MIDWEST TUNGSTEN SERVICE

Tips

BASIC VACUUM THEORY

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Vacuum means “emptiness” in Latin. It is defined as a space from which all air and other gases have been removed. This is an ideal condition. The perfect vacuum does not exist so far as we know. Even in the depths of outer space there is roughly one particle (atom or molecule) per cubic centimeter of space.

Vacuum can be used in many different ways. It can be used as a force to hold things in place - suction cups. It can be used to move things, as vacuum cleaners, drinking straws, and siphons do. At one time, part of the train system of England was run using vacuum technology.

The term “vacuum” is also used to describe pressures that are subatmospheric. These subatmospheric pressures range over 19 orders of magnitude.

Vacuum Ranges

Ultra high vacuum				Very high		High		Medium				Low	
10^{-16}	10^{-14}	10^{-12}	10^{-10}	10^{-8}	10^{-6}	10^{-4}	10^{-3}	10^{-2}	10^{-1}	1	10	10^{2}	10^{3}

(pressure in torr)

There is air pressure, or atmospheric pressure, all around and within us. We use a barometer to measure this pressure. Torricelli built the first mercury barometer in 1644. He chose the pressure exerted by one millimeter of mercury at 0^{o}C in the tube of the barometer to be his unit of measure. For many years millimeters of mercury (mmHg) have been used as a standard unit of pressure. One millimeter of mercury is known as one Torr in honor of Torricelli. The international standard (SI) unit of measure is the Pascal (PA). It is one newton of force per square meter and is named after a French physicist. Other seldom used forms are the millibar and the atmosphere (ATM).

In the atmosphere, surfaces are constantly being bombarded by molecules. Some of these molecules bounce off the surfaces and others attach themselves, sometimes reacting chemically to the surface. Within a vacuum, a clean surface gets considerably less bombardment, leaving the surface clean or uncontaminated for a much longer period of time.

Removing the air from a vacuum chamber creates a space which contains few molecules. This allows a much higher evaporation rate for material with less need to elevate the temperature. This is because you have removed the pressure of the gas against the surface of the evaporant and much less energy (heat) is needed for a molecule of the evaporant to break free from the surface.

Vacuum Units Conversion Chart

EQUALS	TORR	PA	MILLIBAR	ATM
1 TORR	1	133	1.33	.00132
1 PA	.0075	1	.01	.00000987
1 MILLIBAR	.75	100	1	.000987
1 ATM	760	101,325	1,013	1

Due to the smaller numbers of molecules in a vacuum, you also reduce the conductivity, or transference, of heat. This is the effect we create within a thermos bottle. Air molecules bumping into the bottle will carry away a little heat with them as they leave. The fewer molecules, the less heat transfer. Another type of heat transfer, radiation, is uneffected by lower pressures. Radiant heat can be blocked or reflected, however. That is why the thermos bottle is shiny, to reflect radiant heat back to the contents of the bottle. This analogy might be helpful when troubleshooting burned parts in your chamber.

Terms and Definitions

Atmosphere - (ATM) 14.7 psi at sea level

Atmospheric pressure - The pressure exerted by the air above the earth's surface

Mean free path - The average distance between collisions of electrons, ions, or molecules in a gas.

Micron - 10^{-3} torr (.001 millimeters of mercury)

Newton - The SI unit of force. 1 Newton accelerates a 1 kg. mass by 1 meter/second^2

Pascal - (PA) The SI standard unit of vacuum measure. 133.32 Pascals = 1 Torr

Torr - A measure of pressures in an evacuated area. One millimeter of mercury in a glass tube.

Vacuum - 1. A space from which all air and other gases have been removed (ideal)
2. A controlled gaseous environment at a pressure less than atmospheric

Our customers are invited to call if they would like more information about vacuum.

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