C SERIES

Compressible Flow Unit – C1-MKIII

The C1-MKIII Compressible Flow Unit has been developed jointly between Armfield Ltd and an experienced lecturer in mechanical engineering of **Reading College of Technology**.

The unit serves to introduce users to all the basic concepts of compressible flow through a number of experimental procedures with a variety of interchangeable clear acrylic test sections.

Project work: Students may devise additional experiments using the equipment as a project work exercise. Examples are provided

IMPROVED BLOWER WITH INTEGRAL MOTOR GIVING INCREASED EFFICIENCY AND REDUCED NOISE

C1-MKIII Compressible Flow Unit Software Package

Experimental content

- Demonstrate the phenomenon of 'choking' in a convergent/divergent duct
- Investigate the validity of the isentropic flow equations for compressible flow in a convergent duct
- Demonstrate the effect of compressibility on flow equations for a convergent duct
- To deduce a value of Specific Heat Ratio (γ) for air using the equation for isentropic flow in a convergent duct
- Investigate pressure recovery along a divergent duct by measuring duct efficiency
- Investigate the relation between friction loss & velocity for incompressible flow and to find an approximate value for the friction coefficient
- To investigate the relation between the friction coefficient and the Reynolds number for a given pipe
- Determine the friction coefficient for a case of compressible flow
- Investigate the relation between the pressure recovery across a sudden enlargement and upstream flow velocity, assuming incompressible flow
- To determine the coefficient of discharge
- Investigate the validity of the formula for the pressure rise across a sudden enlargement for compressible flow
- To investigate, for incompressible flow, the relation between the flow rate through and the pressure drop across, a pipeline orifice.
- To determine the relationship between the coefficient of discharge and the ratio (n) for the pipeline orifice
- Investigate the effects of compressibility on discharge coefficients
- To investigate the variation of pressure rise, power input and isothermal efficiencies of a centrifugal compressor with mass flow rate at constant speed
- Produce a performance characteristic using mass flow rate and pressure rise as parameters, with contours of constant speed and constant efficiency
- Account for the energy provided by the compressor driving motor
- To investigate the relationship between fluid velocity and pressure drop (head loss) along a 90° smooth bend
- Investigate whether the pressure varies radially across a bend

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URL: http://www.armfield.co.uk/c1mkiii
Applications: ChE ME CE IP

Description

The C1-MkIII equipment comprises a single-stage air compressor, complete with a test section and a throttling valve, plus an electronics console containing the necessary controls and instrumentation.

The single-stage compressor is driven by an integral three-phase AC motor. The compressor speed can be varied using an advanced torque-vector frequency inverter, which gives stable and accurate speed control plus direct electronic read-out of the torque produced by the motor.

The compressor is fitted with an outlet duct incorporating a throttling valve, which allows the flow to be varied independent from compressor speed.

The equipment is supplied with a convergent-divergent test section, fitted at the compressor inlet, designed to produce Mach-1 velocity at the throat. The duct is fabricated from clear acrylic, enabling the student to see the construction and the profiles. A pressure-sensing ring tapping is provided at the inlet, at the throat and at the discharge end of the diffuser. This duct allows all the major concepts of compressible flow to be demonstrated.

The electronics console includes two high-range and two low-range differential pressure sensors plus a control for motor speed and displays for the compressor speed, the pressures and the motor torque.

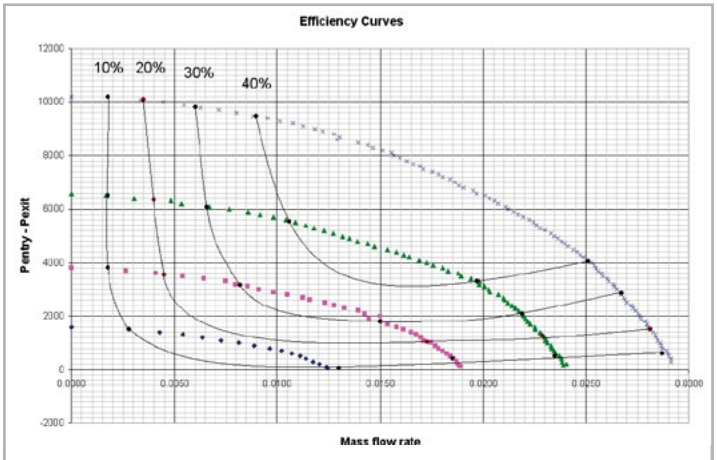
Features

- Variable-speed air compressor with accurate electronic speed control
- Electronic pressure sensors
- Standard unit includes convergent-divergent duct designed to produce Mach 1 velocity at the throat
- Data logging option available

