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SENSITIVITY COMPARISON OF HELIUM LEAK DETECTOR VS MASS SPECTROMETER (RESIDUAL GAS ANALYZER)

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AGS DIVISION TECHNICAL NOTE

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At the Conversion Parameter Working Committee Meeting of Sept. 20th, some questions were raised concerning the relative sensitivity of a mass spectrometer to that of a commercial helium leak detector, the thought being that perhaps either instrument could be used on the converted AGS vacuum system.

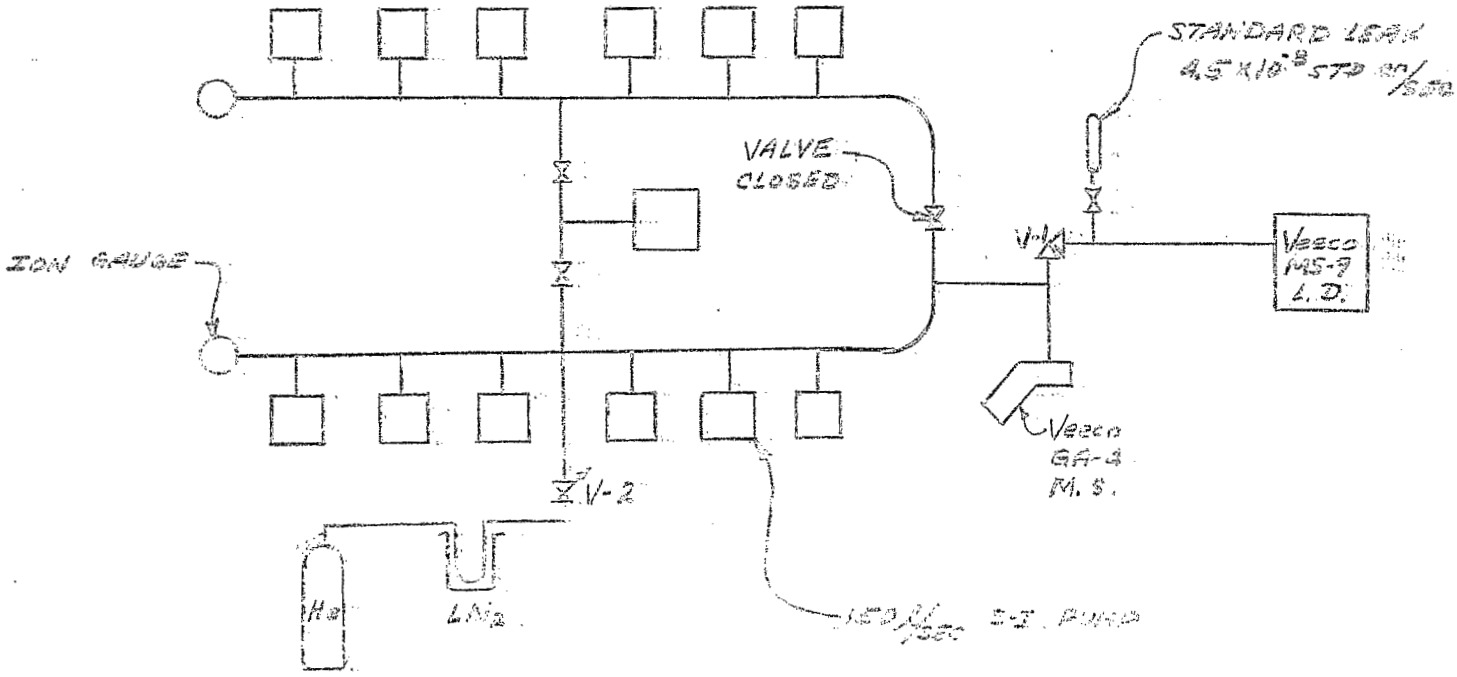
Tests were conducted comparing a commercially available 60^{o} magnetic sector mass spectrometer (Veeco GA-4) to a helium leak detector of comparable design (Veeco MS-9).

The results show the leak detector to be 3 to 5 times more sensitive to helium than the mass spectrometer. The reason for this difference, even though both instruments are of similar design, is that the mass spectrometer baffles more of the ion current thereby reducing the sensitivity, but increasing the resolving power of the instrument. The leak detector uses less baffling and achieves higher sensitivity with reduced resolution.

Note: The GA-4 mass spectrometer can also make use of an electron multiplier for increased sensitivity. However, it is not as versatile when used this way and, therefore, was not considered in this test.

The response time of the leak detector for one-half superperiod (length of mockup) was also measured. It was less than three seconds with all twelve pumps operating.

