## 7. INSTALLATION

The proper functioning of a thermostat depends primarily on the correct choice of the component, but also the conditions of its installation. Conditions used to calibrate regulating and control equipment in the factory are always ideal laboratory conditions, ensuring measurement accuracy and repeatability. These conditions are rarely those found in practice when installing thermostats. However, with a minimum of constraints, it is possible to optimize assemblies.
One's will always bear in mind these two essential rules:
• A thermostat measures the temperature where the sensing element is located, and it is therefore necessary that this place is representative of the temperature that must be controlled.
• The thermal inertia is the most common causes of poor regulation. A thermostat does not have an instant response to a temperature change.

### 7.1 GENERAL RULES

• THERMAL CONDUCTIVITY
The temperature of a medium (liquid, air, metal) decreases progressively as the distance from the heat source. This decrease, called thermal gradient is inversely proportional to the thermal conductivity of the medium. For good temperature control, first step is to make this decrease as low as possible: by stirring the liquid, stirring the air, using metals that are good conductors of heat.
In unstirred liquid baths, thermal variations that rise several tens of degrees between different measurement points are quite common. It is the same in the air.
• RESPONSE TIME
Practically speaking, the time taken by a device to change temperature is proportional to its mass and inversely proportional to its thermal conductivity.
Subject to the same variation of temperature, a large block of copper takes longer to heat up than a little. A block of pure silver of the same weight will react much more quickly.
In one room, sun exposure will raise rapidly the temperature of the ambient air because its mass is low, but the walls will react much more slowly because they are much more massive, even if their thermal conductivity is higher. Therefore, to control the air conditioner, make sure that the thermostat measure the temperature of the air and not of the walls.

**Thermal conductivity of some materials**

| Materials | Thermal conductivity at 20°C (W•m-1•K-1) | Materials | Thermal conductivity at 20°C (W•m-1•K-1) |
|---|---|---|---|
| PU foam | 0,025 | Titanium | 20 |
| Ait (atmospheric pressure) | 0,026 | 304 Stainlss steel | 26 |
| EPS | 0,036 | Mild steel | 46 |
| Fiber glass wool | 0,043 | Platinium | 72 |
| Cork | 0,043 | Iron | 80 |
| Wood (Average) | 0,16 | Cast iron | 100 |
| Abestos | 0,17 | Silicium | 149 |
| Epoxy | 0,25 | Aluminum alloy (with SiC) | 150-200 |
| Nylon | 0,25 | Pure aluminum (99.9%) | 237 |
| PPS (Ryton) | 0,3 | Massive silicium carbide | 250 |
| Vulcanized rubber (EPDM) | 0,4 | Gold | 317 |
| Water | 0,63 | Copper | 390 |
| Concrete | 0,92 | Silver | 429 |
| Glass | 1,23 | Graphite | 500-2000 |
| Bakelite | 1,42 | Diamond | 1000-2600 |
| Quartz | 10 | Graphene | 4000-5300 |

It is easily possible to see that if a thermal gradient takes 1 second to be transmitted in a silver part, it will take 1.1 seconds in copper, 2.5 seconds in aluminum alloy, 4.3 seconds in iron, 6.3 seconds in mild steel, 16.5 seconds in stainless steel, 680 seconds (more than 11 minutes) in non-stirred water and 16500 seconds (more than 4 hours) in still air.

• TIME NEEDED TO HEAT
An issue frequently raised, and that many consider as associated with thermostats is the time it takes to heat a product. In fact, at constant power, the amount of heat (energy) required to heat a product depends on its mass and its heat capacity, and not on the thermostat.
Specific Heat capacity (or specific thermal capacity) is the energy it takes to bring a body to raise its temperature by one degree kelvin for a mass of one kilogram. It is expressed in joules per kelvin per kilogram (J / K). It originates from the "calorie" that was defined as the amount of heat required to raise 15 ° C to 16 ° C the temperature of one gram of water.
The table below gives some common values