White Paper

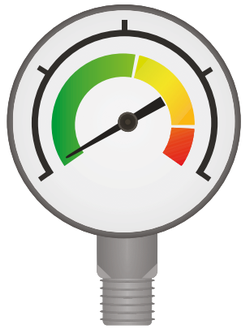
Distributed By: Camlab Ltd
Unit 24, Norman Way Industrial Estate
Over, Cambridge, CB24 5WE, United Kingdom
T: +44 (0) 1954 233 110 E: sales@camlab.co.uk

camlab

WELCH®
An Ingersoll Rand Business

Precise Vacuum Control in Lab Processes

www.welchvacuum.com



CHOOSING THE RIGHT VACUUM GAUGE FOR YOUR LABORATORY APPLICATION

Vacuum plays a major role in a large number of laboratory applications including rotary evaporation and filtration. The selection of the right vacuum depth is crucial for the success of numerous critical lab processes conducted in fields ranging from biotechnology to medicine, pharmacology, wastewater treatment and food and beverage quality control. Precise vacuum control and regulation in laboratory settings is typically ensured with the help of several popular types of vacuum meters such as the Pirani gauge and the capacitance diaphragm gauge.

MEASURING HEAT LOSS

The Pirani gauge is a thermal conductivity gauge that enables fast and accurate measuring of low pressures in vacuum systems by monitoring the transfer of heat within the vacuum environment. The working principle of the device is based on the fact that the thermal conductivity of any gas directly depends on its pressure. As gas pressure drops, the density of the gas decreases too and the smaller number of gas molecules as well as the longer distances between them mean that it takes more time for the gas to conduct heat.

The main element of the gauge, which is highly useful for measuring pressure levels of between 0.5 Torr and 10^{-4} Torr, is a metal sensor wire (a filament) that is placed in a tube. The wire is exposed to the vacuum system and connected to an electrical circuit from which pressure readings are taken. Once the wire has been heated to about 50°C, the gauge tube is opened and gas molecules enter it colliding with the hot filament and gradually cooling it, with the speed of the process depending on the system pressure level.

Due to the fact that the electrical resistance of the metal wire will change along with its temperature, any change in resistance will reflect changes in pressure. In most cases, the temperature of the heated wire is kept constant and the system pressure is indicated by the voltage required to maintain that temperature. The proper calibration of the gauge for particular processes is crucial as different gases have their own thermal conductivity and heat capacity characteristics.

An inexpensive and robust device, the Pirani gauge is appreciated for its fast and accurate response to pressure change, as well as its ability to measure a wide range of pressure levels. The fact that the readings can be taken remotely is an asset too. However, the gauge also has its disadvantages, including the frequent calibration requirement and its inability to measure very low pressure. To provide gas-type independence and increased measuring accuracy in deep vacuum systems, the Pirani gauge can be used together with the capacitance diaphragm gauge.

VACUUM-INDICATING DIAPHRAGMS

The capacitance diaphragm gauge, which can be used to measure vacuum levels of between atmospheric pressure and 10^{-5} Torr, indicates pressure by measuring the force exerted on its diaphragm by the vacuum system and converting it into an electrical signal. The main element of the gauge is an elastic ceramic or metal diaphragm that acts as an electrode and along with an additional electrode constitutes a pressure-dependent capacitator. Its mechanical deflection is a function of the applied pressure, irrespective of the type and concentration of the used gas.

As the materials that compose diaphragms are corrosion-resistant, capacitance diaphragm gauges are useful in applications where aggressive gases are used, including in the semiconductor industry. The thickness and size of the diaphragm determines how sensitive a given gauge is and which pressure ranges it can effectively measure. The limited range of a single diaphragm is the main reason why capacitance diaphragm technology is nowadays often combined with other measuring technologies such as the Pirani thermal conductivity method.

SELECTING YOUR GAUGE

Choosing between a single-sensor device and a device that utilizes two different measuring principles depends on the nature and needs of the particular vacuum process. The limitations of Pirani technology, which provides the highest measuring accuracy in the medium vacuum range, may justify the use of an additional capacitance diaphragm sensor in applications with a requirement for measuring a broader vacuum range and achieving higher sensitivity at the high and low pressure ends.

Whether you are using the Pirani measuring principle alone or in combination with the capacitance diaphragm method, some important considerations need to be taken into account when selecting the proper gauge for your laboratory application. Pirani gauges, which are arguably the most widespread type of vacuum measuring instruments in the world today, are available in many different variants with a wide range of sensor and electronics related configurations possible.

