## 1. Temperature measurement

In this section, we focus on RTD and thermocouples.

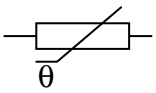
### RTD: Resistive thermal device

**Field of application:**

- 

**Principle:** the sensitive element of RTD is made from pure material whose resistivity varies as a function of temperature (Platinum Pt or Nickel Ni).

**Electrical symbol:**




This coefficient is called the sensitivity [Ω/°C]

**Measurement range:**

- Pt100 : -200 à +650 °C
- Pt1000 : -200 à +650 °C
- Ni1000 : -50 à +250 °C

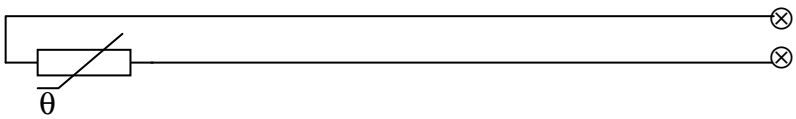
**Characteristics:**

- R (θ) = 100 + 0,385.θ
- R (θ) = 1000 + 3,85.θ
- R (θ) = 1000 + 0,164.θ

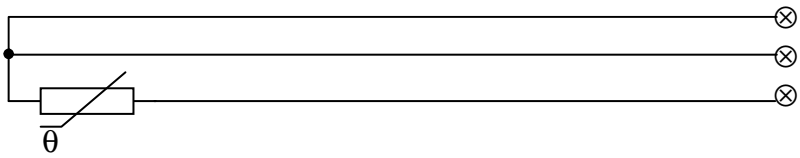
- *What measuring instrument do you need to get temperature value with this type of sensor?*
- *The measuring instrument indicates 119 Ω, what is the corresponding temperature?*

**Connecting:**

- **2-wire connection :** This connection is suitable for short distances




- **3-wire connection:** This connection helps removing error due to lead resistances



idely used

neasurement
measurement e.g.: powerful industrial furnace
e measurement

evice made by two dissimilar metals joined together at the sensing end,
**end.**

n **junction end** and **tail end** generates an Electro-motive Force (Emf)

$$E_M = E_{JE} - E_{TE}$$

e and Emf is a non-linear function, each thermocouple has its own hermocouple conversion table:

| | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|
| | -1228 | -1263 | -1299 | -1334 | -1370 | -1405 | -1440 |
| | -867 | -903 | -940 | -976 | -1013 | -1049 | -1085 |
| | -496 | -534 | -571 | -608 | -646 | -683 | -720 |
| | -116 | -154 | -193 | -231 | -269 | -307 | -345 |
| | 117 | 156 | 195 | 234 | 273 | 312 | 351 |
| | 510 | 549 | 589 | 629 | 669 | 709 | 749 |
| | 911 | 951 | 992 | 1032 | 1073 | 1114 | 1155 |
| | 1320 | 1361 | 1403 | 1444 | 1486 | 1528 | 1569 |
| | 1738 | 1780 | 1822 | 1865 | 1907 | 1950 | 1992 |
| | 2164 | 2207 | 2250 | 2294 | 2337 | 2380 | 2424 |

*utlet temperature of a compressor. Your TESTO 922 is out of order, but in which you plug the K thermocouple probe. The voltmeter indicates mperature is 22°C, what is the outlet temperature of this compressor?*

