This chapter is divided into four sections:

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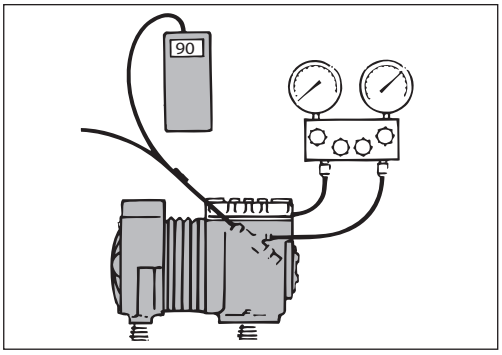
Measuring Instruments

Instruments for fault location

The items of equipment most often used for locating faults in refrigeration systems are as follows:

1. Pressure gauge
2. Thermometer
3. Hygrometer
4. Leak detector
5. Vacuum gauge
6. Clamp ammeter
7. Megger
8. Pole finder



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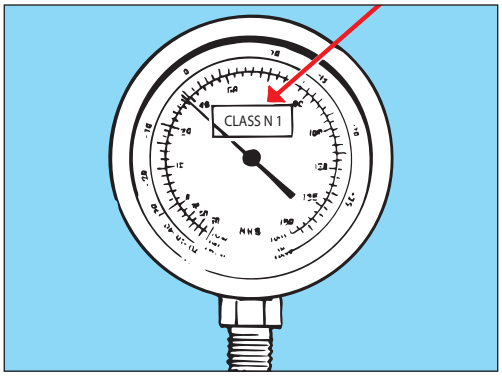
Classification of instruments

Instruments for fault location and servicing on refrigeration systems should fulfil certain reliability requirements.
Some of these requirements can be categorised thus:

a. Uncertainty
b. Resolution
c. Reproducibility
d. Long-term stability
e. Temperature stability

The most important of these are a, b, and e.



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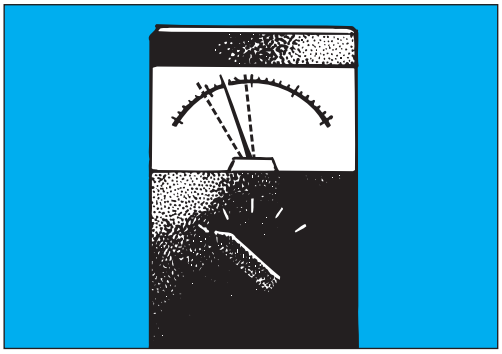
a. Uncertainty

The uncertainty (accuracy) of an instrument is the accuracy with which it is able to give the value of the measured variable.

Uncertainty is often expressed in % (±) of either: Full scale (FS) or the measuring value. An example of uncertainty for a particular instrument is ±2% of measuring value, i.e. less uncertain (more accurate) than if the uncertainty is ±2% of FS.



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b. Resolution

The resolution of an instrument is the smallest unit of measurement that can be read from it.

For example, a digital thermometer that shows 0.1°C as the last digit in the reading has a resolution of 0.1°C.

Resolution is not an expression of accuracy. Even with a resolution of 0.1°C, an accuracy as poor as 2 K is not uncommon.

It is therefore very important to distinguish between the two.

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c. Reproducibility

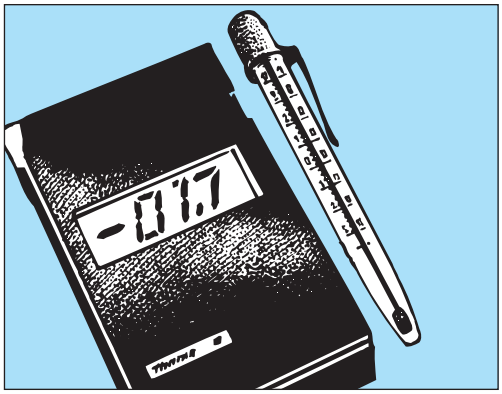
The reproducibility of an instrument is its ability to repeatedly show the same result for a constant measuring value.