Test Apparatus: "Mock-up" Conversion System in Bldg. 197



Test Procedure:

1. Calibrate leak detector with valve V-1 closed.
2. Open valve V-1 and adjust mass spectrometer zero to that of the leak detector.
3. Bleed-in helium through valve V-2 and record output signal change of L.D. and M.S.
4. Compare sensitivity of L.D. to M.S. by using $\text{Sen} = \frac{\text{change signal}}{\text{Change He partial press}}$ assume the change in He partial press is the same in both instruments compare the ratio:

$$\frac{\text{sensitivity L.D.}}{\text{sensitivity M.S.}}$$

Test Results

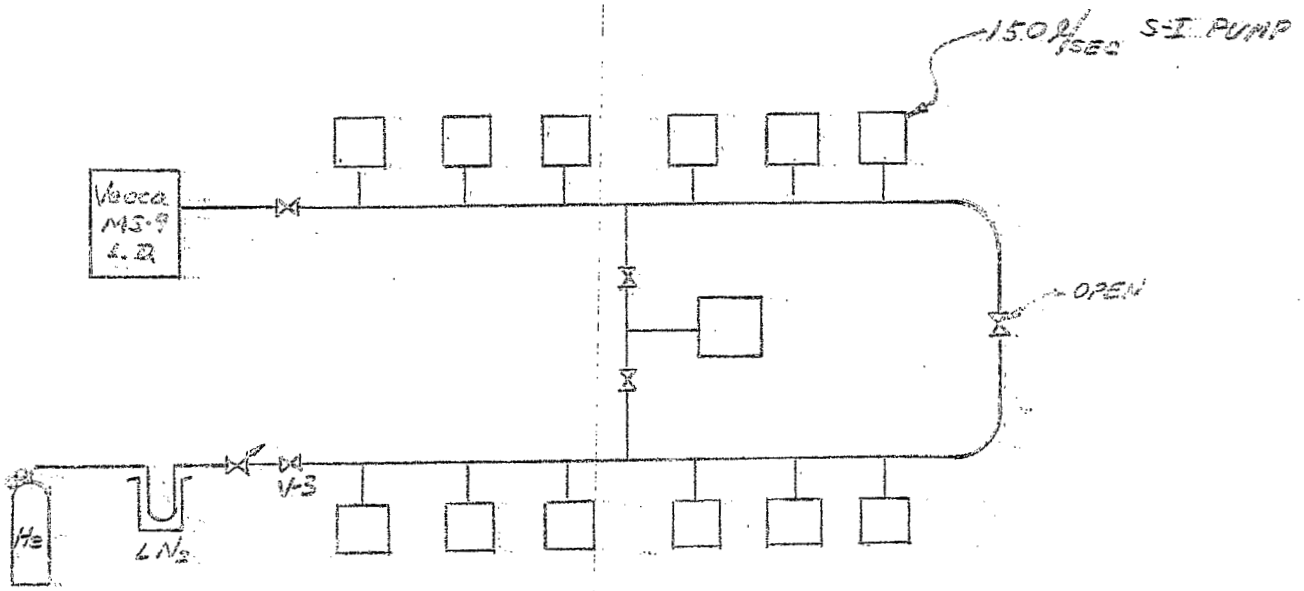
1. Leak dectector sensitivity (minimum detectable leak)=6.4×10^{-10} std. cc/sec.
2. It was not possible to maintain a steady pressure with the leak either opened or closed therefore points on either side of opening or closing the leak were used.

	(Δ signal)L.D. Scale divisions	(Δsignal) M.S. Scale divisions	Sensitivity Ratio $\frac{L.D.}{M.S.}$
Close valve	300-80 = 220	98-22 = 76	2.9
Open "	840-25 = 215	180-5 = 175	4.7
Close "	890-100 = 790	190-27 = 163	4.8
Open "	300-36 = 264	70 - 8 = 62	4.3
Open "	880-200 = 680	180-49 = 131	5.2
Close "	880-160 = 720	180-41 = 139	5.2

Note: All sputter-ion pumps remained operating during this test.

Response Time Measurement

The response time of the leak detector to a helium leak was also measured. Again the "mock-up" system was used, however, this time the entire system was used (1/2 superperiod). The leak detector was connected to one end of the system and a helium leak to the other as shown below:



The system was pumped to a base pressure, valve V-3 was opened and the time recorded until a signal response was noted on the leak detector.

Test Results

Run #1 - Starting with a 50 scale division background due to residual helium in the system the response time was 2.9 sec. All twelve pumps were operating during this test. The helium leak size may be approximated by calculating the pumping speed at the leak due to the sputter-ion pump (using 150 ℓ/sec for its speed) and measuring the change in pressure before and after opening the leak.

$$Q = s\,\Delta P = (61)\,(2.8 \times 10^{-5})\ T\ell/\text{sec}$$

$$Q = 1.71 \times 10^{-3}\ \frac{T\ell}{\text{sec}} = 2.3 \times 10^{-3}\ \text{std cc/sec}$$

Run #2 Starting with a background of 70 scales the response time was 2.3 sec.

Run #3 Starting with a background of 62 scales the response time was 1.2 sec (larger leak used).

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