OPTIMIZATION OF A VACUUM PUMP

a methodology to obtain the optimum setup of the porting angles of the pump with a combined approach between lumped parameter model and Genetic Algorithms

PIERBURG PUMP TECHNOLOGY

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WHY VACUUM PUMPS ON CAR ENGINES?

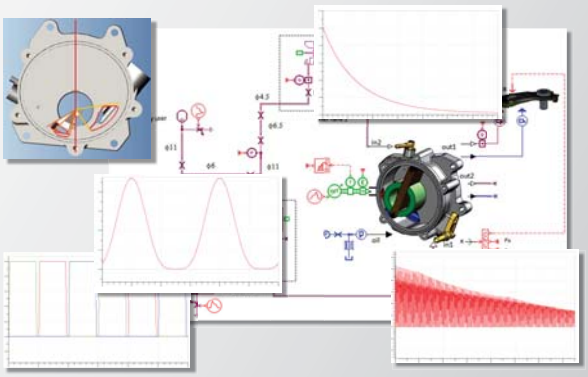
The vacuum pump for automotive application is a volumetric pump that fulfills the main task of assisting the vehicle's braking by venting the internal capacity of the brake booster. Its usage includes also some additional tasks.

The current trend to theoptimization of the engine's energy balance calls for more efficient pumps; to this aim, a new generation of products has been introduced by Pierburg Pump Technology. Its efforts have been appreciated by a constantly increasing number of customers.

REDUCING POWER CONSUMPTION WITHOUT LOSING PERFORMANCE

The target requirements of a vacuum pump's design concern the power consumption and the time needed to obtain a given level of vacuum (together with reliability, robustness and sound emission, of course).

Some of the main drivers for both the mentioned targets are the values of the phase angles of the internal ports of the pump: these parameters are usually setup through the experimental approach as a result of a compromise between both the goals.



… A STIMULATING CASE TO BE STUDIED!

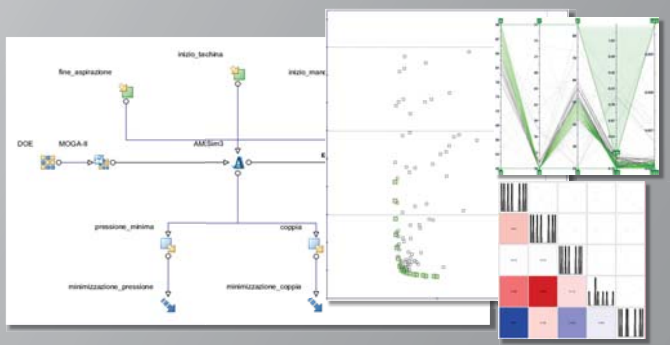
Unlike in the usual volumetric compressors a large quantity of oil is present in the pump'schamber, since it serves as a sealing agent. As a result, a free-surface splash flow is shown consisting of a bi-phase mixture air/oil.

To this aim a model hasbeen developed within the AMESim code by Politecnico of Turin together with PPTItaly: the bi-phase mixture is reduced to a separate flows system employing some setup coefficients where both the phases share the same flow section.

modeFRONTIER TOOL IN COMBINATION WITH LUMPED PARAMETER MODEL

Thanks to the interaction between modeFRONTIER and AMESim ambient through a dedicated node, the optimization of the porting angles of the pump can be performed with target on both the power consumption and the performance.

To this aim the MOGA-II algorithm has been employed involving a DOE of 7 designs and a scheduler of 22 generations. Moreover, two additional runs have been performed starting from the Pareto frontier obtained from the previous ones.



GOOD AGREEMENT WITH EXPERIMENTAL

+

TIME TO MARKET REDUCTION

AN EFFICIENT APPROACH

The optima are clearly highlighted ir the obtained Pareto frontier.The results of the optimization are in good agreement with the ones obtainedthrough the experimental approach.

The CAE optimization seems to be reliable with the additional benefit of a large time and resource saving. Further improvement can be achieved decreasing the computational time of the optimization: to this aim it could be considered to employ the Response Surface Methodology.