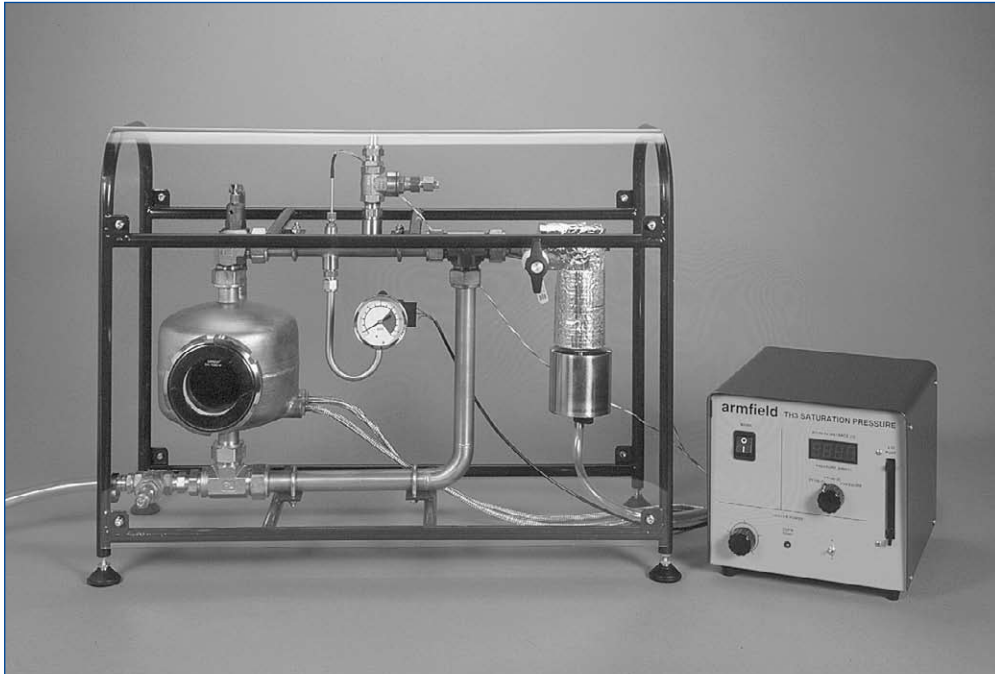




armfield

SATURATION PRESSURE

TH3
issue 3



The Armfield Saturation Pressure Apparatus has been designed to introduce students to how the temperature of water behaves at its boiling point with variation in the absolute pressure.

Saturation curves can be obtained by the student and compared with published steam tables. The quality of steam exiting the apparatus can be determined using a throttling calorimeter connected at the point of discharge.

INSTRUCTIONAL CAPABILITIES

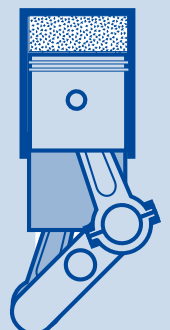
- *Understanding saturation curves and the characteristics of a two phase fluid*
- *Understanding the origin and use of steam tables*
- *Using a throttling calorimeter to determine the quality of wet steam*

KEY FEATURES

- *Measurement of the relationship between temperature and pressure of the saturated vapour in the loop*
- *Convenient control of heat input to the boiler using variable power control*
- *Sight glass in the boiler allows observation of the boiling patterns in the water*
- *Safe operation with pressure relief valve and permanent indication of system pressure*
- *Pressure and temperatures measured can be logged using a PC (optional teaching software available)*

Thermodynamics

T



DETAILED EXPERIMENTAL CAPABILITIES

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

Saturation Loop:

- observation of the patterns of boiling at the surface of the water
- measurement of the temperature of saturated steam over the range of pressures 0 to 7 bar gauge and comparison of the saturation curves obtained with those published in steam tables.
- the concept of a saturation line
- the describing equation and linearisation
- gauge and absolute pressures
- temperature scales
- the characteristic behaviour of a two phase fluid
- the effect of rate of response on the accuracy of measurement

Throttling Calorimeter:

- determination of the condition of the wet steam (quality of the steam) produced by the Saturation Pressure Apparatus at different operating pressures.
- use of the steady flow energy equation
- the two property rule
- use of steam tables
- the difference in enthalpy between phases - enthalpy of vaporisation