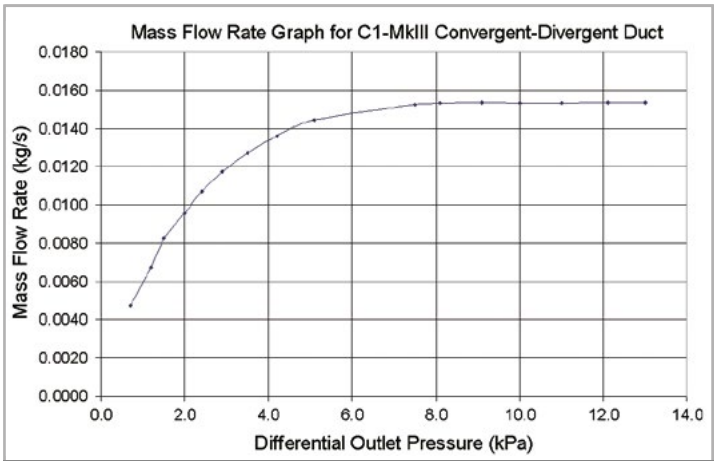
Benefits

The air compressor on the MkIII version comprises a single-stage, side-channel blower with the following benefits:

- Lower speed operation
- Integral motor with direct drive
- Reduced operating noise
- Reduced vibration levels



Performance curve obtained with C1-MkIII-35



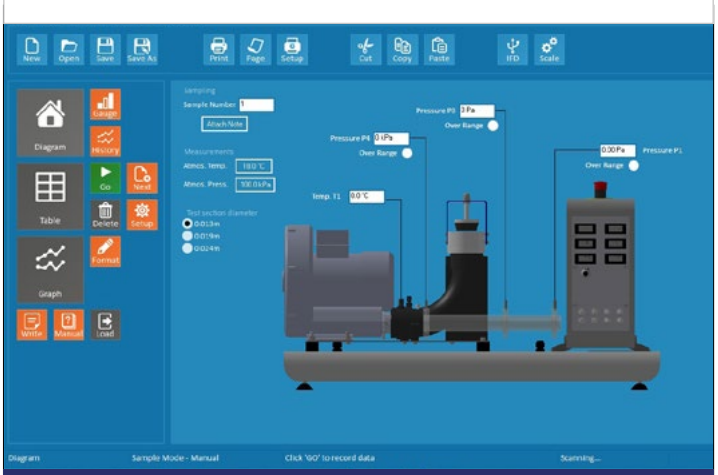
Graph showing the effect of choking in a convergent-divergent duct

Software (included as standard)

C1-MkIII-DTA-ALITE includes two electronic thermometers and a computer interface device to allow the temperatures and pressures to be data logged on a Windows PC.

The advanced educational software provides a wide range of data logging and plotting options.

The user must have a PC with a USB port, running Windows 7 or above.



Typical C1-MkIII Armsoft project diagram

Convergent - Divergent- Test Section

The equipment is supplied with a convergent-divergent test section, fitted at the compressor inlet, designed to produce Mach-1 velocity at the throat.

The duct is fabricated from clear acrylic, enabling the student to see the construction and the profiles. A pressure-sensing ring tapping is provided at the inlet, at the throat and at the discharge end of the diffuser.

This duct allows all the major concepts of compressible flow to be demonstrated.

Optional accessories

Additional sections provided:

- Three straight ducts of different diameters, to allow pressure losses incurred in a straight pipe to be studied in relation to Reynolds number
- A sudden enlargement section
- A 34mm nominal bore test section with four interchangeable orifice plates
- A 90° bend test section. Provision is made to investigate the radial pressure difference across the bend

The C1-MkIII-35 option comprises a test section to measure the air flow entering the compressor.

This facility, in conjunction with the electronic torque measurement and thermometers on the basic C1-MkIII, enables full compressor performance tests to be conducted over a wide range of shaft speeds.

C1-MkIII-35 Compressor Test Accessory

The C1-MkIII-30 option includes additional inlet test sections for further demonstrations and investigations into compressible flow.

The test sections are made from clear acrylic to aid visualisation and fitted with pressure-sensing ring tappings.

This accessory includes a bench stand to house all the accessories (plus the standard test section and the C1-MkIII-35 test section) when these are not being used.

