on oil and oil products (various oils, fuels and lubricants, fuel oil, bitumen, petrol) stored inside these tanks. They become contaminated and hence their quality is reduced. In addition, because of the oil sludge accumulation, the volume of the reservoir is reduced, the service life is shortened, and the performance capability of both the tank itself and the equipment is deteriorating. One of the main conditions ensuring reliable storage and technological purity of the product is the regular tank cleaning.

To reduce the consumption of material resources for the purification of RVS-2000 and RVS-20000 involved in the process of preparing water for reservoir pressure maintenance, the task was to develop a mobile unit for tanks cleaning.

The initial water separation unit includes:

- Crude processing facility (CPF)
- Make-up and stratal water processing unit (UPP and PV)

In turn, the CPF includes:

- System for receiving gas-water emulsion from wells;
- Primary gas separation system in oil and gas separator

- Oil heating unit;
- Unit for gathering of bottom water in a storage tank;
- Mobile unit for inner tank cleaning;
- Oil transmission system to an export pumping station;
- Gas supply system to the oil and gas separator with direct heating and gas-fired power plants;

-Gas flaring facility;

- Record-keeping system for oil, bottom water and oil-associated gas;

The object of study: the tank cleaning process at the oil and gas field.

The subject of study: initial water separation facility at the Vankor work site.

The purpose of the work: development of a mobile automated complex for tank cleaning involved in the process of water treatment to reduce costs and labor inputs for inner tank cleaning process.

The objectives of study:

1) to carry an analysis of mobile tank bottom sediments cleaning unit implementation validity for the next 10 years;

2) to conduct the study of the stratal water properties;

3) to analyze the existing inner tank cleaning technologies;

4) to offer an engineering solution, to design a mobile unit constructed exceptionally from locally produced equipment to reduce costs and labor inputs;

5) to calculate the economic efficiency of project implementation.

Host company: OOO “RN-Vankor”. One of the researchers took an international internship in French Institute of Petroleum (IFP School) (the city of Rueil-Malmaison near Paris, France).

MAIN POINTS

General characteristics of the Vankor work site

The Vankor oilfield is located in a remote area of Western Siberia, in its north-eastern Yenisei part, beyond the Arctic Circle, in the Upper Bolshaya Khet River basin, the left tributary of the Yenisei River. The area is characterized by the complex of natural and climatic conditions of the forest tundra and subzones of the extremely-northern taiga, the harsh climate, the presence of permafrost, and the lack of industrial and social infrastructure.

Vankor company is implementing a project to develop the Vankor oil and gas field, which is the largest of the oilfields discovered and brought into production in Russia over the past twenty-five years. This field is located in the north of Eastern Siberia in the Turukhansk district of the Krasnoyarsk region, 142 km from the town of Igarka. Its area is 447 sq. km.

The technological process of water treatment for reservoir pressure maintenance system

The reservoir pressure maintenance system is a complex of technological equipment necessary for preparing, transporting, pumping an injectant into the reservoir in order to maintain the reservoir pressure and achieve maximum oil productive rates from the reservoir.

One of the important tasks for make-up and stratal water processing unit at Free Water Knock Out unit-SOUTH is:

- Injected water conditioning (composition, physical and chemical properties, impurity level, oxygen, microorganisms) according to the requirements of project documentation.

From the water supply well pad mineralized make-up water at a pressure of 0.6-1 MPa and a temperature of +20 °C is fed through a valve with solid suspended particles of 40,0 mg / dm^3 to the separation cone for sand screening. The separation cone is equipped with highly efficient sleeves for separation solid particles, which are installed inside the vessel between the supporting plates.

At a maximum flow the sand separator operates with a pressure difference of 0.65 MPa, while solid particles with a diameter greater than 20 microns are effectively removed.

