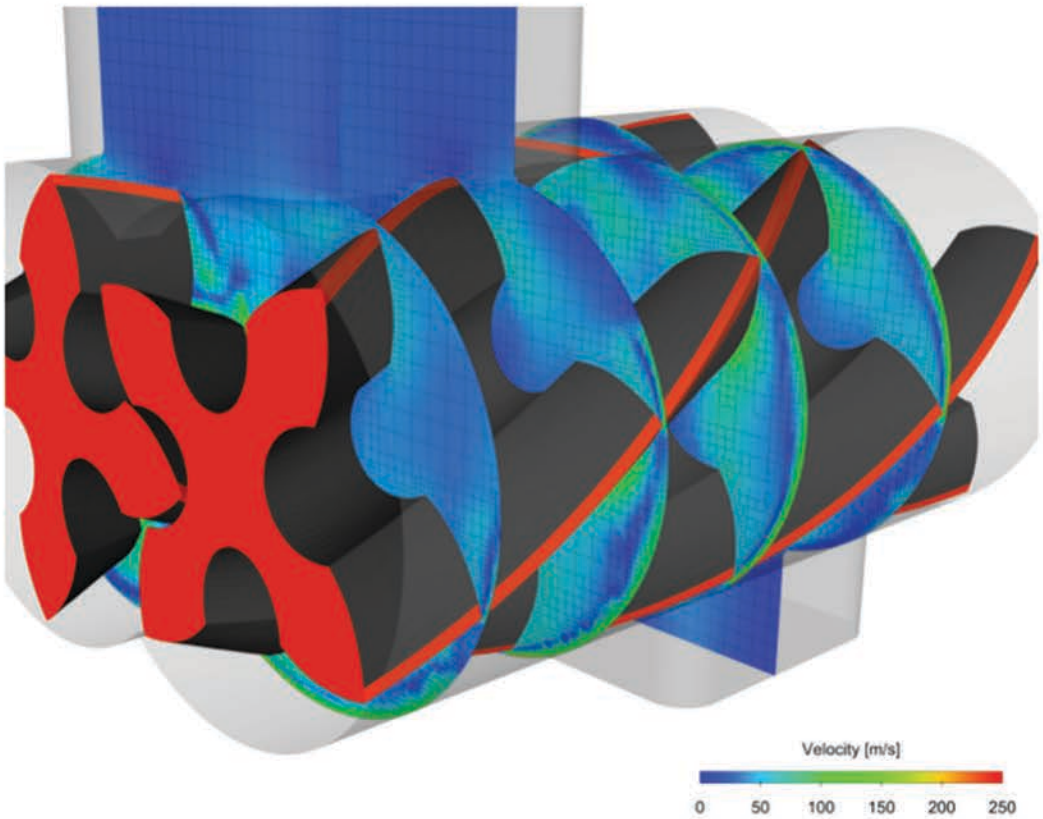
TINY GAPS: USING CFD TO STUDY ROTARY SCREW COMPRESSORS

RESEARCH REVIEW

CONVERGENT SCIENCE



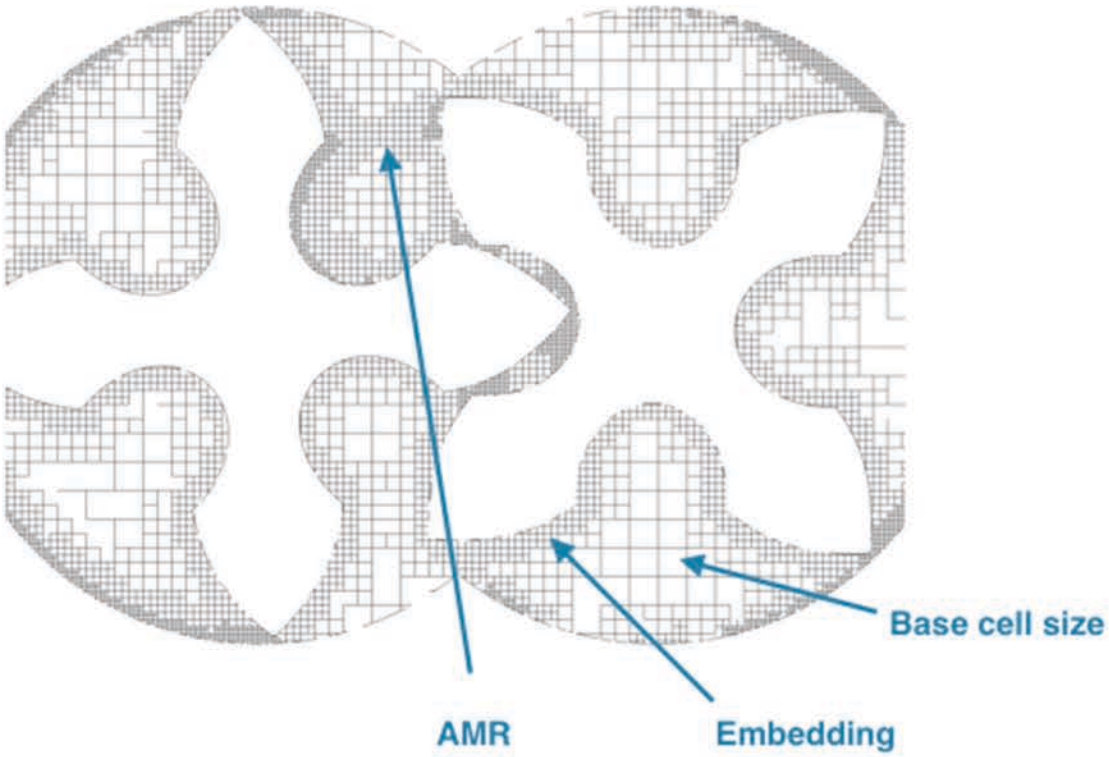
OVERVIEW

The rotary screw compressors we use today were invented by the Swedish engineer Alf Lysholm. This unique design uses a rotary type positive displacement mechanism that reduces the pulsation of flow, or surging, that is common in the more traditional piston compressors. Rotary screw compressors are used everywhere from large industrial applications to small power tools. The typical whining sound associated with a pneumatic grinder is a great reference to this unique constant positive displacement of air.

