NEW POSSIBILITIES FOR IMPROVING RELIABILITY OF HYDRAULIC EQUIPMENT WITH THE HELP OF HYDRODYNAMIC CLEANING

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Summary. The results of studies applying the method of hydrodynamic separation of the two-phase fluids and industrial filtering polluted water, particularly in industries such as mining, metallurgy, agriculture and others that can reduce water consumption, improve the durability of the equipment, improve the environment and reduce the cost of separation of solid impurities. Method proved useful, because it requires no maintenance and supervision, and change the filter elements, or cleaning them, there are no moving parts, does not require external power supply. The article is devoted a number of innovative technical solutions, some of which have already been considered and tested in industry.

Key words: hydrodynamic cleaning, filters, recycling, fine purification in the suction line.

INTRODUCTION

Filtration plays an important role not only in obtaining high-quality liquid, but also in increasing longevity of hydraulic systems. Proved that if we increase the fineness of purification of N times, the durability of devices is increasing in N^3 times. For example, if the size of particles passing the liquid through a hydraulic machine, dropped twice, the life of its increased 8-fold [1, 2].

There is an entire industry to create devices for purifying liquids: hundreds of companies worldwide producing mechanical filters (delaying the particle baffles), magnetic filters, electrostatic filters, hydrocyclones, centrifuges, clarifiers, etc [8, 13].

Each of these devices, along with the merits of a number of significant disadvantages: mechanical filters and hydrocyclones takes a large pressure difference to overcome the hydraulic resistance, centrifuges require a sufficiently large electric power, magnetic filters trap basically only ferromagnetic particles, electrostatic filters have high demands for quality fluid and require a high voltage, septic tanks require large areas and long periods of time.

THE STATEMENT OF THE PROBLEM

These shortcomings do not allow for fine cleaning fluid in the first place for the dynamic (centrifugal) pumps. These pumps in the suction line should ideally be a depression less than 1 bar. But considering the energy expended in frictional resistance of the liquid, to ensure the speed, to lift the fluid, in practice the maximum vacuum does not exceed 0.65-0.75 bar. In addition, it should be noted that the pressure in the system can not be lower vapor pressure, because In this case, the liquid boils, there will be cavitation and liquid supply pump stops.

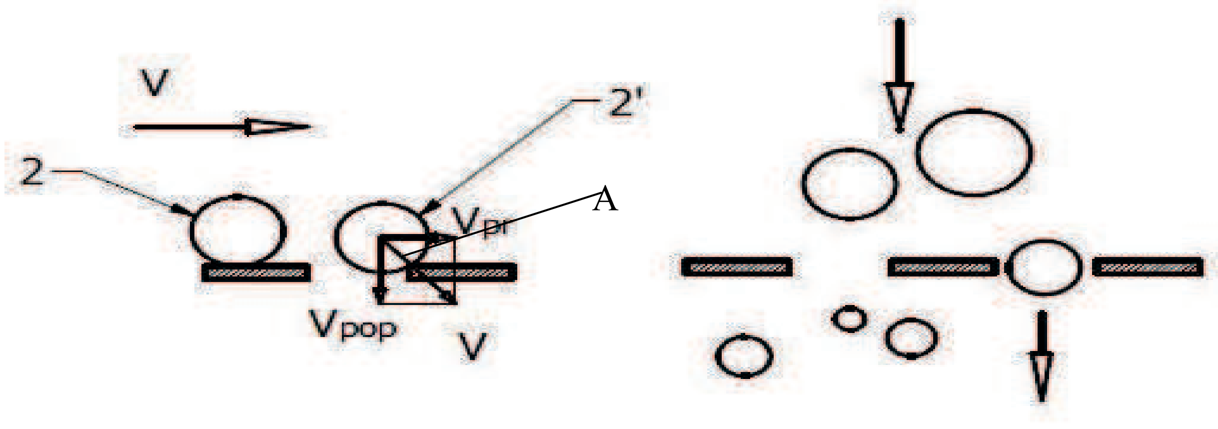
The same can be said about the bulk hydromachines. For example, at the entrance to the gear pump, which makes 2000 rpm, discharge is only 0.25 bar, which in practice does not allow the liquid to raise even one meter.

