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Filtration Oil Treatment Unit of Screw Compressor

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***Abstract* — The article is devoted to the oil treatment system of a compressor unit designed for gas transportation. There is a design of the oil treatment unit, located separately from the compressor in this article. The main elements of the system are considered, the conditions of their work and the operational order are defined. The design of the treatment unit, the distinctive features, the principle of operation are described.**

***Keywords* — compressor system; screw compressor; treatment system; treatment unit.**

I. INTRODUCTION

Screw gas compressors are used in the oil industry in the gathering and transporting facilities of associated gas. These compressors have a much lower metal steel intensity, compared to piston and rotary compressors, create less vibration and inertial loads, which determine the minimum requirements for the compressors' base. Compressor units 7VKG-30/7 with a flow rate for suction equal to 32 m^3 / min, respectively, are unified. They are designed to compress the associated gas of the last stages of separation. Installations operate at ambient temperatures from -40^{0}C to + 40^{0}C [1-2].

The installations consist of three main units: 1) a compressor unit, which consists of a compressor, an electric motor, branch sleeve, mounted on a frame (coarse and fine oil filters, a cut-out valve and a local control unit are attached to the frame), 2) an oil cooling block consisting of oil coolers and an electric-powered fan, 3) a remote control system switchboard.

The compressor unit and the oil cooling unit are connected by pipelines, and the automation cabinets are connected by signal and power cables.

II. METHODS AND MATERIALS

When analyzing the operation of 7VKG compressor units for the period from 2014 to 2016, the following deficiencies in the compressors' operation were identified: 1) a decrease in the overhaul period in the compressors' operation, 2) an increase in the number of unplanned maintenance repairs [3-4].

While detailed analysis of the compressor failure causes, the following were found: since the presence in the oil of contamination, they accumulate in the cavity of the mechanical seal and thrust chambers of the compressor, and therefore bearings lubrication is significantly deteriorated, the bearings work under conditions of heating and intense wear and as the result the destruction of the compressor rotors bearings, the formation of chips, the destruction of graphite rings and driving washer of the mechanical seal [5-6].

To increase the 7VKG compressor units operating term, it is necessary to change the existing oil scavenge and filtering system in order to maintain the physicochemical properties in the given parameters and to ensure a minimum content of mechanical and other impurities (water, sulfur inclusions, gas condensate), which cause increased wear of the compressor units [7-8].

TABLE I. SPECIFIC FAILURES OF COMPRESSORS

Item	2014	2015	2016
Number of compressor failures, pcs.	2	3	4
Number of overhauls of 7VKG compressors, pcs.	2	2	2
Discovered defect	rotors wear bearing, mechanical seal failure	bearing, mechanical seal failure	rotors wear, bearing, mechanical seal failure
Causes of failure	bearing failure	contamination in the body, bearing failure	contamination in the body, bearing wear

The operating system of oil treatment from contamination on 7VKG compressors (Figure 1) represents a block of coarse and fine filters mounted on each of the five compressor units (Figure 2).

