

## Fluid Friction Measurements – C6-MKII-10

The Armfield C6-MKII-10 Fluid Friction Measurements unit provides facilities for the detailed study of fluid friction head losses, which occur when an incompressible fluid flows through pipes, fittings and flow metering devices.

**DATA LOGGING & COMPUTER AIDED EDUCATIONAL SOFTWARE AVAILABLE**



**F1-10 Hydraulics Bench**

The unit is designed for use with Armfield F1-10 series of benches

**C6-MKII Test pipes samples, Perspex Venturi and Orifice Plate**

### Experimental content

A wide range of measurements, demonstrations and training exercises are possible with the equipment:

- ▶ Confirming the relationship between head loss due to fluid friction and velocity for flow of water
- ▶ Determining the head loss associated with flow through a variety of standard pipe fittings
- ▶ Determining the relationship between pipe friction coefficients and Reynolds' number for flow through a pipe with roughened bore
- ▶ Demonstrating the application of differential head devices in the measurement of flow rate and velocity
- ▶ Providing practical training of pressure measurement techniques
- ▶ Enhancing understanding of the hydraulic principles involved through the use of complementary computer software

## Description

Pipe friction is one of the classic laboratory experiments and has always found a place in the practical teaching of fluid mechanics.

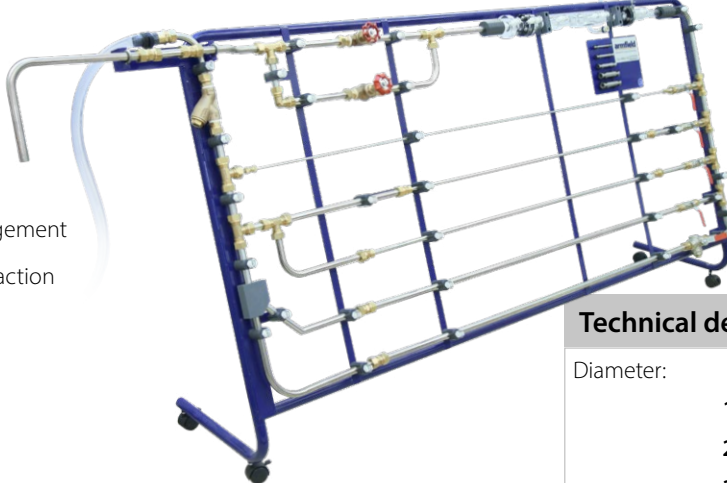
With this unit, friction head losses in straight pipes of very different sizes can be investigated over a range of Reynolds' numbers from  $10^3$  to nearly  $10^5$ . This covers the laminar, transitional and turbulent flow regimes in smooth pipes.

In addition an artificially roughened pipe is supplied, which at the higher Reynolds' numbers shows a clear departure from the typical smooth bore pipe characteristics.

In addition to the equipment for the study of losses in straight pipes, a wide range of accessories are included such as pipe fittings and control valves, a Venturi tube, an orifice plate assembly and a Pitot tube.

**An arrangement of six pipes provides facilities for testing the following:**

- ▶ Four smooth bore pipes of different diameters
- ▶ Artificially roughened pipe
- ▶ 90° bends (large & small radii)
- ▶ 90° elbow
- ▶ 90° mitre
- ▶ 45° elbow
- ▶ 45°Y
- ▶ 90°T
- ▶ Sudden enlargement
- ▶ Sudden contraction
- ▶ Gate valve
- ▶ Globe valve
- ▶ Ball valve
- ▶ Inline strainer
- ▶ Perspex venturi
- ▶ Perspex orifice meter
- ▶ Perspex pipe section with a pitot tube & static tapping



Short samples of each size test pipe are provided loose so that the students can measure the exact diameter and determine the nature of the internal finish.

The ratio of the pipe diameter to the distance of the pressure tapplings from the ends of each pipe has been selected to minimise end and entry effects. A system of isolating valves is provided whereby the pipe to be tested can be selected without disconnecting or draining the system. This arrangement enables tests to be conducted on parallel pipe configurations.

An optional floor-standing Hydraulics Bench incorporates a sump tank and volumetric flow measurement facility. Rapid and accurate flow measurement is possible over the full working range of the apparatus.

The level rise in the measuring tank is determined by an independent sight gauge. A 250ml capacity glass measuring cylinder is supplied for measuring the flow rate under laminar conditions (very low flows).

