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Combined Operating Process of Torque Flow Pump

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Introduction

Due to a simple design and hydraulic passage that is the least susceptible to clogging, torque flow pumps (TFP) of Turo type are the most common pumps used for pumping various hydraulic mixtures. These pumps are referred to vortex pumps, operation of which is accompanied by energy loss and vortex formation resulting in low economic efficiency.
Since the TFP is a vortex hydraulic machine, the ratio of the fluid velocity in the free pump passage to the impeller rotational speed is an indicator of the TFP efficiency. The higher the value of , the more efficient the pump is. The mechanism of the energy transfer in the TFP is caused by both blade and vortex operating process, or a combined operating process.

Research methodology

Now consider the energy balance in the TFP with the experimental impeller. In the analysis of the energy balance [7] the following types of losses are distinguished:
- mechanical losses (friction losses in shaft seals , friction losses in bearings , disc friction losses)
- hydraulic losses (losses during the first stage of the energy transfer process - losses at the pump inlet and at the inlet to the impeller; losses during the second stage - losses caused by eddy displacement losses in the free passage of the pump; losses in the hydraulic passage outlet).
In the case of a combined operating process, the exchange of momentum between the impeller and fluid is performed due to both the longitudinal free vortex action in the free passage of the pump and the blade effect - similar to the operating process in centrifugal pumps. That is, the blades extended in the free passage of the TFP change its energy balance: losses in the second stage of the energy transfer process are divided into losses of the vortex operating process and losses of the blade operating process (Fig. 3). The blade effect is more perfect in terms of energy efficiency, since the hydraulic efficiency of the centrifugal pumps is 0.85-0.95, and in the vortex pumps the corresponding efficiency of the operating process is 0.60-0.63. Thus, the total efficiency of the pump increases, and the greater the ratio the greater the efficiency is. Practically, the maximum achievable efficiency of such pump corresponds to the level of efficiency of centrifugal pumps with an open impeller.

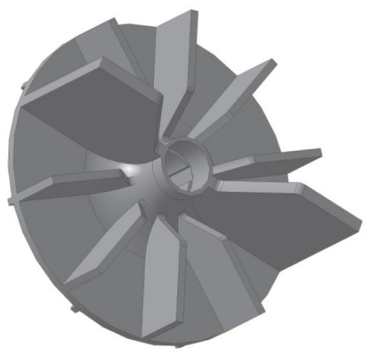

Figure 1. Experimental impeller

Results

According to the test results, the head at the design flow rate m3/h at maximum extended blades is around 10% and the efficiency 4.5% greater compared to completely recessed impeller.
The increase in the parameters of the pump can be explained by the fact that the more impeller blades extend to the free passage the more circumferential component of the velocity is in the area where two flows mix together – the one that exits the impeller and another that circulates in the free passage. Also it creates an increase of the energy transmitted to the circulating flow and, as a consequence, the number of cycles of its rotation reduces in the free passage before entering the discharge nozzle. This, in turn, reduces hydraulic fluid friction losses in the casing and increases the pump head and efficiency. In addition, the portion of the blade operating process increases during energy transition in the TFP.

