

Why Pressure Scales Cause So Much Confusion

Anthony D. Buonaquisti
University of South Florida

Pressure scales can be extremely confusing to new operators. This is not surprising. To my mind, there are three primary areas of confusion.

Firstly, the pressure of gas inside an instrument changes over many orders of magnitude during pump-down. The change is about 9 orders of magnitude for a traditional Scanning Electron Microscope and about 13 orders of magnitude for an ultra-high vacuum instrument such as a Scanning Auger Microprobe.

To give an idea about the scale of change involved in vacuum, consider that the change in going from ambient pressure to that inside a typical ultra high vacuum system is like comparing one meter with the mean radius of the planet Pluto's orbit. The fact is that we don't often get to play with things on that scale. As a consequence, many of us have to keep reminding ourselves that 1×10^{-3} is one thousand times the value of 1×10^{-6} - not twice the value.

The second source of confusion has to be the design of pressure gauge displays. Although modern gauges are digital and consequently trivial to read, most instruments have older, moving coil gauges in which a needle indicates the value of pressure. The visual layout of these gauge displays can be extremely confusing. Many instruments use a single gauge display, which not only indicates different pressure ranges, but also has the scales so arranged that, on one scale, the needle sweeps right for falling pressure, but on another scale, the needle sweeps left.

A third source of confusion has to do with the units we use

to characterize pressure. There are an incredible variety of pressure scales. Although most of us will not encounter all of these scales except in textbooks, all of us will encounter enough of them to marvel at technologies' ability to make life "interesting".

The fact is that 1 Torr of gas pressure equals:

1333 dyne per square centimeter
1333 microbar
1333 Bayre
1000 microns of mercury
133.3 Newton per square meter
1333333 Geede
13.59 millimeters of water
13.59 kilograms per square meter
1.33 millibar
1.35 centimeters of water
1.35 Guericke
0.0393 inches of mercury
0.0193 pounds per square inch
0.1333 Pieze
0.00135 technical atmosphere
0.00135 Barr
0.00131 physical atmosphere
133.3 Pascal

One might ask why there is such a variety of scales?

Well, pressure is force per unit area so we can pick out the units that are consistent with this (for example, dyne per square centimeter and the Newton per square meter).

In addition, we used to describe a force as a mass unit acted on by gravity, so we can pick out those units that describe pressure as a mass per unit area (for example, kilograms per square meter, pounds per square inch, and kilograms per square centimeter).

Now, we can also characterize pressure by the height of a

Crystal Clear.

The Meiji EM Series of Modular Stereo Microscopes.

If you are looking for precision, durability, quality and value in a stereo microscope, we invite you to take a closer look at Meiji's EM Series of Stereo Microscopes.

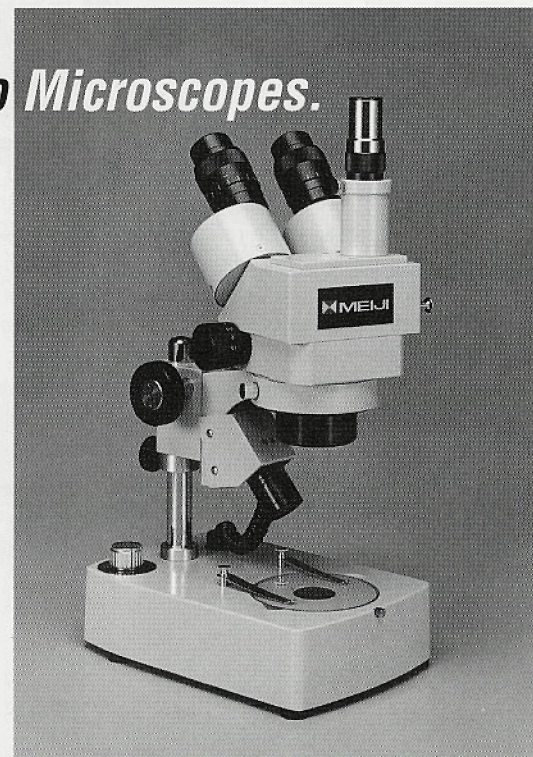
The modular design (A wide variety of bodies, single magnification or zoom— rotatable 360°, auxiliary lenses, eyepieces, stands, holders, etc.) gives you the freedom to create the ideal instrument for your specific needs or application, and Meiji stands behind every instrument with its limited **Lifetime Warranty**.