Reproducibility is given in % (±).

d. Long-term stability

Long-term stability is an expression how much the absolute accuracy of the instrument changes in, say, one year.

Long-term stability is given in % per year.



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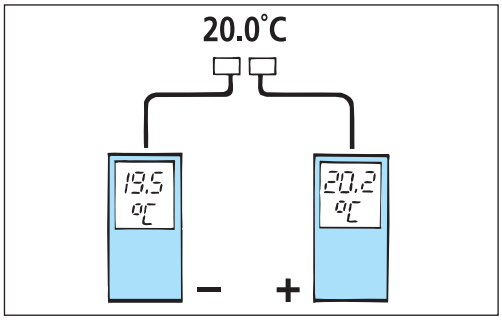
e. Temperature stability

The temperature stability of an instrument is how much its absolute accuracy changes for each °C temperature change the instrument is exposed to.

Temperature stability is given in % per °C.

Knowledge of the temperature stability of the instrument is of course important if it is taken into a cold room or deep freeze store.



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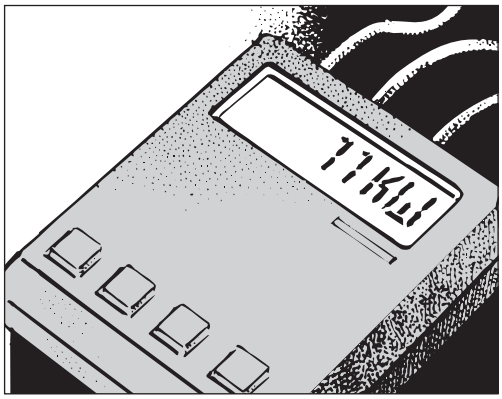
Electronic instruments

Electronic instruments can be sensitive to humidity.

Some can be damaged by condensate if operated immediately after they have been moved from cold to warmer surroundings.

They must not be operated until the whole instrument has been given time to assume the ambient temperature.

Never use electronic equipment immediately after it has been taken from a cold service vehicle into warmer surroundings.



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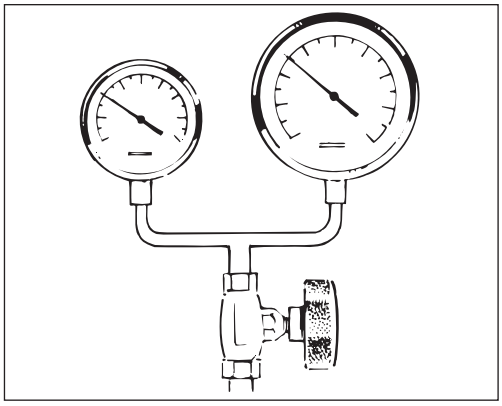
Check and adjustment

Readings from ordinary instruments, and perhaps some of their characteristics, change with time.

Nearly all instruments should therefore be checked at regular intervals and adjusted if necessary.

Simple checks that can be made are described below, although they cannot replace the kind of inspection mentioned above.



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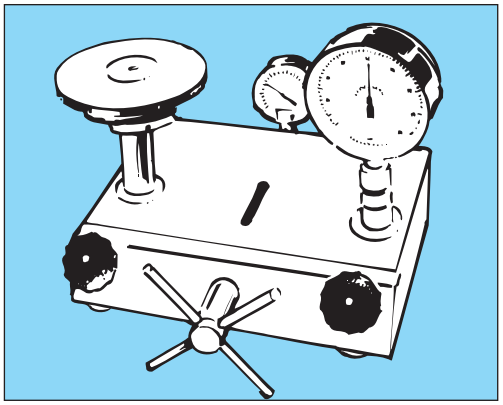
Check and adjustment (cont.)

The proper final inspection and adjustment of instruments can be performed by approved test institutions.