It is clear that the installation of fine filters, requiring the pressure drop in the network, equal to 2 bars, quite impossible. Therefore, the filters are installed in the suction lines (reception filter), only protect the system from the remnants of paint, lint and large particles of dirt. For example, if sufficiently prolonged operation of the hydraulic machine to hold all the particles larger than 25 microns, the reception filter passes particles up to 300 microns. As a result, in the presence of abrasive contaminants life more expensive centrifugal pump is reduced to 1.5 years instead of 12-15 years, as provided for technical documentation.

As a rule, fine filters are installed in the discharge line after the pump to protect the hydraulic and other waterworks, and the pumps are still unprotected and so are most alert and at the same time the most expensive element gidromashinostroeniya.

Thus, the idea of installing filtering devices on the suction pump (to pump), not requiring to the same summing them foreign sources of energy is a global society and can bring huge savings and significant improvement of ecological condition.

Traditional mechanical filters (delaying the particles with porous walls) are widely used in engineering, but they are inherent high differential pressure, lack of subtlety treatment, the need for periodic replacement or regeneration. Obligatory element of them is a bypass valve which, with the filter pollution and the growth differential pressure line connects the contaminated fluid with a line of pure fluid, bypassing the filter elements.



a b

Fig. 1. Schematic Diagram of particles hydrodynamic Separation

Studies have shown that most of the time the valve opened, bypassing the liquid. Thus, from a practical point of view to judge the subtleties of filtering characteristics of the filter properly. The system is polluted considerably stronger than it might appear [2].

In the 70 years of the last century in the Donbass State Technical University in Ukraine have been proposed, theoretically grounded and are now widely available so-called hydrodynamic filters.

In essence this is a fundamentally new principle of separation of two-phase liquids into fractions, ie method of separation. There are many technical realization of this principle [3, 4].

The essence of the hydrodynamic filtering is shown in Fig. 1. When passing through a porous barrier conventional filters provide out of the liquid particles, large hole in the septum, and the smaller will be held together with liquid (a). Detainees particles will close the pores, increasing the pressure drop across the septum, while the latter did not reach the limit, and will not open the bypass valve.

If you make the longitudinal motion of particle 2 along the porous surface, it will participate in two motions: a rate V_{PR} and transverse speed V_{pop}. The resulting vector of the velocity V can pass above or below point A (in Fig. 1b shows the particle 2 in the early subsidence at the time (the hole) and at the end (2 '). In the first case the particles do not pass through the porous membrane, the second - will be held.

It is clear that the higher the ratio of V_{PR} / V_{pop}, especially fine particles will linger partition. Furthermore, even large particles can not close the hole in a perforated septum and, therefore, take into account the pressure drop.

RESULTS AND DISCUSSION

Schematic design of hydrodynamic filter is shown in Fig. 2. Unfiltered liquid pump 1 through line 2 comes into the filter housing, partially cleaned filter element 3 and goes to tons of pipeline 4. A smaller part of the stream, which flows into the cavity between the housing and filter element provides a longitudinal movement of pollutant particles and after the throttle 5, resets the pipeline 6 in the bath.