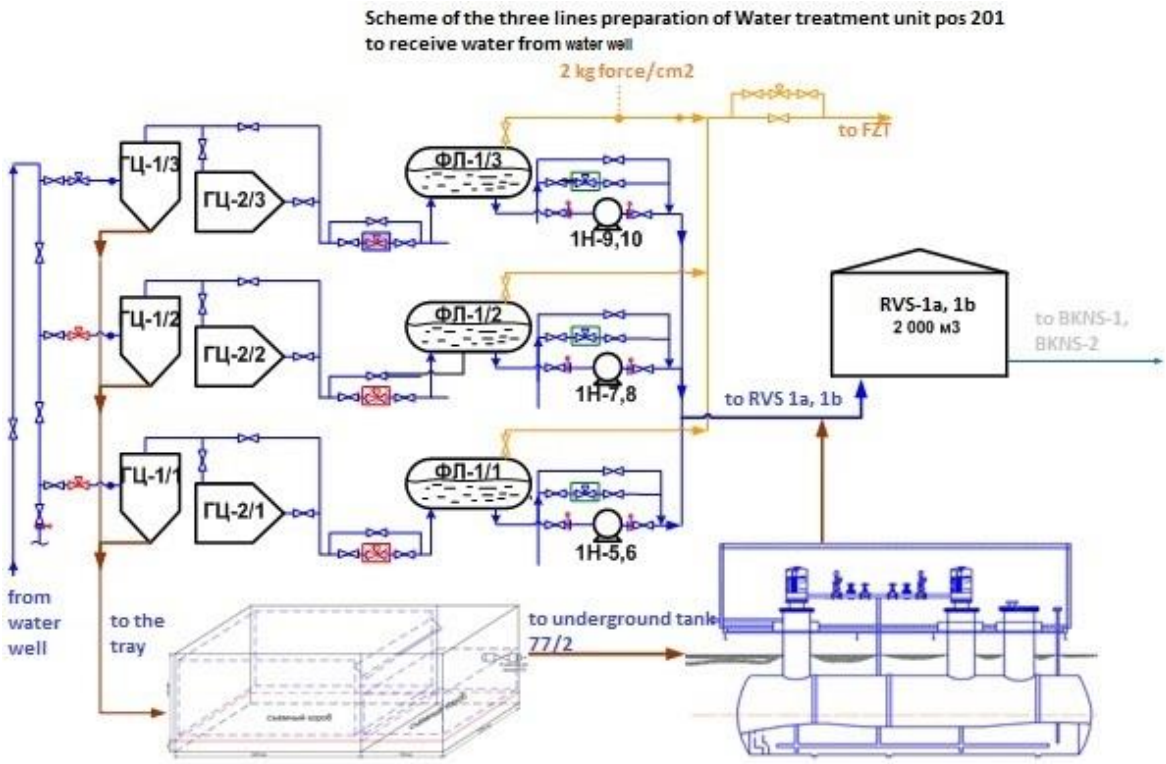

Figure 1 - The scheme for water treatment in a water supply well and a closed drainage system.

The centrifugal pull separates the suspended particles from the liquid, the purified water from the vessel exits through the upper nozzle and enters the degasser. The solid particles exit the separation cone through the bottom stream along the drainage line and are removed as a concentrated suspension into the tray (a tank for solid particles). As can be seen from the scheme the by-product is a liquid with the high content of suspended particles. After settling in the tray, the sand-laden liquid enters the underground tank from where it is pumped to the RVS tanks by semisubmersible pumps.

The stratal water that has been separated during the oil treatment enters the stratal water balancing tank P-2 with the volume V = 20000 m. In case of P-2 tank withdrawal to be repaired, it is possible to use the second balancing tank P-1 for these purposes. The treatment of stratal water is carried out through the unit heater treater pumps. If necessary, the stratal water from the tank P-2 can be delivered to the horizontal flow filters of the filtration facility.

After settling in P-2 tank, the stratal water is fed to the pumps suction and then to the stratal water treatment facility.

During the operation period when insignificant volumes of stratal water enter the facility together with the liquid-gas mixture, the essential part in the injected amount belongs to makeup water. Therefore, for this period of oilfield operation, it is possible

to treat makeup water on the makeup water treatment lines and stratal water treatment lines. Stratal water is being cleaned at the filtration unit after settling in P-2 tank.

Technology of tanks cleaning

Tank cleaning from sediments is a dangerous and time-consuming work that requires considerable material costs. Even the most advanced method of tank cleaning, existing at the moment, does not exclude human labor and people staying in the gassy area inside the reservoir.

Before the tank is taken out of service, the bottom sediment is washed out by a fixed system.

The sequence of technological operations for washing-out and bottom sediments removal from the reservoir are the following:

- washing-out of bottom sediments with the oil supplied through the fixed system;
- pumping out the bottom sediments together with oil;

The reservoir washing-out must be completed one day before its decommissioning.

There are two ways to wash out the bottom sediments from the reservoir by means of a fixed system consisting of pipe distribution system and washing nozzles: separate, or combined.

The equipment to be cleaned is shown in Table 1.

Table 1 - Basic equipment to be cleaned

№	Description	Volume, m3	Qty
1	Stratal water balancing tank	20000	2
2	Stratal water surge vessel	2000	1
4	Separator	200	4
6	Electrostatic coagulator	400	2
10	Heater treater	400	3
11	Gas and oil separator with water disposal	200	4

The quality of the reservoir or processing unit cleaning is controlled in the following ways:

-measuring of the hydrocarbons concentration in the gassy area of the reservoir, processing unit (maximum permissible concentration is not more than 300 mg / m^3);

-visually;

-measuring the maximum permissible fire load in the most polluted place (it is not more than 0.2 kg / m^2 for work inside the reservoir without people and 0.1 kg / m^2 with people inside the reservoir) for carrying out fire work.

Mobile unit for inner tank cleaning diagram

Later a mobile inner tank cleaning unit was designed in order to reduce the consumption of material resources for the washing out of RVS-2000 and RVS-20000 involved in the process of water treatment for the reservoir pressure maintenance.

