Design of a Mixed Flow Pump Stage using TURBOdesign1 and CFD Code

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Introduction

Hyosung-Ebara is one of leading pump makers in Korea. We have secured the leading pump maker’s position with the continuous effort over the last 45 years and we can offer customers a one-stop solution from design to manufacture to shop test to supervisor services.

Hyosung-Ebara manufactures pumps which are used in almost every industrial and oil-field application. Furthermore, we manufacture energy-saving, high-performance, fully submersible sump, sewage and drainage pumps designed for the professional engineering contractors.

Design of a Mixed Flow Pump Stage

Hyosung-Ebara has been using TURBOdesign1 for two years and in a recent project the method was used in the design of both centrifugal and mixed flow pumps. A 3D view of the mixed flow pump is shown in Fig. 1. The pump rotates at 1,000 rpm with a flow rate of 1000m3/hr and head rise of 7m. In this example, the impeller and diffuser were designed with the TURBOdesign1 coupled with the Design of Experiment Method. The performance of the stage was predicted by using the CFD code and experimental measurement. Eight design parameters were used for this study.

By using the design parameters and method of 2^K factorial, an experimental table consisting of 17 geometries were created, which were then generated by TURBOdesign1. The flow through the different configurations were analysed by CFD and by using the Response Surface Method an optimized blade loading was generated. The selected optimised blade loading was then used to design three impellers with different euler heads (or exit rVt). The designed impellers are shown in Fig.2.

As the rVt value is increased, the outlet angle of impeller is increasing in regular sequence. The impellers shown in Fig. 2 are presented in order of increasing rVt. The corresponding diffusers for each impeller were then designed simply by specifying the impeller exit rVt at the diffuser inlet and zero rVt at the exit. Fig.3 shows the front and side views of diffusers 1 and 2.

Fig.1: 3D view of a mixed flow pump.

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Case 1

Case 2

Case 3

Fig.2: Designed impellers, presented in order of increasing rVt.
Fig. 4 shows the comparison of predicted flow field in the original diffuser and the diffuser designed by TURBOdesign1. In the new diffuser the corner separation which is typical of this type of vaned bowl diffuser has been suppressed resulting in significant improvement in performance. The new stage has been manufactured. The impeller was manufactured by 5 axis machines out of aluminium and the diffuser was made out of polyamide with a rapid prototyping method. The performance of the new stage was measured which confirmed significant improvement in performance.

![Comparison of flow in the original and new diffuser](image)

**Conclusion**

TURBOdesign1 enabled us to achieve a significant hydraulic performance improvement in a relatively short period of time. By using TURBOdesign1 we can meet our customer requirements in terms of performance and compactness of our stages with ease.

“TURBOdesign1 has enabled us to meet our customer requirements in terms of performance and compactness of our stages with ease”