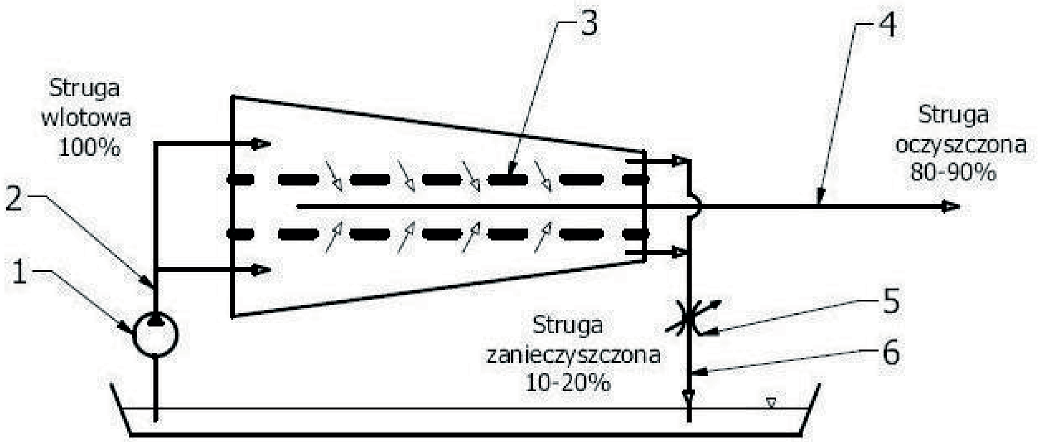


Fig. 2. The schematic diagram of hydrodynamic filter

Cavity between the shell and a conical filter element is performed to maintain the longitudinal velocity of particles as purification of the stream. Adjusting the throttle 5, you can change the fineness of purification, increasing or decreasing the longitudinal velocity.

There are other design schemes, where the contaminated liquid from the pump goes into the cylinder, and refined - comes from without.

Presented in Figure 2 scheme was first implemented in 1971 in a coal power processor, which allowed a 30% increase of their reliability. In 2000, a Polish company Hert estimated DonSTU developed plant dust control of coal dust by wetting of tiny drops. These plants have successfully worked in the mines Sofiyivka and Myslowice [5]. Fig. Figure 3 shows a hydraulic circuit and the general form of the filter FHN -150.

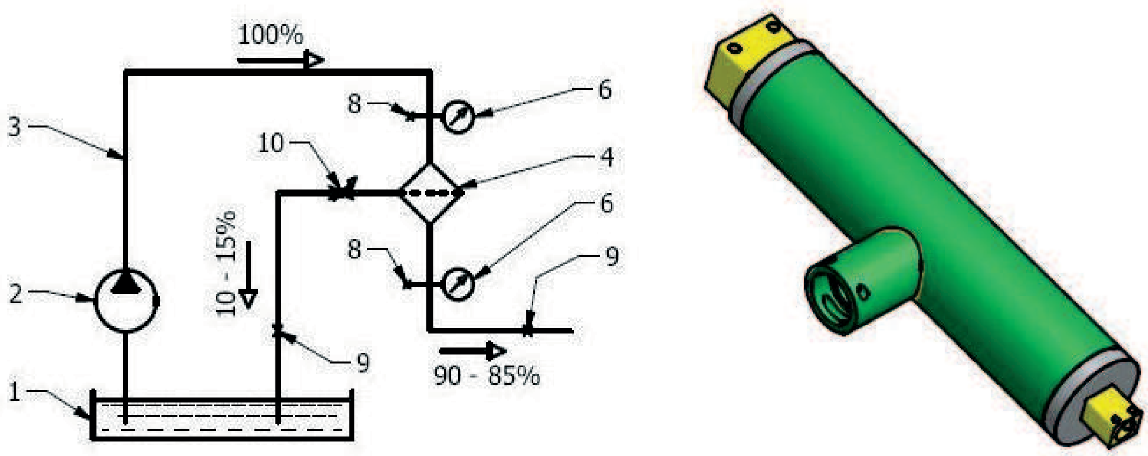


Fig. 3. The schematic Diagram of hydrodynamic, fluid filtration (graphic: FHN-150 filter)

Research of Dr. Moland showed that the filter fully satisfies the requirements of the coal industry, not missing a dirt particles greater than 50 mm, running continuously for a year without replacement, cleaning and maintenance. Dropped 10% of the flow is directed to cool the motor.

Since 2005, in collaboration with the company DonSTU Hert has developed a self-cleaning filter that did not require a reset of the flow of the system, which expanded the scope of its application. The filter has passed the certification of the head of the Mining Institute and is recommended for use in coal mines for water supplied to the dust control.

Figure 4 shows a general view and the hydraulic circuit of the filter [8, 9].

