颜　禹,陆晓峰,朱晓磊.进口弯管及前置扰流子对离心泵性能影响[J].农业工程学报,2013,29(20):74-81

进口弯管及前置扰流子对离心泵性能影响

Effect of import bend and forward turbolator on performance of centrifugal pump

投稿时间：　2013-04-15　最后修改时间：　2013-09-18

中文关键词：离心泵,效率,数值模拟,扰流子,进口流场,运行性能

英文关键词:centrifugal pumps　efficiency　computer simulation　turbolator　inlet flow field　operation performance

基金项目:江苏省自然科学基金（BK20131411）

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中文摘要:

为提高离心泵运行性能，设计了3种弯管前置扰流子。利用计算流体动力学软件FLUENT中提供的多重参考系（MRF）模型，采用标准k-ε模型和SIMPLE算法求解不可压缩Navier-Stokes方程，对带有不同进口弯管及扰流子的离心泵在设计工况下进行全流场数值模拟。结果表明：离心泵外接弯管上90°弯头的转向半径R和入口直管段长度L对泵的运行效率均有影响，其中转向半径的影响更为明显，通过适当的增加R和L可有效地提高离心泵的运行效率，效率最高可达81.98%。而在弯管前端安装扰流子后，泵的入口流动状态可以得到很好的改善，进而提高离心泵的运行效率和抗汽蚀性能，其中以CJ-3406翼型扰流子性能最佳，效率最高可提高4%，而采用3307b翼型扰流子时有效汽蚀余量最高可提高近0.2 m。该文为实际生产中如何改进入口管路和提高离心泵的运行性能提供了新思路。

英文摘要:

Abstract: As an important kind of fluid conveying equipment, a centrifugal pump is widely used in modern industrial production, but the issue of its low operation efficiency was not solved effectively, and at the same time a large amount of energy is consumed by a centrifugal pump every year, a huge burden has been brought on economic development. In order to improve the operation performance of a centrifugal pump, with the idea of improving the inlet flow field of a centrifugal pump, three kinds of bend forward turbolators were designed. First of all, the blade and central body of the turbolator and the centrifugal pump were modeled by Pro/E, and then meshed in Gambit. Finally, the whole flow field of a centrifugal pump with an imported bend was simulated under the design conditions by using a MRF model which was supported by Fluent, both the standard k-ε turbulence model and the SIMPLE method were adopted to solve the Navier-Stokes equations for incompressible flow. According to the simulation results under different import lines, it was concluded that both the turning radius (R) of the 90 degree elbow and entrance straight tube length (L) of the bend had an influence on operation efficiency, and that the former was more obvious. The efficiency of a centrifugal pump can be effectively improved by increasing R, and it will be first increased and then decreased with the increasing L, the maximum efficiency can be reached when L=D, so the operation efficiency can be improved by an appropriate increase of R and L, the maximal efficiency can be up to 81.98%. After installing a turbolator, the inlet flow state of a pump got a considerable improvement, the efficiency of centrifugal pump was improved, and from all kinds of turbolator, the CJ-3406 had the most obvious effect, it can increase the efficiency by 4%. This indicates that the efficiency can be better improved when the aerofoil curve changes gently. With a turbolator, the work space of a centrifugal pump can be saved, so the turbolator can be better served for actual production. At the same time, the speed direction is perpendicular to the impeller inlet when the fluid flow through the pipe elbow. Centrifugal pump inlet flow can be more uniform and axisymmetric flow can be involved in the import which ensures the uniform distribution of pump inlet pressure. What is more, both the pressure and velocity of the import are improved, so the performance of anti-cavitation of a centrifugal pump is enhanced, the NPSHa can be increased by 0.2 m with the turbolator of 3307b. This article provides a new train of thought for improving the inlet line and the operation performance of a centrifugal pump in actual production.

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