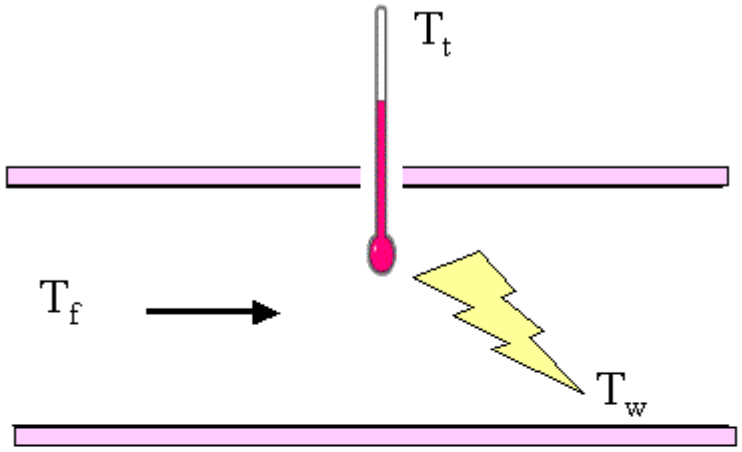
Effect of Radiation on Temperature Measurement

You want to measure the temperature of a fluid flowing in a duct or a pipe using a thermometer. You stick a thermometer inside the duct facing the incoming fluid and read the thermometer's reading. Is this really the true temperature of the fluid? Not if the thermometer is facing a surface or an object with a lower temperature. So what you have to do is to use the formulation below in order to estimate the true temperature of the fluid.



$$h.(T_f - T_t) = \varepsilon_t \sigma (T_t^4 - T_w^4)$$

Solving for T_f

$$T_f = T_t + \frac{\varepsilon_t \sigma (T_t^4 - T_w^4)}{h}$$

The formulation assumes a steady-state situation where the reading of the thermometer is stabilized. Under this condition the heat lost by radiation to the cooler object is balanced by the heat gained due to convection from the moving fluid. The second term on the right hand side of the equation above is the difference between what you read and what the real temperature is. This term is significant for low values of h and high values of thermometer emissivity. One way to reduce this unwanted effect is to coat the sensor with a low emissivity/high reflectivity material.

The same concept applies to human comfort. You may be sitting in an area with a nice flow of cool air but facing a hot sun coming through your window. There is a chance that you will not be too comfortable and decide to pull the shades down.