TELEDYNE INSTRUMENTS
Hastings Instruments
A Teledyne Technologies Company

APPLICATION NOTE

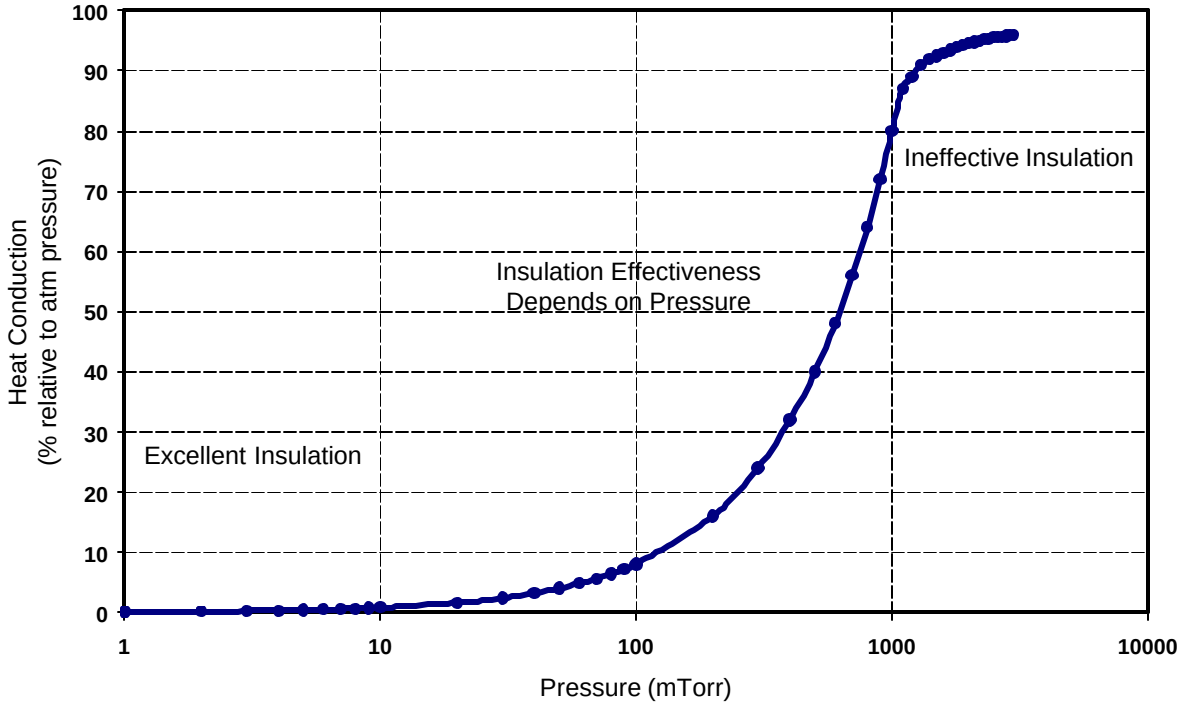
HASTINGS

Maintaining an Effective Vacuum Jacket

How can you ensure a vacuum jacket is working properly?

The technique of using a vacuum guard or barrier to thermally insulate a cryogenic or refrigerant tank is pretty obvious--remove the air from around an object and you remove the conductive heat transfer. But in practice, this method is only effective if the less than 1/1000th of the air remains in the space! In other words, if the pressure is much above 1 Torr, the jacket is worthless. As the graph below shows, the insulating effectiveness improves as the pressure is reduced below 1 Torr and is essentially perfect at pressures below 10 mTorr. (Radiation and conduction through mechanical connections will then dominate the heat transfer.) So to know how well the jacket is doing its job, you need to know what its pressure is. If the pressure is above 1 Torr, there is very little benefit; if it's in the mTorr range, then all is well.

Heat Conduction in Air



Method

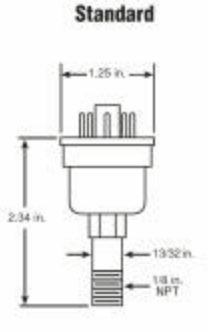
To effectively measure pressure in the mTorr range, a vacuum dial gauge is simply not sensitive enough. All of the effects that we're interested in happen while the needle is resting on the "0" of the dial (remember we need to know how much of the last 1/1000th of an atmosphere is left). However, there is a kind of vacuum gauge that performs very well in this range by actually measuring the thermal conductivity of the gas to infer the pressure. Called a thermal conductivity, thermocouple, or TC gauge, it is an effective and reliable way to ensure the insulating properties of the jacket. When you think about it, a thermal conductivity gauge uses the best technology for this application because it directly measures how well the vacuum is insulating.

To implement a simple scheme for continuously monitoring a vacuum jacket for stationary application (e.g. LNG, cryogenic bulk tank, or vacuum jacketed pipe) the gauge tube and readout electronics can be permanently installed on the vacuum containment. For outdoor installations the tube can be mounted on the tank with the electronic readout located remotely. For some situations monitoring is only done periodically (dip-stick check). This may be the case on a cryogenic tank truck or rail car where the tube is generally installed permanently and checked with a hand-held, battery operated electronic unit.

While the ideal location of the gage tube(s) depends on the configuration of the system, some general guidelines can be considered. Of course, for the situation where periodic checks are made with a hand-held readout, the tube should be installed in an easily accessible location. The technical considerations would dictate that the gauge tube be located near anticipated leak points or moving seals like valve stems or rotary feed-throughs. In actively pumped vacuum jacket systems, installing a gauge tube near the pump will not necessarily indicate when leaks begin to adversely affect the performance of the jacketing. The pressure at the pump is always the best (lowest), while what you need to know is the worst pressure. For this reason, locations in the more remote branches or dead-end sections are the best for ensuring that adequate insulating properties are maintained.

Instrument Choice

There are several versions of TC gauge tubes, each designed to satisfy specific requirements. For general purpose monitoring of vacuum jacketed pipes, bulk tanks and dewars in controlled environments (indoor facilities), the Hastings DV-6M thermocouple gauge tube is a cost-effective device with a measurement range of 1 to 1000 mTorr. For installations that may have excessive vibration or mechanical shock, a ruggedized version of the tube is also available as the DV-6R. For use in the harshest environments, a weatherproof stainless steel gauge tube, the DV-6S, is the best choice. Its additional features include a removable, tethered metal cap to protect the electrical connector pins. All variations of the DV-6 come standard with 1/8" NPT for easy installation on the jacket enclosure.



DV-6R

The vacuum reading from any of these DV-6 tubes can be accomplished with either a dedicated electronic display or a hand-held battery operated readout. The Hastings Digital VT provides continuous monitoring with an easy to read LED display. For periodic vacuum checking of one or more tubes, the hand-held HPM-4/6 is recommended. For convenience, it is powered by a 9V battery and can be connected to any DV-6 tube for an instant reading. To ensure the most accurate measurement, the DB-20 Reference Tube (with NIST Traceable calibration) can be used to validate the electronic calibration.

Digital VT-6

HPM 4/6

DV-6S

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

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