EVOLUTION OF THE LABORATORY VACUUM PUMP

BY JOHN BUIE

Vacuum pumps are an essential piece of equipment and used in a wide variety of processes in most laboratories. However, despite numerous advances over the past 70 years, many industry professionals still believe that vacuum technology has not progressed, and that there is no benefit from updating a laboratory pump.

However, if one studies the evolution of the laboratory pump over the past 25 years, it becomes apparent that this is an area of significant innovation, with important developments in high vacuum technology, corrosion resistance, vacuum control, and improvements in the efficiency and ecological impact of vacuum pumps.

In **1206**, the suction pump, a predecessor to the vacuum pump, was invented by the Arabic engineer Al-Jazari. It was not until the fifteenth century that the suction pump first appeared in Europe.

In **1643**, the first mercury barometer was invented by Evangelista Torricelli, based upon earlier work by Galileo. The first sustained vacuum was achieved later the same year.

In **1654**, Otto von Guericke invented the first true vacuum pump, and used it to evacuate the air between two hemispheres in order to demonstrate that they could not then be separated by two teams of horses (the famous "Magdeburg hemispheres experiment").

In **1874**, a new style of pump consisting of vanes mounted to a rotor that turned within a cavity was patented by Charles C. Barnes of Sackville, New Brunswick, Canada. This type of pump became known as the rotary vacuum pump, and took depth of vacuum to a new level.

In **1855**, Heinrich Geissler invented the mercury displacement pump and used it to achieve an unprecedented vacuum of around 10 Pa (0.1 Torr).

In **1911**, Professor Dr. Wolfgang Gaede first reported the principle of the molecular drag pump at a meeting of the Physical Society in Karlsruhe. The pump was extremely well received and was considered to be the major event of the meeting. After many problems and setbacks, the first 14 pumps were ready for sale by the fall of 1912.

In **1953**, Raymond Herb invented the first practical Getter-ion pump, which prevented the vacuum chamber from rusting through the use of titanium metal.

In **1960**, Varian introduced the Vaclon pump, the first pump able to operate at rates of 1,000 liters/sec.

1950

In **1915**, Irving Langmuir invented the diffusion pump, using mercury as the pump fluid. The use of mercury enabled the pump to continue working at elevated temperatures, but was soon replaced due to its toxicity.

By the **1920s**, the oil-sealed rotary vane mechanism was the typical design for most primary pumps.

In **1926**, M. Siegbahn developed the first disk-type molecular drag pump.

In **1929**, Kenneth Hickman developed synthetic oils with low vapor pressures. These would soon prove invaluable in gas diffusion pumps.

In **1930**, Cecil R. Burch and Frank E. Bancroft filed for a patent for the gas diffusion pump using low-vapor pressure oils. The patent was granted in 1931.

In **1937**, C.M. Van Alta developed the first diffusion pump with a capacity of greater than 100 liters/second. Also in this year, the multi-stage, self fractionating diffusion pump was invented by L. Malter.

In the late **1950s**, researchers at Varian invented the ion pump in order to improve the life and performance of its own high-frequency microwave tubes used in radar technology. The ion pump was able to achieve an ultra-clean vacuum environment.

In **1954**, the single-cell ionic pump was developed by A.M. Gurewitsch and W.F. Westendorf.

In **1955**, R. Herb invented the orbiton pump with electron-impact Ti sublimation.

In **1957**, researchers at Varian invented the Nobel Vaclon pump, the first electronic device to operate without fluids or moving parts and be resistant to power failures. The all-electronic pump made surface science possible for the first time.

In **1958**, Pfeiffer Hockvakuumtechnik GmbH invented the turbomolecular pump, improving on the performance of diffusion pumps and Gaede's molecular pump. Also in this year, Varian introduced the modern Vacsorb cryosorption pump.

In **1961**, C. H. Kruger and A. H. Shapiro developed the statistical theory of turbo-molecular pumping that is still the basis of much research today.

In **1969**, K.H. Mirgel developed the vertical unidirectional turbomolecular pump.

In **1971**, Osaka Vacuum manufactured the first domestic turbomolecular pump for small-scale applications.

In **1972**, Varian's Vacuum Division introduced the contra-flow concept, allowing higher test port pressures by using a simplified vacuum system design.

In **1974**, the first oil-free piston vacuum pump was developed by John L. Farrant.

In **1980**, Osaka Vacuum Ltd. developed the compound molecular pump.

In **1982**, VACUUBRAND introduced the first chemistry-design pump with a full fluoropolymer flow-path. This pump's design allowed it to overcome the performance challenges of fluoropolymer flow under pressure.

In **1984**, the Drystar dry (oil-free) vacuum pump was patented by Edwards High Vacuum Limited. The dry claw pump became essential to the semiconductor market.

In **1987**, VACUUBRAND introduced the first microprocessor vacuum pump controller able to detect vapor pressures and adapt vacuum levels to changing solvent conditions.