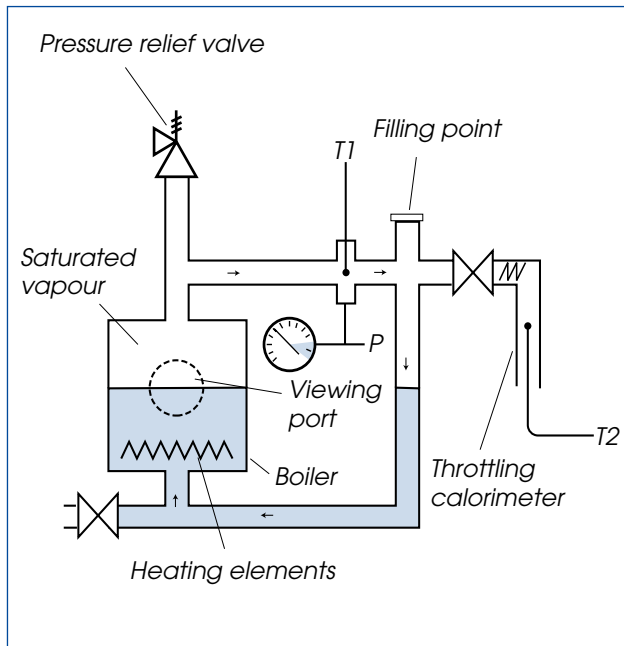
DESCRIPTION

A bench top unit designed to introduce students to the characteristics of saturated water vapour.

The apparatus consists of a rectangular pipe loop incorporating a cylindrical boiler in one vertical limb. Pure water in the boiler is heated to its boiling point using a pair of cartridge heaters with variable power control. A sight glass on the front of the boiler allows the internal processes to be observed, namely boiling patterns at the surface of the water, and also allows the water level in the boiler to be monitored. Saturated steam leaving the top of the boiler passes around the pipe loop before condensing and returning to the base of the boiler for re-heating. The operating range of the boiler and loop is 0 to 7 bar gauge. The top limb of the pipe loop incorporates a PRT temperature sensor and an electronic pressure sensor to measure the properties of the saturated steam. A filling point on the top limb allows the loop to be filled with pure water and allows all air to be vented safely before sealing the loop for pressurised measurements. A vapour offtake, with isolating valve, allows steam from within the loop to be passed through a throttling calorimeter, the purpose of which is to demonstrate how the dryness fraction of the saturated steam in the loop can be determined. The steam expands to atmospheric pressure as it is throttled and a second PRT temperature sensor measures the temperature of the steam following expansion.

The apparatus is designed for safe operation with a pressure relief valve set to operate if the pressure rises above the working pressure and a Bourdon gauge that remains operational when power is disconnected from the electrical console.

All power supplies, signal conditioning, circuitry etc are contained in an electrical console with appropriate current protection devices and an RCD for operator protection. Readings from the sensors are displayed on a common digital meter with selector switch and all corresponding signals are routed to an I/O port for connection to a PC using an optional parallel interface/ educational software package (TH-304IFD).



TH3: Schematic diagram of apparatus

OPTIONAL ARMFIELD ACCESSORIES

TH-304IFD:

Educational software for TH1-TH5 on a single CD-ROM complete with Data-logger

RECOMMENDED INSTRUMENTS

Accurate barometer: (to determine the absolute pressure)

ORDERING SPECIFICATION

- **A bench top unit comprising a boiler vessel and pipe loop with a pressure relief valve to limit the operating pressure to 8 bar gauge. A sight glass on the front of the boiler allows the boiling patterns to be observed and a Bourdon type gauge indicates the pressure in the apparatus at all times for safe operation.**
- **A throttling calorimeter mounted adjacent to the pipe loop allows the condition of the saturated steam to be determined by measuring the temperature of the steam following throttling to atmospheric pressure. Temperatures in the pipe loop and inside the throttling calorimeter are measured using PRT sensors and pressure in the loop is measured using an electronic pressure sensor.**
- **An electrical console houses the necessary electronics with current protection devices and an RCD for operator protection. A digital meter with selector switch displays all sensor measurements. Corresponding signals are routed to an I/O port for connection to a PC. An optional interface device and educational software package is available.**
- **The boiler is heated by a pair of 500 W electric heating elements with variable power control and over-temperature protection.**
- **A comprehensive instruction manual is included with a range of fully detailed laboratory teaching exercises.**

SERVICES REQUIRED

Single phase mains electrical supply:

TH3-A: 220/240V/1ph/50Hz @ 10A

TH3-B: 120V/1ph/60Hz @ 15A

TH3-G: 220V/1ph/60Hz @ 10A

Initial fill with pure water (3 litres) and replenish as consumed

OVERALL DIMENSIONS

Saturation Loop/Throttling Calorimeter

Height: 0.580m

Width: 0.670m

Depth: 0.290m

Electrical Console

Height: 0.215m

Width: 0.225m

Depth: 0.290m

SHIPPING SPECIFICATION

Volume: 0.48m³

Gross Weight: 68kg

Armfield Limited

Bridge House, West Street, Ringwood,
Hampshire BH24 1DY, England

Tel: +44 (0)1425 478781 Fax: +44 (0)1425 470916

E mail: sales@armfield.co.uk

URL: <http://www.armfield.co.uk>

USA Office:

Armfield Inc.

436 West Commodore Blvd (#2)
Jackson NJ 08527

Tel: (732) 928-3332 Fax: (732) 928-3542

E mail: info@armfieldinc.com

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
iss3/5k/0904/San.*