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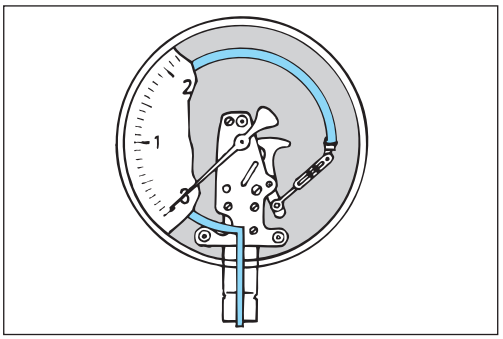
Adjustment and calibration

Pressure gauges

Pressure gauges for fault location and servicing are as a rule of the Bourdon tube type. Pressure gauges in systems are also usually of this type.

In practice, pressure is nearly always measured as overpressure.
The zero point for the pressure scale is equal to the normal barometer reading.

Therefore pressure gauges have a scale from –1 bar (–100 kPa) greater than 0 to + maximum reading. Pressure gauges with a scale in absolute pressure show about 1 bar in atmospheric pressure.



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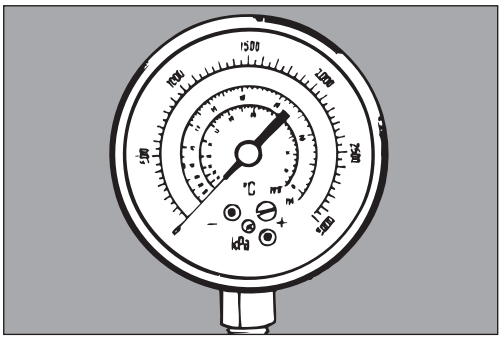
Service pressure gauges

As a rule, service pressure gauges have one or more temperature scales for the saturation temperature of common refrigerants.

Pressure gauges should have an accessible setting screw for zero point adjustment, i.e. a Bourdon tube becomes set if the instrument has been exposed to high pressure for some time.

Pressure gauges should be regularly checked against an accurate instrument. A daily check should be made to ensure that the pressure gauge shows 0 bar at atmospheric pressure.



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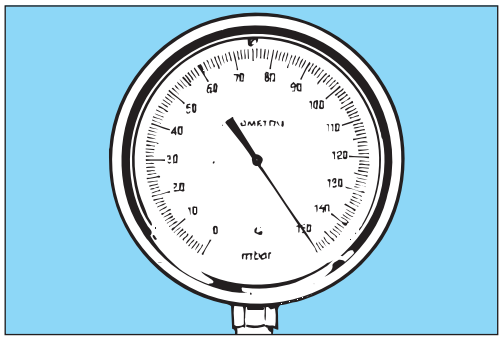
Vacuum gauges

Vacuum gauges are used in refrigeration to measure the pressure in the pipework during and after an evacuation process.

Vacuum gauges always show absolute pres-sure (zero point corresponding to absolute vacuum).

Vacuum gauges should not normally be exposed to marked overpressure and should therefore be installed together with a safety valve set for the maximum permissible pressure of the vacuum gauge.



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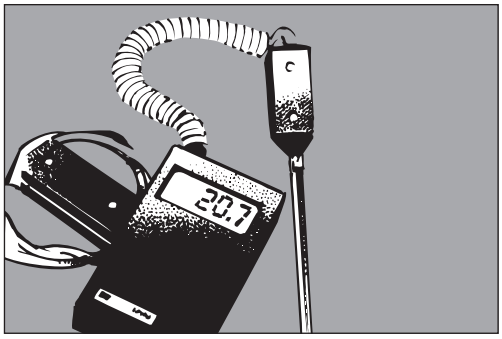
Thermometer

Electronic thermometers with digital read-out are in widespread use for servicing. Examples of sensor versions are surface sensors, room sensors and insertion sensors.

Thermometer uncertainty should not be greater than 0.1 K and the resolution should be 0.1°C.