In **1994**, VACUUBRAND introduced the first local-area vacuum network, subsequently named VACUU-LAN®, with integrated check valves and chemistry-resistant components. This network allowed up to eight different lab vacuum applications to be simultaneously operated by one pump. This approach became the norm in lab vacuum supply across Europe.

In **1996**, VACUUBRAND introduced the PC 2001, the first frequency-controlled diaphragm vacuum pump. This pump allowed vapor pressures to be electronically detected and adapted in response to changing solvent conditions without programming. It was also able to operate hysteresis-free.

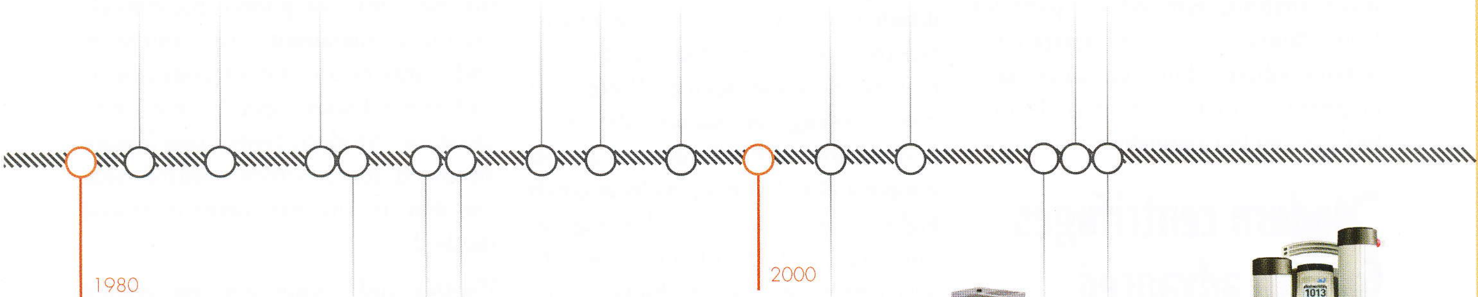
In **2002**, VACUUBRAND introduced the MD1 VARIO-SP pump, the first fully integrated 24 VDC variable-speed diaphragm pump, offering new options for instrumentation designers.

Also in **2002**, Pfeiffer Vacuum brought a magnetically-coupled line of rotary vane pumps to the market.

In **2004**, VACUUBRAND introduced its "XP-series" of compact rotary vane pumps. These pumps had one-third of the environmental impact of traditional belt drive pumps without sacrificing vacuum and pumping speed.

In **2008**, Pfeiffer Vacuum launched the HiPace™, capable of operating at rates of 1,000 to 2,000 liters/second.

In **2009**, VACUUBRAND introduced the VSP 3000, the first chemistry- and shock-resistant Pirani vacuum sensor. This pump allowed robust monitoring of rotary vacuum applications, with vacuum pressures down to 10-3 mbar.



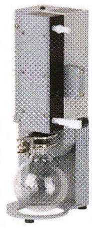
In **1988**, VACUUBRAND introduced the first lab vacuum pumps with integrated solvent vapor recovery. These pumps allowed users to capture and recycle waste vapors rather than exhaust them into the atmosphere.

In **1990**, VACUUBRAND introduced the first dual-application chemistry vacuum pump, capable of electronically controlling one application while providing filtration vacuum to a second port.

In **1991**, VACUUBRAND introduced the Chemistry-HYBRID pump that integrated both a rotary vane pump and diaphragm pump on a single shaft and motor. As solvent vapors from the pump oil were continuously distilled in this hybrid pump, oil changes were reduced by 90 percent compared with single rotary vane pumps.

In **1998**, Varian developed TriScroll® Dry Pump, the only two-stage vacuum pump on the market at the time. This pump employed a unique, patented TriScroll pumping capability.

In **2000**, Pfeiffer Vacuum launched the vacuum DigiLine™— the first full line of digital vacuum gauges.



In **2007**, VACUUBRAND introduced the Peltronic® condenser, the first electronically cooled condenser that allowed vacuum pump waste vapor recovery without an external coolant for the first time.

In **2009**, KNF Lab launched the wireless SC920 series vacuum pump system, featuring fast and precise processing, quiet operation and easy regulation of all vacuums. The wireless remote control allowed users to locate the processing equipment away from the pump to save lab space, avoid needless opening of the fume hood and remove tangled cables.

THE FUTURE FOR LABORATORY VACUUM PUMPS

Innovation in vacuum technology is currently being driven by the many diverse manufacturing and research processes that rely on vacuum systems, particularly the manufacture of semiconductors. With increasing demand for reliable and efficient vacuum techniques, the rate of innovation looks likely to increase in the immediate future.

Experts predict that vacuum pumps of the future will offer greater reliability and be able to operate for longer periods of time before maintenance is required. Laboratory pumps are also expected to be smaller, more efficient, and generate less heat, noise and vibration. It is likely that they will also better resist corrosion and be easier to clean and repair.

Technological developments are likely to include higher shaft speeds and innovation in pumping mechanisms for improved performance. Vacuum pumps are also expected to incorporate novel materials and improved design to further improve performance and reduce operating costs.