MICROMETER
MODELS: V-1 RM AND V-2RM

The 3-D Micrometer combines the Variable Volume Pressure Controller with a mechanical readout. It is designed to determine and establish exact volumetric changes in pneumatic systems required in pressure/volume and leak rate measurements.

SPECIFICATIONS MODEL: V-1RM

PRESSURE RANGE:	0 - 1,000 psi
ADJUSTMENT SENSITIVITY:	0.0005 psi
LEAK RATE:	Less than 1×10^{-5} atm cc/sec
TOTAL MECHANICAL ROTATION:	33 1/2 turns. (nom.)
TEMPERATURE RANGE:	32°F – 120°F
PNEUMATIC PRESSURE GENERATION:	35 psia
PROOF PRESSURE:	2,000 psi
CONSTRUCTION:	Aluminum body. Stainless steel screw and valve stem. (All stainless steel construction available for use with corrosive gases.)
LIFE:	250,000 cycles
WEIGHT:	4.8 lbs.

SPECIFICATION MODEL: V-2RM

PRESSURE RANGE:	0 - 6,000 psi
ADJUSTMENT SENSITIVITY:	.005 psi
LEAK RATE:	1×10^{-3} atm cc/sec
TOTAL MECHANICAL ROTATION:	78 turns
TEMPERATURE RANGE:	32°F – 120°F
PROOFPRESSURE:	12,000 psi
CONSTRUCTION:	Aluminum body; stain less steel lead screw and valve, bronze nut, Viton and Teflon seals
LIFE:	250,000 cycles
WEIGHT:	6.5 lbs.
TOTAL VOLUME:	1.53524 cubic inches

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LEAK RATE MEASUREMENTS WITH 3D INSTRUMENTS MICROMETERS BY MEDIA LEAKAGE COLLECTION

1. The 3D Instruments Micrometer, as shown in Figure 1, consists of a cylinder (1) and piston (2) whose critical dimensions are held to very close tolerance. A by-pass Valve (3) to interconnect the cylinder volumes on either side of the piston is incorporated in the micrometer. Axial position of the piston is controlled through a precision lead screw (4) so that each revolution of the control shaft (7) produces a precise volumetric change. An anti-rotation mechanism (8) is incorporated to prevent the piston from rotating on its axis. A digital counter (6) is geared (5) to the control shaft to record and display the change in piston position which may easily be converted into engineering units of volume.

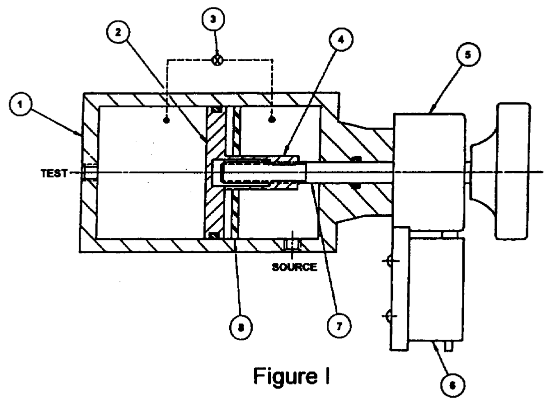


Figure I

2. The simplest method of determining leak rates is to place the test article in a chamber as shown in Figure II. Leakage gas is collected in the 3D Instruments Micrometer while maintaining a constant differential pressure across the test article.

