

VAPOUR-COMPRESSION REFRIGERATION UNIT – RA1 MKII

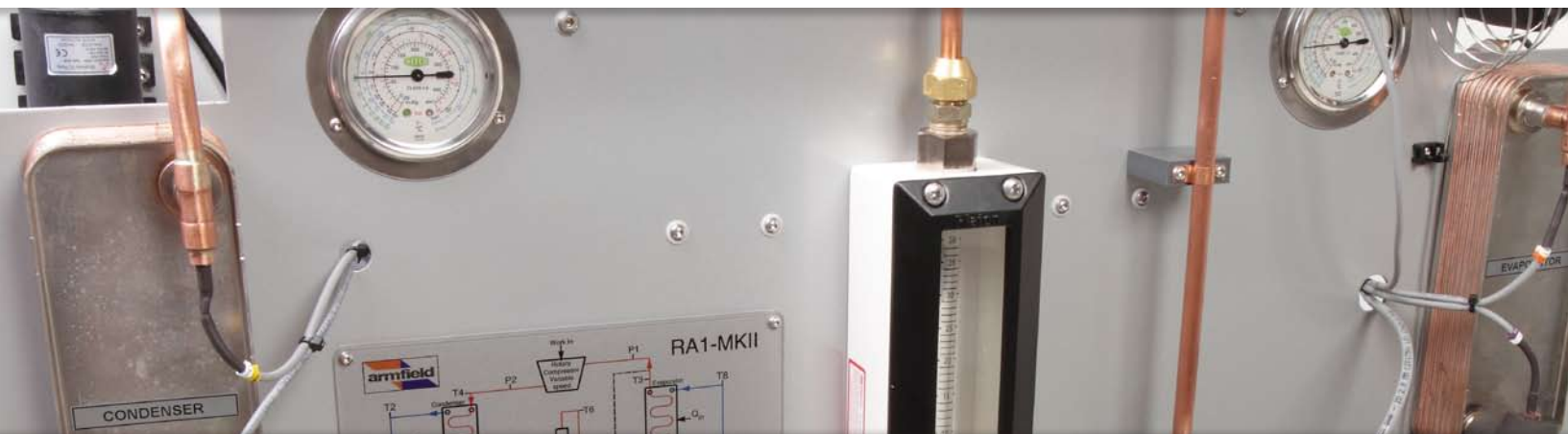
NEW COMPUTER CONTROLLED VAPOUR-COMPRESSION REFRIGERATION UNIT



FEATURES

- > Complete system enabling demonstration of the vapour-compression refrigeration cycle
- > Computer controlled with automatic recording of measured and calculated variables using a PC
- > Hermetically sealed rotary compressor with wide speed range can be varied by the operator
- > Condenser and evaporator both use plate heat exchangers with water as the heat transfer medium enabling a full energy balance to be carried out while varying the operating conditions on both sides of the compressor
- > Overall performance of the system is calculated and displayed continuously enabling the effect of changes in the system to be evaluated
- > Instrumented with electronic sensors measuring temperatures throughout the process, pressure on both sides of the compressor and independent water flowrates through the condenser and evaporator
- > Bourdon type gauges indicate the pressure and corresponding refrigerant saturation temperature on both sides of the compressor independent from the electronic systems
- > Variable speed pumps supply water at stable temperature and pressure from a large reservoir to the condenser and evaporator eliminating random fluctuations
- > The use of submersible pumps simplifies installation and ensures self-priming of the water systems
- > Superheat conditions in the condenser and evaporator are calculated and displayed continuously together with the instantaneous Coefficient of Performance (COP)
- > Expansion valve setting can be varied by the operator to change the operating point (evaporator superheat setting)
- > Separation of the refrigerant and water circuits aids understanding of the refrigeration system and the function of the various components
- > Alarms protect the equipment from misuse by switching the compressor off if pressures, temperatures, flowrates etc drift outside acceptable limits. Advanced warnings enable the operator to take remedial action before the compressor is switched off
- > Use of the refrigerant flowmeter as a sight glass enables observation of any vapour bubbles downstream of the compressor when conditions are not optimal





INSTRUCTIONAL CAPABILITIES

- > Demonstration of the important features and operation of a vapour-compression refrigeration system, involving the combined processes of compression, condensation, expansion and evaporation (the vapour – compression thermodynamic cycle)
- > Analysis of the heat transfer processes in the condenser and evaporator where phase changes in the refrigerant stream occur
- > Investigation of the effect of the following changes on the operation of the system and the resulting Coefficient of Performance:
 - The effect of varying compressor speed on refrigerant pressures and temperatures in the system
 - The effect of varying cooling water flowrate through the condenser
 - The effect of varying heating water flowrate through the evaporator
 - The effect of adjusting the setting of the Expansion Valve to vary the operating point (evaporator superheat setting) for different load conditions
- > Modelling the system thermodynamically by plotting T-s and P-h diagrams using the properties for R134a refrigerant
- > Performing a full energy balance across the system

DESCRIPTION

The vapour-compression refrigeration system is the most common refrigeration system used today. RA1-MKII is a computer controlled vapour-compression refrigeration system with automatic recording of all important process variables using an integral USB interface device.

