APPLICATION REPORT

OIL-FREE VACUUM SYSTEMS FOR USE ON GLOVEBOXES

Variable speed chemistry-diaphragm pumps

vacuubrand

Technology for Vacuum Systems

OIL-FREE VACUUM SYSTEMS FOR USE ON GLOVEBOXES

VARIABLE SPEED CHEMISTRY-DIAPHRAGM PUMPS

For gloveboxes, an oil-sealed rotary vane pump is typically used to remove the air from the main and transfer chambers. Rotary vane pumps are usually chosen because of the lower investment costs compared to other vacuum technologies. Unfortunately, the continuous operation of the rotary vane pump often leads to very high energy, maintenance and repair costs.

In many cases, however, the vacuum produced by a four-stage chemistry-diaphragm pump is sufficient for operation with gloveboxes. As illustrated by this case at F. Hoffmann-La Roche AG, using variable-speed chemistry-design pumping units, the premium paid for such a vacuum system is offset in a relatively short time by the significantly lower operating costs.

Daniel Guthauser has been the technical manager of the metal catalysis laboratory at F. Hoffmann-La Roche AG in Basel, Switzerland since 2004. He is responsible for the proper functioning of all technical systems so that the chemists and laboratory technicians can carry out their experiments effectively. Pressure autoclaves of various sizes must be regularly maintained and adapted for process research and development. Glovebox vacuum supply was his problem child for many years, and he was looking for a suitable solution.

Mr. Guthauser, what background do you bring to your duties in the metal catalysis lab?

Before I started my apprenticeship as a chemist (today, as a chemical and pharmaceutical technologist), I had already completed an apprenticeship as a car mechanic. That's how I learned brazing and welding, among other things. My technical expertise in this metal catalysis laboratory is influenced by my expertise in chemistry as well as my technical and electronics education.

We understand that there is a glovebox in your laboratory. For what is this used?

Primarily for the storage of oxygen-sensitive metal catalysts. Occasionally, small syntheses of less than 1 g are carried out in the glovebox. Since some oxygen can always get into the chamber, both through the lock operation and also by the diffusion through the gloves, we maintain 2 to 5 mbar pressure, with argon as inert gas. The oxygen concentration in the chamber is less than 2 ppm. This value is continuously monitored.

Daniel Guthauser is technical manager for the metal catalysis laboratory of F. Hoffmann-La Roche AG in Basel.

Are solvents also used?

We use various solvents, such as ethanol, methanol, toluene, triethylamine or methylene chloride. Therefore, the argon blanket is constantly recycled to a copper catalyst and filtered with molecular sieve. The copper catalyst serves to neutralize the oxygen, while the molecular sieve collects the solvent vapors.

What is the function of the vacuum pump in the operation of the glovebox?

The pump is needed for three different processes. First, for pressure stabilization in the glove box. Working with the gloves always creates a certain overpressure. To correct this, a valve opens to the pump, which lowers the excessively high pressure. Second, to keep the locks in an inert condition. Here, several cycles are run in which the vacuum pump first evacuates the lock before the argon is introduced. Third, the vacuum pump is used in the regeneration of the various filters.

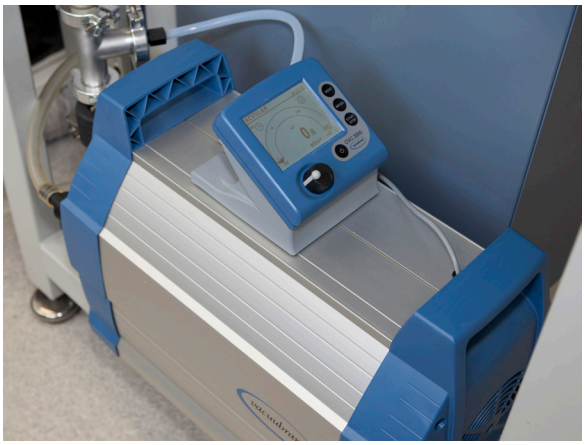
What vacuum system was used initially? How did this work out?