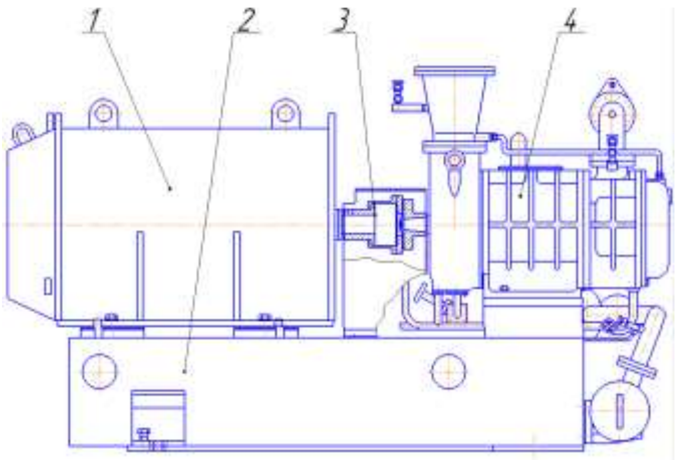

Fig. 1. Compressor unit: 1- drive; 2 - frame; 3 - coupling; 4 - screw compressor

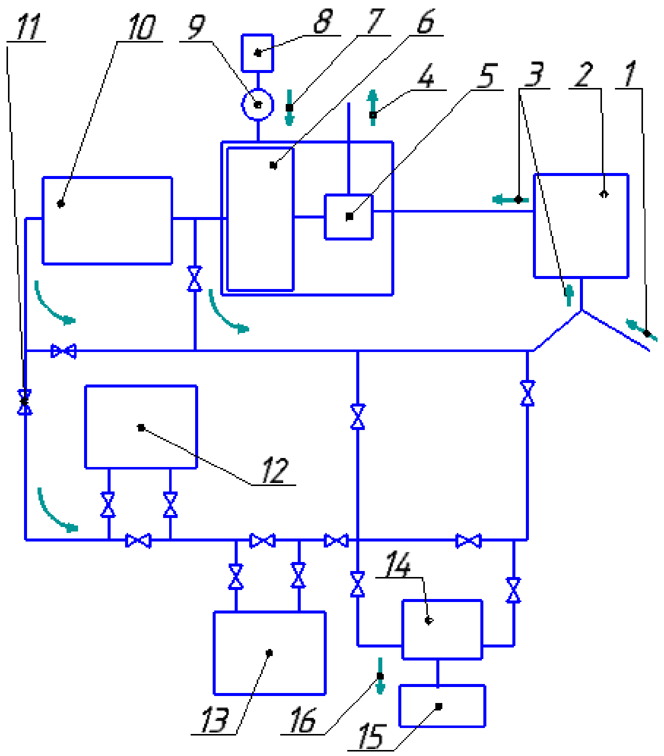

Fig. 2. Compression unit scheme: 1 – the gas, 2 – screw compressor, 3 – gas and oil joint source transportation, 4 – gas outlet line, 5 – bearing retainer, 6 – oil tank, 7 – clean oil source transportation, 8 – clean oil tank, 9 – rattigan rod, 10 –air-cooler exchanger, 11 – slide valve, 12 – primary oil purification unit, 13 – secondary oil filter, 14 – shale-shaker tank, 15 – oil recovery unit, 16 – drain oil

III. Results and Discussions

To improve the oil treatment quality and preserve its physicochemical properties, it is proposed to change the design of the oil system of a compressor station by installing additional primary and fine oil purification units with higher capacity after air-cooled oil coolers. The proposed oil treatment unit is a primary oil purification unit consisting of 6 filters of vertical design (Figure 3).

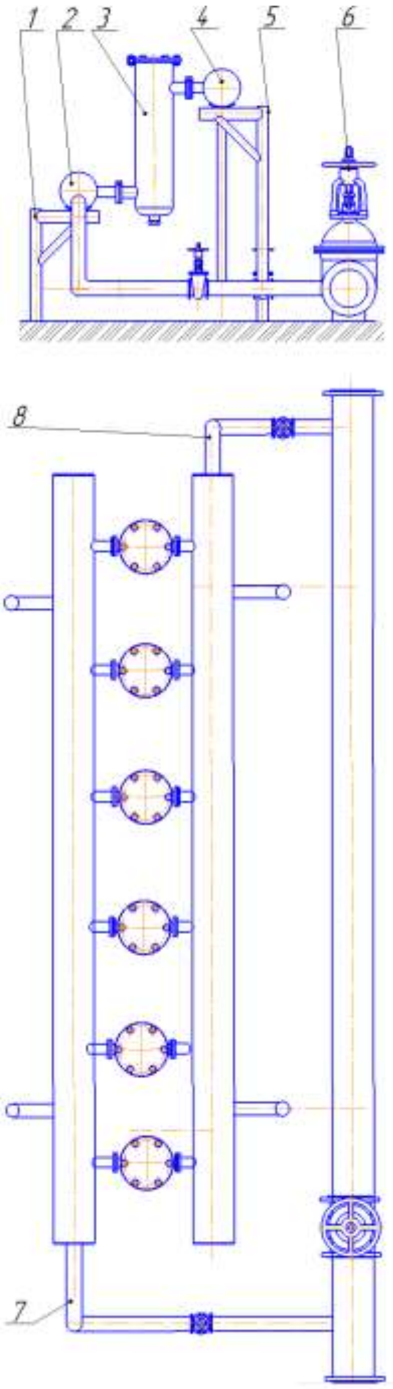

Fig. 3. Filtering system for primary purification: 1 – column, 2 – return oil manifold, 3 - primary filter, 4 - supply manifold, 5 - stand, 6 - slide valve, 7 - drain line, 8 - delivery line

The gauze element is a metal grid with square cells, the filtration accuracy is 100 microns, the gauze element area is 0.16 m^2. The filter design (Figure 4) provides a tank for separated water and mechanical impurities, as well as a choke for drainage and control of the residue presence.