The hermetically sealed refrigerant compressor incorporates a brushless three phase DC electric motor that is driven by a variable speed controller. Compressor speed and power supplied is displayed on the PC.

The refrigerant exiting the compressor passes through a condenser, receiver, filter, variable area flowmeter, expansion valve and evaporator before returning to the inlet side of the compressor.

The condenser and evaporator are brazed plate heat exchangers and utilize a large common reservoir of water to minimize changes in water temperature during operation.

The use of a reservoir to recirculate the same water eliminates the need for a permanent mains water connection or water flowing continuously to drain. This also isolates the system from fluctuation in mains water pressure or temperature.

The flow of water through each heat exchanger is independently controlled by a pair of variable speed submersible pumps, adjusted by the operator using the PC.

The RA1-MKII Refrigeration Unit is designed so that the student can simulate different environments and perform measurements to enable a complete understanding of the refrigeration process and the influence of different parts of the process. Alarms protect the equipment from misuse by switching the compressor off if pressures, temperatures, flowrates etc drift outside acceptable limits. Advanced warning of a fault condition is indicated on the PC mimic diagram so that the operator can take remedial action before the compressor is switched off.

The unit is totally self-contained, only requiring connection to an electrical supply and a suitable PC (not supplied). The unit is supplied with the necessary software and incorporates a USB computer interface device. The software also includes online Help Text detailing each of the exercises defined in the instruction manual.

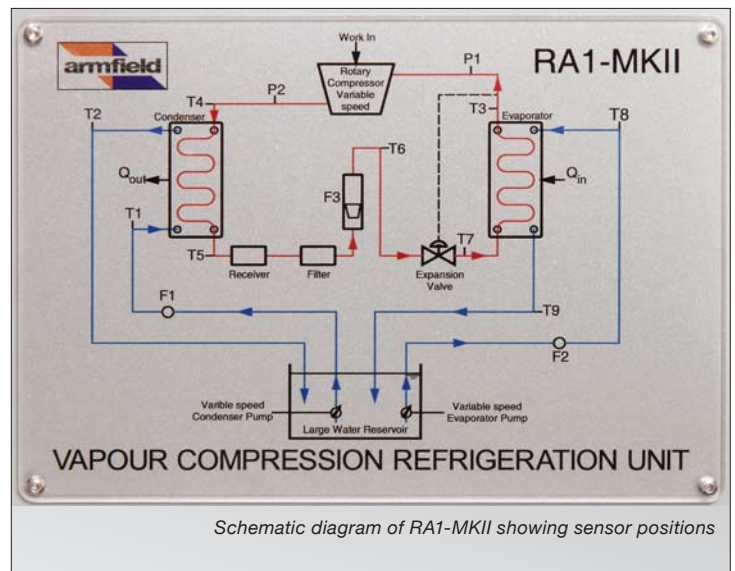
The water reservoir, fabricated using GRP (glass reinforced plastic), is designed to stand on a level floor. The process components are all mounted on a metal support frame that is designed to stand top of the water reservoir with four flexible tubes connecting the process to the reservoir.

Temperatures throughout the system and pressures on both sides of the compressor are measured. The refrigerant flow rate is determined using a variable area flowmeter.



TECHNICAL DETAILS

Refrigeration system	Vapour-compression type
Refrigerant	R134a
Compressor speed range	2000 to 4400 RPM
Compressor supply	24V DC to speed controller of brushless 3 phase DC motor
Compressor rating	7.11 cm ³ (0.434 cu in) for high evaporator temperature with 7.2°C rating point
Condenser	Brazed plate heat exchanger using water as heat transfer medium
Evaporator	Brazed plate heat exchanger using water as heat transfer medium
Water reservoir	Working capacity 400 litres
Temperature sensors	NTC Thermistor
Refrigerant flowmeter	Variable area flowmeter

