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Grid Generation for Screw Compressors with Variable Geometry Rotors

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Twin screw compressors are positive displacement machines commonly used in industrial applications. These are usually produced with the uniform pitch helical rotors, mostly due to manufacturing constraints. However, other twin screw machines, such as vacuum pumps more often use variable pitch rotor for improved efficiency. Moreover, other screw machines such as single screw machines are of nonparallel axes and cross sectional profile which changes along the rotor axis. Their manufacturing is more challenging compared to twin screw compressors. With advancements in manufacturing and measurement technologies, the new generation of screw machines may see rotors with variable pitch and variable profile which could lead to improved efficiency and extension of operating range of such machines.

Grid generation of a standard twin screw compressors pioneered by authors in late 1990's allowed use of Computational Fluid Dynamics (CFD) for analysis and improvements in this technology. This technique is since widely used for machines with parallel rotors, uniform profile and constant lead, such as twin screw compressors and expanders, gear pumps, multiphase pumps etc.. In order to analyse novel configurations of screw machines with non-parallel axes and variable geometry profile by use of CFD it is necessary to produce suitable numerical mesh capable for reliable calculation of 3D transient fluid flows within domains with sliding and stretching interfaces.

An Algebraic grid generation algorithm applicable to Finite Volume Method (FVM) in variable pitch and variable profile screw machines is described in this paper. It is based on the principles developed for the uniform pitch rotors with constant cross-section profile and is also compatible for rotors with variable geometry.

CFD calculations are presented to compare performance of an oil-free 3/5 lobed twin screw compressor with constant pitch and variable pitch rotors and uniform 'N' profile and variable pitch and variable lead rotors. The improvements are achieved with variable lead and variable profile rotors by reduced throttling losses, reduced sealing line length towards high pressure domains and a larger discharge area for the same pressure ratio.

Keywords: Algebraic Grid Generation, Computational Fluid Dynamics, Twin Screw Compressor, Variable Pitch Rotors, Variable Rotor Profile.