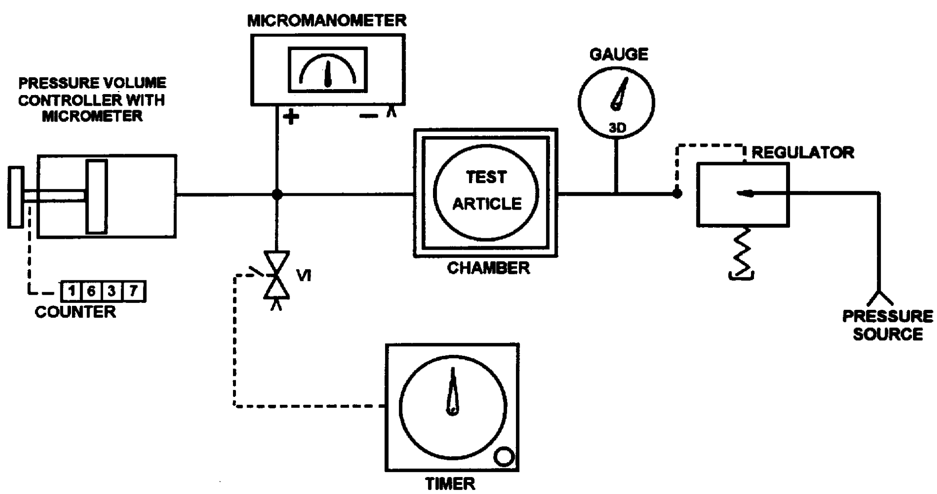


Figure II

3. Procedures for leak rate measurement are as follows:

   a. Open Valve V-1 and reset timer to zero.
   b. Pressurize the test article to the desired level by adjusting the Regulator until the Gauge displays the required pressure level.
   c. Allow a few minutes for the system pressure and temperature to stabilize.
   d. Close Valve V-1 which also starts the timer.
   e. Observe Micromanometer. Any gas leaking through the test article will cause the Micromanometer to deflect.
   f. The Micromanometer is maintained at null by rotating the control shaft of the 3D Instruments Micrometer counterclockwise.
   9. At the conclusion of the test period, open Valve V-1 which also stops the timer.
   h. Dividing the leakage volume displayed on the 3D Instruments Micrometer by the time of the test period yields the precise leakage volume per unit time.

4. Several points should be kept in mind during operation of the system.

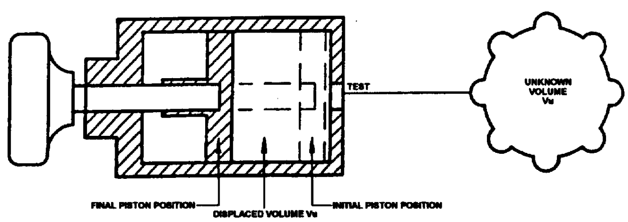
   a. All mechanical devices have some backlash. Control shaft backlash can be eliminated by rotating the control shaft clockwise to the stop, then counterclockwise at least two full turns prior to each test.

   b. For maximum repeatability, tests should always be started with the same digital count on the 3D Instruments Micrometer.

   c. Local heat and cooling sources should, to the maximum extent practical, be isolated from all elements of the test systems prior to start of test. One of the easily overlooked sources of temperature change results from pressurization of the test article. Gas expansion and compression result in adiabatic heat transfer during pressurization. Therefore, the gas in the test article should be allowed to return to ambient temperature prior to test initiation.

5. If it is possible to maintain the entire test volume at constant temperature throughout the test period, accuracy of one part in one thousand of indication can be expected at reasonable volume change levels. Inasmuch as the temperature cannot be maintained perfectly constant, it would be desirable if we could predict the loss in accuracy per degree temperature change. However, the temperature of interest is the gas temperature rather than ambient. The gas temperature will affect the total gas pressure as a direct function of total thermal input. Since the test volume is distributed, some thermal gradients will exist. These thermal gradients may be ignored since repetitive testing will produce the same gradients from test to test if the test conditions and procedures are identical for each test. Over a reasonable period of perhaps fifteen minutes, and particularly if care is exercised to avoid upsetting system thermal stability, exceptional repeatability is capable of being realized since the test method starts at zero pressure and is maintained at that level throughout the test period. Thus, the test method does not, in itself, introduce thermal change or instabilities.

DETERMINATION OF LEAKAGE RATES USING THE MICROMETER, MODEL: V-1RM



ASSUME CLOSED ISOTHERMAL SYSTEM

LET P_1 = INITIAL ABSOLUTE PRESSURE
P_2 = FINAL ABSOLUTE PRESSURE

IF INITIAL VOLUME IN PV CONTROL IS ZERO, THEN:

$$P_1 V_u = P_2 (V_u + V_D)$$
$$\therefore V_u = P_2 V_D / (P_1 - P_2)$$

FOR A STANDARD VM:

THREAD PITCH = 13/INCH
BORE DIAMETER - 2.5 INCHES

$\therefore$ IF N = NUMBER OF TURNS, THEN

$$V_D = \frac{\pi d^2}{4} \cdot \frac{N}{13} = (0.337760)\ in^3$$

SO, FOR VOLUME Vu IN CUBIC INCHES:

$$V_u = \frac{(0.3776) P_2 N}{P_1 - P_2}$$