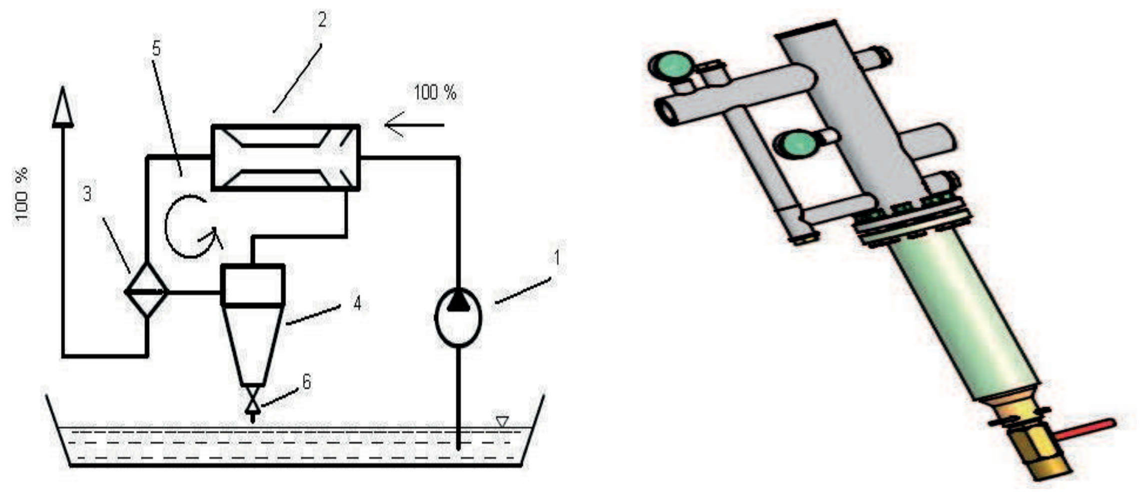


Fig. 4. Hydrodynamic filter with closed circuit (graphic: FHN-150A filter)

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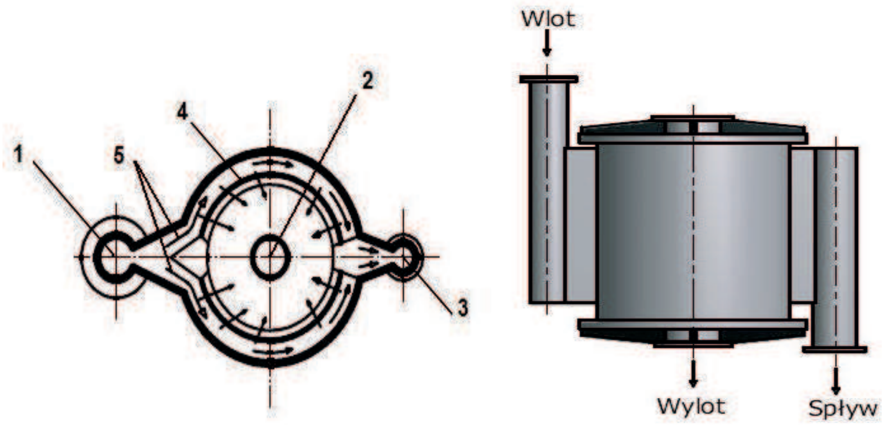

Fig. 5. The schematic diagram of the circular, hydrodynamic filter (graphic: OWHD 2000 filter)

Water is pumped a fire or a pipeline 1. It then passes through the injector 2 and hydrodynamic filter 3. Reset hydrodynamic filter enters the cyclone 4, where the separated fluid flows back through the injector to the fine cleaning and contaminated the hydrocyclone is going in the hopper 4 and periodically removed through a valve 6.

The contaminated liquid is fed through conduit 1, which is divided into 2 streams around the drum 5, 4-coated wire mesh, creating a centrifugal force, reducing pressure drop during cleaning liquid drum 4. Part of the liquid (10%) together with the contaminants discharged through the filter outlet 3 and the purified fluid through the pipe 2.

From our point of view, the best solution would be installing filters at a hydrodynamic injection line, ie after the pump and suction line, ie to the pump.

For fine purification of large amounts of fluid (up to 10 000 m ^{3} / h) was designed filter, the general form of which is shown in Figure 5. This filter is designed for sprinkler systems in agriculture, for water supplied to the centrifugal pump, but especially found great use in the metallurgical industry.

Such a decision would protect the pump from abrasive particles, increasing its reliability in several times. Since the hydrodynamic filters work with any pre-pollution, self-cleaning, require no maintenance and ensure the highest fineness cleaning, installing them in the suction line makes centrifugal pumps almost forever . Moreover, there will be no need for cleaning fluid after the filter (sand traps, etc.), because contaminants remain at the point of liquid intake.

