APPLICATION BRIEF

Cray and ANSYS Achieve Extreme Scaling Improvements on ANSYS® Fluent® Using CSCS's Cray® XC30™ System

ANSYS Fluent

ANSYS Fluent is a computational fluid dynamics (CFD) software solution used to predict flow, turbulence, heat transfer and reactions for industrial applications ranging from air flow over an aircraft wing to combustion in a furnace, from bubble columns to oil platforms, from blood flow to semiconductor manufacturing, and from clean room design to wastewater treatment plants. Advanced solver technology provides fast, accurate CFD results, flexible moving and deforming meshes, and superior parallel scalability. Additionally, Fluent has a record of outstanding parallel scalability up to thousands of processors, enabling high-fidelity results in the shortest possible time.

Swiss National Supercomputing Centre

The Swiss National Supercomputing Centre (CSCS) enables world-class research with supercomputing capabilities available to domestic and international researchers. CSCS's resources are open to academia and available to users from industry and the business sector as well. The center's Cray XC30 system "Piz Daint" is a hybrid system featuring Intel® Xeon™ processors and NVIDIA® Tesla® GPUs. Piz Daint provides up to 20 times more compute performance than its predecessor while using only up to two and a half times as much electrical power.

Cray XC30 'Piz Daint' System

- Cabinets: 28
- Peak Performance: 7.87 PF
- Compute Nodes: 5,272 (one 16-core Intel Xeon E5 series processor and one NVIDA Tesla K20X GPU per node)
- System Memory: 169 TB
- Interconnect: Aries
- Storage: 2.5 PB

Situation

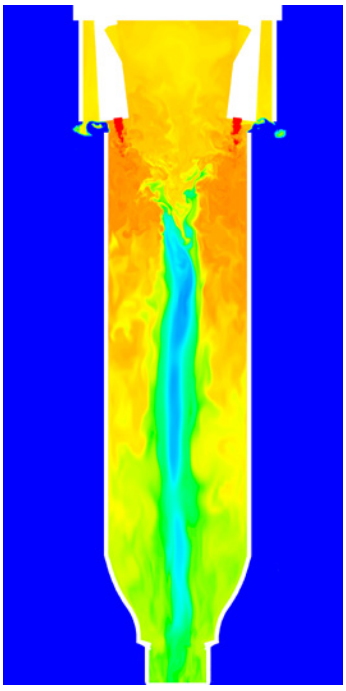
Tetra Pak is the world's leading food processing and packaging solutions company. To improve performance and accelerate its packaging machine filling system design and development process, the company uses ANSYS computational fluid dynamics (CFD) simulation software. Specifically, Tetra Pak had been using the traditional Reynolds-averaged Navier-Stokes (RANS) turbulence models to develop its systems. While these models are industry standard and computationally cheap, they contain assumptions that can introduce errors. This situation meant that the engineers had to produce and optimize more real-life prototyping systems, costing the company time and money.

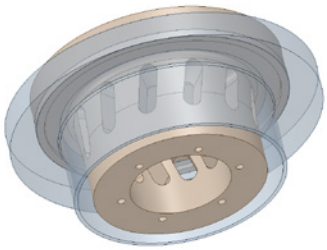
To improve this situation and get higher-fidelity simulation results, Tetra Pak needed to run large eddy simulation (LES). This mathematical model for turbulence is common in scientific research institutions but less used in industry as it uses a lot of computing power. Since LES is a very accurate way to simulate the flow, Tetra Pak needed ANSYS Fluent to exploit extreme-scale high performance computing (HPC) and speed up the pace of their innovation.

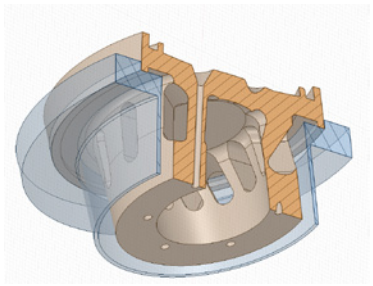
Challenge

Large eddy simulation has been under development for more than four decades. But it has never lived up to the expectation that it could eventually replace RANS turbulence models on a grand scale. The main limitation results from the high resolution demands for wall-bounded flows. For this reason, classical LES has largely remained a research tool even though many industrial applications can benefit from it.