## 2. Pressure measurement

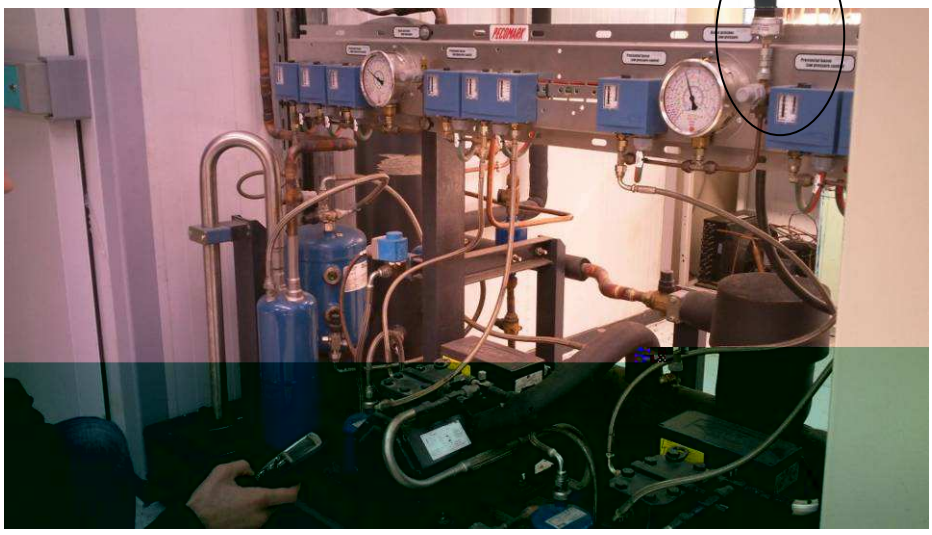
### Pressure gauge or Manometer

**Field of application:** Pressure indication

### Digital pressure transmitters

**Field of application:** Pressure control

e.g. Condensing unit with low pressure control



To controller

### Digital differential pressure transmitters

**Field of application:**

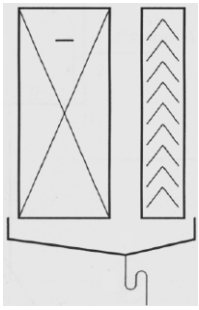
- gas or liquid flow measurement
- liquid level measurement within tanks
- testing how dirty an air filter is

E.g. Airflow measurement using velocity wing

### 3. Level measurement

**Hydrostatic method measurement**: This method requires a differential pressure manometer.

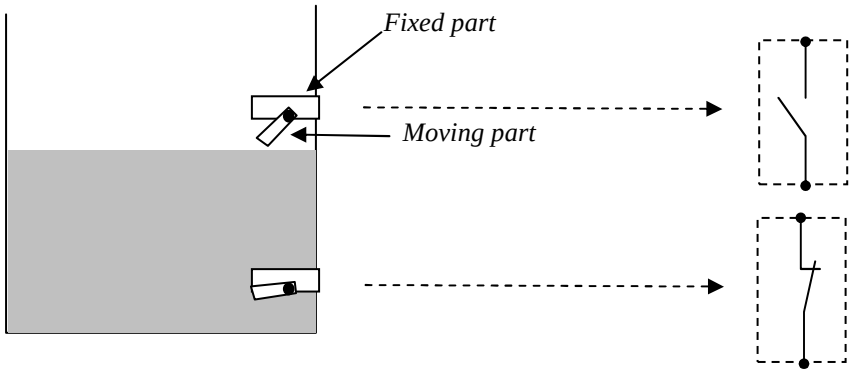
**Field of application:** level measurement of liquid within tanks
E.g. condensate recovery tanks



$\Delta P = \rho.g.h + P_{ATM} - P_{ATM}$ as a result $\Delta P$ is directly proportional to h

