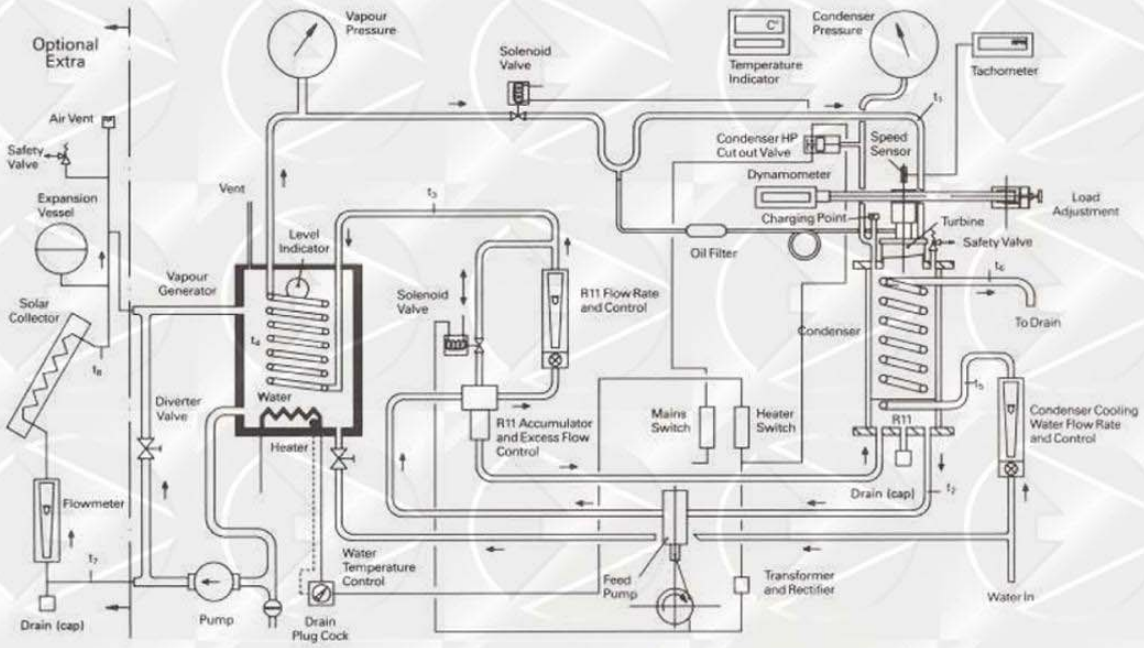
Solar/Heat Source Vapour Turbine F820

Machine Code F820 has been superseded by F821. The Unit now operates on Refrigerant R141b instead of R11, the use of which is being phased out under the terms of the Montreal Protocol. The unit specification has also been upgraded to include a load cell and digital electronic indicator in place of the spring balance illustrated. The unit power supply requirement has also increased from 1.7kW to 2kW.

The current unit has been upgraded to include a load cell and digital electronic indicator in place of the spring balance illustrated.

P.A.Hilton Ltd.

Solar/Heat Source Vapour Turbine F820



Introduction

This bench top unit has been designed with two main objectives:

(i) To provide a compact and easily understood vapour power plant which has the same major components and characteristics as a conventional steam power plant, but at a small fraction of its capital and running costs.

(ii) To demonstrate, on a laboratory scale, the ability to produce shaft power from Solar Radiation.

The unit incorporates a water heat source using an electrical resistance heater within the unit. A solar panel (with installation kit) which will alternatively provide the necessary hot water, is offered as an optional extra.

The unit operates on a classic thermodynamic cycle and will be of interest to those studying thermal power plant and energy conservation, particularly in

Chemical Engineering

Marine Engineering

Mechanical Engineering

Plant and Process Engineering

Environmental Studies, etc.

