



armfield

EXPANSION PROCESSES OF A PERFECT GAS

TH5
issue 3



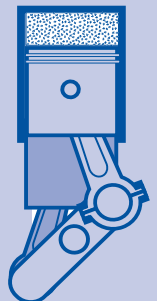
The Armfield Expansion Processes of a Perfect Gas apparatus has been designed to introduce students to a range of basic thermodynamic processes using air as the working fluid.

INSTRUCTIONAL CAPABILITIES

- *analysis of the pressure changes in the processes involves the First Law of Thermodynamics.*
- *the exercises assist the student in understanding the Second Law of Thermodynamics and its corollaries*
- *the relationship between pressure, volume and temperature can be explored and used to determine other thermodynamic properties*
- *the different responses resulting from fast or slow changes in a process and the relationship between the pressure and temperature of air can be observed*

Thermodynamics

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KEY FEATURES

- *interconnected vessels operating under pressure and under vacuum are supplied complete with electric air pump and appropriate instrumentation ready for use.*
- *this modern version of a classic experiment (attributed to Clément and Désormes) allows pressure and temperature changes to be monitored continuously using a PC. (optional teaching software available)*
- *the vessels can be operated singly or in combination allowing processes whereby air flows from a pressurised vessel to atmosphere, from atmosphere to an evacuated vessel or from a pressurised vessel to an evacuated vessel.*

DETAILED CAPABILITIES

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

- *the non-flow energy equation*
- *the behaviour of a perfect gas and its describing equations*
- *an adiabatic reversible process (isentropic expansion)*
- *a constant volume process*
- *an adiabatic irreversible process*
- *conversion of pressure units*
- *a constant internal energy process*
- *polytropic processes, with the limiting case of $n = \gamma$*
- *conversion of pressure units*
- *gauge and absolute pressures*
- *the unsteady-flow energy equation (in vacuum mode)*

DESCRIPTION

The apparatus consists of two floor-standing interconnected rigid vessels, one equipped for operation under pressure and the second under vacuum.

An electrically operate air pump mounted on top of the vessels, together with valves and tappings allows the appropriate vessel to be pressurised or evacuated as required to suit the teaching exercise. The vessels can be used independently or together to allow different thermodynamic processes to be evaluated. A pressure sensor connected to each vessel and a temperature sensor inside each vessel allow the changes in the properties of the air contained within the vessels to be monitored continuously.

Both vessels are constructed from clear rigid plastic which affords light insulation between the air inside the vessel and the surroundings to reduce heating/cooling but allows each vessel and its contents to return to ambient temperature reasonably quickly.

The capacity of the pressurised vessel is approximately 23 litres. The capacity of the evacuated vessel is approximately 11 litres. Each vessel incorporates the following features:

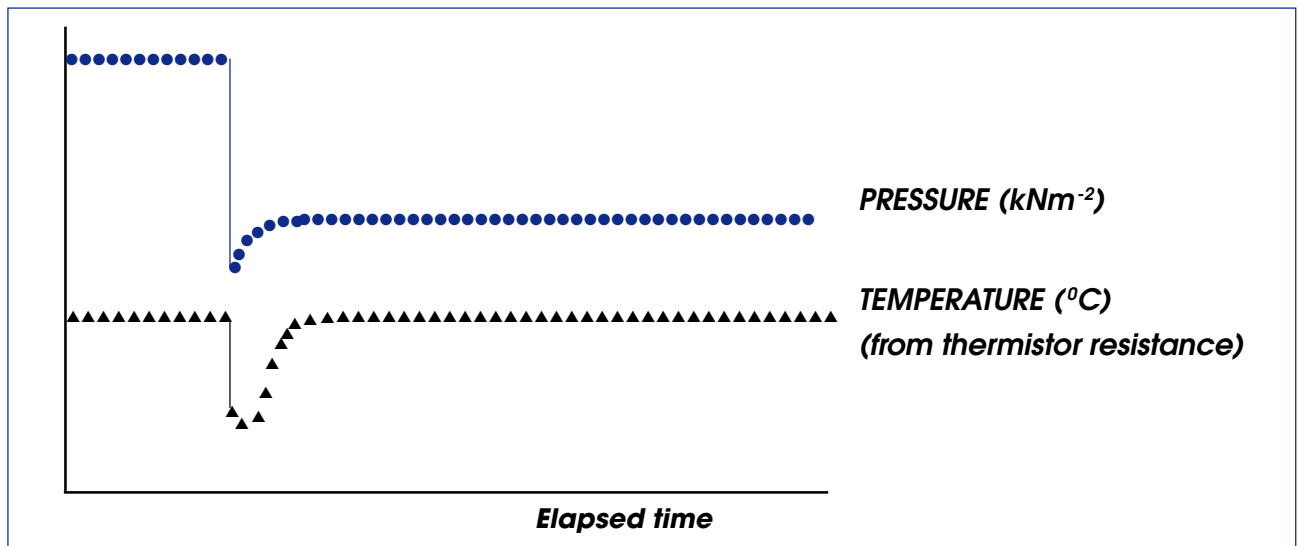
- *connection to the air pump via an isolating valve to allow the vessel to be pressurised/evacuated*
- *connection to a piezo-resistive sensor to measure the pressure/vacuum inside the vessel (range of both sensors $\pm 34.5\text{kN/m}^2$)*
- *connection to a large bore pipe and valve to allow depressurisation/pressurisation of the vessel to/from the atmosphere (the valve is rapidly opened and closed to provide a small step change in pressure)*
- *interconnection between the two vessels via a large bore pipe and valve (fast change) and small bore pipe and needle valve (gradual change).*