The secondary oil filter consists of 10 vertical filters installed in parallel (Figure 5). The filter element is a metal grid with square cells, the filtration accuracy is 80 microns, the area of the filter element is 0.08 m^2. The filter design (Figure 6) provides a tank for water and contamination, as well as a choke for drainage [9-10].

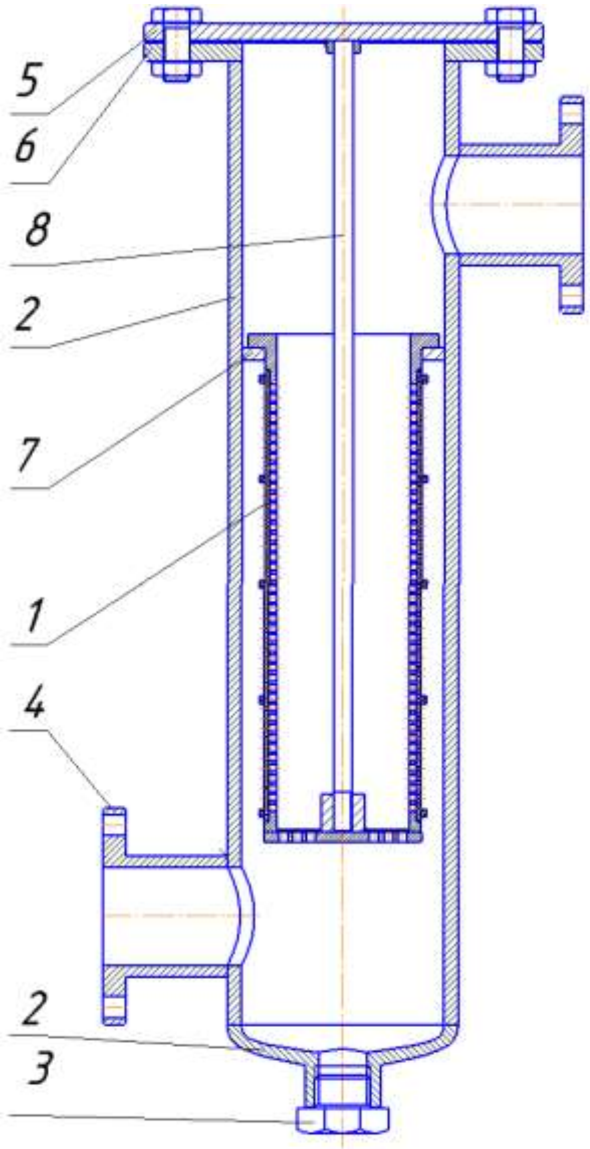

Fig. 4. Secondary oil filter design: 1 – body, 2 – filter, 3– end plug, 4 – nozzle, 5 – cover, 6 – flange, 7 – collet, 8 – stem

