Technote **#57**

IRt/c heat balance series for medical applications

The Heat Balance (HB) Series of IRt/cs measure the internal temperature of the target material non-invasively, 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

The IRt/c.01HB model pictured measures internal fluid temperature. For this, it measures both tubing surface and ambient temperatures, then calculates the internal temperature necessary to maintain heat balance. A convenient clip head provides a reproducible mounting location for the sensor. This can be quickly attached to new tubing and removed from used tubing.

Principles of Operation

Fluid at temperature Tf flowing in tubing transfers heat via convection through thermal resistance Rf to the tubing inside surface. This in turn conducts heat to the tubing's external surface through thermal resistance Rt. This then transfers to the environment via radiation and convection thermal resistance Ro. Other temperature values are: the wetted surface of the tubing (Tw); outside surface of the tubing (Ts); the local ambient (Ta).

Employing the method of thermal analysis with electrical analogs: current = heat flow; voltage = temperature, the heat transfer equation may be written as follows:
The IRt/c-HB Series measures both Ts and Ta, and solves this equation automatically for fluid temperature Tf, providing a highly accurate method of monitoring or controlling the temperature of interest.
The configuration shown above is model IRt/c.01HB-J-37C with its convenient tubing clip. Any of the IRt/c models can be configured for the HB calculation. Contact CleverIR for further details.

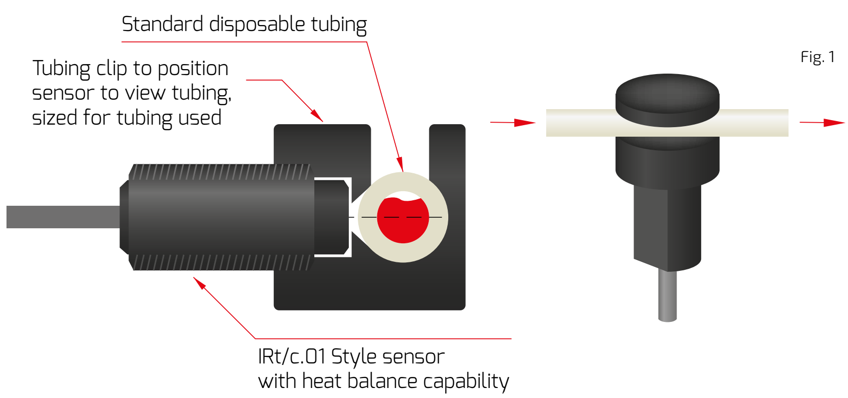
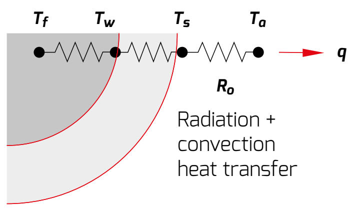


Fig. 1



$$q = \frac{1}{R_f + R_t + R_o} (T_f - T_a)$$

and via heat balance:

$$= \frac{1}{R_o} (T_f - T_a)$$

Accordingly,

$$T_f = \frac{R_f + R_t + R_o}{R_o} (T_s - T_a) + T_a$$

TN-2025-57-EN-V0

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