Tip of the Month/No. 12

Cleaning vacuum measuring equipment (Part 1)

Question:
What is the best way to clean vacuum gauges? Which equipment and tools are needed?

Answer:
Cleaning vacuum measurement equipment, or, to be more precise, vacuum gauges, must be done very carefully and take into account the type of measurement system concerned. Success is often not predictable, and, with some types, it is usually more economical to replace the sensor than to attempt to clean it.

Background:
A vacuum measurement instrument is a vacuum gauge, which measures the total pressure.

Pressure is defined as the force exerted by the gas per unit area (for example, in the unit Newton per square centimeter). It is caused by the collisions of the gas molecules with the vessel wall. At atmospheric pressure, the highest pressure in vacuum technology, the force is 1 kp/cm^2 = 9.81 N/cm^2.

Note: Place a 1,000 g hammer carefully on the tip of your little finger to get a feel for this pressure.

When evacuating a vacuum vessel, the pressure rapidly decreases by several orders of magnitude and, at the same time, the force per unit area decreases to the same extent.

Note: Replace the hammer by a standard size business card to get a feel for the force per cm^2 at about 1 hPa.

If the pressure continues to drop, it requires delicate mechanics, and possibly electrical amplification, to measure the minute forces.

Note: To feel these minute forces, nature has equipped our skin with tiny hairs.

Direct measurement of pressure through determining the force acting on a known area is no longer viable once you get to high vacuum. The reason for this is that the minute forces are no longer detectable. Pressure-dependent gas properties are used as an alternative, to indirectly deduce the pressure in the vacuum system:

- Heat conduction in thermal vacuum gauges, e.g. Pirani vacuum gauge
- Gas friction, e.g. spinning rotor gauge
- Ionization, e.g. cold and hot cathode vacuum gauge.

These indirect measurement methods require very delicate measurement systems to capture the small effects as signals and, with electrical amplification, to make them show up on a display. So before you start cleaning, let the conclusion from the preceding overview sink in:

Vacuum gauges are sensitive instruments; their task is naturally incompatible with rough or abrasive cleaning procedures.

Finally, we will look at the real problem, which is the dirt that must be removed.

Vacuum gauges are usually in operation for a very long time before the operator has the urge to clean them. These periods may be measured in weeks, but usually in months, or even years.

As the reader is probably a driver, he can certainly imagine the difference between a car wash after:
(a) a 5-km drive on a dusty dirt track and
(b) a six-week vacation of 5,000 km through Scandinavia.

You get the idea. Cleaning a vacuum gauge is almost always like case (b). This means, it is not about loose dust that you just quickly rinse off. It is more a matter of "accumulated" deposits that have built up over long periods of time and are firmly attached. To return to the car example: Imagine insects that you have collected on the front of your car during a long vacation.

The high temperatures encountered at times, and the formation of reactive particles, in some vacuum gauges, cause chemical reactions by gases and vapors on the surfaces of the sensor elements. This often causes thermally and electrically insulating layers to form, which adhere firmly and impair the function of the indirect measurement principles. Cleaning a vacuum gauge means removing these layers.

In the next edition of our "Tip of the Month", we will focus on the cleaning methods for the various types of vacuum gauge.

Do you have a question yourself which you would like us to answer on this page as a new tip of the month? If so, please let us know. (info@pfeiffer-vacuum.de)

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