



S220

Rankine Cycle Steam Turbine



- ***Operates on a true Rankine Cycle with boiler, turbine, feed-pump and condenser.***
- ***Stabilises in minutes and allows rapid data collection.***
- ***Bench top unit allows similar experimental procedures to full size plant.***
- ***Optional power generation module.***
- ***Optional Computerised Data Acquisition***
- ***Two year warranty***

Introduction

In the past, steam power plant for teaching purposes would have been adapted from large scale industrial plant incurring high capital, running and maintenance costs.

There are also adapted model reciprocating steam engines or units that consist of only a boiler, turbine and condensate collector with no feed pump.

The Hilton Rankine Cycle Steam Turbine S220 is a low cost alternative to the existing Hilton Steam Generator and Service Module S200 and Steam Turbine Module S210. ***Like these already well proven units the S220 operates on a true Rankine cycle with boiler, turbine, sub-atmospheric pressure, water cooled condenser and a boiler feed-pump.*** Indeed the Rankine Cycle Steam Turbine S220 incorporates many well proven components from both the S200 and S210 units.

The unit will provide interesting and instructive experimental work for all students but will be of particular interest to those studying:

- **Thermodynamics**
- **Heat Transfer**
- **Chemical Engineering**
- **Mechanical Engineering**
- **Power Engineering**
- **Marine Engineering**
- **Plant and Process Engineering**

Experimental Capabilities

- **Investigation of a true Rankine Cycle Steam plant.**
- **Determine of cycle thermal efficiency based on shaft power.**
- **Determination of friction losses at various exhaust pressures.**
- **Investigation of turbine torque/speed and power/speed characteristics.**
- **Investigation of steam quality by throttling.**
- **With the optional power generation module demonstration of electrical power generation.**

Description

The unit is supplied as two complimentary modules.

An independently certified electric boiler with safety valve, automatic control system and fail safe pressure switches, provides steam at up to 8 Bar gauge to a solenoid valve.

This in conjunction with an optical sensor limits the maximum turbine speed to a safe level. Steam flow to the turbine can be throttled by a hand valve and the boiler, turbine inlet and condenser pressures are indicated on gauges.

The impulse turbine is driven by a convergent divergent nozzle and turns a brake wheel with speed sensor and digital indicator allowing true shaft power to be determined. An optional electrical power generator is also available for demonstration purposes.

The turbine exhausts into a condenser and this passes water to a similar water reservoir. The reservoir connects to a boiler feed pump. Like full size real power plant the condenser operates at sub-atmospheric pressure and the unit incorporates an air extraction system.

The boiler feed pump and non-return valves to the boiler complete the full Rankine cycle.

Instrumentation includes all relevant system pressures, system temperatures, and cooling water flow rates, turbine speed and brake load. A combination of digital and analogue displays show the recorded parameters.

Optional Power Generation Module.

An optional electrical power generation module is available that replaces the standard belt brake and load cell. This allows students to experience the operation of the full steam power plant where power generation is the objective.

Note that on certain competitive systems where there is ONLY electrical power generation and no shaft power measurement the important concept of system losses cannot be demonstrated.

Operation

Due to the low thermal inertia of the system, experimental work can be commenced within a few minutes of switching on. As the unit is a complete Rankine cycle the operation can continue as long as the electrical supply and cooling water are available. The need for expensive feed water treatment is not required as the unit can be operated on a small volume of de-mineralised water that is generally readily available for topping up automotive batteries.

Additional safety features include boiler and condenser relief valves and high pressure switches together with turbine speed control. Electrical safety includes miniature overload cut out switches and an earth leakage circuit breaker.



Specification

General

A bench top Rankine cycle steam turbine with electric fired boiler, throttle valve, impulse turbine, sub-atmospheric water cooled condenser and boiler feed pump. Instrumentation to record all relevant temperatures, pressures, cooling water and gas flows, turbine speed and turbine brake load.

Safety to include high pressure cut out switches and relief valves on boiler and condenser, steam solenoid valve and electrical overload cut outs and earth leakage circuit breaker.

Detailed

Boiler: Independently certified electric boiler with automatic control, pressure switches, fail safe pressure cut out and large capacity relief valve

Turbine: Single stage, axial flow impulse (De Laval) turbine on a vertical shaft mounted in corrosion resistant sealed ball bearings. Convergent-divergent nozzle discharges at 20° to plane of turbine rotation and rotor has blades with 45° inlet and discharge angles. Rotor diameter 50mm. Maximum turbine speed 40,000 rpm.

Water cooled Condenser: Condenses turbine exhaust steam allowing heat rejection from the system to be measured.