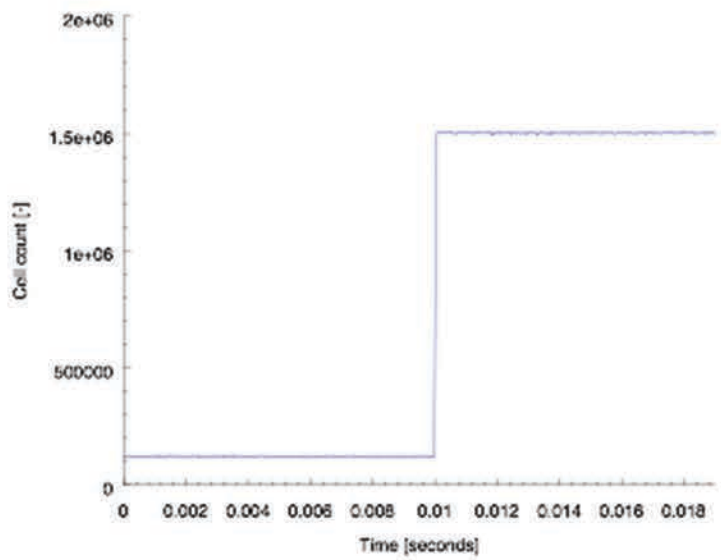
While power tools and large industrial applications are common uses for the rotary screw compressor, the automotive industry uses them as well; they are referred to as “blowers” or supercharges. Whatever the application, rotary screw compressors have one commonality:, they all have very tight clearances and rotate at very high speeds. This poses a challenging problem when trying to understand airflow and efficiencies at their operating speed of ~15,000 RPM with a typical clearance of 20-150 microns.