One of the most crucial choices that need to be made concerns the selection of the right sensor wire material. Several different types of filaments are commonly used depending on process parameters such as gas type, temperature and pressure level, with no single material suiting all applications as they all show different levels of resistance to corrosion and contamination. Inappropriately chosen filaments can be damaged within minutes from coming into contact with aggressive gases, whereas their contamination may result in inaccurate measurements.

Tungsten and gold-coated tungsten are the standard options for many relatively undemanding vacuum applications. However, tungsten is not resistant to a number of gases used in processes that include dry etching. It is also negatively affected by water vapor that causes corrosion and may lead to the gauge's failure. In some cases, putting a special coating on the tungsten wire may be a sufficient solution to this problem, while on other occasions utilizing a more resistant nickel or platinum wire may be necessary.

- ✔ Choose if you want a Pirani gauge with or without the capacitance diaphragm method
- ✔ Consider the right gauge for your vacuum pressure
- ✔ Review which solutions might impact the gauge

TWO IN ONE

Reliance on an experienced vacuum industry partner able to suggest the optimal gauge variant based on your unique application requirements is crucial for your peace of mind as you focus on your mission-critical laboratory vacuum processes. Welch, a brand of Ingersoll Rand, the world's leading provider of pressure and vacuum solutions for numerous industries, offers state-of-the-art multi-range vacuum gauges that combine the advantages of both the Pirani and the capacitance diaphragm measuring methods in a single design.

Welch's VMpro 1 and **VMpro 2** combination gauge models feature tungsten and nickel sensor wires for generic and more aggressive gas applications, respectively, as well as ceramic diaphragm sensors for increased resistance. These sensors are designed to measure with high accuracy rough and fine vacuum ranges between 1,125 Torr and 3.8×10^{-5} Torr. The use of capacitance diaphragm technology ensures that the gauges provide reliable gas-type independent measurements in the range between atmospheric pressure and 10 mbar.

Compared to standard single-sensor Pirani gauges, whose measurement range is from 5×10^{-4} mbar to 1,000 mbar and which offer the best accuracy (15% of reading) in the 1×10^{-3} mbar to 100 mbar range, our Pirani-capacitance diaphragm gauges have a measurement range of between 5×10^{-5} mbar and 1,500 mbar and provide the highest accuracy (of between 15% and 2.5% of reading) in the 1×10^{-3} mbar to 1,050 mbar range. The gauges, each of which is tested for accuracy before it reaches the user, are particularly accurate in the atmospheric pressure range.

Welch's VMpro 1 and **VMpro 2** gauge models offer ample customization potential with regard to flange and filament materials and allow for any mounting orientation. They feature a built-in digital LCD display that shows the current measuring principle and ensures clear readability for easy vacuum level monitoring. The capacitance diaphragm sensor heads can be easily replaced, making the gauges highly convenient and cost-efficient devices that can be the perfect fit for many lab vacuum applications.

GENERAL CONTACT

AMERICAS
Tricontinent Scientific Inc.
12740 Earhart Avenue
Auburn, CA 95602
USA

Tel: +1530 273 8888
Fax: +1530 273 2586
liquidhandling.tcs@irco.com

ASIA PACIFIC
Gardner Denver Thomas Pneumatic Systems (Wuxi) Co., Ltd.
No. 1New Dong An Road
Shuofang Town
Wuxi, Xinwu District
Jiangsu 214142
China

Tel: 400-012-1268
Fax: +86 510 6878 2200
QQ: 800 018 724
tricontinent.cn@irco.com

EMEA
Gardner Denver Thomas GmbH
Livry-Gargan-Str. 10
82256 Fuerstenfeldbruck
Germany

Tel: +49 81412280 0
Fax: +49 81418892136
thomas.de@irco.com

Welch is a recognized provider of vacuum pumps, systems, and fittings for industrial, life sciences, and laboratory applications. We design, manufacture, and deliver products meeting the strictest requirements for mission-critical applications, and provide a comprehensive offering of products and great engineering capabilities to fit our customers' needs. As a reliable and trusted partner for OEMs, we stand up to the challenge of supplying best-in-class products and solutions on time to manufacturers of equipment in the life sciences, healthcare, and industrial segments.

Please check out all our brands for your mission-critical flow control technologies:

THOMAS	WELCH	TRICONTINENT	ZINSSER ANALYTIC	ILS	ADI
OEM Pumps thomaspumps.com	Vacuum Pumps & Systems welchvacuum.com	Syringe Pumps tricontinent.com	Lab Automation zinsser-analytic.com	Syringes microsyringes.com	Gas Sampling Pumps airdimensions.com