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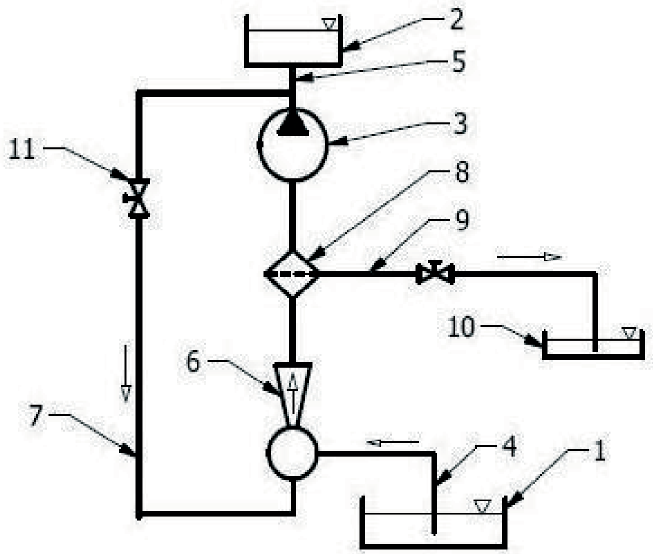

Fig. 6. The schematic diagram of liquid filtration at the pump sucking point

Earlier implementation of such a system was impossible due to the fact that the discharge at the inlet to the pump was not enough to overcome the resistance of filters (it is usually more than 0.2 MPa). Hydrodynamic resistance of the same fine filters even on the largest capacity is 0.02 MPa, and this allows us to apply them in practice.

Fig. 6 shows the basic hydraulic circuit in which the filter is installed before the pump [11]. The solution is based on the principle of the liquid recirculationPump 3 from the container 1 liquid is supplied to the consumer 2, forming a negative pressure in the pipe 4 and the high pressure in the pipe 5. Part of the liquid from the pipe line 5 to 7 is sent to the jet pump 6, which increases the pressure in the line of the fluid on the fine filter 8, increasing the anti-cavitation properties of the pump 3 and compensating for pressure loss in the filter 8. Part of the liquid with contaminants discharged from the filter 8 and 9 in the capacity of the pipeline 10. Valves 11 and 12 are regulated depending on the flow parameters in pipes 7 and 9 to optimize the whole.

CONCLUSION

Created as a result of work of Ukrainian and Polish scientists hydrodynamic cleaning allowed to make a fundamentally new approach to the problem of cleaning fluid and the first to show the feasibility of fine cleaning fluid in the suction line, the most protecting all hydraulic components from wear.

Despite all the advantages of the above-described system, it is necessary for its implementation to evaluate the feasibility of energy losses. Tests have shown that, in connection with recycling (supply of fluid from the discharge line into the suction line), pump efficiency is reduced by 20%. We believe that in most cases, this energy loss is acceptable because it is offset by the obvious advantages of the system and, moreover, such a reduction in efficiency corresponds to his downfall after a relatively short operation associated with the wear of the pump. Recently, in order to reduce energy loss company J . T . S . (The successor firm Hert , Katowice, Poland) and the University DonSTU (Alchevsk, Ukraine) have made significant improvements in the systems described that allowed to refuse relief of fluid required for cleaning the bowl 10. Now reset only particles of dirt, while maintaining self-cleaning. Thus was the full-flow filtration. At the booths JTS . pass debug mode.

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НОВЫЕ ВОЗМОЖНОСТИ ПОВЫШЕНИЯ НАДЕЖНОСТИ ГИДРООБОРУДОВАНИЯ С ПОМОЩЬЮ ГИДРОДИНАМИЧЕСКОЙ ОЧИСТКИ

Аннотация. Приведены результаты анализа, применения метода гидродинамической фильтрации для очистки загрязненных жидкостей в индустриальном водоснабжении, особенно в горной промышленности, металлургии, сельском хозяйстве, что обеспечит снижение водопотребления. Преимуществом метода является , отсутствие необходимости технического обслуживания фильтроэлемента, в виду его самоочистки, а также отсутствие подвижных частей и необходимости внешнего электропитания. Статья посвящена ряду инновационных технических решений, некоторые из которого уже были рассмотрены и проверены в промышленности.

Ключевые слова: гидродинамическая очистка, фильтр, восстановление, линия всасывания.