



## *Film & Dropwise Condensation Unit H911*



- *Specially developed water cooled condenser presents an almost isothermal surface to the steam.*
- *Bench top, compact and portable unit requiring only a 3 kW electrical supply, cooling water and a drain.*
- *Self-contained – incorporates its own steam generator and air extraction system.*
- *Stabilises very quickly – many different conditions may be investigated in a normal laboratory period.*
- *Heat fluxes approaching  $10^6 \text{ w M}^2$  are possible.*
- *Thermocouple attachment technique allows measurement of mean surface temperature without interfering with the surface properties.*
- *Two year Warranty.*



## ***Introduction***

The use of steam both for power production and to convey heat has a long history and its use in these fields is likely to continue into the foreseeable future. In all applications, the steam must be condensed as it transfers heat to a cooling medium which could be the cold water in the condensers of a generating station, the hot water in a heating calorimeter, a sugar solution in a sugar refinery, etc. During condensation very high heat fluxes are possible and provided the heat can be quickly transferred from the condensing surface into the cooling medium, steam using heat exchangers can be compact and effective.

Steam may condense onto a surface in two distinct modes, known as Filmwise and Dropwise. It is important that all engineers and technologists should be aware of the above and should understand the features of filmwise and dropwise condensation.

The Hilton Film & Dropwise Condensation Unit has been specifically designed for student use and to provide visual and quantitative results related to heat transfer during condensation. The unit is self-contained, having its own steam generator and air extraction system as well as condensers' to provide filmwise and dropwise condensation. A very interesting and important range of experimental investigations can be conducted and this unit will be a valuable addition to thermodynamics, heat transfer and other laboratories associated with courses in:

- Building Services
- Chemical Engineering
- Energy Transfer and Conservation
- Marine Engineering
- Mechanical Engineering
- Nuclear Engineering
- Plant and Process Engineering

## ***Experimental Capabilities***

- Visual observation of filmwise and dropwise condensation, and of nucleate boiling.
- Measurement of heat flux and surface heat transfer coefficient in both filmwise and dropwise condensation at pressures up to atmospheric.
- Investigation of the saturation pressure/temperature relationship for H<sub>2</sub>O between about 20°C and 100°C.
- Demonstration and investigation of the effect of air in condensers.
- Demonstration of Daltons Law.

## ***Description***

Steam generation and both types of condensation take place in the same thick walled glass cylinder with metal cover plates.

The lower cover houses an electric heating element, a thermocouple to measure the saturation temperature of the H<sub>2</sub>O and a combined filling and draining valve from 0.4kW to 3kW by a manual triac control.

The upper cover housed two water cooled copper condensers, one of which is gold plated to promote dropwise condensation, and the other is in its natural state to give filmwise condensation. The cover is also fitted with a pressure relief valve and has connection to a pressure gauge, a pressure switch and to an air extraction system.

Considerable effort has been devoted to the design of the condensers, so that, although water cooled, there is little variation of the surface temperature and also that the mean metal temperature is obtained without the use of external thermocouples. The water flow rate through the condenser is measured by flow meters which are fitted with control valves.

A water jet vacuum pump is used intermittently to draw air (plus a certain amount of steam) from the chamber. Before entering the pump, the mixture is allowed to cool slightly so that some of the steam condenses. The condensate is removed by a separator and turned to the chamber, while the saturated air passes to the vacuum pump.

A multi-point electronic thermometer indicates all important temperatures and the rate of heat transfer is calculated from the water flow rate and its temperature rise.



## Specification

### Panel:

High quality ABS Plastic, having an attractive appearance, and on which the following components are mounted.

### Steam Chamber:

Thick walled glass cylinder with flared ends and P.T.F.E. seals to nickel plated brass cylinder covers.

### Condensers:

TWO - water cooled – mounted in upper cylinder cover.

Dimensions: 12.7 mm external dia. x 90 mm effective length. Specially designed and fabricated from copper and brass, incorporating a heat exchanger to minimise variation of surface temperature

- Dropwise condenser – gold plated.
- Filmwise condenser – natural finish.

Each condenser shell is fitted with three thermocouples connected to measure the mean metal temperature and two thermocouples to measure the inlet and outlet water temperatures respectively.

### Heating Element:

Coiled 3 kW electric heating element with thermal protection.

### Heater Control:

Triac control to manually vary heat input from approximately 0.4 to 3.0 kW.

### Air Extraction System:

Air cooler, separator and water jet vacuum pump with the necessary valves.

## Instrumentation

### Temperature:

Multi point electronic analogue thermometer to indicate all important temperatures.

### Pressure Gauge:

100 mm dia. To measure chamber pressure. Range – 100 to +100 kNm<sup>-2</sup> gauge.

### Flow Meters:

TWO – variable area type, with control valve. To measure the water flow rate through the condensers.

- Ranges: ONE – 4 to 50 gm s<sup>-1</sup> (Dropwise)  
 ONE – 1 to 12 gm s<sup>-1</sup> (Filmwise)

## Safety

### Pressure Relief Valve:

Spring loaded valve fitted to upper cylinder cover – set to discharge a t 20 kN m-2 gauge.

### Pressure Switch:

Diaphragm type pressure switch to switch off heater when the chamber pressure exceeds 10 kN m-2 gauge. Manually re-set.

### Heater Thermal Protection:

To interrupt the heater circuit if the heater overheats due to inattention to the water level in the chamber. Manually re-set.

All electrical components are earthed and fused.

## Dimensions

Height	710 mm
Width	710 mm
Depth	240 mm
Weight	30 kg

## Services required

### Electrical:

Either:

A. 3kW 220/240 Volts, Single Phase, 50 HZ (with earth/ground)

or:

B. 3kW 110/120 Volts, Single Phase, 60 Hz (with earth/ground)\*

\*Supplied with 110/240 Volts transformer

### Water:

Cold water.

- Continuous: 300 litre per hour, at 25 m head minimum
- Intermittent 1000 litre per hour

## Ordering information

### Order as:

H911 Film and Dropwise Condensation Unit.

### Electrical Specification:

Either:

A: 220/240 Volts, Single Phase, 50 Hz (with earth/ground)

Or:

B: 110/120 Volts, Single Phase, 60Hz (with earth/ground)

## Language

Either: English, Spanish or French

## Shipping Specifications

Nett Weight: 29 kg

Gross Weight: 84 kg

Packing Case Size: 0.889 x 0.889 x 0.483 m

Packing Case Volume: 0.382 m<sup>3</sup>



## ***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.

## ***Also Available On Request***

- Further detailed specification.
- Additional copies of instruction manual.
- Recommended list of spares for 5 years operation.

## **P.A.HILTON Ltd.**

Horsebridge Mill, King's Somborne,  
Stockbridge, Hampshire, SO20 6PX, England.

Telephone: National (01794) 388382  
International +44 1794 388382

Fax: National (01794) 388129  
International +44 1794 388129

E-mail: [sales@p-a-hilton.co.uk](mailto:sales@p-a-hilton.co.uk)  
Website: [www.p-a-hilton.co.uk](http://www.p-a-hilton.co.uk)