Each pressure tapping is fitted with a quick action self-sealing connection. Probe attachments with an adequate quantity of translucent polythene tubing are provided so that any pair of pressure tapplings can be rapidly connected.

All the test pipes and fixed interconnecting pipes are fabricated in stainless steel.

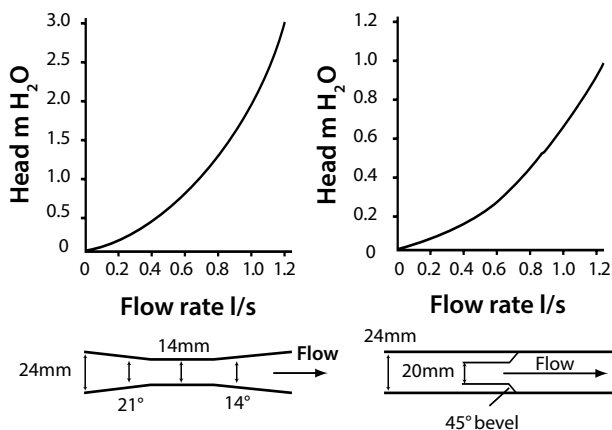
### Technical details for test pipes:

Diameter:

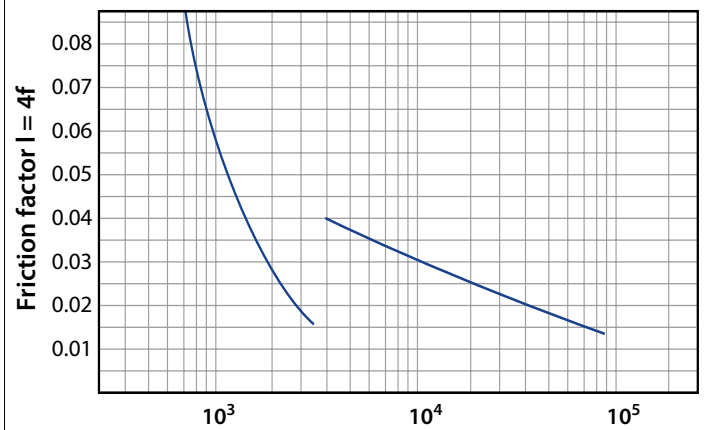
1. 6.4mm OD x 4.5mm ID
2. 9.5mm OD x 7.7mm ID
3. 12.7mm OD x 10.9mm ID
4. 19.1mm OD x 17.2mm ID
5. 19.1mm OD x 17.2mm ID (Roughened)

Distance between tapplings: 1m

Number of tapping points: 38



Examples of typical results obtained by comparing test data with published results



Moody diagram obtained from typical results



## Ordering options

In order to complete the full range of experiments possible with the C6MkII, it is necessary to measure pressures over a greater range than a single instrument can provide.

Armfield recommend the use of a water manometer for the low-pressure measurements and an electronic pressure meter for the high-pressure measurements.

### Order Codes:

- ▶ H12-2: Liquid manometer (water)
- ▶ H12-8: Portable pressure meter (electronic)

Also available for use with data acquisition instruments is a software package, which performs all the necessary calculations from readings entered manually.

### Order code:

- ▶ C6-MkII-ABASIC: Educational software for fluid friction measurements (manual data entry)
- ▶ Automatic Data Acquisition  
C6-MkII-DTA-ALITE: Computer Data Capture Unit

The C6-MkII-DTA-ALITE is a small data logging unit, which enables the recording of data to a suitable PC (not supplied).

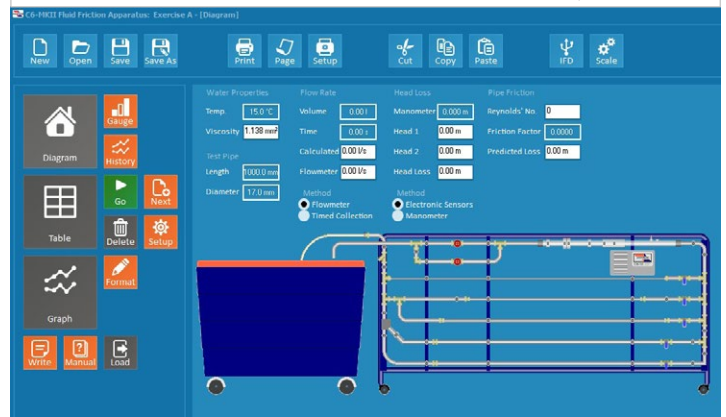
The unit comprises an interface device with USB port and cable, a turbine-type flow meter complete with associated pipework, and two independent pressure sensors with quick-release fittings.

