CURRENT TECHNIQUES AND CHALLENGES IN THE DESIGN OF VACUUM PUMPS

Magnus Janicki
Oerlikon Leybold Vacuum GmbH, Bonner Str. 498, 50698 Köln - GERMANY
magnus.janicki@oerlikon.com

ABSTRACT

The industrial design of vacuum pumps in general tries to optimize the vacuum performance and the energy efficiency of newly developed pumps in the limits of mechanical, thermal and financial possibilities [1]. Different simulation techniques are used to find the optimum design parameters prior to the prototype testing.

In most vacuum pumps all three flow regimes, the viscous, the transition and the molecular flow are to be found simultaneously at different locations. As most flow models show good accuracy only in a specific flow regime, the calculation of the vacuum performance of the integral pump is often not covered by a single simulation model. While CFD methods are very useful in the viscous flow regime, their accuracy decreases when the flow enters the transitional flow regime [2]. Monte Carlo methods on the other side are very helpful in calculating molecular flow but become computationally intensive with higher gas pressures due to the necessity of high particle numbers and the inclusion of collisions between the particles [3], [4]. Additionally there are nearly no commercial tools to calculate the flow of rarefied gases in three dimensional geometries.

This talk gives an overview of simulation models that are used in the industrial design of vacuum pumps, especially with screw vacuum pumps, roots blowers and turbo molecular pumps. It is shown, how far these techniques help during the development process of new pumps and where their simulation capabilities are limited.

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