C1-MkIII-30 Additional Test Sections

Detailed experimental capabilities

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

Basic unit (C1-MkIII):

- Phenomenon of choking in a convergent-divergent duct
- Pressure flow characteristic of a convergent-divergent duct
- Effect of compressibility on flow equations
- Determination of gamma for air

- **Added capability with C1-MkIII-30 accessory:**
- Simple pipe friction
- Variation of friction coefficient with Reynolds number
- Friction coefficient for compressible flow
- Pressure recovery across a sudden enlargement
- Pressure drop across a pipeline orifice
- Pressure drop across a 90° bend

Added capability with C1-MkIII-35 accessory:

- Centrifugal compressor performance characteristics
- Energy balance for compressor

Requirements

Scale

1Ph | PC | USB

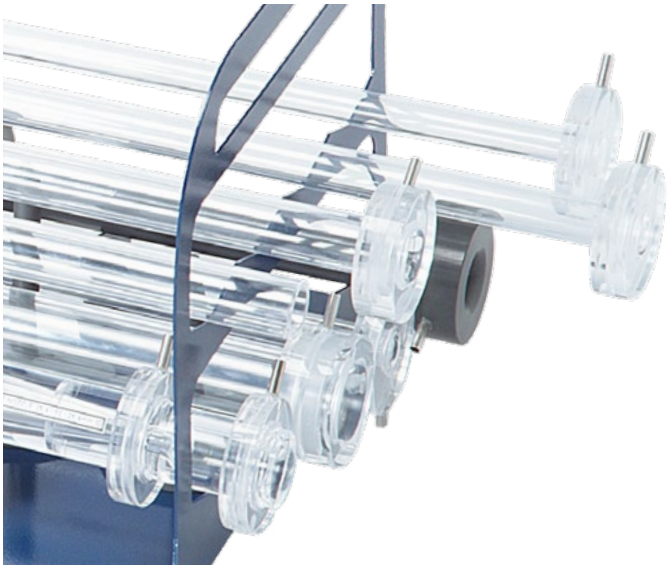
Electrical supply:

- C1-MkIII-A: 220-240V / 1ph / 50Hz / 6A
- C1-MkIII-G: 220-240V / 1ph / 60Hz / 6A

A 1500VA transformer is available to accommodate 120V / 1ph / 60Hz

Computer:

The user must have a PC with a USB port, running Windows 7 or above



Technical specifications

Compressor speed:	3,300rpm (max)	
No. stages:	1	
Motor Power:	0.55kW	
Sensors:	+/- 103.4 kPa	x1
	+/- 34 kPa	x1
	+/- 1744 Pa	x2

Overall dimensions

Dimensions Stowed (excluding power supply)

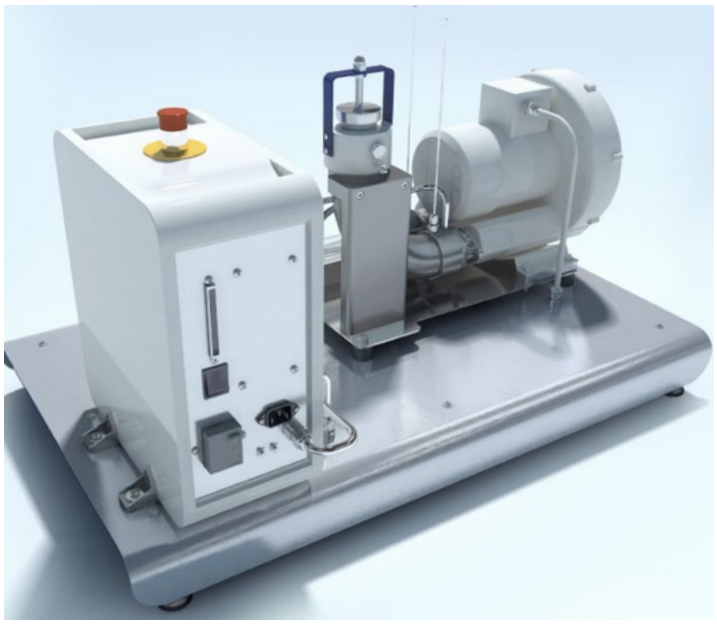
	C1-MkIII	C1-MkIII-30	C1-MkIII-35
Length	0.880m	1.250m	0.290m
Width	0.500m	0.310m	0.270m
Height	0.527m	0.340m	0.090m

Packed and crated shipping specifications

	C1-MkIII	C1-MkIII-30	C1-MkIII-35
Weight	50kg	20kg	10kg
Volume	0.30m^3	0.50m^3	0.03m^3

Ordering specification

- A benchtop unit designed to demonstrate and teach the fundamentals of compressible flow to engineering students
- Fitted with a single-stage, side-channel blower
- Complete with convergent-divergent duct capable of achieving Mach 1 velocity at the throat
- Advanced torque-vector speed control of blower motor with electronic torque measurement
- Four electronic pressure sensors
- Test section made from clear acrylic
- Additional test sections available (x6) complete with benchtop stand
- Compressor test accessory available
- Data logging accessory as standard, complete with educational software and electronic temperature sensors



Accessories

C1-MkIII-30 Additional Test Sections
C1-MkIII-35 Compressor Test Accessory

Related products

- C Series products
- F6 Air Flow Rig

Ordering codes

C1-MkIII-A
C1-MkIII-G
C1-MkIII-30
C1-MkIII-35
TRANSFORMER-1500VA

Armfield standard warranty applies with this product