TELEDYNE INSTRUMENTS
Hastings Instruments
A Teledyne Technologies Company

APPLICATION NOTE

HASTINGS

Optimizing Load Lock Operation

How can better pressure measurement improve the operation of your load lock?

If we consider the primary purpose of a load lock—to pass from an ambient condition to a vacuum process condition—it only makes sense that the better it can match those two environments, the better it can do its job. Measuring pressure effectively at these two levels is critical to the proper operation of a load lock. At ambient pressure, when the load lock is opened to the room or handler, it is ideal to have a slightly positive relative pressure. This reduces the flow of contaminated, humid air into the load lock. However, if the load lock pressure is too high, it can cause a symptomatic "popping" sound as a burst of gas exits the load lock, creating its own set of problems. Precise measurement near atmospheric pressure allows the load lock to open only when it has been properly vented.

At transfer pressures in the mTorr range, the measurement is also critical to effective load lock performance. If the gauge reads too high, the actual pressure will be lower than necessary when the transfer occurs. This situation results in the loss of valuable time as the load lock chamber remains in the pumping phase too long. On the other hand, if the gauge reads too low, the actual load lock pressure will be too high when the transfer valve opens. The resulting higher contaminant levels can migrate from the load lock during transfer, compromising the purity of the process environment.

The need for precise pressure measurement in these two very different ranges requires that two different sensing techniques be employed. Several approaches to this task have historically been used. One method has been to use a convection enhanced pirani vacuum gauge to measure both pressure regions. While this type of gauge functions relatively well for the low pressure transfer; it has significant issues at the vent pressure condition due to response time, gas type, attitude, and temperature. A mechanical force-based pressure switch has sometimes been used for the vent pressure indication; however, this technology has inherent variability which creates over-pressure or under-pressure events. Using two properly selected, separate gauges is an effective technical solution but requires more electronics, interfaces, and vacuum connections. The ideal approach to load lock pressure measurement combines two sensors, each targeted for the specific task, in a single instrument.

Objectives

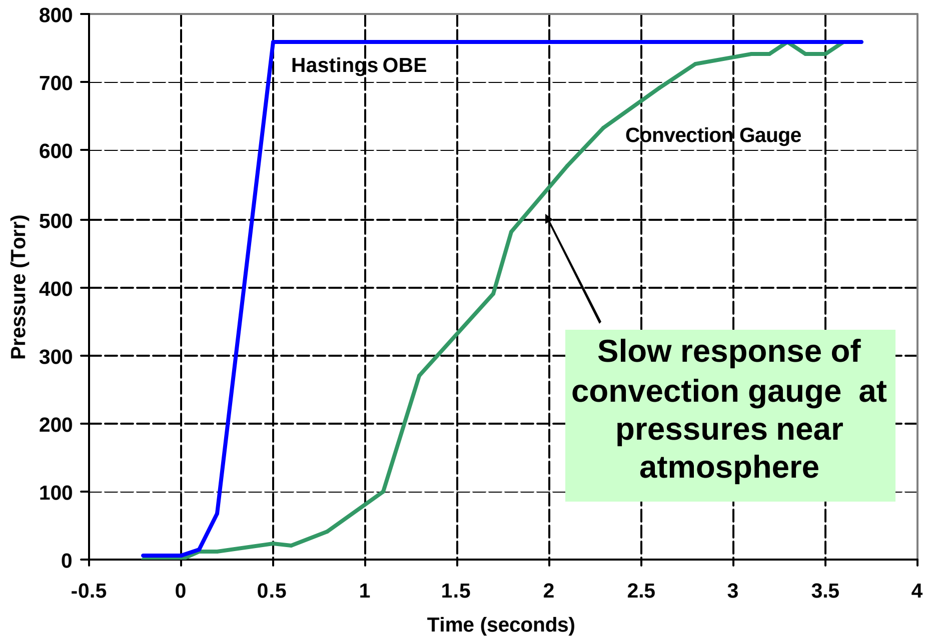
- ✓ Ensure proper load lock vent and transfer conditions
- ✓ Avoid "popping" events when opening the load lock
- ✓ Reduce contaminant transport to the process

Method

Proper load lock operation requires an accurate measurement at ambient (atmospheric) pressure and at transfer pressure in the mTorr range. Pressure measurement in between these regions is useful for diagnostic reasons, but is not critical to the function of the load lock.

When considering the vent to atmospheric pressure, the load lock pressure must be above the ambient pressure, typically by a few Torr. This provides the proper condition for opening the load lock door to the room. Pressure switches based on mechanical linkages, springs, and contacts cannot achieve this level of precision and often allow the door to open before the load lock has attained positive relative pressure. To compensate for the variability of mechanical switches, some systems add a "wait period" to ensure the load lock chamber has vented enough. However, this practice causes an unnecessary delay and can often produce too much positive pressure.

Similar problems occur when controlling the load lock using a convection enhanced pirani vacuum gauge (sometimes called a convection gauge). While these gauges are capable of providing a measurement at atmospheric pressure, the accuracy can be quite poor due to many factors that adversely affect the signal. Being an indirect measurement of pressure, this gauge bases its reading on the cooling of a hot wire due to the gas's natural convection. While pressure does affect the convection cooling, other variables that also have a significant impact on the sensor wire are gas type, ambient temperature, and orientation of the wire (attitude). Another issue with using this type of gauge to monitor venting has to do with its response time. Since convection currents take time to become established in the volume around the sensor wire, the pressure readings are slow to stabilize as well. The figure shows this dramatic effect as the load lock is rapidly vented to atmospheric pressure. This lag causes delays and over-pressure problems when venting with a convection enhanced pirani gauge.



The best technique for measuring pressure in the load lock requires two sensor technologies, each designed for the specific needs of the two distinct functions of the load lock. The vent pressure measurement is best accomplished by a direct measurement—one that senses the force on an area—since it is relatively insensitive to gas type, temperature, and orientation. A diaphragm-based sensor is well suited to this task. When the load lock door is open, the sensor output is recorded by the system as the ambient pressure for the subsequent vent cycle. In this way, slow changes in the ambient condition (typically due to weather or building control) can be accommodated. Since a diaphragm sensor set for atmospheric pressure is incapable of also providing sufficient resolution at the mTorr level, a thermocouple or pirani gauge is often used to control the transfer operation. While it may be technically superior, having two completely separate gauges with their own vacuum ports, cables, and electronics is practically undesirable. Recently though, multi-sensor instruments which combine the two measurement regions effectively in a single device have become available for load lock applications.

Instrument Choice

With a diaphragm piezo-resistive sensor, a micromachined pirani sensor, and all the supporting electronics in one compact device, the Hastings HPM-2002-OBE is the recommended instrument for load lock applications. Its diaphragm sensor produces a rapid (200 msec), accurate (1.5%), gas type independent reading at atmospheric pressure to precisely indicate the end point for venting. Its advanced micro-pirani technology indicates the transfer pressure in the mTorr range to ensure minimal contamination to the process. The on-board electronics includes two settable trip points and produces a continuous pressure signal in the range between the two critical regions. The 2002-OBE is a proven design for load lock applications having already demonstrated their functionality and dependability on over a thousand systems in the field for over four years.

For Information on all Teledyne Hastings Vacuum Measurement and Mass Flow Instruments, visit our website:

www.teledyne-hi.com

or contact us at 1-800-950-2468

