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COMPUTATIONAL STUDY OF SLUDGE PUMP DESIGN WITH VORTEX IMPELLER

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Abstract: *This paper presents a computational study of sludge pump design with vortex impeller. It contains two design variants of vortex impeller, which is supported by CFD calculations in ANSYS Fluent. By modeling the problem in Fluent, it has been verified that such impellers could be fitted into the existing spiral casing with channel impeller. It was verified that the original operating parameters were maintained. Results of these design solutions and evaluation of effect of some construction modifications on the characteristics of the pump have been shown.*

Keywords: ***Sludge pump, vortex impeller, characteristics, design, Computational Fluid Dynamic.***

1. Introduction

Sludge pumps are used in many different branches of industry. We can find them in wastewater treatment plants, industry, home, etc. This paper describes a design of vortex impeller which can be fitted into existing spiral casing of original sludge pump with channel impeller. It was proposed using the original operating parameters and the impeller is based on the principle of vortex impeller with commercial name TURO. The second design variant of impeller is based on principle of vortex impeller which is called SuperVortex and is made by Danish company Grunfos. Models were created for both impellers and the CFD calculations for both design variants were made to assess suitability of use. For solution and subsequent evaluation of this problem, we used the values obtained from CFD calculation.

2. Design of impellers

The basic equations described in (Feranec, 200?) were used for design of this impeller. The model of the Turo impeller is shown in fig. 1.The other impeller model was created by cranking the vanes from the Turo impeller and by creating the so called spur. For this reason this impeller will be called "Turo with spur" and it can be seen in fig. 2.

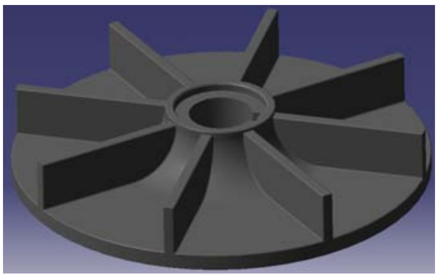

Fig. 1: Turo impeller model

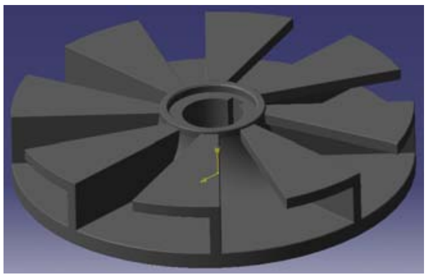

Fig. 2: Turo with spur impeller model

3. Evaluation

A focus was put on following characteristics Y – Q, η – Q, P – Q. The Y- Q characteristic should be considered as stable if the condition of stability is fulfilled across the whole range of the flow rate as stated in (Pochylý et al., 2009). Main Y – Q characteristics with the Turo and the Turo with spur impellers are shown in fig. 3.These characteristics are stable at whole range of the flow rate. Another part was computation of the axial force acting to the impeller. The axial force applied to the impellers was obtained, like other values, from CFD computation. The magnitude of axial force acting to the impeller can be lowered by some of construction adjustments stated in (Gančo, 1999).

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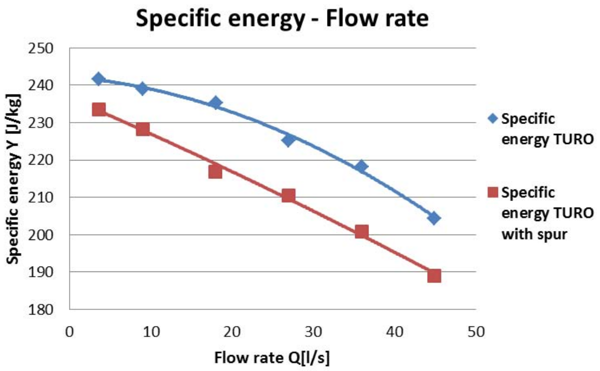

Fig. 3: Y – Q characteristics both design variants

The influence of construction design to pump characteristics was examined. Three models of gap between the pump casing and the impeller were created. First solution was a conical gap with angle 15°, then a very small cylindrical gap, which was almost like a wall behind impeller and the last solution was large cylindrical gap between these parts. For better illustration, these gaps are shown in fig. 4.

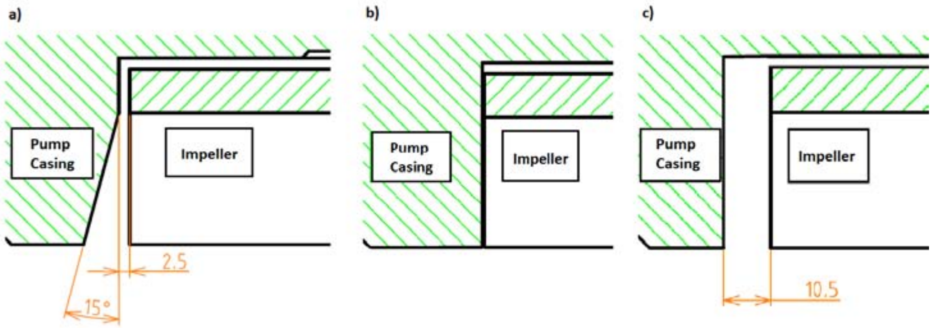

Fig. 4: Types of gaps; a) Conical gap; b) Very small cylindrical gap; c) Large cylindrical gap

4. Conclusions

The aim of this paper was to create a computational model and to design vortex impellers. The Turo impeller fulfilled operating parameters of the original pump. In the second design variant, a decrease of characteristics values can be seen. The axial force acting on impellers of this type of pumps is not large. Moreover, it can be improved by some construction adjustments. Both impellers have a stable Y – Q characteristic; this is very important in terms of occurrence of undesired pressure and flow pulsations. This paper has shown three different solutions of a gap between the impeller and the pump casing. From results, it can be seen to what extent the characteristic can be influenced by this change. The original conical gap can be assessed as the best solution of these design variants.

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