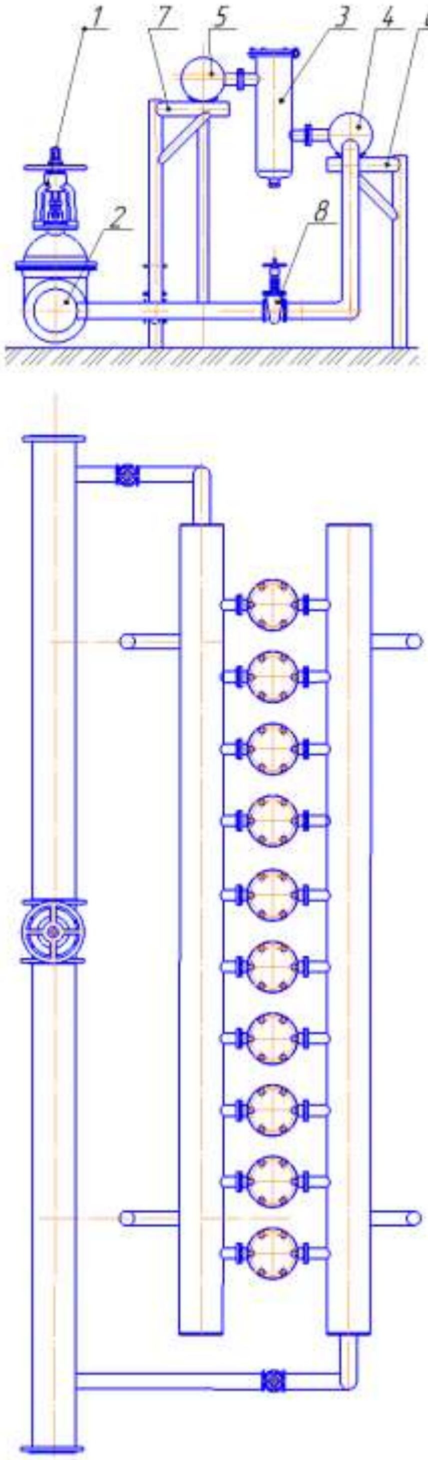

Fig. 5. Filtering system for secondary oil filter: 1 – slide valve, 2 – oil line; 3 – secondary oil filter, 4 – return oil manifold, 5 – supply manifold, 6 – column, 7 – column, 8 – slide valve

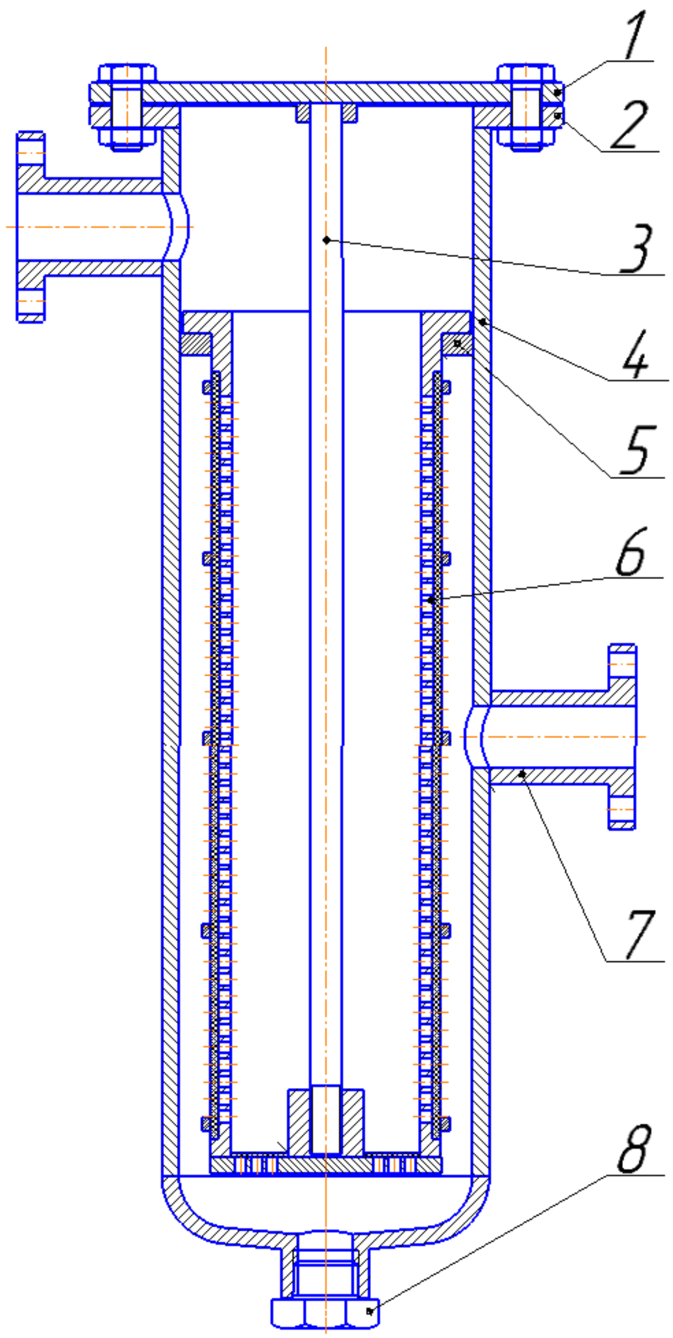

Fig. 6. Secondary oil filter design: 1 – cover, 2 – flang, 3 – stem, 4 – body, 5–collet, 6 – filter, 7 – adapter, 8 – slide valve

