GEROTOR PUMP OF VARIABLE PERFORMANCE

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Abstract
The essence of the work is to develop a fundamentally new design solution for the gerotor pump to improve its energy efficiency and technical performance. The main idea is to provide variable performance of the pump in order to expand its possibilities of use and maintain high energy efficiency in different operating modes of the system. Also, one of the main tasks is the expanded use of the pump in various industries, which will make it possible to reduce the costs of energy resources in mechanical engineering and mobile technology, as a result of which the saving of energy resources will be ensured in systems where the gerotor pump is used.

Keywords: hydraulic pump; gerotor pump; variable productivity; energy efficiencies; industry; mobile equipment.

INTRODUCTION

Gerotor pumps are used in the automotive industry, in agricultural machinery, as well as in special machinery. When using gerotor pumps to ensure high energy efficiency, it is necessary to ensure a stable rotation frequency of the pump shaft. But modern systems are quite flexible, which makes it necessary to operate the pump in an inefficient mode. Therefore, the development and creation of a gerotor pump of increased efficiency is an important decision. The proposed design is considered based on the operation of an internal combustion engine, but may have extended applications.

The gerotor pump is a gear pump with an internal gear without a separate sickle-shaped segment, the gears are located with the appropriate eccentricity. The inner gear always has one less serrature than the outer gear. [1]

In the automotive industry, it is used as an oil pump for the internal combustion engine oiling system. In agricultural machinery, is often used as a pump-dispenser for the hydraulic control system of a tractor [2]. In the construction industry, such pumps are mainly used for pumping polystyrene concrete, paint and plaster mixes, floor pouring and similar work [3]. The use of this type of pump in a wide range of machines, mechanisms, and equipment shows the feasibility of finding ways and methods to increase the energy efficiency of the gerotor pump.

EXPOSITION

Since technological processes require a variable pump supply, which is currently implemented by changing the frequency of rotation of the input shaft of the pump, it leads to the manifestation of the main drawback of the gerotor pump. We propose to realize structurally combined two gerotor pumps. The idea is to use a small pump to ensure the supply of working fluid to the system when the needs are close to the minimum and the possibility of connecting a large pump. Pumps can be connected in two ways: in an axial connection and in a radial connection. Placement in an axial connection is possible provided the radial size of the pump is preserved. Nevertheless, the use of a combination of radial pumps is preferred (Fig. 1). Such a scheme has a slight increase in the overall dimensions of the pump and at the same time it is quite easily arranged in the system of existing mechanisms. [3, 4, 5]

The proposed pump works as follows. A constant rotation frequency is applied to the input shaft of the pump. The input shaft is rigidly connected to the inner rotor of the small pump. The operation of a small gerotor pump ensures a 10-20% higher supply of working fluid than the minimum.

