



armfield

FLUID FRICTION MEASUREMENTS

C6MkII

issue 2



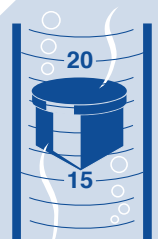
The Armfield Fluid Friction Measurements unit provides facilities for the detailed study of fluid friction head losses which occur when an incompressible fluid flows through pipes, fittings and flow metering devices. The unit is designed for use with the Armfield F1-10 Hydraulics bench.

INSTRUCTIONAL CAPABILITIES

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*

Applied Fluid Mechanics



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 , thereby covering 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 standard including 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:

- 4 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 tapings 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. The arrangement allows 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 quick action self-sealing connections. Probe attachments with an adequate quantity of translucent polythene tubing are provided so that any pair of pressure tapings can be rapidly connected.

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

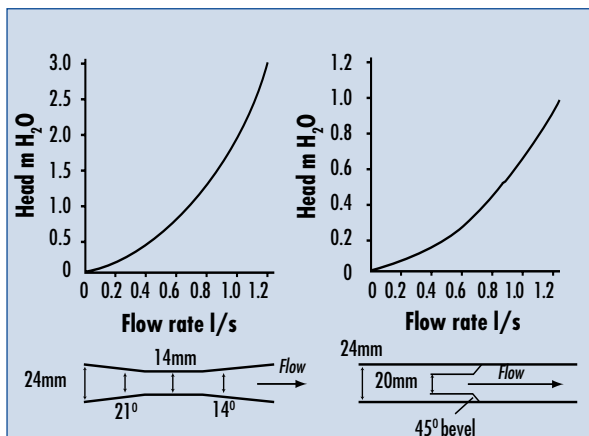
TECHNICAL DETAILS

Test pipes:

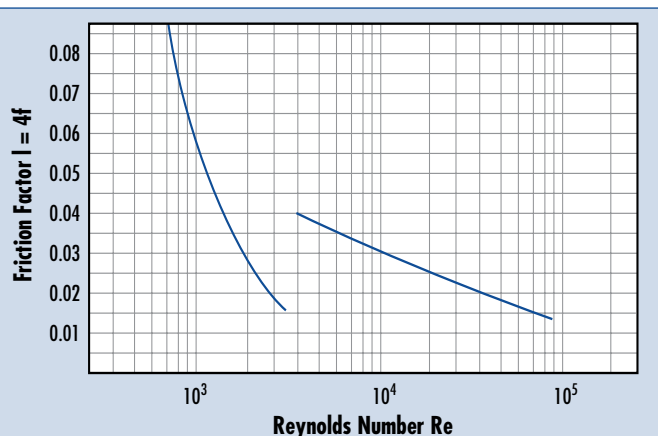
- Diameter:
1. 19.1mm O.D. x 17.2mm I.D.
 2. 12.7mm O.D. x 10.9mm I.D.
 3. 9.5mm O.D. x 7.7mm I.D.
 4. 6.4mm O.D. x 4.5mm I.D.
 5. 19.1mm O.D. x 15.2mm I.D. (Roughened)

Distance between tapings: 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

C6MKII-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).

C6MKII: Fluid Friction Measurements

This comprises the C6MKII-10 described above, plus a hydraulics bench. An instrumentation option is required (see below).

INSTRUMENTATION OPTIONS

Manual Data Acquisition

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: One metre pressurised water manometer

H12-8: Hand held digital pressure meter

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

Order code:

C6-301: Educational software (manual data entry)

Automatic Data Acquisition

C6-50: Computer data capture unit

The C6-50 is a small data logging unit which allows the recording of data to a suitable P.C. (not supplied). The unit comprises an interface device with USB Port and cable, a turbine type flowmeter complete with associated pipework, and two independent pressure sensors with quick release fittings.