Experimental capabilities

- Clear and easily observed demonstration of a classic Rankine Cycle.
- Production of Torque/Speed and Power/Speed curves for a single stage impulse turbine.
- Use of property charts or tables and the application of the First Law of Thermodynamics to produce energy balances.
- Determination of thermal efficiency at a range of turbine inlet and exhaust pressures.
- Comparison of performance with the Rankine Cycle, (including the external isentropic efficiency of turbines).
- Estimation of total frictional losses in turbines.

In addition, With Optional Solar Panel

- Demonstration of the production of shaft work from solar radiation.
- Measurement of solar energy collection at a range of mean water temperatures.

Description

(Please refer to the schematic diagram on opposite page)

The vapour generator (or boiler) consists of a coiled copper tube through which pressurised R11 flows. The coil is immersed in an insulated tank containing hot water provided by either an electric resistance heater which is housed within the tank, or by the optional solar energy collector mounted in a suitable position outside.

The vapour produced then flows through a convergent-divergent nozzle and impinges on the blades of a single stage impulse turbine. The turbine is mounted on the condenser and the exhaust vapour from it passes directly over the water cooled coil. The condenser, which has a high strength glass shell, is partly flooded to provide the R11 with a few degrees of sub-cooling.

A low speed reciprocating feed pump draws condensed R11 from the bottom of the condenser and delivers it, via a control valve and flow meter, to the vapour generator for re-evaporation. An accumulator fitted between the feed pump and vapour generator smooths most of the pulsations arising from the action of the pump.

A small quantity of lubricating oil mixed with the R11 and is separated from the high pressure vapour line and fed to the turbine bearings.

Maximum power is obtained at about 20,000 rev. min^{-1}. A simple band brake dynamometer applies and measures the resisting torque to the turbine shaft. An optical sensor senses the rotational speed of the turbine and this is displayed on a digital meter.

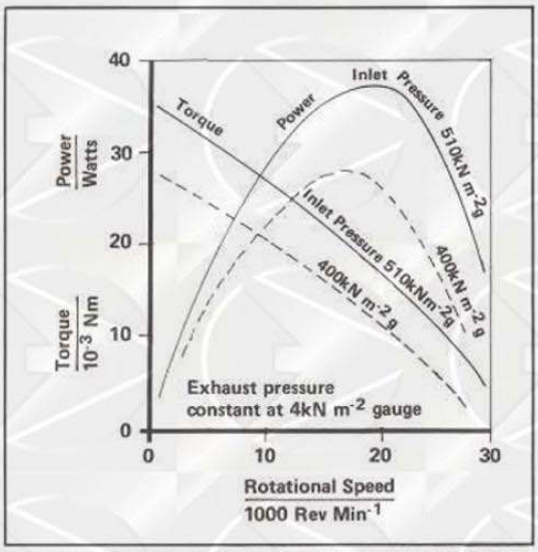
Optional solar energy collecting system

As an "optional extra", the F820S "Solar Panels and Installation Kit" which provides all the components necessary to run the F820 from natural solar radiation where conditions are suitable. Customers are expected to carry out the installation work and to provide a simple framework to support the panel. The kit includes $4m^2$ of high efficiency collecting panel, a water flow meter and thermocouples (to be connected to the F820 Temperature Indicator) and all necessary connecting pipework and fittings.

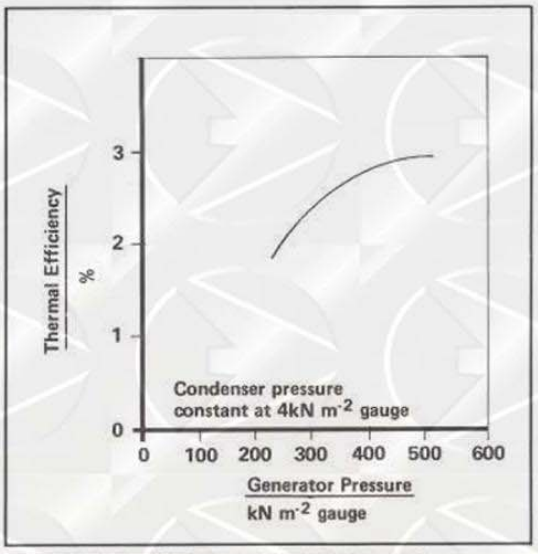
All machines are provided with external unions, a pump and a diverter valve, which enable the unit to be quickly connected to a solar energy hot water system.