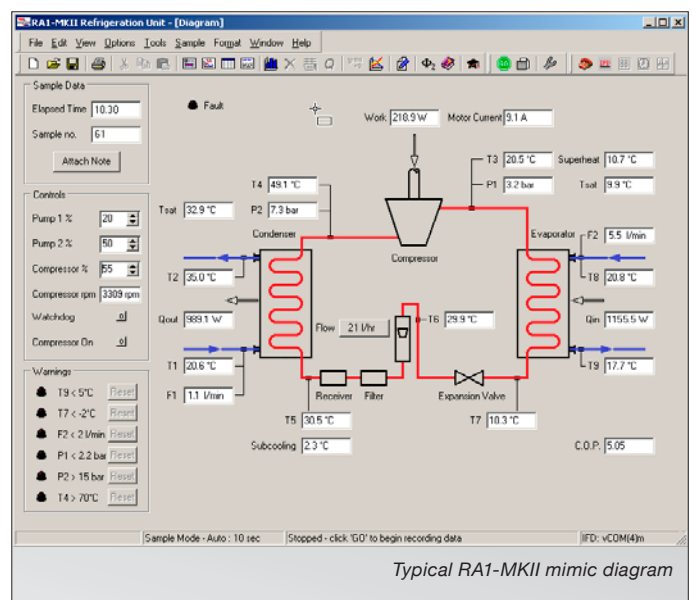


SOFTWARE DETAILS

The software includes a range of functions and capabilities designed to make the operation of the equipment and processing of the results more straightforward, and also to enhance student understanding of the subjects being covered.

It includes:

- Diagrammatic representation of the equipment, complete with continuous real time display of the various sensor outputs and instantaneous Coefficient of Performance
- Automatic data logging of sensor values into spreadsheet format
- Enables operator control of compressor speed (motor speed), condenser cooling water flowrate (pump speed) and evaporator heating water flowrate (pump speed)
- Incorporates maximum and minimum temperature limits to protect the equipment against misuse
- Additional USB driver is included that enables the outputs to be read in other software programs such as Labview™



ORDERING DETAILS

RA1-MKII-A/B/G

Bench mounted refrigeration unit with separate floor standing water reservoir

ESSENTIAL ACCESSORIES

Personal computer with USB port
(required but not supplied)

COMPLEMENTARY PRODUCTS

RA2 Air Conditioning Unit
RA3 Air Conditioning Unit
TH1 Temperature Measurement and Calibration
TH2 Pressure Measurement and Calibration
TH3 Saturation Pressure
TH4 Recycle Loops
TH5 Expansion Processes of a Perfect Gas

REQUIREMENTS

Electrical supply:

Single phase electrical supply:

RA1-MKII-A	230V/ 1ph / 50Hz @ 5 Amps
RA1-MKII-B	110V / 1ph / 60Hz @ 10 Amps
RA1-MKII-G	220V / 1ph / 60Hz @ 5 Amps

Cold water supply:

Supply of cold water to fill reservoir (working capacity 400 litres), permanent connection to water supply is not required.

Personal Computer:

The system is designed to be used with a personal computer (not supplied). The computer must have a USB port and run Windows 98 or later.

OVERALL DIMENSIONS

Refrigeration unit (process)

Length: 0.95m
Depth: 0.52m
Height: 0.50m

Water reservoir

Length: 1.09m
Depth: 0.71m
Height: 0.79m

note: Refrigeration unit is located on top of the water reservoir when installed.

SHIPPING SPECIFICATION

Volume: 1.26m³
Gross weight: 160kg

ORDERING SPECIFICATION

- Complete refrigeration system enabling demonstration of the vapour-compression refrigeration cycle
- Fully instrumented to enable complete analysis of the processes involved and calculation of the changes in performance with operating conditions
- Computer controlled system with automatic recording of process variables using an integral USB interface
- Hermetically sealed rotary compressor driven by DC motor with three phase BLDC variable speed drive
- Compressor speed under computer control with a wide range of operation from 2000 to 4400 RPM
- Real time display of superheat calculations
- Real time display of Coefficient of Performance
- Energy transferred to the evaporator and from the condenser measured independently on the service side of the process
- Measurement sensors include:
 - 9x Thermistor sensors measuring temperatures throughout the system
 - 2x Turbine type flow meters measuring flow of water through the condenser and evaporator
 - 2x Electronic sensors measuring pressures before and after the compressor
 - 2x Bourdon type refrigeration pressure gauges (with scale indicating equivalent refrigerant saturation temperature)
 - 1x Variable area flowmeter measuring refrigerant flowrate
 - 1x DC Current shunt measuring current to the compressor motor
- Supplied complete with large water reservoir to isolate the process from fluctuations in temperature or pressure in the mains water supply
- Comprehensive instruction manual supplied

FOR FURTHER INFORMATION ON THE ADVANCED FEATURES OF THE SOPHISTICATED ARMFIELD SOFTWARE VISIT:
www.discoverarmfield.co.uk/data/armsoft/



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