

HYDROGEN BUBBLE FLOW VISUALISATION SYSTEM – F14MkII



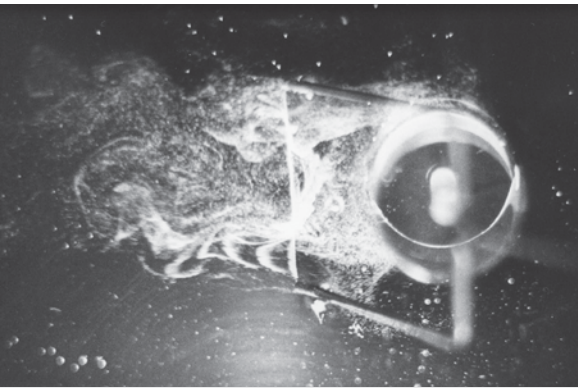
DEMONSTRATION CAPABILITIES

- > visualisation of two-dimensional flow using hydrogen bubbles
- > observation of flow around standard shapes (cylinder, aerofoil etc)
- > analogy to aerodynamic flow
- > understanding laminar and turbulent flow
- > demonstration of boundary layer growth
- > demonstration of boundary layer separation and eddy formation
- > quantitative analysis of flow patterns using pulsed bubbles
- > observation of flow around user created models (project work)
- > large scale presentations/recording of patterns using a video camera or web cam (not supplied)

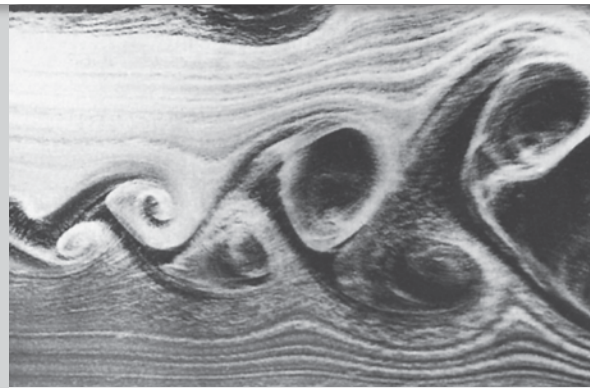
The Armfield Hydrogen Bubble Flow Visualisation System has been designed to allow viewing of the complex flow patterns associated with water flowing past solid objects or boundaries. The hydrogen bubble technique is highly visual and is particularly useful for laboratory and lecture theatre work. A stream of small hydrogen bubbles accurately follows the water and clearly shows any changes in the direction of the water as it flows around objects in its path.

The MkII version of the F14 includes a smaller electronic control console that incorporates improved digital controls and a low voltage LED lighting module that gives improved illumination of the bubbles for clearer demonstrations. Changes in the design of the bubble generator allow the system to be operated without the need for conditioning of the water using salts.





Electrolysis of hydrogen bubbles in water



Karman Vortex street behind a cylinder

DESCRIPTION

The Armfield Hydrogen Bubble Flow Visualisation System is compact, bench mounted and self-contained requiring only filling with water and connecting to a mains electrical supply.

It comprises a flow tank, a separate electronic control console and a comprehensive set of clear acrylic flow visualisation models.

The top of the flow tank is manufactured from GRP for durability and incorporates a wide, shallow working section with a flat black acrylic bed for flow visualisation studies. A smooth flow of water at variable velocity is passed through the working section. This is achieved by using a unique fluid drive unit, in combination with flow straighteners. The depth in the working section can be changed by a set of weir strips at the discharge end.

A number of acrylic models are provided with the equipment, such as an aerofoil section and cylinders of different diameter. These can be positioned in the working section to show the flow effects around these shapes. User defined models can also be used.

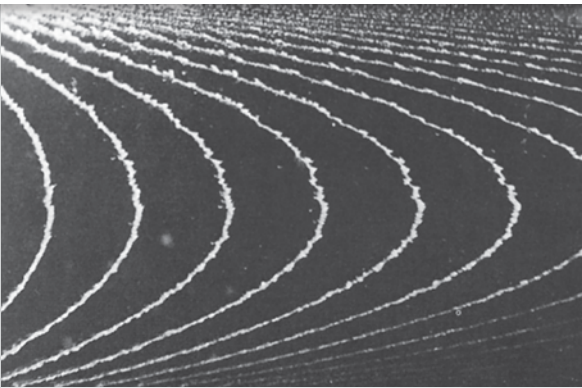
A lighting module, placed in the water at the side of the working section, produces a wide beam of light below the surface of the water and illuminates the hydrogen bubbles to aid visualisation of the flow patterns.

The hydrogen bubbles are produced by a fine platinum/iridium cathode wire located under the surface of the water and normal to the direction of flow. The wire is kept taut by a forked holder (supplied in three widths) and is held in the required position by an adjustable support tripod. Hydrogen bubbles can be produced using plain tap water, however Glauber's salt is also supplied with the unit for more detailed studies.

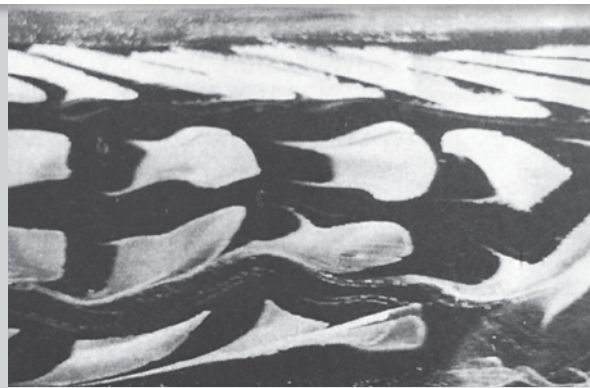
The electronic control console provides all of the necessary electrical services for the flow tank and incorporates the hydrogen bubble generator. All operating parameters are displayed on a liquid crystal display. Controls are included for the water pump, light source and hydrogen bubble generator.

