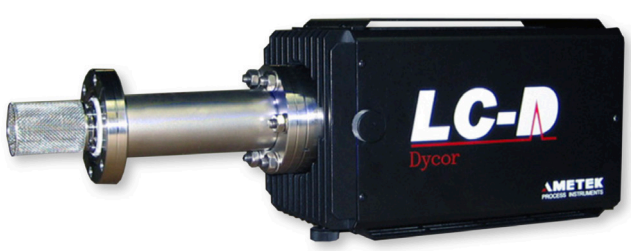
AMETEK®
PROCESS INSTRUMENTS

APPLICATION NOTE

VACUUM CHAMBER PUMP-DOWN QUALIFICATION TEST

Process Analyzer Applications

Valuable manufacturing time can be saved in determining if a process tool is ready for production by conducting a pump-down test using a residual gas analyzer (RGA). The type of analyzer used for this application can either be an open ion source sensor installed directly on the process tool (recommended), or a closed ion source sensor using the associated sampling inlet and pumping system.



LC-D RESIDUAL GAS ANALYZER

EQUIPMENT

The analyzer used for this application note was a 1-200 AMU range Dycor™ RGA with both Faraday cup and electron multiplier detector. The quadrupole sensor was mounted directly to the transfer chamber of the tool using a standard 2-3/4-inch diameter conflat flange.

TYPICAL TOOL PUMP-DOWN PROCEDURE

A pump-down script was written to monitor the residual gases of a vacuum chamber. The system was exposed to air for maintenance and then returned to normal operating conditions. The determination of when a vacuum system is ready for production use will vary from process to process. In this demonstration, the criteria are met when the major constituents of air (nitrogen (N_2), oxygen (O_2), argon (Ar), and carbon dioxide (CO_2)) have been reduced to ultra-high vacuum levels.

The script reconfigures the analyzer modes and alarms during the pump-down. The script can be started automatically at a set time, started manually with a simple keystroke, or initiated via a digital input from the vacuum system or control room.

DATA ANALYSIS

The script starts by initiating the compare function of the software. It then recalls an analog scan that was saved in an earlier test when the vacuum system was known to be in a pumped-down state, ready for process. This recalled scan is referred to as the "reference scan". In this example, the **reference scan** is named the "Gold Standard" (see Figure 1) and must match the **"current scan"** at the end of the test. The **"current scan"** (Figure 2) indicates there is an air leak. This is evident because the m/z 32 (O_2) peak is at the same level as the m/z 18 (water) peak. The easiest way to determine a leak is to compare the ratios of a few key peaks.

Compare the m/z 14/15 and the m/z 31/32 peak heights. If 14 is higher than 15 and 32 is higher than 31, there is an air leak. Another way to determine an air leak is to note the ratio of 28 to 32 (N_2 to O_2). If it is between 4/5 to 1, then it indicates air is present in the chamber.

The script then proceeds to load the trend mode with alarm limits that are set to indicate whether the pump-down is actually proceeding correctly. The trend starts at 14:33 with the gas species being at very high levels due to an air leak. The air leak is subsequently found and fixed within a couple of minutes following the start of the trend, resulting in a drop in partial pressures. At approximately 14:37, the mass 28 (N_2) limit of 1.0 x 10-7 is reached, and the bake-out of the system starts automatically.

The bake-out and pump-down of the system continues for 30 minutes. The heater is then turned off and the trended gas species start falling at a rapid rate. After an hour, all the constituents of air, mass 28 (N_2), 32 (O_2), 44 (CO_2), and 40 (Ar), are within the UHV range. Mass 18 (water) is falling as is the total pressure. This indicates the chamber is ready for use.

The script loads a different configuration file with the alarm levels set at the much lower limits of 10-7 Torr (for the high limit) and 10-12 Torr (for the lower limit). The trend continues while the gate valve is closed to the chamber pump and a rate-of-rise test is performed.

During the rate-of-rise test, all the gas species are stable and show no sign of increasing. With the limits lowered, when any of the air species to start to rise, the script has been set up to perform an analog scan and archive that scan for later analysis. But, in this case, the rate-of-rise test shows no signs of an air leak. The pump-down test is finished and the RGA is ready to perform the next task.

The inherent sensitivity and software capability of the Dycor RGA provides a cost-effective way to increase the quality and yield of the customer's process.

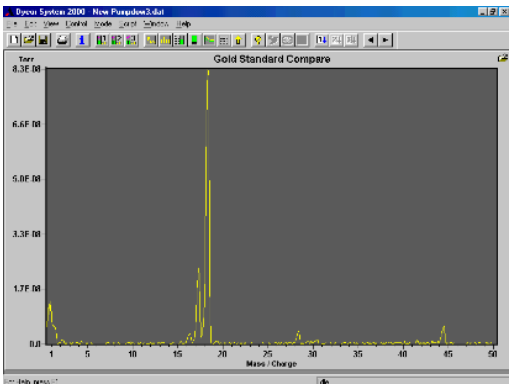


Figure 1. Reference scan (gold standard)

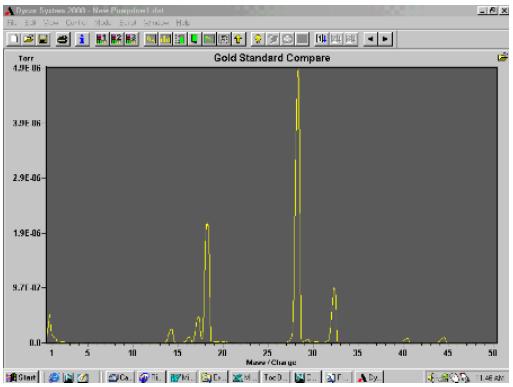


Figure 2. Current scan

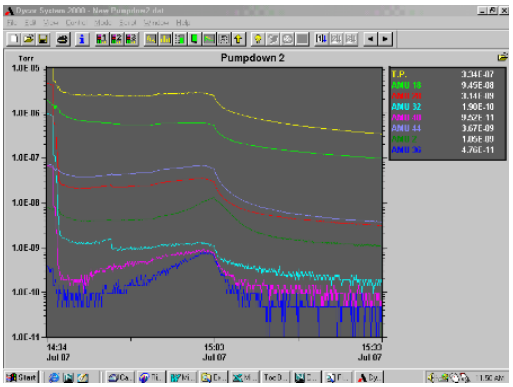


Figure 3. Bake out and pump down

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