Tip of the Month No. 11

Leak detection using auxiliary pumps

Question:
In your last tip of the month, you described accelerating the detection of a helium leak through the use of a turbopump. I tried that. But it took me more time just to get the turbopump going than it did for the remaining measurement. What could be the reason for that?

Answer:
You describe how you had to wait a long time before you could even switch on the turbopump. So you are losing a lot of time in the pressure range above 0.1 hPa. Extended pump downtimes in this pressure range are often a consequence of residual moisture or massive gas emissions from the parts to be tested. As long as there is residual moisture, for example from an upstream washing process or from solvent residues, the liquid and its vapor pressure determine the time requirement for the pumping-out phase. Only once the liquid has been removed, can the pump down time be influenced by the use of built-in vacuum pumps in the leak detector or external vacuum pumps.

Background:
Cleaning and drying the parts as well as possible is an absolute prerequisite for a leakage test with long-term stability and short test times. If the test object emits particles, then they are transported with the gas flow during pump down and land in the valve block, the pumps and the spectrometer cell of the leak detector. Humidity can condense in the operating fluid of the backing pump and emulsions can form with the pump oil. The consequence of condensate and/or particles in the leak detector is a high operating pressure, a high increase in the leakage rate background signals, reduced long-term stability and shorter maintenance intervals of the leak detector.

The effects of humidity on a test object have already been described in our Tip No. 2. To study this in greater depth, we would recommend Part 2 of our new catalogue “Vacuum Technology Book, Volume II”.

But what can the user do if it is not possible to carry out cleaning? For example, if a leakage test must be conducted on parts which have already been used with an operating medium or have been contaminated by process-related wear?

Energy is required to transport particles. An air flow stream only has sufficient energy at high gas tightness levels to move particles. This is the case when there is comparatively high pressure at the start of the pump down phase or during fast venting procedures. When using an external pump for the pump down phase, it becomes contaminated with particles. If the leak detector is initially switched on at low pressures, the risk of particles contaminating the measurement instrument is significantly reduced. Pumps and leak detectors can also be protected from the intrusion of particles through up-stream dust filters. For external pumps, filters from the series SAS and DFT can be used, which have filter elements with an effective mesh size of 5 to 6 µm (figure 1). These synthetic filter elements prevent swelling as would be expected with paper filter elements and thus make the elements insensitive to the simultaneous occurrence of particles and moisture.

Figure 1: Particle filters in the SAS

The aforementioned filters are only of limited suitability for leak detectors. The reason for this is the very small mesh size, which has a substantial flow resistance at the low operating pressure of the leak detector and extends the response time during the test phase. Here filters are used with a design that optimizes flow performance (figure 2). When selecting the filter element, the selection of the mesh size must compromise between protecting the leak detector and the response time during the test phase. For this reason, the filter elements for the particle filters shown below are available in standard mesh sizes of 5 and 20 µm. Additional mesh sizes are available upon request.

Figure 2: Particle filter for leak detection that optimizes flow performance

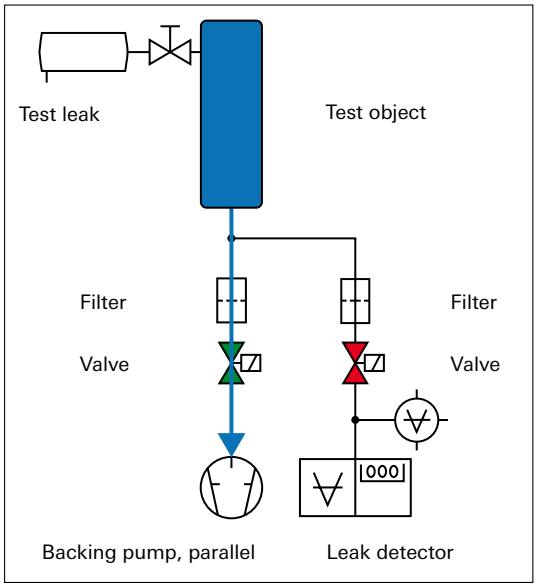

Figure 3: Evacuation of the test object with external backing pump

If a mechanical backing pump is operated as a “dirt eater” in parallel to the leak detector, then valve switching is necessary during the course of the leak detection process (figure 3). The external backing pump should take over the pumping down of the test apparatus without the leak detector. In this phase, the leak detector is isolated with a valve.

If a sufficiently lower test pressure is achieved, the valve is opened and the gas flow from the test object can be used by the leak detector to provide proof of a leak.

However, the gas flow does not only consist of the test gas alone, but rather is still mainly composed of gas emissions from the surfaces of the test object. If these gas emissions are so high that the built-in backing pump in the leak detector cannot handle the flow and maintain the pressure in the operational range of the leak detector, then the external backing pump must continue to be operated in parallel (figure 4).

The consequence is a loss in intensity in the leakage test, since the test gas stream partially flows to the external backing pump and only partially to the leak detector. Quantification can only be achieved here through measuring with a test leak in the test object.