**Capacitive detectors and Float level switch**

**Field of application**: these detectors provide on/off switch. They are ideal for low or high-level alarm application.



## 4. Flow measurement

### o PITOT tube differential pressure flow-meter

**Field of application:** Airflow measurement

**Principle:** the fluid velocity is a function of the differential pressure.

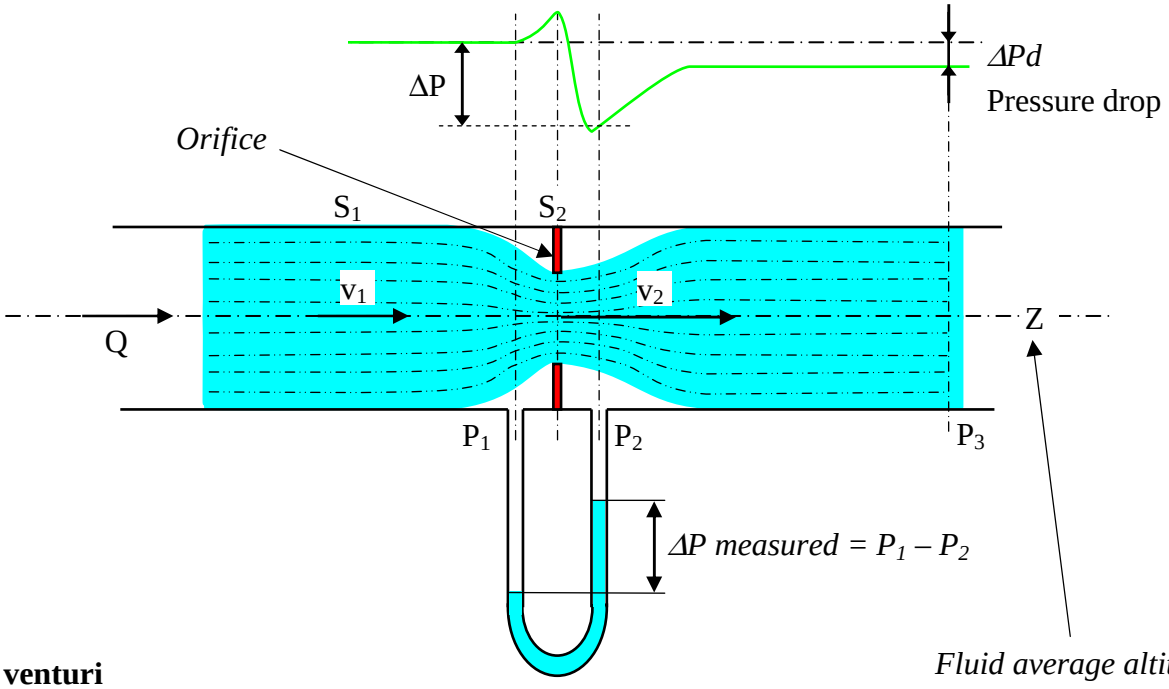
$$v = \sqrt{\frac{2 \,.\, (P\ totale - P\ statique)}{\rho}}$$

### oDiaphragm and Venturi method

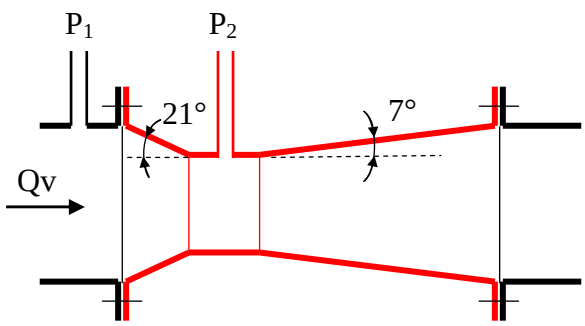
**Field of application:** Gas and liquid flow measurement
**Principle**: an orifice or a restriction generates a pressure difference **ΔP** that is a function of the volume flow rate:

$$\mathbf{Q_v = k.\sqrt{\Delta P}}$$

**The diaphragm**

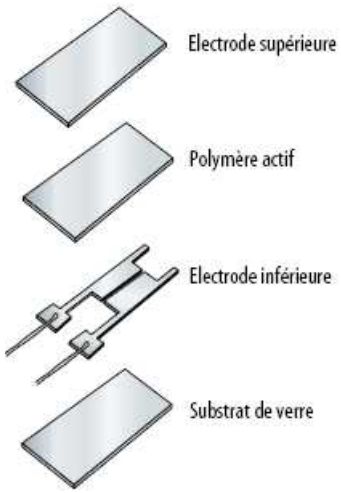



**The venturi**



## 5. Humidity measurement


Hygrometer family includes quite a few different technologies for humidity measurement. The most widely used are impedance hygrometer.




**Principle of capacitive hygrometer:** The sensitive element of a hygrometer is a capacitance whose dielectric is made from a hygroscopic substance. This substance, with a thickness of few micrometers, is a polymer that absorbs water molecules contained in the air. As a result, the capacitance varies. A electronic device converts this capacitance variation into a relative humidity value.