The 32/64-bit compatible software features real-time data display on a mimic diagram of the apparatus, tabular and graphical display of logged data and calculated parameters, plus full educational help texts detailing operational procedures and practical exercises.

**Note:** The electrical sensors supplied with the C6MkII have been selected to measure over the full range of the C6 pressures and flow rates. However, in order to obtain accurate results at very low flows or differential pressures, it may be necessary to use a volumetric flow measurement method and/or a pressurised water manometer.

## Minimum computer requirements

The C6-MkII-ABASIC and the C6-MkII-DTA-ALITE require a PC, running Windows 7 or above and a spare USB port (not supplied by Armfield).



C6MKII Software diagram screen (above) Exercise table (below)



## Ordering options

### ► C6-MkII-10: Basic Fluid Friction Measurements

This comprises the framework containing the pipes and fittings. It requires an Armfield F1-10 Hydraulics Bench plus an instrumentation system (see below).

## Optional accessories

H12-8: Digital Pressure Meter

H12-2: Liquid Manometer

C6-MkII-A-BASIC: Education software for manual data entry

C6-MkII-DTA-ALITE: Data logging accessory with software for C6-MkII



**F1-10-2 Hydraulics Bench**  
With digital flow meter

## Complementary products

C1-MkII: Compressible Flow Bench

C2: Subsonic Wind Tunnel

C3-MkII: Multi-pump Test Rig

C4-MkII: Multi-purpose Flume

C7-MkII: Pipe Surge and Water Hammer

C9: Flow Meter Demonstration Unit

C10: Laminar Flow Table

C11-MkII: Flow in Pipe Networks

F1-18: Energy Losses in Pipes

F1-21: Flow Meter Demonstration

F1-22: Energy Losses in Bends

## Overall dimensions

### Dimensions C6MKII-10

Length	1.10m
Width	2.25m
Height	0.43m

### Packed and crated shipping specifications

Volume	1.4m <sup>3</sup>
Gross weight	165Kg

## Requirements

## Scale

F1-10 PC USB



Electrical supply: The F1-10 requires an electrical supply, please refer to the F1 data sheet for details.

- F1-10-A: 220-240V / 1ph / 50Hz / 10A
- F1-10-B: 110-120V / 1ph / 60Hz / 10A
- F1-10-G: 220V / 1ph / 60Hz / 10A
- F1-10-2-A: 220-240V / 1ph / 50Hz / 10A
- F1-10-2-B: 110-120V / 1ph / 60Hz / 10A
- F1-10-2-G: 220V / 1ph / 60Hz / 10A

## Recommended instruments

Stop watch

Vernier calliper

## Ordering specification

- A unit for the detailed study of fluid friction head losses, which occur when an incompressible fluid flows through pipes, fittings and flow metering devices
- A substantial floor-standing tubular steel frame supports test circuits comprising:
  - Four smooth-bore pipes of different diameters ranging from 4.5mm ID to 17.2mm ID
  - Artificially roughened pipe
  - 90° bends (large & small radii)
  - 90° elbow
  - 90° mitre
  - 45° elbow, 45°Y, 90°T
  - Sudden enlargement
  - Sudden contraction
  - Gate valve
  - Globe valve
  - Ball valve
  - Inline strainer
  - Perspex venturi
  - Perspex orifice meter
  - Perspex pipe section with a pitot tube & static tapping
  - 38 tapping points
- All fixed pipes fabricated in stainless steel
- Suitable for studying Reynolds' numbers from 10<sup>3</sup> to nearly 10<sup>5</sup>
- A system of isolating valves, quick-release manometer connection valves and self-sealing pressure tappings ensure fast, accurate results
- Data logging accessory available
- Computer aided learning program available
- A user instruction manual provides installation, commissioning and maintenance data, together with student exercises
- The unit is designed for use with a Hydraulics Bench (F1-10)

## Ordering codes

C6MkII-10: Basic Fluid Friction Measurements

**Armfield standard warranty applies with this product**

## Knowledge base

- > 30 years expertise in research & development technology
- > 52 years providing engaging engineering teaching equipment

Benefit from our experience, just call or email to discuss your laboratory needs, latest project or application.

An ISO 9001:2015 Company



**armfield.co.uk**

## Aftercare

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