The external backing pump can only be shut off if the gas flow is low enough that it can be pumped down by the built-in backing pump of the leak detector (figure 5).

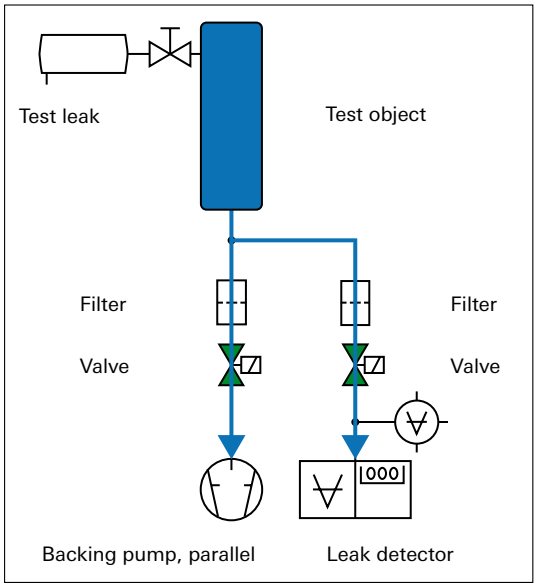

Figure 4: Leakage test of the test object with parallel operation of leak detector and external backing pump

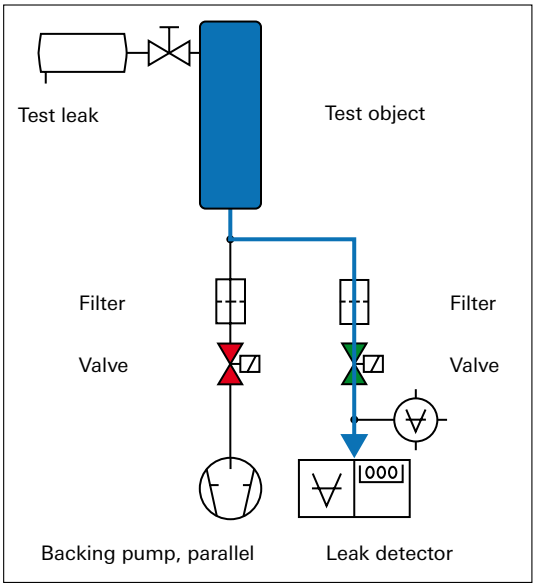

Figure 5: Leakage test of the test object using only the leak detector

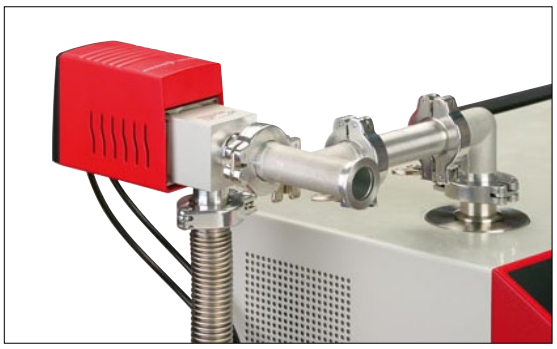

Figure 6: Bypass option

In this case, all gas emissions flow from the test object to the leak detector. An external test leak is thereby only necessary for measuring the response time but not for quantification of the leakage rate. Thus the leakage rate displayed on the leak detector corresponds to the leakage rate of the test object.

This test method is most conveniently realized with the parallel use of a mechanical backing pump with a bypass option (figure 6). The bypass option replaces both valves mentioned in figure 3, 4 and 5 and is directly controlled by the leak detector without an additional control system.

As a result, we recommend an ASM 340 leak detector with equipment for partial flow measurement for the previously mentioned test procedure, consisting of the bypass option and external fore-vacuum pump. The equipment for partial flow measurement alternatively enables the parallel operation or isolating of the external backing pump during the test. The leak detector also has a setting for the fine adjustment of the maximum test pressure which makes precise control of the process possible.

Our Tip:
A manual test station or a leak detection system only achieve their full potential when testing dry and clean components. If corresponding preparation of the part is not possible, filters and mechanical vacuum pumps operating in parallel to the leak detector can be used in order to remove gas emissions, vapors and particles from the vacuum system as far as possible prior to the actual test. This is most conveniently achieved using a leak detector with equipment for partial flow measurement and adjustable testing thresholds.

The results of these measures are
- high long-term stability of the leak detector
- long maintenance intervals
- low maintenance costs

You are welcome to conduct your own experiments on using auxiliary pumps in leak detection in the practical portion of our leak detection seminar. This applies for both the use of backing pumps in parallel to the leak detector as well as the use of turbopumps in series to the leak detector as described in our last Tip.

The next seminar in English takes place on June 26/27, 2013 in Asslar. It would be a pleasure to welcome you to our headquarters. Of course you may also book your attendance at the theoretical part of the seminar on June 26th independently of the practical portion on the following day and vice-versa. And if your problem is too specialized for our basic seminar, we would be pleased to provide you with a quote for a seminar tailored to your requirements in your native language, either at our company or at yours.

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