The unit diagram is shown below in Figure 2.

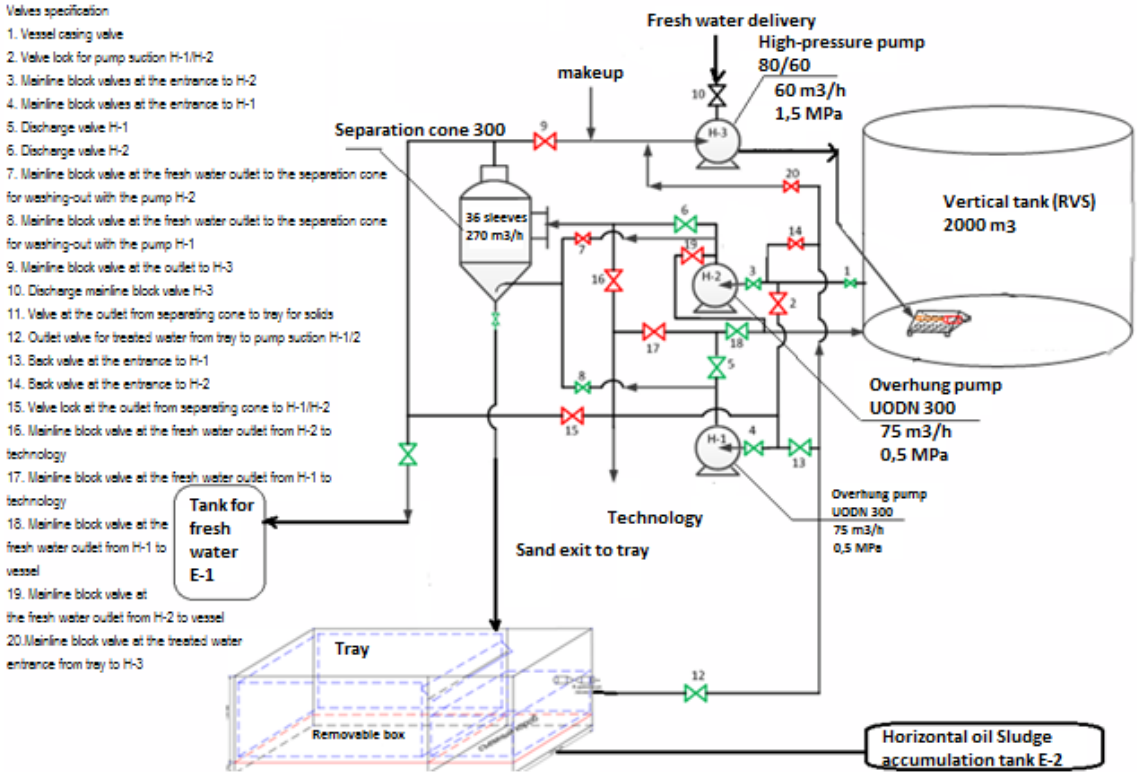

Figure 2 - A mobile inner tank cleaning unit diagram based on the Makeup water treatment facility

The bottom water with a high content of suspended particles is taken up by a Screw pump (4) at the produced pressure of 12 bar and delivery of 70-100 m³ / h. Solid particles are separated in the separation cone for sand removal (5). Separated sand is diverted into a gravity sludge tank with an integrated screw (6). Purified water enters the surge vessel (1), from where it is taken by the pump (2) to the hydromonitor (3) at a pressure of 15 bar with the delivery of 80 m³ / h.

Pumping of water from the tank for solids and the surge vessel is carried out by two pumps (7) at a pressure of 5 bar with the delivery of 90 m³ / h.

The bottom water with the high percentage of sand in it is taken from the protected tank by H-2 pump. The sand-laden liquid is delivered under the required pressure to the separation cone, where the effective separation of the two components is performed: water and sand. Separated sand from the bottom of the separation cone enters the sludge tank (tray), from where the settled water is delivered to H-1pump. From the transfer unit, water can be returned back to the tank or fed to the separation section.

Purified water from the separation cone can be withdrawn from the plant or fed to H-3 (high-pressure pump) which is used to feed the liquid to the tank of the bottom sediment washing-out system (jet heads).

To reduce the concentration of salts in the unit there is fresh water supply (makeup) or surfactants involved.

CONCLUSIONS AND RECOMMENDATIONS

The work presents a set of measures for the technical upgrading and the creation of a mobile complex for steel vertical tank cleaning from the sediments of the stored oil and stratal water. The designed stages characteristic of this technological process make it possible to separate the incoming water from sand and deliver the quality profile specified in OST 39-225-88 "Water for reservoir flooding. Quality requirements". The order of cleaning works and interaction of all members of the team is reflected, flow charts and 3-d model of the project are provided. Technically and economically, the applicability and expediency of the mobile complex implementation has been proved.

The results of this thesis were presented at the 69th International Youth Scientific Conference in Oil and Gas.