Garafolo tests spacecraft seal to verify computer models

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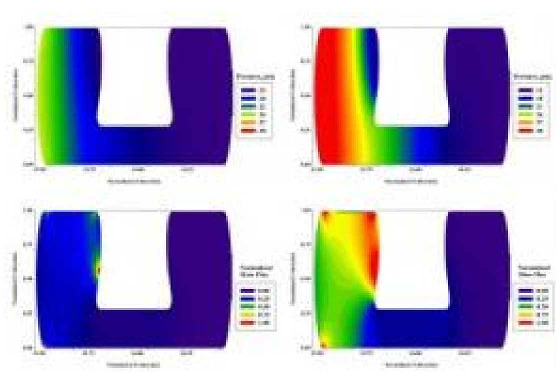
University of Akron researcher Nicholas Garafolo leveraged Ohio Supercomputer Center systems to analyze air leakage of main interface seals -- shown here as an orange ring -- used in NASA's International Low Impact Docking System (iLIDS). Credit: NASA illustration

An Akron researcher is designing computer prediction models to test potential new docking seals that will better preserve breathable cabin air for astronauts living aboard the International Space Station and other NASA spacecraft.

Garafolo recently analyzed a two-piece elastic silicone – or elastomer – seal, using the IBM 1350 Glenn computer cluster at the Ohio Supercomputer Center (OSC). His model simulated air leakage through the elastomer, taking into account the effects of gas compressibility and variable permeability.

"Recent advances in both analytical and computational permeation evaluations in elastomer space seals offer the ability to predict the leakage of space seals," said Nicholas Garafolo, Ph.D., a research assistant professor in the College of Engineering at The University of Akron (UA). "Up until recently, the design of state-of-the-art space seals has relied heavily on intuition and costly experimental evaluations. My research evaluated the performance of the compressible permeation approach on a space seal candidate."

Garafolo serves on a research team tasked with testing polymer/metal seals being considered for future advanced docking and berthing systems. The university researchers work with partners in Cleveland, Ohio, at NASA's Glenn Research Center, which is responsible for developing the main interface seals for the new International Low Impact Docking System (iLIDS).



The University of Akron's Nicholas Garafolo accessed Ohio Supercomputer Center systems to characterize computational pressure profiles (top) and computational mass flux (bottom) of a potential main interface seal for docking at the International Space Station and other new spacecraft. Credit: Garafolo/UA

"For many years, Ohio industry has invested heavily in the aviation, aerospace and manufacturing sectors, which naturally led OSC to focus a portion of its computational resources on the field of advanced materials," said Ashok Krishnamurthy, interim co-executive director of the center. "Dr. Garafolo's work is an excellent example of how modeling and simulation often allows scientists to analyze materials in ways not possible through simple observation or physical experimentation."

NASA has been developing low-impact docking seals for manned missions to the International Space Station, as well as for future exploratory missions. Common to all docking systems, a main interface seal is mated to a metallic flange to provide the gas pressure seal.

"The two-piece seal system, for which experimental studies of seal performance are well documented, utilizes two elastomer bulbs, connected with a web and retained with a separate metallic ring," Garafolo explained. "Baseline referent leak rate experiments were performed with a multitude of pressure

differentials. The prediction method consisted of a computational analysis of referent geometry with temperature and pressure boundary conditions."

To establish an analytical understanding of space seal leakage and construct their computational prediction tool, Garafolo and his colleagues modeled how air leaked into and through the elastomer seal, while taking into account the effects of gas compressibility and the variability of permeation on air pressure. The research team's first evaluations showed significant correlations between the experimental values and the computer modeled results.

For pressure differentials near operating conditions, the leak rates determined by the model accurately reflected the experimental results, within the bounds of uncertainty. For pressure differentials exceeding normal operating conditions, the differences between the experimental results and computational numbers were not quite as close, as expected. The larger differences in the leak rates, however, were attributed to extrapolation errors of the model parameters.

Provided by Ohio Supercomputer Center