Compressor oil from the grease filter tank enters the air-based oil cooler, the oil is cooled, then the oil enters the primary filter unit, where contaminations are separated. Filtration quality is controlled by sampling after filters. Filter cleaning is performed by disconnecting the filtration line from the oil system without shutting down the compressors. If the oil analyzes show a deterioration in the physico-chemical characteristics of the compressor oil, then the secondary oil filter unit is also included in the operation. To implement this the gate valves №1,2,3 are opened, the oil is supplied by a gear pump NSh-8 to the secondary oil filters unit and further to the system. In connection with the installation of the filter unit, it becomes possible to filter and return oil from the tank to collect oil leaks from compressors, as well as oil that has been separated during the process of further gas purification.

For further oil properties restore (regenerate), it is suggested to install a heating tank and oil sludge with a useful volume of 4-5 m^3. Oil is pumped into the sludge tank using an NSh-8 pump after secondary oil filterst. For the reduction of the electricity cost for heating, the flow of oil after the oil separator E-6 to the pump intake bypassing the air cooler is possible. Next, the oil is heated to a temperature of 80-90^{0}C. Heating above 90^{0}C is undesirable, as it can lead to foaming of the oil as a result of boiling water contained in the waste oil. When heated, the process of sedimentation of the contaminations and water in the lower part of the vessel is accelerated. The evaporation of light hydrocarbon fractions and gas condensate dissolved in oil, the presence of which in oil reduces the flash point of the oil, also occurs. The time of heating and sludge oil at a temperature of 80-90^{0}C is from 6 to 12 hours. Further, electric tenes with a total power of 20 kW are turned off and further oil sludge occurs. The control of the interface phases of separated water contaminations and purified oil is carried out on the level gauge glass. Contaminations and water are pumped out into the waste oil tank for subsequent disposal. Next, samples of purified oil are taken. In case of a positive result, a portion of the new oil is added to the purified oil and pumped into the oil system of the compressor station.

This method of treatment allows restoing the properties of waste oil viscosity, the presence of contaminations, reducing the water content to the parameters close to the properties of new oils.

Filters are cleaned as sediment accumulates in the sludge zone. Cleaning is performed while reducing the filter capacity, characterized by a differential pressure at the inlet and outlet of the filter ΔP = 0.1 MPa. Filters are started up every day for a certain time (2 ... 6 hours), providing double filtration of the total amount of oil found in the oil system of the installation.

IV. Conclusion

As a result of the improvement in the compressor's unit oil treatment system, the following positive results were obtained:

- installation of an additional cleaning system allows you to monitor and maintain within the normal range the physico-chemical characteristics of the oil, the oil replacement period in the oil system increases, which increases the compressors' workover interval, reduces the consumption of materials during maintenance and scheduled operation during compressor repairs.
- filters with a larger filtering surface have increased capacity and allow separating contaminations in the most efficient way. The filter efficiency ensures effective oil filtration with simultaneous operation of several compressors. In the case of residue, cleaning and maintenance of filters does not require switching work to another compressor (the current system), which

significantly affects the reliability of the compressor due to the reduction of peak loads on the working units.

- the installation of the heating capacity and oil sludge and the secondary oil filter unit allows for a closed system cleaning the oil without pumping it into the overall system. The use of heating significantly accelerates the process of precipitation of contaminations that are in a finely divided state, of water separation, and also reduces the content of hydrocarbons light fractions, which normalizes the values of oil by viscous properties.
- the stabilization of the physicochemical parameters of the oil in the oil system determines the replacement period for the entire volume of oil found in the circulation system of the compressor station is increased by 1.5-2 times.

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