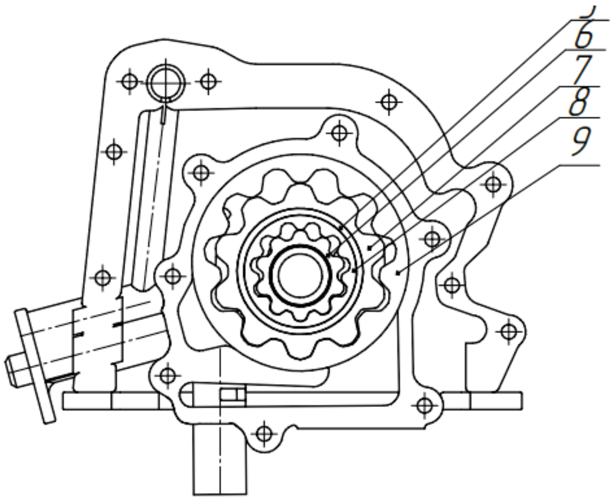


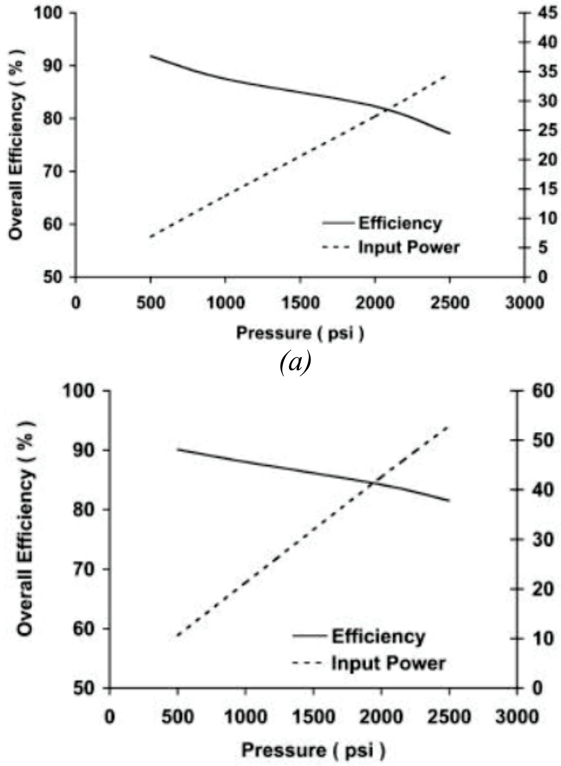
Fig. 1. Energy-efficient gerotor pump

At the same time, the outer rotor of the small pump is connected to the inner rotor of the large pump through an electromagnetic coupling. The connection through the electromagnetic coupling allows to implement variable rotation frequency of the rotors of the large pump. As a result, we will get a pump that can be directly controlled by the controller, which will provide quite high flexibility when working as part of a mechanical system. Energy efficiency is achieved due to the constant operation of the small pump in an efficient mode, and when it is necessary to increase the supply of the working fluid, the large pump is turned on.

Also, such a scheme can be inversion. If in the system there is a need to change the supply of the working fluid in a small range of values, then a large pump is rigidly connected to the input shaft of the pump, and a small pump is connected due to an electromagnetic coupling. Such a pump switching scheme significantly increases the energy efficiency of the gerotor pump.

As a result, we get a pump with the ability to adjust the flow of the working fluid, which has a fairly simple design. In turn, such a pump is cheaper to manufacture compared to adjustable axial-piston or radial-piston pumps.

Figure 2 shows the graph of the efficiency of the gerotor pump at the input shaft rotation frequency of 1200 rev/min (a) and 1800 rev/min (b). [4, 5]



(b)

***Fig. 2.** Efficiency index of the gerotor pump*

It can be seen from the graphs that the maximum efficiency of the pump is achieved at low pressure values (500 psi) and decreases slightly (by 10%) when the pressure increases by 4 times (up to 2000 psi). At the same time, when increasing the rotation frequency of the pump shaft from 1200 to 1800 rev/min, there is a decrease in the efficiency of the pump by 5% under the same conditions of pressure change.

The above data are valid only with a constant supply of working fluid. If a similar pump is used in the system and at the same time it becomes necessary to change the supply of the working fluid, the efficiency of the pump under the same conditions of pressure change decreases in one case to 30% (at 1200 rev/min), in the other to 22% (at 1800 rev /min).

The calculations of the proposed design of the gerotor pump show an improvement in the efficiency of operation when the supply of the working fluid is changed. Thus, under the above operating conditions, in the case of an additional pump connection, to increase the supply of working fluid, the efficiency of the pump increases to 21% (at 1200 rev/min) and 16% (at 1800 rev/min), when the supply of working fluid is increased by 40%, in comparison with the classic design of the gerotor pump with similar characteristics.

CONCLUSION

The increase in efficiency of the proposed design of the gerotor pump has been theoretically confirmed. The increase in efficiency is up to 21% compared to the classic design of the gerotor pump with similar characteristics.

The proposed gerotor pump will increase the efficiency of equipment or mobile machines with the possibility of control from the controller, which will additionally ensure the flexibility of the systems.

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