CFD STUDY

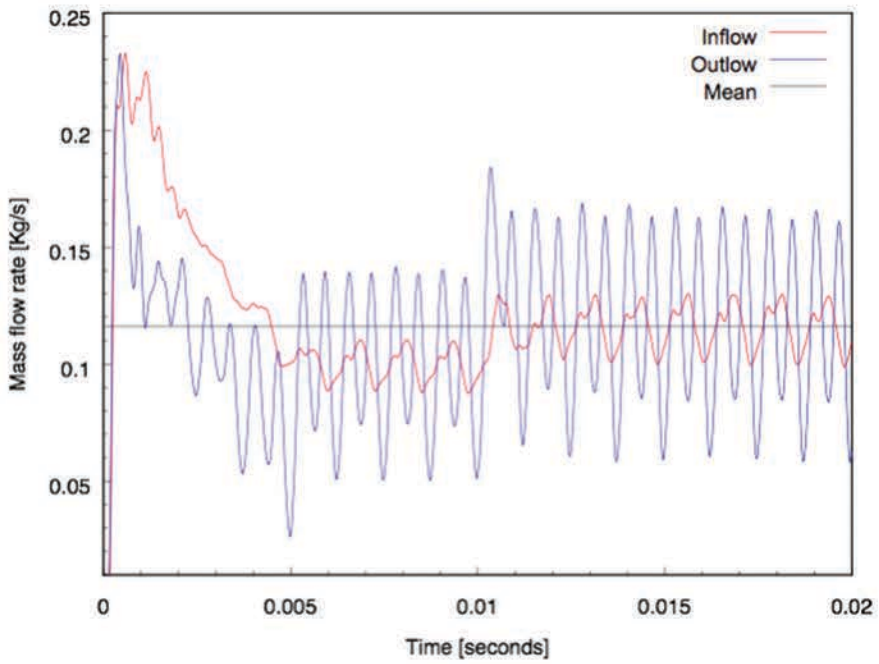
With CFD, these devices can be studied in great detail provided the computational mesh is created accurately. With CONVERGE, the meshing is automated and fully coupled with the solver at runtime to ensure the accuracy of the mesh. The user only needs to set the rotation axis and RPM of the rotors. The grid generation process is automated and requires no user intervention.



The base cell size is a key parameter that needs to be specified. Any additional grid resolution is specified through Adaptive Mesh Refinement (AMR), which is a process that automatically adds mesh resolution based on user-specified gradients during during, and/or fixed embedding. Both processes are illustrated in the figure above. A positive scale will make the grid finer.

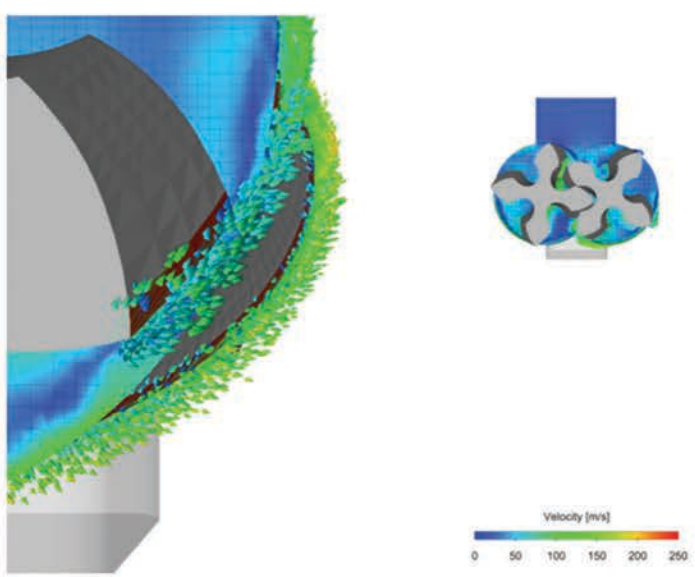


The above graph shows the cell count as a function of time. Up to 0.01 seconds the cell count is less than half a million and reaches ~1.5 million after. This is accomplished using the grid scaling feature, which runs the case coarse until a prescribed time for faster convergence.