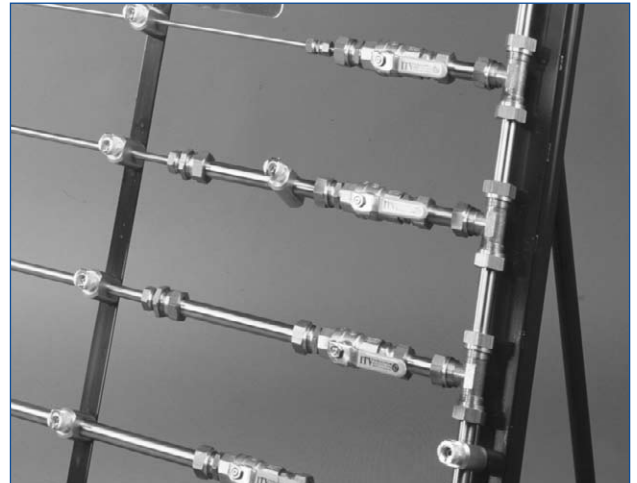
The software features real-time data display on a 'mimic diagram' of the apparatus, tabular and graphical display of logged data and calculated parameters, plus full educational help texts detailing operational procedures and practical exercises.

***Note:** The electrical sensors supplied with the C6-50 have been selected to measure over the full range of the C6 pressures and flowrates. 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.

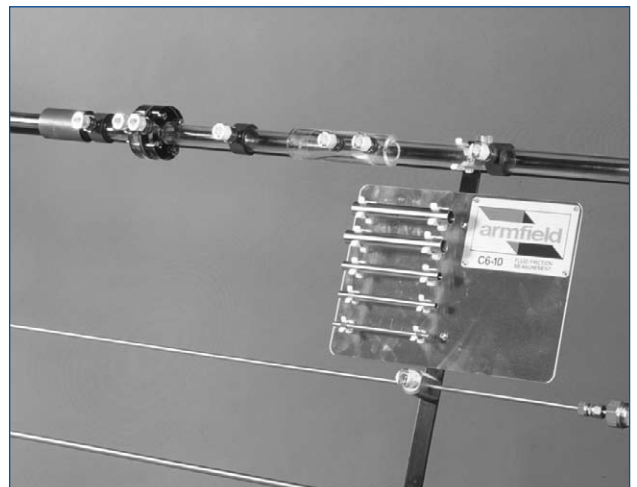
MINIMUM COMPUTER REQUIREMENTS

The C6-MkII-301 and the C6-50 require a Windows PC (not supplied by Armfield).

The PC must use Windows 98, ME, 2000 or XP as the operating system. The C6-50 also requires a USB port.



Control valves and pressure tapings



Clear acrylic pipe section and test pipe samples

COMPLEMENTARY PRODUCTS

C1:	Compressible Flow Bench
C2:	Subsonic Wind Tunnel
C3:	Multi-pump Test Rig
C4:	Multi-purpose Flume
C7:	Pipe Surge and Water Hammer
C9:	Flow Meter Demonstration Unit
C10:	Laminar Flow Table
C11:	Flow in Pipe Networks
F1-18:	Energy Losses in Pipes
F1-21:	Flow Meter Demonstration
F1-22:	Energy Losses in Bends
F1-18-301:	Windows Program for F1-18 Energy Losses in Pipes
F1-21-301:	Windows Program for F1-21 Flow Meter Demonstration
F1-22-301:	Windows Program for F1-22 Energy Losses in Bends

RECOMMENDED INSTRUMENTS

Stop watch
Vernier caliper

OPTIONAL ACCESSORIES

F1-10:	Hydraulics bench
H12-8:	Digital pressure meter
H12-2:	1m pressurised water manometer
C6-301:	Education software for manual data entry
C6-50:	Data logging accessory with software

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:
 - 4 smooth-bore pipes of different diameters ranging from 4.5mm I.D. to 17.2mm I.D.
 - 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 10^3 to nearly 10^5
- 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 the F1-10 hydraulics bench

OVERALL DIMENSIONS

C6MkII-10	Height:	1.10m
	Width:	2.25m
	Depth:	0.43m

SHIPPING SPECIFICATION

C6MkII-10	Gross Weight:	165Kg
	Volume:	1.4m ³
C6MkII	Gross Weight:	325Kg
	Volume:	2.9m ³

ARMSOFT Armfield software

For further details of the comprehensive capabilities of Armfield software please visit:
www.discoverarmfield.co.uk/data/armsoft

Specifications may change without notice
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