A pointer thermometer with vapour charged bulb and capillary tube is often recommended for setting thermostatic expansion valves.
As a rule it is easier to follow temperature variations with this type of thermometer.



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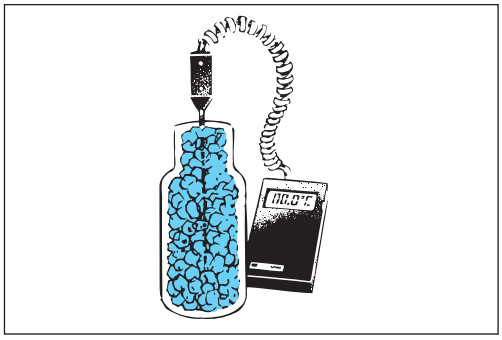
Thermometers can be relatively easily checked at 0°C in that the bulb can be inserted 150 to 200 mm down into a thermos bottle containing a mixture of crushed ice (from distilled water) and distilled water. The crushed ice must fill the whole bottle.

If the bulb will withstand boiling water, it can be held in the surface of boilover water from a container with lid. These are two reasonable checks for 0°C and 100°C.

A proper check can be performed by a recognised test institute.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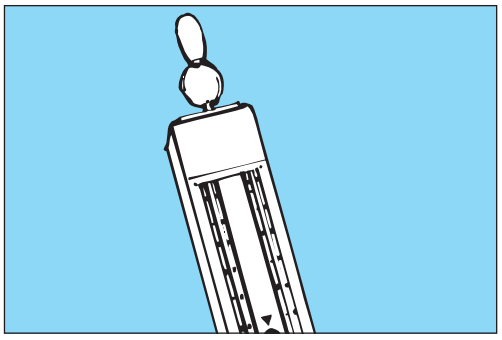
Hygrometer

There are different types of hygrometers for measuring the humidity in cold rooms and air conditioned rooms or ducts:

- Hair hygrometer
- Psychrometer
- Diverse electronic hygrometers

A hair hygrometer needs adjustment each time it is used if reasonable accuracy is to be maintained. A psychrometer (wet and dry thermometer) does not require adjustment if its thermometers are of high quality.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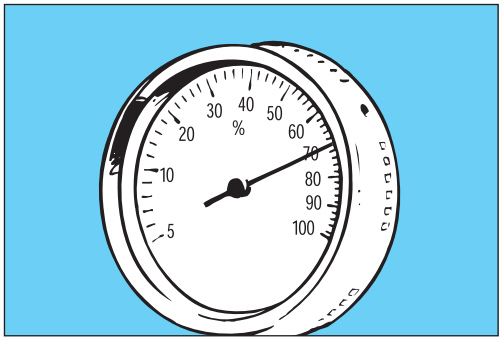
At low temperature and high humidity, the temperature differential between wet and dry thermometers will be small.

Therefore, with psychrometers the uncertainty is high under such conditions and an adjusted hair hygrometer or one of the electronic hygrometers will be more suitable.



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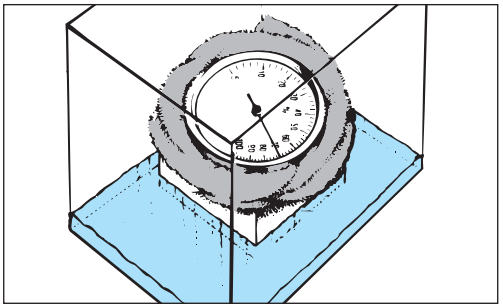
Hygrometer (continued)

A hair hygrometer can be adjusted by winding a clean, damp cloth around it and then placing it in an airtight container with water at the bottom (no water must be allowed to enter the hygrometer or come into contact with its bulb).

The container with hygrometer is then allowed to stand for at least two hours in the same temperature as that at which measurements are to be taken.

The hygrometer must now show 100%. If it does not, the setting screw can be adjusted.



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