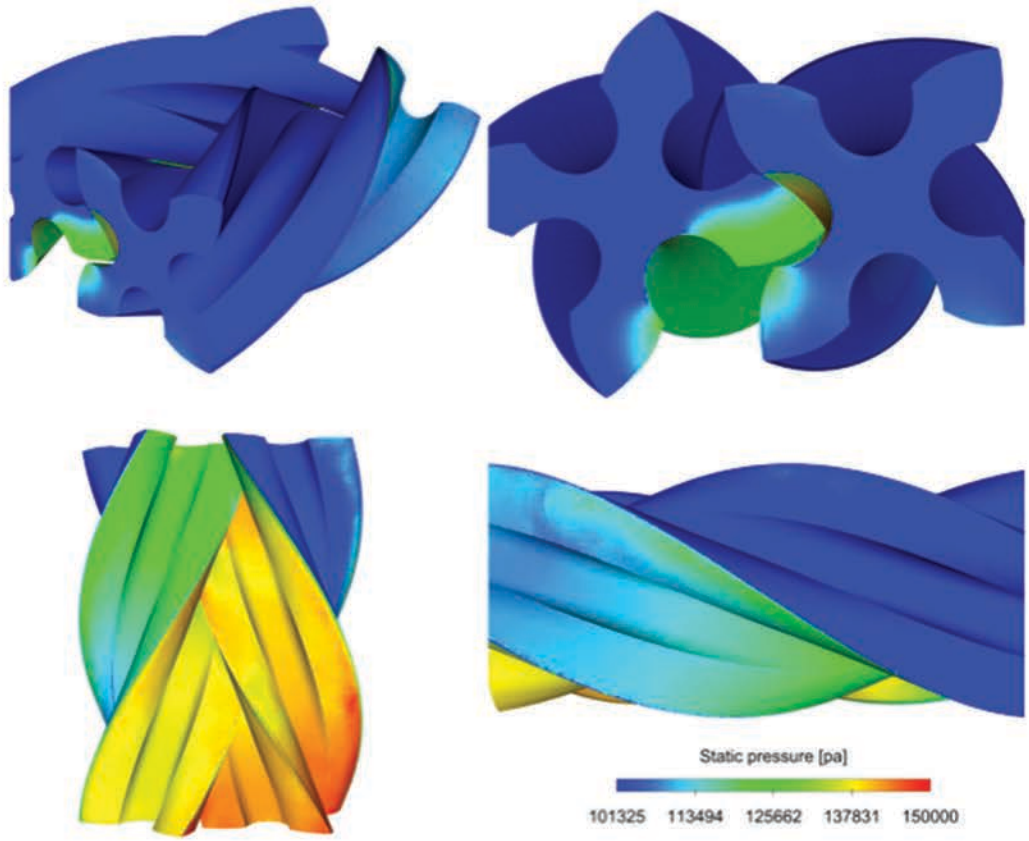


The above plot shows the mass flow rate through the inlet and outlet boundaries as a function of time. The mean value presented in black can be compared against experimental measurements.

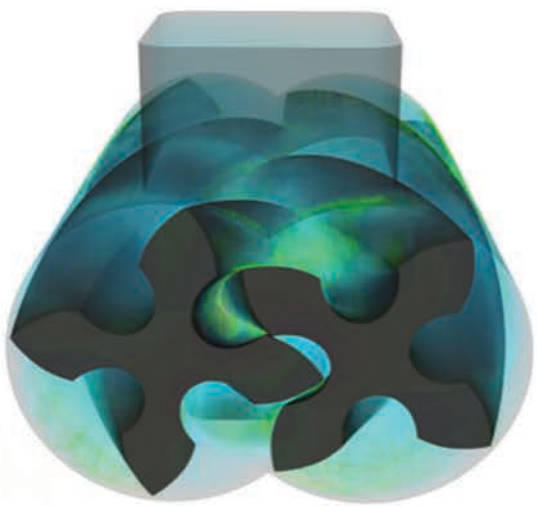
From a design point of view the “leakage” or “slippage” occurring past the rotor tips is very important. The following plot shows how leakage occurs in this particular design.



With AMR and fixed embedding, analyzing leakage or slippage past rotor tips is easy and accurate. Since slippage is a function of the tip clearance, the fixed refinement near the rotor tips needs to be set correctly. The only input parameter that the user specifies is the scale for the fixed embedding.



Pressure acting on the rotor is an important factor in the design process. The above image shows the static pressure acting on the rotors. CONVERGE also outputs torque values acting on rotors as a standard output.



CONTACT INFORMATION

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