The resistance heater may be switched on to augment the solar input when necessary.

Experimental results



Torque v Speed and Power v Speed Characteristics of Turbine



Effect of Generator Pressure on Thermal Efficiency of Cycle

Specification

General

Compact and self-contained bench top vapour power unit using R11 and operating on the Rankine Cycle from a hot water heat source within the unit. Mechanical output is from a single stage impulse turbine and heat is rejected to a water cooled condenser. Instrumentation allows the measurement of all important quantities.

Optional solar panels and a package of components to enable the unit to operature from solar energy are available.

Detailed

Panel: High quality GRP panel on which all components are mounted.

Vapour Generator: Copper generating coil in water filled stainless steel tank fitted with thermostatically controlled 1.5kW heater.

Turbine: Single stage impulse turbine – power output approximately 35W at 20,000 rev. min^{-1}.

Condenser: Water cooled coil housed in glass walled cylindrical chamber.

Feed Pump: Single acting plunger pump driven by 12V D.C. motor supplied from transformer and rectifier.

Accumulator: To smooth flow and spill excess R11 to condenser.

Circulating Pump: To circulate water through vapour generator tank and solar panels (if fitted).

Instruments: 12 point digital temperature indicator with spare stations for solar system if fitted; two pressure gauges, ranges 0 to 800kN m^{-2} and –100 to +100kN m^{-2} respectively; R11 flowmeter 1 to 7 g s^{-1}; Water flowmeter 4 to 50 g s^{-1}; Digital Tachometer with optical sensor 0 to 99999 rev. min^{-1} Band brake dynamometer for 0–5N net force at pulley.

Optional Extra: Solar Collector Package for customer installation, including:

Two flat plate solar collectors, each $2m^2$; Water flow meter; Two type K thermocouples; 30m coil of 12.7mm external dia. copper tube; 30m thermal insulation; Expansion vessel; Set of pipe fittings for connecting components to panel of unit.

Safety: Turbine enclosed in strong guard ring. High pressure cut-out and safety valve fitted to condenser. Safety valve supplied for solar panels. All components earthed (grounded). Unit protected by miniature circuit breaker and residual current circuit breaker.

Dimensions

Height:	925mm	Depth:	43mm
Width:	1060mm	Weight:	80kg

Accessories and Spares

Unit supplied with:

One experimental, operating and maintenance manual, Accessories and spares for 2 years normal operation.

Also available:

Recommended list of spares for 5 years operation (details on request).

Services required

Electrical:

Either: **A.** 1.7kW 220/240 Volts, Single Phase, 50Hz. (With earth/ground)

or: **B.** 1.7kW 110/120 Volts, Single Phase, 60Hz. (With earth/ground)

Water: 3 litres/m in cooling water at 15m head (min) **The maximum recommended water temperature is 22°C. If required, details of a suitable water cooler are available.**

Ordering information

Order as:

F820 Heat/Solar Source Turbine

Please specify:

Electrical supply:

Either: **A.** 220/240 Volts, Single Phase, 50Hz. (With earth/ground)

or: **B.** 110/120 Volts, Single Phase, 60Hz. (With earth/ground)

Optional Extra: F820S Solar Panels and Installation Kit

Language – either: English French Spanish

Shipping specification

Nett Weight:	80kg
Gross Weight:	170kg
Packing Case Size:	1.25 x 0.622 x 1.194m
Packing Case Volume:	$0.928m^3$

Please note

Units fitted with instruments calibrated in units other than S.I. or for use on non-standard voltages are available on special order.

The policy of P.A. Hilton Limited is one of continual improvement and they reserve the right to revise this specification without notice.

