armfield

PIPE SURGE AND WATER HAMMER APPARATUS

C7
issue 11

Pipe surge and water hammer are two related but independent phenomena which arise when fluid flowing in a pipe is accelerated or decelerated. The associated pressure transients can be damaging to pipework or components and systems must be designed to avoid or withstand them.

The equipment designed by Armfield clearly demonstrates the different effects resulting from gradual or instantaneous changes in fluid velocity (created by slow and fast valve closure). Effect of initial fluid velocity can also be investigated.

Pipe surge resulting from a gradual change in fluid velocity is clearly seen as fluctuating changes in head in a surge shaft.

Water hammer resulting from a rapid change in fluid velocity is clearly seen as large changes in pressure monitored using a pair of transducers and indicated using an oscilloscope.

DEMONSTRATION CAPABILITIES

- *demonstration of pipe surge*
- *determination of oscillatory characteristics of the surge shaft*
- *demonstration of frictional head loss between reservoir and surge shaft*
- *comparison between theoretical and measured pressure profiles produced by water hammer*
- *using a dual trace storage oscilloscope to record transient water hammer pressure profiles*
- *measuring the pressure profile characteristics*
- *determination of the velocity of sound through a fluid in a pipe*
- *demonstration of the effects of cavitation on subsequent cycles.*

Applied Fluid Mechanics

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DESCRIPTION

The equipment comprises two stainless steel pipes connected to a constant head tank. A service module provides the water supply to the head tank and also incorporates a volumetric tank for flow rate measurement, sump tank, circulating pump and flow control valve.

Water enters the two test pipes via the constant head tank and discharges into the volumetric tank. A dump valve in the volumetric tank returns the water to the sump tank.

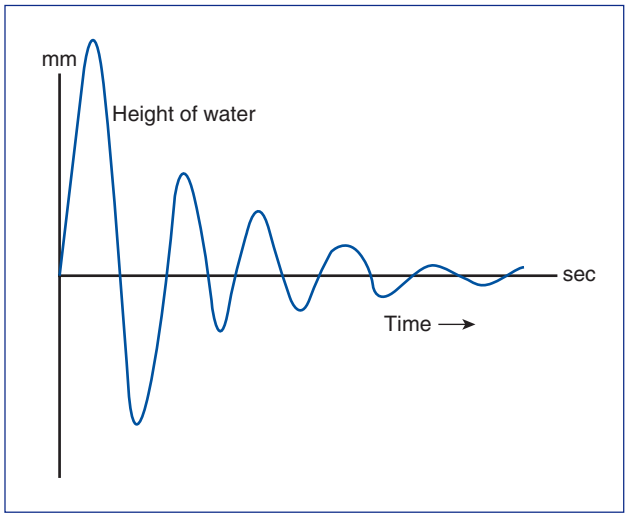
The pipe surge test section incorporates a clear acrylic surge shaft to enable visualisation of its oscillatory characteristics to be demonstrated. A metric scale on the shaft permits the height of the oscillations to be measured. The test pipe terminates with a lever operated gate valve and separate flow control valve.

The water hammer test section uses a unique fast acting valve specifically designed by Armfield.

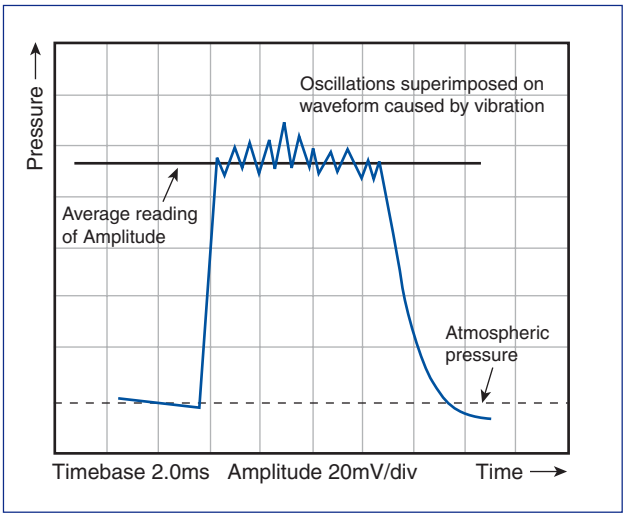
A moving shuttle within the valve travels with the water flow, thereby enabling a very high closure rate to be obtained. The valve can easily be operated simply by pressing the valve release button, and a spring loaded plunger re-sets it for further use. Straight pipes are used, rather than a coiled arrangement, to reduce the distortion of the pressure wave.

Pressure transducers mounted at the fast acting valve itself and at a point along the test pipe provide analogue outputs which are fed into a signal conditioning module. The corresponding output voltage from the signal conditioning module can then be fed into a dual trace oscilloscope (C7-11A). A Centronics printer output is available from the oscilloscope. This allows the stored display to be transferred onto a suitable printer (C7-12) to provide a hard copy of the transient.

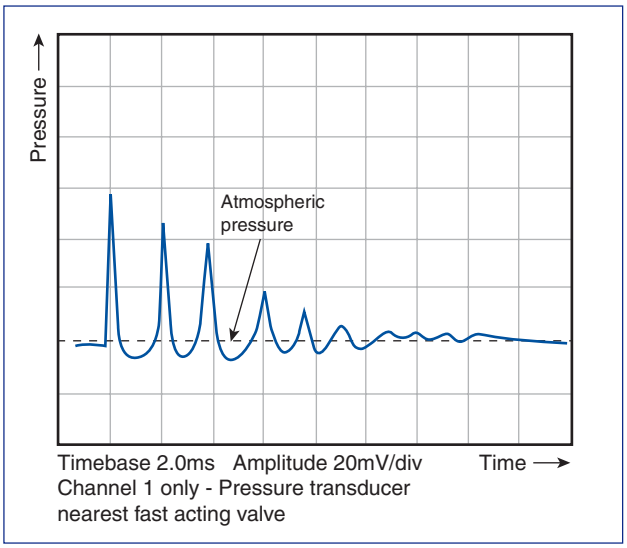
The pipe surge (C7-10) part of the apparatus may be ordered separately, with the water hammer (C7-11) being added at a later stage if required.