For more information on these economically priced stereo microscopes, please call, FAX or write us today.



MEIJI TECHNO AMERICA

2186 Bering Drive, San Jose, CA 95131, Toll Free Telephone: 800.832.0060
FAX: 408.428.0472, Tel: 408.428.9654



column of liquid that it can support (for example, microns of mercury, millimeters of water, centimeters of water and inches of mercury).

Some are "honorary" scales where a scale is renamed in honor of a significant vacuum scientist (Pascal, for Blaise Pascal, which is the same as the Newton per square meter scale; Torr, for Evangelista Torricelli, which is the same as the millimeters of mercury scale; Gaede, for Wolfgang Gaede, which is the same as the Newton per square meter scale, and Guericke, for Otto von Guericke, which is the same as the centimeters of water scale).

Mix in the fact that some countries used pounds and inches, giving pounds per square inch, while other countries used kilograms and meters giving kilograms per square meter and kilograms per square centimeter.

Finally, as all had access to mercury and water, many measured in microns of mercury, millimeters of water, centimeters of water, and inches of mercury.

Pretty soon 20 pressure scales seems like a shortlist of options.

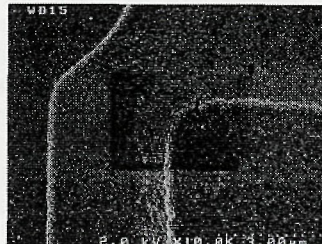
In the end, pressure units are like antiques. They give us a taste of how vacuum technology developed. Each scale has its story and was someone's contribution. We are left with the clutter or, if we prefer, the charm.

In the U.S. we traditionally use the Torr scale when characterizing gas pressure inside a vacuum system. Nevertheless, the designated Standard Industrial Unit (SI) is the Pascal scale. As above noted, 1 Torr is equal to 133.3 Pascal.

So, the next time someone brags about being in the "low negative sevens", ask them is that's in Pieze, Guericke's, Gaedes, Bayres or just plain Torr. ■

Remove the Veil from SEM Samples!

EVACTRON™
***in-situ* Plasma Cleaning stops contamination inside your SEM!**



Unwanted Artifact
A short SEM scan started a contamination deposit.



After Evactron Cleaning
2 minutes of cleaning *in-situ* removed the deposit and prevented new artifacts.

XEI SCIENTIFIC

SEM-CLEAN™ Systems for SEMs
3124 Wessex Way, Redwood City, CA 94061
(650) 369-0133, FAX (650) 363-1659
Email: RVaneXEI@concentric.net
www.semclean.com

STOP HASSLING WITH MULTIPLE SERVICE CONTRACTS!

START by putting all of your instruments under one service contract with MAS (regardless of make or model). Our expert **EM SERVICE GROUP** has the knowledge and skills to keep your instrument working at its best.

TEM'S / SEM'S	PREP EQUIPMENT	SPECIAL SERVICES
<p>HITACHI TOPCON</p> <p>JEOL ISI</p> <p>AMRAY CAMBRIDGE</p>	<p>VACUUM COATERS</p> <p>PLASMA ASHERS</p> <p>SPUTTER COATERS</p> <p>ION MILLS</p>	<p>STAGES</p> <p>BEAM BLANKERS</p> <p>CUSTOM DEVICES</p>

NEW NEW NEW

Authorized service representatives for Gatan preparation equipment and Topcon TEM'S.

Contracts and On-Demand
Emergency Service at
Reasonable Rates from
Factory Trained Specialists.



800-421-8451

3945 Lakefield Court Suwanee, Georgia 30024 770-866-3200 FAX 770-866-3259
616 Hutton Street Suite 101 Raleigh, North Carolina 27606 919-829-7041 FAX 919-829-5518
ADVANCED ANALYTICAL PRODUCTS AND SERVICES