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Leaflet No. F820L/E/1/9850

F820S
Solar Panels and Installation Kit

Model Numbers F820 Solar/Heat Source Vapour Turbine and R851 Vapour Jet Refrigerator and Heat Pump may be run from any source of hot water at a sufficiently high temperature, i.e. about 90°C.

In locations where conditions are suitable, the F820S Solar Panels & Installation Kit enables these units to be run from hot water generated in solar panels. The Kit, which is for on site assembly and installation, includes the solar panels and all the components required for connection to the unions provided on these units.

The solar panels are of the flat plate type with a selective finish, housed in a durable aluminium casing. The rear face of the panel is well insulated with rockwool and the front face is protected by an air gap and a special plastic film having a higher transmission than glass.

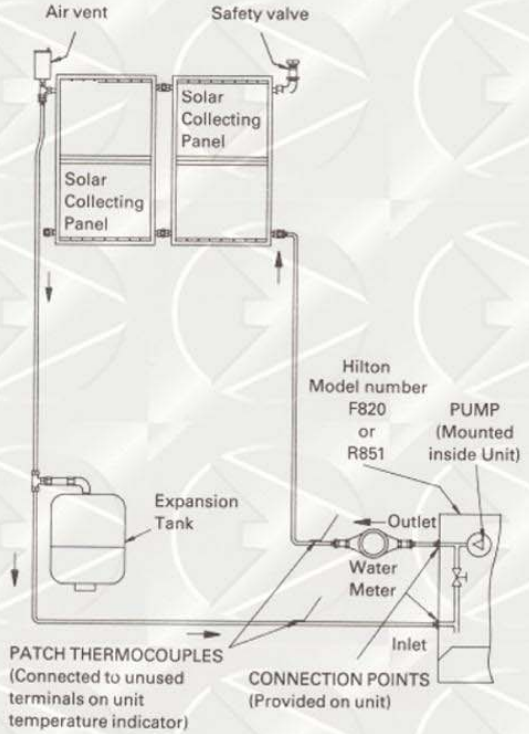
To reduce heat losses and wind loads, the panels should be mounted in a sunny sheltered position so that, at noon, the face of the panel receives solar radiation normally. The panels should be as close as possible to the connected unit (12m maximum) and if possible at a higher level to assist venting.

Screens are provided on the panels and these must be closed when the panels are not in use.

Water connections between the panels and unit are via annealed copper tubes which are insulated during assembly. The water is pressurised to 200 kN m^{-2} g by a pressurised air cushion in an expansion vessel and an automatic vent discharges air from the highest point.

A water meter and thermocouples (for connection to the unit instrument panel) enable the heat collection rate to be measured.

ARRANGEMENT OF COMPONENTS INCLUDED IN F820S SOLAR PANELS AND INSTALLATION KIT



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SPECIFICATION

GENERAL
Solar panels and all components for site assembly to enable Hilton Model Nos. F820 or R851 to run from solar radiation.

DETAILED
Solar Panels: Two high efficiency solar panels each 1.92m².

Instruments: Hot water meter to indicate total water flow. Type K patch thermocouples for connection to the temperature indicator on unit.

Pipe, Fittings, etc.: 12.7mm o.d. × 30m long copper tube with suitable compression fittings; Tubular thermal insulation × 30m long; Safety valve; Automatic air vent; Air cushioned expansion vessel; Pressure gauge; Panel mounting brackets; Corrosion inhibitor/anti-freeze solution.

Panel Dimensions: Two, each 1700mm × 1262mm × 105mm.; weight 26 kg.

The policy of P.A. Hilton Limited is one of continual improvement and they reserve the right to revise this specification without notice.

SERVICES REQUIRED

None

ORDERING INFORMATION

Order as:

F820S Solar Panels and Installation Kit

SHIPPING SPECIFICATIONS

Net weight:	65 kg
Gross Weight:	196 kg
Packing Case Size:	2.083 × 0.432 × 1.486 m
Packing Case Volume:	1.340m³