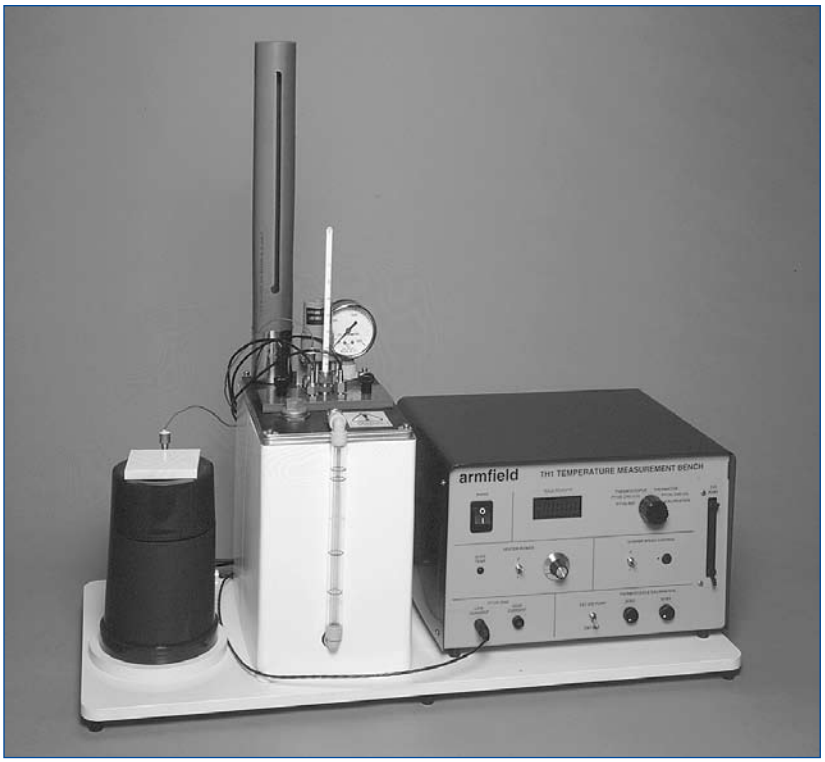
armfield

TEMPERATURE MEASUREMENT AND CALIBRATION

TH1
issue 3



The Armfield Temperature Measurement and Calibration unit is designed to introduce students to temperature and how different techniques can be employed to measure this variable. The thermometric properties and characteristics of temperature measuring devices can be investigated and the devices calibrated using precisely generated fixed points and an accurate reference thermometer.

INSTRUCTIONAL CAPABILITIES

- *Concepts of measurement and temperature scales*
- *Thermometric properties and characteristic behaviour of different sensors*
- *Structure of the International Temperature Scale (ITS90)*
- *Calibration and the use of fixed points*
- *Sources of error in measurement and calibration*

KEY FEATURES

- *Thermometric properties (physical changes due to temperature) of different sensors are investigated*
- *Condensing vapour (using a hypsometer) provides an accurate fixed point for calibration*
- *Stirred hot water bath provides variable temperatures*
- *Reference PRT with NAMAS calibration supplied*
- *All electrical sensors can be logged using a PC (optional teaching software available)*

Thermodynamics

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DETAILED EXPERIMENTAL CAPABILITIES

Teaching exercises will enable students to become familiar with the following topics:

Concepts of measurement and calibration:

- *Celsius (Fahrenheit) and absolute temperature scales*
- *conversion of arbitrary scale into engineering units - correlating equations*
- *zero error*
- *scale error*
- *non-linearity*

Properties and characteristic behaviour of different sensors:

- *thermoelectric properties of platinum resistance thermometer (PRT), thermocouple and thermistor*
- *bimetallic thermometer (with dial gauge)*
- *expansion (liquid in glass)*
- *speed of response and the effect of a sheath*

Structure of the International Temperature Scale (ITS90):

- *the reference PRT equation and the standard temperatures*
- *correction equations*

Calibration:

- *boiling point/condensation point - use of saturation temperature tables*
- *establishment of accurate fixed points*
- *ice point or triple point*
- *primary calibration of a PRT using fixed points and ITS90*
- *secondary calibration of a thermocouple or other sensor against a PRT at several water bath temperatures*

Sources of error:

- *static and dynamic errors*
- *thermal linking and the effects of the sensor on the target temperature*
- *conduction error*
- *connecting lead effects*
- *self heating effects*
- *manufacturing tolerances*
- *signal conditioning*
- *display accuracy and resolution*
- *cold junction compensation (for thermocouples)*

Project work:

- *calibration of alternative temperature sensors/thermometers*
- *properties of alternative temperature sensors*
- *ageing and drift*

DESCRIPTION

A bench top unit designed to introduce students to temperature, temperature scales and commonly available devices to measure temperature.
The equpment comprises a hypsometer/hot water bath and ice flask to generate accurate fixed points (the condensation point and triple point of water) and variable temperatures.

Temperature sensors having different thermometric principles and characteristics are supplied. An accurate platinum resistance thermometer (PT100) with five point NAMAS calibration certificate and temperature indicated directly in ^{o}C, is included for reference.

The temperature of the condensing water vapour in the hypsometer can be determined accurately using steam tables (included in the teaching manual and educational software), provided that an accurate barometer (not supplied) is available. The water level is simply raised to change the hypsometer into a variable temperature water bath.

The unit is designed for safe operation with insulation surrounding the vessel and a protected steam vent. A radiation shield surrounds the sensors to be calibrated to minimise measurement errors. A common carrier allows all sensors to be transferred simultaneously from ice flask to the hypsometer/water bath.

All power supplies, signal conditioning circuitry etc are contained in an electrical console with appropriate current protection devices and an RCD for operator protection.

All thermometric properties and temperatures measured are displayed on a digital meter with selector switch and all corresponding signals are routed to an I/O port for connection to a PC using an optional interface device with educational software package (TH-304IFD).

The following sensors/signal conditioning circuits are included:

Accurate reference PRT with linearised output in ^{o}C.

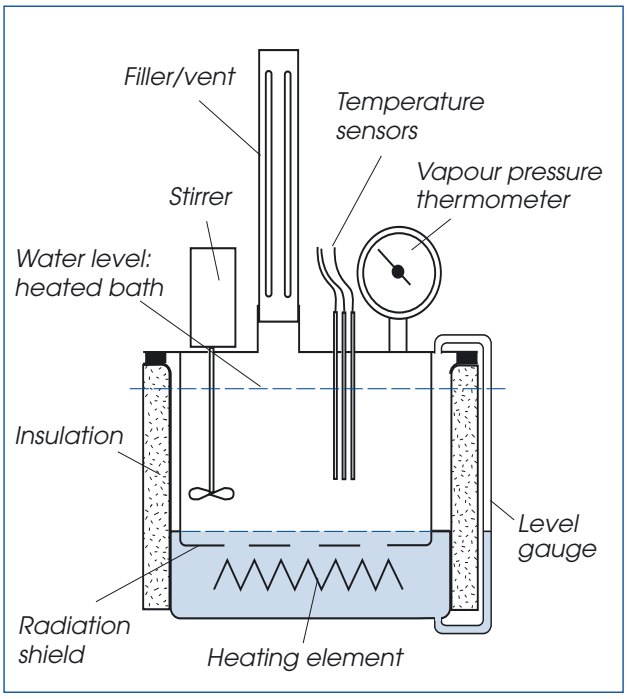
Industrial PRT with a bridge circuit to measure the resistance in Ohms. Higher current can be passed through the sensor to show the effect of self-heating.

Type-K thermocouple using a precision preamplifier to measure the thermoelectric voltage with cold junction compensation or a second thermocouple in ice as required.

