Miniature Vacuum Pumps for Analytical Instruments

Robert J. Kline-Schoder and Dimitri Deserranno

Creare LLC, Hanover, NH

As mass spectrometers have decreased in size, the accompanying vacuum system has come to dominate the overall system size and mass. In many cases this has precluded truly portable applications of mass spectrometers and made many in-situ monitoring systems cumbersome and unwieldy to deploy. For all of the contemplated applications, a great need for the development of small and low power vacuum systems has emerged.

In order to achieve high vacuum in a small, low-power package, a turbomolecular pump is the only viable option. In a turbomolecular pump, the pump rotor tip speed needs to be comparable to the molecular speed of the gas being pumped. This means that when the diameter of the rotor decreases (reducing size and mass), the rotor speed needs to increase proportionally. Also, as pump size decreases, the flow reduces, which necessitates tighter clearances between moving parts of the pump to control leakage. The higher speed and the tighter clearance affect tolerances during pump parts fabrication and assembly. For Mars missions, a turbomolecular pump is coupled with a molecular drag pump on the same shaft driven by the same motor. The molecular drag pump exhausts directly to the Martian atmosphere at pressure up to 10 Torr. Similar demands for high precision manufacture and assembly of the molecular drag pump exist as for the turbomolecular pump.

Since the molecular drag pump is not sufficient to exhaust to terrestrial atmospheric pressures, we also developed rough pump technologies that are small, power efficient, and tailored to mate with our high vacuum pumps. We developed a very small scroll pump with a adequate flow rate, low power rating, and sufficient compression to match our high vacuum pumps. This poster will present miniaturized pumping systems and test data related to environmental testing of the pumps.