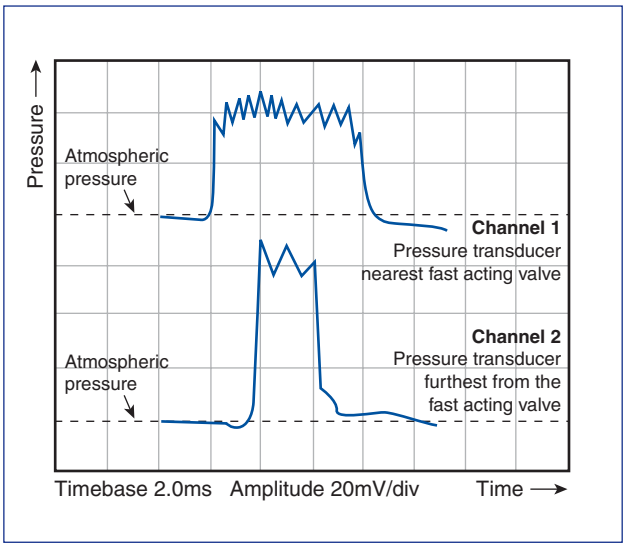
Observed oscillations in surge shaft



Graph of pressure head against time following sudden closure of the valve



Pressure-time diagram showing cyclic nature of pressure pulses with decay due to friction



Using pressure-time diagrams to determine velocity of sound in the test pipe

TECHNICAL DETAILS

C7-10:

Pipe surge test pipe:	*stainless steel 22mm I/D x 3m long*
Surge shaft :	*clear acrylic 40mm I/D x 800mm H*
Service pump:	*centrifugal type, delivering 1.35 litres/sec at 3m H_20*
Flow rate measurement:	*volumetric tank, stepped 0-40 litre high flows 0-6 litre low flows*
Head tank:	*capacity 45 litres made from PVC.*

C7-11:

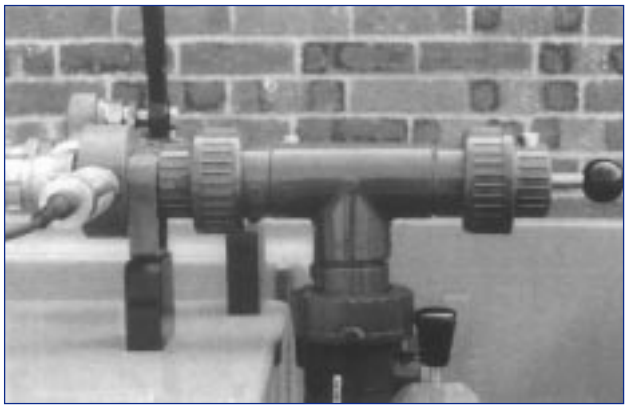
Water hammer test pipe:	*stainless steel 22mm I/D x 3m long*
Pressure transducers:	*2 off range 1 to 69 bar, (13.5 bar max operating) $^1/_4$" BSP connections*

C7-11A:

Oscilloscope	*dual trace storage oscilloscope*

C7-12:

Printer	*with Centronics interface for use with C7-11A*



Fast acting valve and pressure transducer

ORDERING SPECIFICATION C7-10, C7-11, C7-11A

- ***A self-contained unit designed to demonstrate the phenomena of pipe surge and water hammer.***
- ***The unit includes two separate test pipes, service module and constant head tank.***
- ***Two pressure transducers provide electrical signals for connection to a dual trace storage oscilloscope with an integral printer output.***
- ***Straight pipes are used, rather than a coiled arrangement, to reduce distortion of the pressure wave.***

ORDERING OPTIONS

C7-10:	*Self-contained pipe surge apparatus only*
C7-11:	*Water hammer apparatus, additional to C7-10*
C7-11A:	*Oscilloscope for C7-11*
C7-12:	*Printer for C7-11A*

SERVICES REQUIRED

Electrical supply:

C7-10-A:	*220-240V/1ph/50Hz*
C7-10-B:	*120V/1ph/60Hz*
C7-10-G:	*220-240V/1ph/60Hz*
C7-11-A:	*220-240V/1ph/50Hz*
C7-11-B:	*120V/1ph/60Hz*
C7-11-G:	*220-240V/1ph/60Hz*
C7-11A:	*120-240V/1ph/50 or 60Hz*
C7-12-A:	*220-240V/1ph/50Hz*
C7-12-B:	*120V/1ph/60Hz*
C7-12-G:	*220-240V/1PH/60HZ*

OVERALL DIMENSIONS

Height:	*1.865m*
Length:	*3.875m*
Depth:	*0.725m*

SHIPPING SPECIFICATION

C7-10:

Volume:	*2.5m^3*
Gross weight:	*300kg*

C7-11:

Volume:	*0.5m^3*
Gross weight:	*20kg*

C7-11A:

Volume:	*0.1m^3*
Gross weight:	*10kg*

C7-12:

Volume:	*0.1m^3*
Gross weight:	*10kg*

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