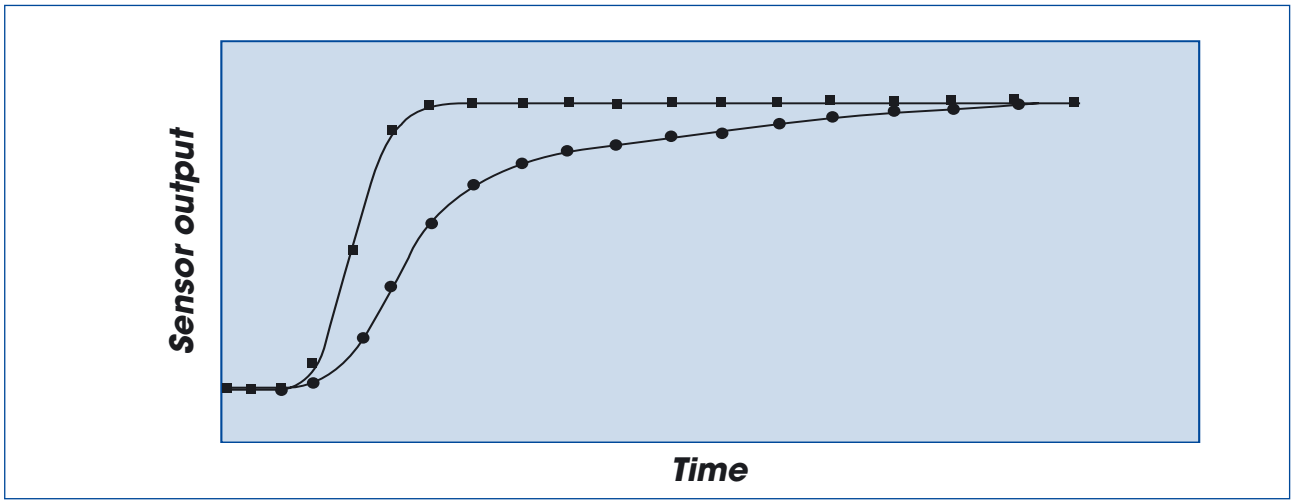
Additional thermocouples allow errors due to response and conduction to be demonstrated. An additional conditioning circuit with user adjustable zero and span controls allows the output to be displayed as a direct reading thermometer calibrated in ^{o}C.

Thermistor with constant current through the sensor to measure the resistance in Ohms.

In addition to the thermoelectric sensors a liquid in glass and vapour pressure thermometer are also supplied.



TH1: Schematic diagram of hypsometer/heated water bath



TH1: Response curves for different temperature sensors

ORDERING SPECIFICATION

- ***A bench top unit comprising a hypsometer/hot water bath and ice flask which generate accurate fixed points and variable temperatures. An accurate platinum resistance thermometer (PT100) with five point NAMAS calibration certificate and temperature indicated directly in °C is included for reference.***
- ***Other temperature sensors include: Platinum resistance sensor, K-type thermocouple, thermistor, vapour pressure and liquid in glass thermometers.***
- ***The hypsometer is heated by a pair of 1kW electric heating elements with variable power control and over-temperature protection.***
- ***The electrical console houses all the necessary electronics with appropriate protection devices and an RCD. A digital meter with selector switch displays all thermometric properties and temperatures measured. Corresponding signals are routed to an I/O port for connection to a PC using the Windows™ operating system, via an interface device.***
- ***An optional interface device and educational software package is available.***
- ***A comprehensive instruction manual with a range of fully detailed laboratory teaching exercises is included in the supply.***

OPTIONAL ACCESSORIES

TH-304IFD:
Educational software for TH1-TH5 on a single CD-ROM complete with Data-logger

RECOMMENDED INSTRUMENTS

Barometer: (to determine absolute pressure)

Stop clock: (when not using the optional interface device/educational software)

DC calibrator/thermocouple simulator: (to demonstrate calibration of instrumentation)

Resistance box/PRT simulator: (to demonstrate calibration of instrumentation/ lead errors)

SERVICES REQUIRED

Single phase electrical supply:

TH1-A: 220v/1ph/50Hz @ 13A
TH1-B: 120v/1ph/60Hz @ 20A
TH1-G: 220v/1ph/60Hz @ 13A

Fill with pure water:

Hypsometer: 1 litre
Water bath: 4 litres

Source of ice shavings made from pure water

OVERALL DIMENSIONS

Height:	*0.680m*
Width:	*0.700m*
Depth:	*0.325m*

SHIPPING SPECIFICATION

Volume:	*0.2m³*
Gross weight:	*15kg*

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The TH range for the study of thermodynamics

TH1:	*Temperature Measurement and Calibration*
TH2:	*Pressure Measurement and Calibration*
TH3:	*Saturation Pressure*
TH4:	*Recycle Loops*
TH5:	*Expansion Processes of a Perfect Gas*

Specifications may change without notice
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