- *fast response thermistor to monitor air temperature inside the vessel*
- *relief valve to prevent over-pressurisation*

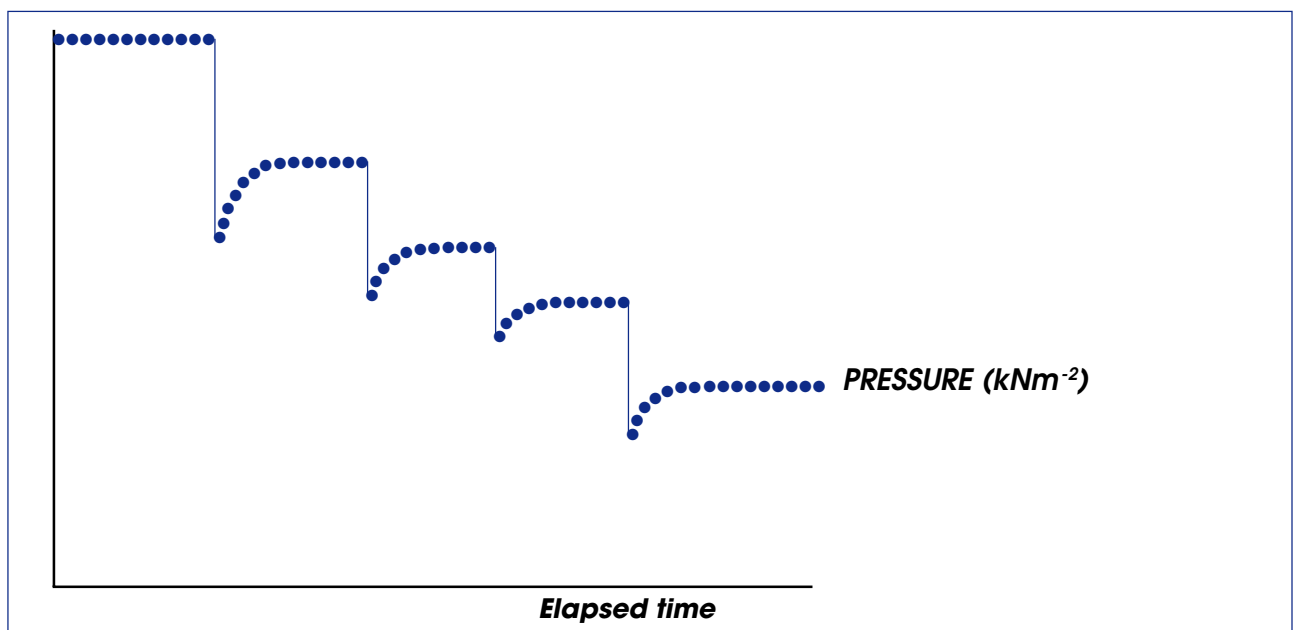
All power supplies, signal conditioning circuitry etc are contained in a simple electrical console with appropriate current protection devices and an RCD for operator protection. The console is designed to stand on a bench top above the pressure and vacuum vessels and incorporates electrical connections for the air pump and sensors.

Readings from the pressure sensors and thermistors are displayed on a common digital meter with selector switch on the front of the console. All signals are simultaneously connected to an I/O Port for connection to a PC with USB port using an optional interface device and educational software package (TH-304IFD) or a user supplied chart recorder as required.

As the teaching exercises require the transient pressure and temperature responses to be observed and recorded one of these recording options is necessary.



Response of the pressurised vessel following a brief depressurisation



Response of the pressurised vessel following stepwise depressurisation

ORDERING SPECIFICATION

- *A small scale unit designed to introduce students to the properties of a perfect gas using air to demonstrate basic thermodynamic processes.*
- *The hardware consists of two floor-standing interconnected rigid vessels, one equipped for operation under pressure and the second under vacuum. Appropriate valves and tappings are fitted to allow different thermodynamic processes to be evaluated. An electric air pump is supplied to allow pressurisation or evacuation of the vessels as required for the different exercises. Each vessel incorporates a fast response thermistor sensor to monitor the temperature of the air and connection to a piezo electric pressure sensor.*
- *All power supplies, signal conditioning circuitry etc are contained in a simple electrical console with appropriate current protection devices and an RCD for operator protection. Readings from the pressure sensors and thermistors are displayed on a common digital meter with selector switch and corresponding signals are routed to an I/O port for connection to a PC using an optional interface device/educational software package or a user supplied chart recorder as required.*

- *A comprehensive instruction booklet describing how to carry out the laboratory teaching exercises is included.*

OPTIONAL ACCESSORIES

TH-304IFD:

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

RECOMMENDED INSTRUMENTS

Barometer to determine the atmospheric pressure

SERVICES REQUIRED

Single phase mains electrical supply:-

TH5-A: 220/240V/1ph/50Hz @ 3 Amps

TH5-B: 120V/1ph/60Hz @ 5 Amps

TH5-G: 220V/1ph/60Hz @ 3 Amps

OVERALL DIMENSIONS

Vessel Assembly:

Height: 800mm

Width: 460mm

Depth: 280mm

Electrical Console:

Height: 220mm

Width: 220mm

Depth: 300mm

SHIPPING SPECIFICATION

Volume: 0.34m³

Gross Weight: 22kg

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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
iss3/5k/1102/B&S.*