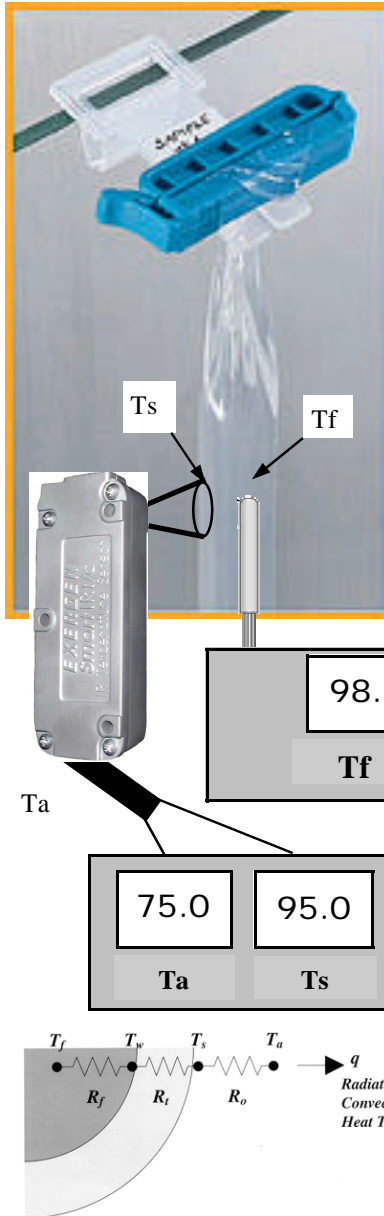


## #102 Smart IRt/c Heat Balance Series For Measuring Internal Temperatures



The Heat Balance (HB) Series of IRt/c infrared thermocouples have the ability to measure the internal temperature of the target material noninvasively, by employing a patented heat balance technique. A typical application in medical equipment is monitoring or controlling the temperature of fluid transported through disposable tubing when warming or cooling:

- Transfusion systems
- IV warming systems
- Dialysis systems
- Cardio-pulmonary bypass systems
- ECMO systems
- Blood analyzers

Other applications are:

- Internal tire temperature
- Internal baking/cooking
- Internal fluid temperatures in packaging

### Example of fluid temperature reading:

The SmartIRt/c-HB model, actually measures the internal fluid temperature by measuring both tubing surface and ambient temperatures and then calculating the internal temperature necessary to maintain the heat balance.

### **Principles of Operation**

Fluid at temperature  $T_f$  flowing in tubing transfers heat via convection through thermal resistance  $R_f$  to the tubing inside surface, which in turn conducts heat to the tubing external surface through thermal resistance  $R_t$ , which then transfers to the environment via radiation and convection thermal resistance  $R_o$ . The temperatures of the wetted surface of the tubing, outside surface of the tubing, and the local ambient are given by  $T_w$ ,  $T_s$  and  $T_a$ , respectively.

Employing the method of thermal analysis with electrical analogs: current = heat flow and voltage = temperature, the heat transfer equation may be written as follows:  $q = (1 / (R_f + R_t + R_o)) (T_f - T_a)$  and via heat balance:  $= (1/R_o) (T_s - T_a)$  Accordingly,  $T_f = ((R_f + R_t + R_o) / R_o) (T_s - T_a) + T_a$

The SmartIRt/c-HB Series measures both  $T_s$  and  $T_a$ , and solves this equation automatically for fluid temperature  $T_f$ , providing a highly accurate method of monitoring or controlling the temperature of interest.

The configuration shown above is the SmartIRt/c-HB measuring the fluid temperature inside a dialysis bag. Any of the SmartIRt/c and IRt/c models can be configured for the HB calculation. We will submit a standard SmartIRt/c to you to set up for calibrating. Just record the  $T_a$ ,  $T_s$ , and  $T_f$  at the absolute low and high extremes and send the unit back to us with the data. We will reprogram the SmartIRt/c so it is setup for HB custom for your application only. Contact the factory for further details.

Also see other Heat Balance related Technotes:

#88 Measuring Tire Tread Internal Temperature and #99 IRt/c Heat Balance Series for Medical Applications