A rotary vane pump was originally supplied by the manufacturer of the glove box. This pump ran continuously for 24 hours, even though it was not needed continuously. Since the glove box with the pump is in the lab, the noise of the pump was a constant burden for the employees. To counteract this noise, the pump was placed in a sound-proof enclosure. This in turn caused a high heat development in the enclosure, which generally led to problems – especially in midsummer – even to the extent of totally damaging the rotary vane pump. In the beginning, when the solvent load was greater, the filter of the molecular sieve was saturated quickly. As a result, more vapors got into the oil of the rotary vane pump, which resulted in a twice-yearly maintenance. Even when solvent loads later dropped and service intervals could be extended for up to one year, the required maintenance and repair work resulted in correspondingly high costs. For these reasons, there was a desire to find a quieter pump solution that only runs when needed and incurs less maintenance and upkeep costs.

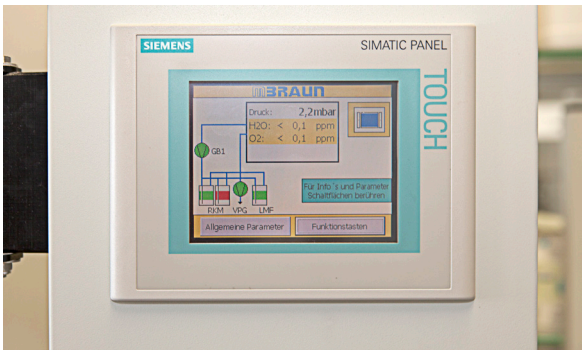
How did you go about finding such a pump?

For me, VACUUBRAND's Roland Leu has been the first point of contact for years when it comes to questions related to vacuum for laboratory applications. At exhibitions and during his visits here at Roche, the topic is often discussed. Some time ago he brought me a chemical-resistant diaphragm pump for testing. At the beginning we were surprised by the significantly higher purchase price compared to the rotary vane pump we had been using. That delayed the procurement process. After the problems with the rotary vane pump persisted, and relying on the confidence we had in the advice of Roland Leu, we bought a four-stage MV 10C NT VARIO® variable-speed chemistry diaphragm pump for our glovebox.

Glovebox in combination with a variable speed VARIO® diaphragm pump



Four-stage VACUUBRAND VARIO® diaphragm pump – the MV 10C NT VARIO – operating at 0.6 mbar.



Siemens Control Panel for configuring the Glovebox

How has the variable-speed chemistry-diaphragm pump worked for you so far?

Since the ultimate vacuum of the chemical diaphragm pump is not quite as deep as that of the rotary vane pump, two additional pump-down cycles are required for lock operation. This change can easily be programmed into the control of the glovebox, since we mostly use the small lock. As we use the big lock on the glovebox only very little and we only gas to 400 mbar per cycle, the additional consumption of argon is negligible. The speed-controlled MV 10C NT VARIO chemistry diaphragm pump adapts its motor speed to the process. If you are not working with the glovebox, the pump regulates the speed back to a standstill. When working in the box, the lock operation and the regeneration operation, the pump speed regulates up according to demand. The speed-controlled chemistry diaphragm pump is therefore significantly quieter and the power consumption and the heat generation are significantly lower. Due to the speed control, the service life of the diaphragms and valves is significantly extended. Thanks to its high chemical resistance, solvent vapors do not affect the diaphragm pump.

The pump has been in continuous use for nearly four years now and no maintenance or repair has been necessary to date. In this way, the higher purchase price of the chemistry diaphragm pump pays off over time. According to VACUUBRAND, maintenance (change of diaphragms and valves) is expected to be due after 10 years. This service can be carried out at Roche, as our mechanics have been trained in this work in the factory at VACUUBRAND.

And so what is your conclusion?

The expectations were met and my initial skepticism eliminated. The replacement of the vacuum pump has resulted in a significant improvement: significantly less noise, a clean, oil-free vacuum, no oil leaks or oil vapor and so far no maintenance and upkeep costs. With the speed-controlled chemical diaphragm pump
MV 10C NT VARIO we have found the optimal vacuum system for our glovebox. The change is clearly a win for us.

CONTACT

VACUUBRAND GMBH + CO KG
Alfred-Zippe-Straße 4
97877 Wertheim, Germany

T +49 9342 808-5550
F +49 9342 808-5555
info@vacuubrand.com
www.vacuubrand.com