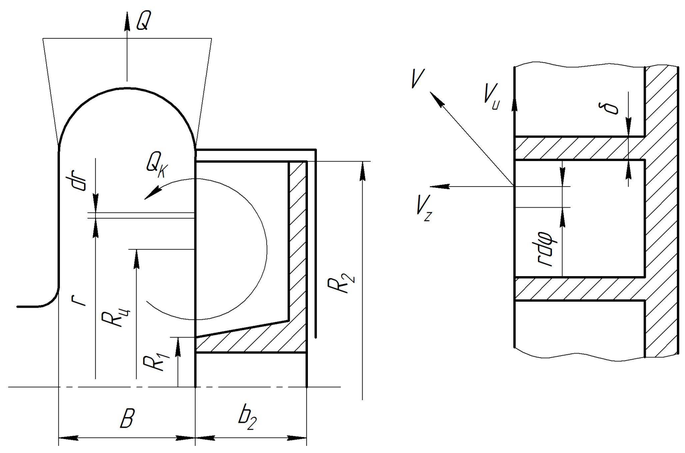

Figure 2. Calculation of fluid movement in TFP

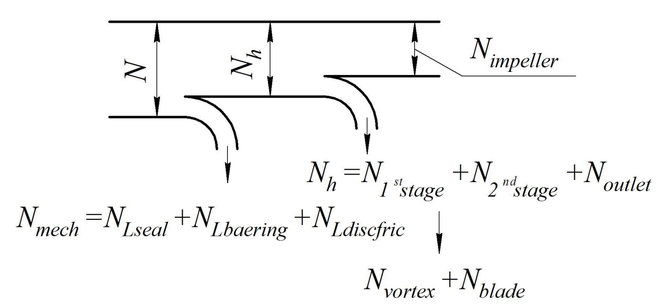

Figure 3. Balance of energy in TFP of Turo type with combined operating process

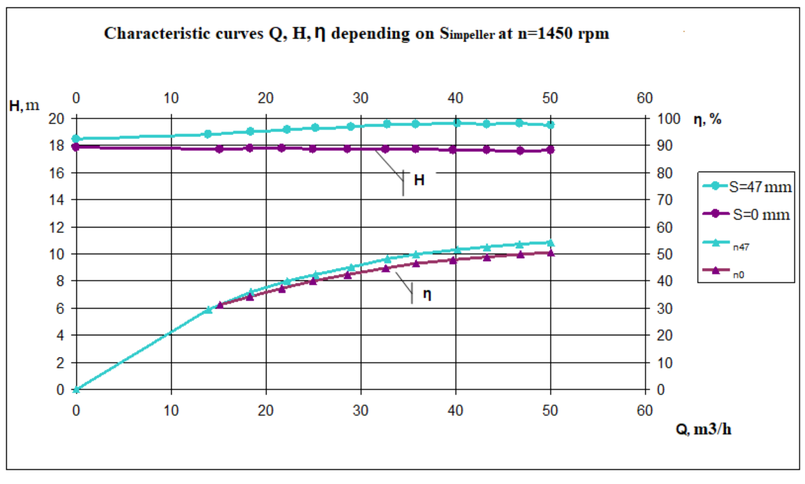

Figure 4. Characteristic curves of AHSC 50/16 pump at *b*=0 mm (completely recessed impeller) and *b*=47 mm (impeller with maximum extended blades)

Conclusions

The mechanism of energy transfer in the TFP is caused by a combined operating process. Economic efficiency of the pump can be improved by increase of the portion of the blade operating process.
The TFP is a vortex hydraulic machine in which the ratio of the fluid velocity in the free passage to the impeller rotational speed is an indicator of the TFP efficiency.
The study have shown that economic efficiency of the TFP of Turo type can be improved and its scope can be increased by modifying the design of the pump, namely the use of an impeller with extended blades.
The basic equation of the TFP, which determines the dependence of the head on the geometric dimensions of the hydraulic passage of the pump with an improved impeller, is obtained by analytical method, which allows us to clarify methodological recommendations for its designing.
Impeller blades that extend into the free passage change its energy balance.
Experimental studies have confirmed the feasibility of changing the geometry of the impeller (extended blades into a free pump passage) in the TFP of the Turo type, since the pump head increases by 10% and the efficiency by 4.5%.
The proposed solution has limitations when liquids with large solid inclusions are pumped.

References

1. .Vortex pumps EGGER series T: http://www.flowex.com.ua/index.php/vikhrevye-nasosy-serii-t.
2. German V. F. (1984) Creation and research of mass-flow torque flow pumps of increased economy. Sumy: the dissertation of the candidate of technical sciences: 05.04.13. p 154.
3. Yevtushenko A. O. (2013) Development of the theory of the working process, the practice of designing and using dynamic pumps : monograph. p. 515.
4. German V F, Kovalev I A, Kotenko A I and Gusak A G (2013) Torque flow pumps (second revised edition). Sumy: Sumy state university. p 159.
5. Kryshtop I. V. (2015) Advanced design of volute of torque flow pump with improved hydraulic performances. Sumy: the dissertation of the candidate of technical sciences: 05.05.17. p 188.
6. Kondus V. Y. (2018) Improving energy efficiency and expanding the parametric range of free-vortex pumps by improving the working body. Sumy: the dissertation of the candidate of technical sciences: 05.05.17. p 201.
7. Panchenko V. O (2019) Improve the technical level of the torque flow pump by improving the geometry of the impeller. Sumy: the dissertation of the candidate of technical sciences: 05.05.17. p 146.
8. Gusak, A.G. Increase of economy of torque flow pump with high specific speed/ O. G. Gusak, I.V. Krishtop, V.F German, V.N. Baga// IOP Conf. Series: Materials Science and Engineering conferenceseries.iop.org/mse. – 2017. – Volume 233. –012004 pp.1–8.
9. Pat. №56039 Ukraine, F04D7/00 u 201006394. Torque flow pump / Panchenko V. O., Yevtushenko A. O., Solyanik V. O., Morgal O. S.: 27.12.2010.
10. Panchenko V. O. (2018) The basic equation of a torque flow pump with a combined workflow. Scientific pages. – Brno, - №9. – PP. 39-40.
11. Antoszewski B., Tarelnyk V. (2014) Laser Texturing of Sliding Surfaces of Bearings and Pump Seals, Applied Mechanics and Materials, Vol. 630, pp. 301-307. https://doi.org/10.4028/www.scientific.net/AMM.630.301

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