Validation for a Quick and Reliable Procedure for Centrifugal Pumps Using Frozen Rotor Methodology in COMSOL Multiphysics®

D. Manenti[1], G. Tanghetti[1], R. Roveglia[1]

[1]Metelli SPA, Cologne (BS), Italy

Abstract

Single stage centrifugal pumps are widely used in several engineering fields such as: room conditioning, energetic cycles, automotive industry, home care, etc. Thus, the possibility of simulate their behaviour, in terms of pressure increase and mass flow rate, is helpful in reducing prototyping costs in the first design stages.

Due to the intrinsic tridimensionality of the fluid flow in these systems, it is usually necessary to model them using 3D domains, which means a high number of Degrees of Freedom (DOF). In addition to this, these systems are composed of a rotating domain (the impeller) and a stationary one (the volute), increasing the complexity of the calculation. Hence, a suitable strategy, applied to decrease the high computational times and costs of these simulations, is recommended. Considering the typical operating regimes of pumps, fluctuation of variables can be neglected; therefore a stationary study results to be more useful than a time dependent one. The only limit of stationary studies is they do not usually consider inertial terms such as centrifugal forces and Coriolis accelerations. The Rotating Machinery Interface is a dedicated tool implemented in COMSOL Multiphysics® in the CFD Module, containing the Frozen Rotor study type. This is a stationary-like study that allows implementing automatically inertial terms. This way, it is possible to avoid the necessity of a moving mesh and, as a consequence, simplify the calculation.

Aim of this study is to evaluate the accuracy of this new methodology by the comparison of simulation results with experimental data. A parametric study, considering different working conditions, was performed on a given pump geometry. The parameters identifying the operating conditions were the impeller rotational speed and the mass inflow rate. As reported in figure 1, the matching between FEM and experimental results is good, underlining the suitability of the new frozen rotor methodology.

Figures used in the abstract

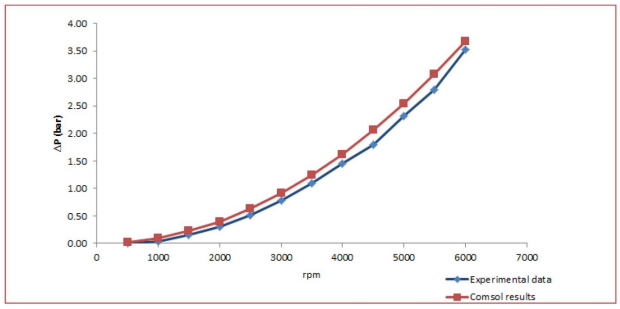

Figure 1: Experimental vs FEM results for different operating conditions of the studied pump.

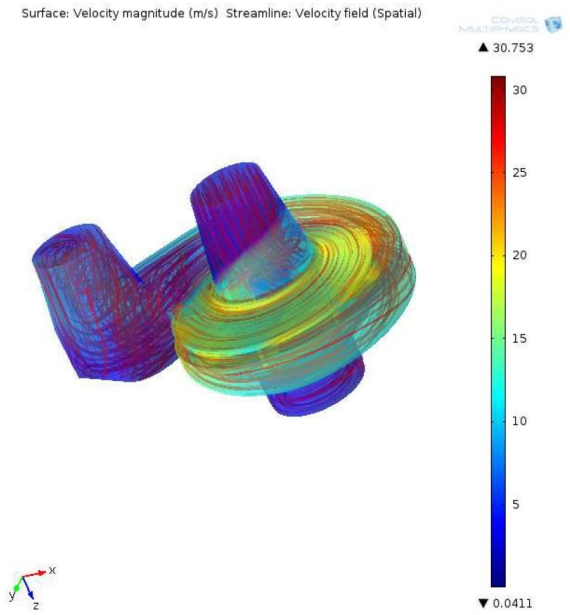

Figure 2: Velocity field (magnitude and streamline) resulting from Frozen Rotor analysis @ 6000[rpm].