Feed Water Reservoir: Collects condensate from the condenser for return via the feed pump to the boiler.

Feed Pump: low volume flow pump.

Flow Meters :- For condenser cooling water. Allows measurement of heat rejection from the condenser.

Digital Thermometer: 0.1°C resolution, with multi-way selector switch for all relevant temperatures

Pressure gauges: For all relevant system pressures.

Turbine Tachometer:- Digital display and over speed cut out.

Turbine brake load: Digital indicator.

Dimensions

Approximate:

Height: 650mm Depth: 655mm
Width: 2000mm Weight: 118kg.

Accessories and Spares

Unit supplied with:

One experimental operating and maintenance manual in English, Spanish, French.

Accessories and spares for 2 years normal operation. List available on request.

Services Required

Electrical: A: 6.0kW 380/415 Volts, **3 Phase + Neutral**, 50Hz (With earth/ground).

Or **B:** 6.0kW 220/230Volts **SINGLE PHASE** 50Hz (With earth/ground).

Or: **C:** 6.0kW 210/220 Volts, **3 Phase**, 60Hz (With earth/ground).

Cold Water: Continuous supply 5 litres/ minute at 25m head, intermittent supply at 25 Litre/minute.

Boiler Feed-Water Small quantity (10litres) de-mineralised or distilled for initial fill. Then approximately 1 litre / . 10 hours running

Ordering Information

S220/220 Rankine Cycle Steam Turbine

S220/415 Rankine Cycle Steam Turbine or

S220/220/SC Rankine Cycle Steam Turbine Computer Linked

S220/415/SC Rankine Cycle Steam Turbine Computer Linked

Optional: S220A Generator demonstration kit.

Electrical Specification

Either: **A:** 380/415 Volts, 3 Phase(10 Amps /phase) +Neutral, 50Hz (With earth/ground).

OR

B: 220/230 Volts, Single Phase (26 Amps) 50Hz (With earth/ground)

OR

C: 210/220 Volts, 3 Phase, 60Hz, (With earth/ground).

Language

Either: English, Spanish, French.

Also Available On Request

Further detailed specification.

Additional copies of instruction manual.

Recommended list of spares for 5 years operation.

Optional Extra S220A **Power Generation module**



The S220A allows students to experience electrical power generation from the shaft power generated by the steam turbine. It may be added or removed from the S220 Rankine Cycle Steam Turbine at any time depending upon the teaching requirements.

Optional Data Acquisition Upgrade

Hardware details

The Optional Computerised Data Acquisition Upgrade consists of a 21 channel Hilton Data logger (D103), together with pre-configured, ready to use, Windows™ compatible educational software.

Factory fitted coupling points on the S220 allow installation of the upgrade to the unit at any time in the machine's extensive life. The Hilton Data logger connects using the cable supplied to a standard USB port on the user supplied PC. If more than one logger is required connection is via a second USB port or standard USB hub.

The combined educational software and hardware package allows immediate computer monitoring and display of all relevant parameters on the S220.

Software Details

The pre-configured menu driven Software supplied with the Computer Upgrade allows all recommended experiments involving the electronic transducers and instruments on the S220 to be carried out with the aid of computerised data acquisition, data storage and on-screen data presentation. This enhances student interest and speeds comprehension of the principles being demonstrated.

Students are presented with either raw data for later hand calculation or alternatively data may be transferred to most spreadsheets for computerised calculation and graphical presentation.

Data may be stored on disc and displayed at any time using the software supplied.

Alternatively data may be transferred to any compatible spreadsheet together with individual time and date stamp on each reading for complex analysis.

Additional Data Logging Facility Supplied As Standard

It comprises an industrially proven 21 channel interface with 8 thermocouples (type T and K as standard) / differential voltage inputs ($\pm 100\text{mv DC}$), 8 single ended DC voltage inputs ($\pm 8\text{v}$), 4 logic or frequency inputs and one mains voltage input. In addition there are on board 12v DC, $\pm 5\text{V DC}$ and $\pm 15\text{v DC}$ power supplies for most commercially available transducers.

The Hilton Data Logging software supplied as standard with the package allows the logger to be disconnected from the S220 and used together with most standard transducers as a stand-alone computer data logger for the instrumentation and monitoring of existing laboratory equipment using locally sourced industrial transducers. The software is also backwards compatible with our many second generation data loggers that are already in use worldwide.

Computer Hardware Requirements

The menu driven Software supplied with the Computer Upgrade will operate on a PC which has at least 0.5Gb Mb ram, VGA graphics, 1Gb hard drive, CD drive and an available USB port. The software is Windows 2000, XP and 7 compatible.

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