The size of the hydrogen bubbles can be varied by adjusting the current to the cathode wire. The generator automatically maintains the current at the required value by varying the supply voltage to compensate for changes in the loop resistance.

The generator can produce a continuous stream of bubbles if required. However to aid visualisation and enable quantitative measurements to be made the bubbles can be turned 'on' and 'off' in a series of pulses, the pulses and spaces being independently and continuously variable with both times indicated on the display.



Laminar velocity profiles in a rectangular duct



Turbulent flow in a rectangular duct

TECHNICAL SPECIFICATION

The supplied software allows remote operation of the F14-MkII electronic control console via a PC (not supplied). This software allows all the control functions to be implemented by the PC, and provides the facility to save a number of set-up strategies. These can be immediately recalled at a later date to simplify the use of the equipment.

Pulse generator: 3 to 2500 mS
on and off periods

Light source: 12 high intensity LEDs

Cathodes: 35, 50 and 75mm lengths

Flow tank capacity: 20 litres (nominal)

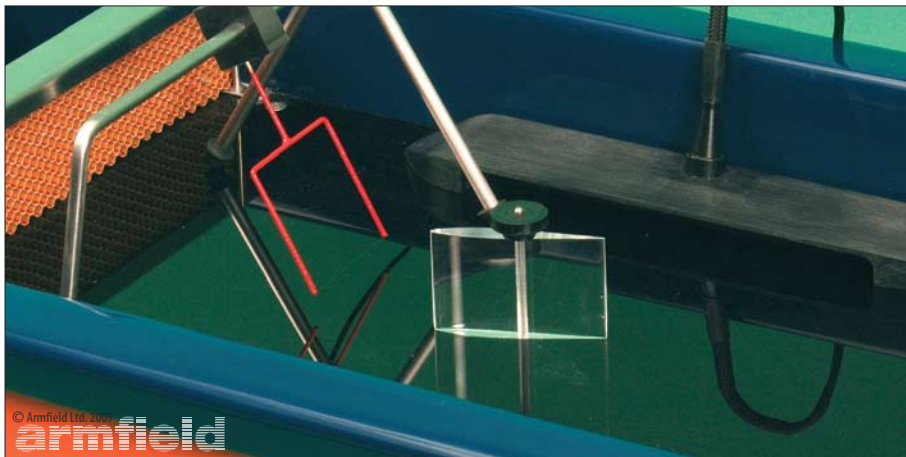
Range of current generator:
0 to 100mA

Working section dimensions:

Length: 0.425m

Width: 0.285m

Depth: 0.036m



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Hydrogen Bubble Flow Visualisation System

OPTIONAL ACCESSORIES

F14-MkII-11: Camera Bracket

The accessory enhances the use of the F14-MkII, by providing a mounting frame for a camera, allowing a still camera, video camera or web-cam to record the flow patterns.

REQUIREMENTS

Electrical supply:

F14-MkII-A: 230V/1ph/50Hz, 2 Amps

F14-MkII-B: 120V/1ph/60Hz, 5 Amps

F14-MkII-G: 220V/1ph/60Hz, 2 Amps

Water:

Fill with clean water.

No permanent connection required.

OVERALL DIMENSIONS

Electrical console:

Height: 0.100m

Width: 0.260m

Depth: 0.310m

Flow tank:

Height: 0.225m (Tank only)

Width: 0.845m

Depth: 0.400m

SHIPPING SPECIFICATION

Volume 1.2m³

Gross weight 150kg

COMPLEMENTARY PRODUCTS

F1: Hydraulics Bench & Accessories with:

F1-301: Computer Aided Learning Programs

F4: Precision Pressure Gauge Calibrator

F5: Osborne Reynolds Demonstration

F6: Air Flow Studies

F9092: Fluid Properties & Hydrostatics Bench

F1-28: Cavitation Demonstration

F12: Particle Drag Coefficients

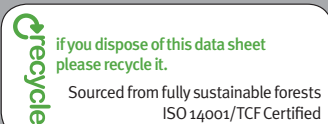
C10: Laminar Flow Analysis Table

C15: Computer Controlled Wind Tunnel

S2: Mobile Bed & Flow Visualisation Tank

ORDERING SPECIFICATION

- A compact, bench mounted, self-contained unit used for flow visualisation studies using water as the working fluid.
- The unit comprises a flow tank incorporating the working section and pumped recirculation system, plus a separate electronic control console.
- A low voltage variable speed pump with a unique fluid-drive unit is located under the working section.
- The electronic control console incorporates manual controls and a 4 line, 20 digit LCD that displays the relevant operating parameters.
- Flow patterns in the water are indicated by small hydrogen bubbles that are generated by an interchangeable fine platinum/iridium wire cathode.
- A low voltage light source illuminates the hydrogen bubbles in the working section.
- Flow visualisation studies can be carried out using plain tap water without the need for additives.
- Optional camera mount allows still camera, video camera or web-cam (not supplied) to record the flow patterns.
- The following models, supplied for flow visualisation studies, are made of clear polished acrylic and supplied in a protective container:
 - One pair 330mm long straight guides
 - One pair spacer blocks for straight guides (grey PVC)
 - One pair blocks with radiused ends
 - Four cylinders 6mm, 12mm, 19mm and 25mm diameter
 - One aerofoil section
 - One flat plate with radiused end
 - One rectangular block 70mm x 40mm x 25mm
 - One curved plate
- A toolkit is supplied
- A user instruction manual provides installation, commissioning, maintenance data, experimental information and suggested flow visualisation demonstrations.



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