

## عنوان مقاله:

Multi-Objective Optimization of Two-Stage Centrifugal Pump using NSGA-II Algorithm

## محل انتشار:

دوماهنامه مکانیک سیالات کاربردی، دوره 11، شماره 4 (سال: 1397)

تعداد صفحات اصل مقاله: 15

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## خلاصه مقاله:

Improving the efficiency and suction capability of a multistage centrifugal pump poses a major challenge for the designer of this type of equipment. This paper deals with the optimization of a two stage centrifugal pump using Non-dominated Sorting Genetic Algorithm II (NSGA-II), coupled with three-dimensional Reynolds-averaged Navier-Stokes (3D-RANS) flow solver. The first stage comprises a suction impeller with a diffuser while the second stage is formed by a second impeller connected to a volute. Both impellers are of different dimensions and are inter-connected by a return channel. This arrangement increases the number of varying parameters and thus can add further constraints on the overall optimization process; as a result, a high computational complexity of NSGA-II and a higher computational fluid dynamics (CFD) simulation cost is incurred. In order to save running time, optimization with CFD simulations are performed on each stage separately shall enable to obtain better parameterization flexibility; therefore, permitting to adopt only three objective functions in as well as limiting other geometrical constraints. The objectives of this study are to maximize the head and hydraulic efficiency at a time where the net positive suction head inception (NPSHi) is kept to minimum. The overall efficiency as well as the head of the optimized pump were increased by ۹.۸% and ۱۵.۷%, respectively, at best efficiency point (BEP) (rotational speed  $N=۲۶۰۰$  rpm); the NPSHi of suction impeller was reduced by ۱۳.۶%. At  $N=۱۴۵۰$  rpm (BEP), an improvement of ۱۴.۹% in the head and ۶.۵۲% for the overall efficiency is observed. An important improvement in performance at different operating flow rates was obtained; this was in addition to other enhancements in the volumetric and hydraulic efficiencies. Unsteady CFD simulations were also performed to predict fluctuations in the pressure field, leakage flows and interactions between impellers and collectors. The obtained results were in agreement with experimental data. The head fluctuation of the optimized pump was also reduced by ۲۲.۵% in amplitude; this was favored by the presence of a tapered blade towards the trailing edge and the extended radial gap by ۴.۸۶% between the second impeller and cutwater, which was caused by the reduction of the impeller diameter.

## کلمات کلیدی:

Multi, stage centrifugal pump, Two, objective optimization, Unsteady, NSGA, NPSHi, CFD, II

