Computational Fluid Dynamics Study of the Magnetically Suspended Centrifugal Blood Pump

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Artificial heart pumps have attracted the attention of researchers around the world as an alternative to the organ used in cardiac transplantation. Conventional centrifugal pumps are no longer considered suitable for long-term application because of the possibility of occurrence of blood leakage and thrombus formation around the shaft seal. To overcome this problem posed by the shaft seal in conventional centrifugal pumps, the magnetically suspended centrifugal pump has been developed; this is a sealless rotor pump, which can provide contact-free rotation of the impeller without leading to material wear. In Europe, clinical trials of this pump have been successfully performed, and these pumps are commercially available.

One of the aims of our study is to numerically examine the internal flow and the effect of leakage flow through the gap between the impeller and the pump casing on the performance of the pump. The results show that the pressure head increases because of the leakage of the fluid through the gap. It was observed that the leakage flow rate in the pump is sufficiently large; further, no stagnant fluid or dead flow regions were observed in the pump. Therefore, the present pump can efficiently enhance the washout effect.

The impeller rotates with minimal fluctuations that are caused by the fluid force and the magnetic force. Therefore, a careful investigation of the pressure distribution around the impeller and the fluid force on the impeller are important to improve the rotation stability. Two models of the pump having volutes with different cross-sectional areas are studied using computational fluid dynamics software. In both the models, the obtained results show an approximately point-symmetric distribution of the time-average pressure; further, the fluctuating pressure exhibits harmonic behavior. The pump characteristics and fluid force acting on the impeller of the two models are shown to be clearly different.