Tetra Pak uses LES for understanding and optimizing "active nozzles" at scale and over a range of conditions. The active nozzle is Tetra Pak's proprietary approach to improved filling machine control but it creates a turbulent swirling motion which is not suitable for simulation by traditional RANS models. Tetra Pak used LES, however, their scalability performance was limited in terms of precision and turnaround time. The company wanted to accurately simulate turbulent mixing in active nozzles with LES and needed to run Fluent at high processor counts.





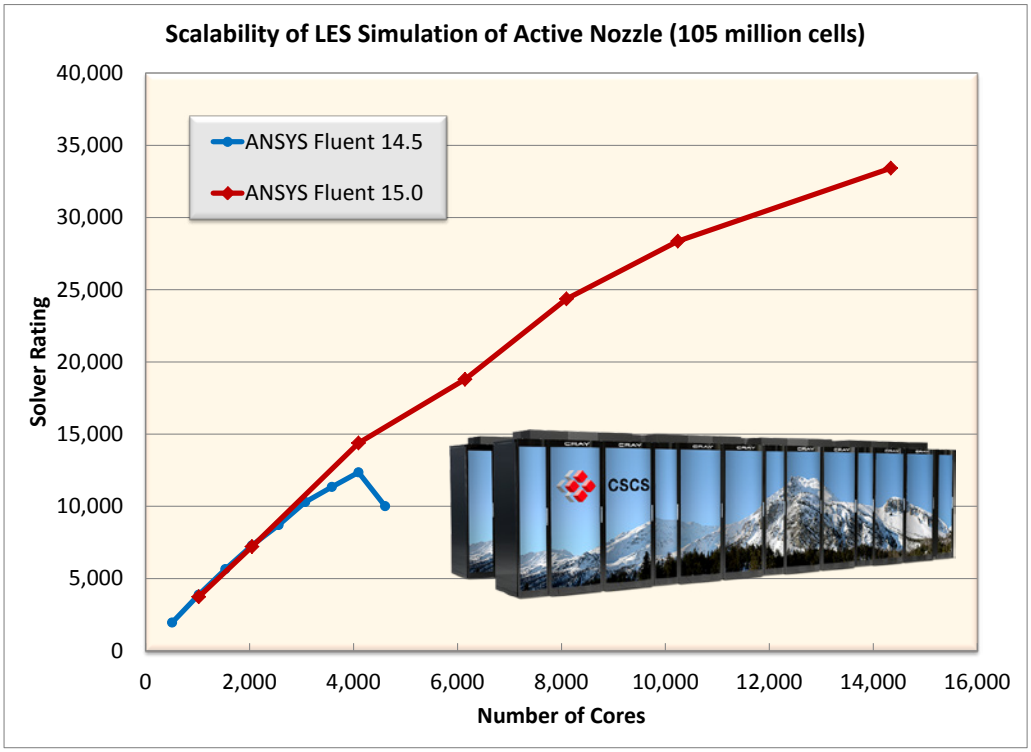


ACTIVE NOZZLES: Using CFD, Tetra Pak developed the active nozzle. The nozzle allows gas to flow and sterilize every part of the machine as well as the aseptic chamber. The process assures effective package sterilization.

Cray Inc.
901 Fifth Avenue, Suite 1000
Seattle, WA 98164
Tel: 206.701.2000
Fax: 206.701.2500
www.cray.com

Solution

ANSYS and Cray worked together to boost the scaling of Tetra Pak's LES simulation on Fluent. First, ANSYS created a version of the application that used the Cray MPI library and allowed users to take full advantage of the Aries interconnect. Then, Cray ran a 105-million cell LES simulation of filling a bottle with detergent on CSCS's Cray XC30 system, calculating two time steps with 10 iterations per time step and measuring the wall clock time for these two time steps. The test produced great results with the code scaling to 14,000 cores.



Cray XC30 Supercomputer

The Cray XC30 supercomputer provides both extreme scalability and sustained performance, with offerings across the performance and price spectrum. It excels at large-scale computations, reducing processing times on a wide range of applications. For additional choice, the Cray® XC30-AC™ (air cooled) supercomputer delivers the same HPC technologies of the high-end XC30 system while economizing the packaging, networking, cooling and power options.

CSCS configured their 28-cabinet Cray XC30 system with 5,272 compute nodes (one 16-core Intel Xeon E5 series processor and one NVIDIA Tesla K20X GPU per node) for a total of 115,984 cores and a peak performance of 7.87 petaflops. The system also features 2.5 petabytes of Cray® Sonexion® storage.