Instruction Manual

HM150.03 Flow Over Weirs Accessory

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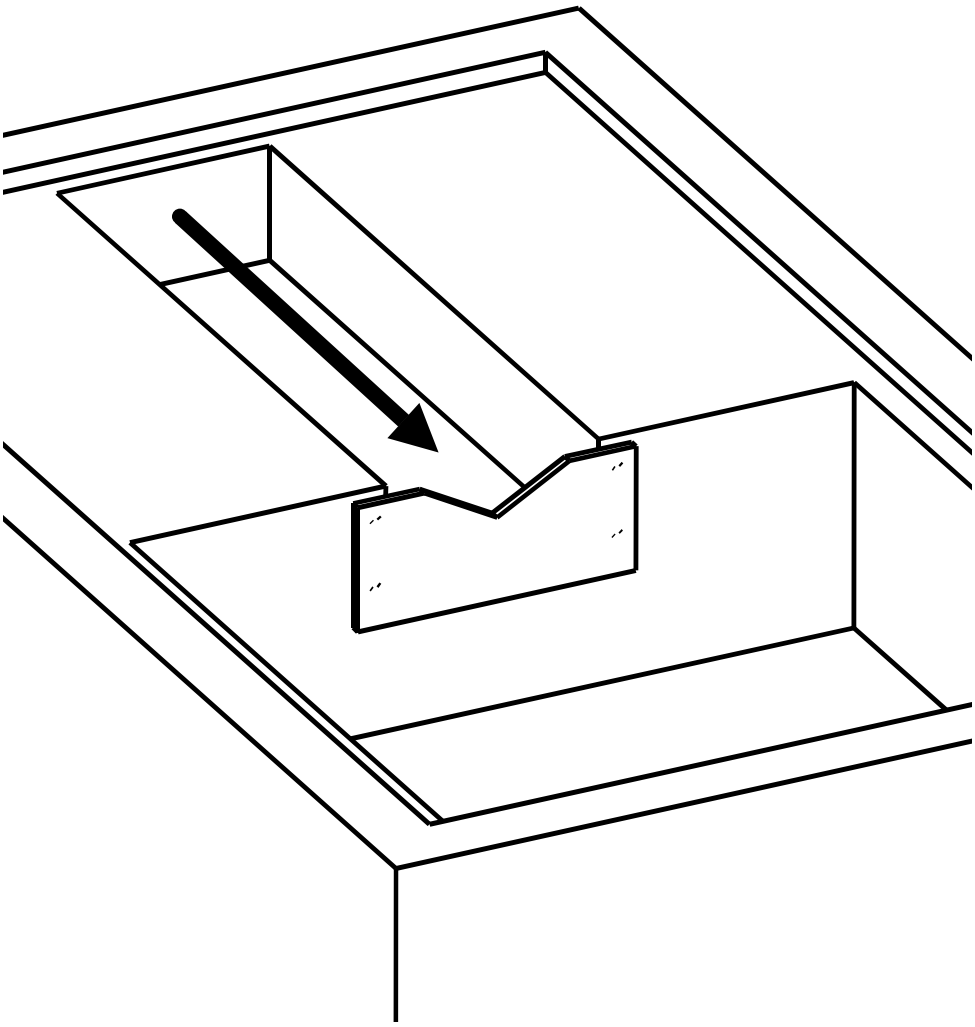

Instruction Manual

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HM150.03 Flow over Weirs Accessory

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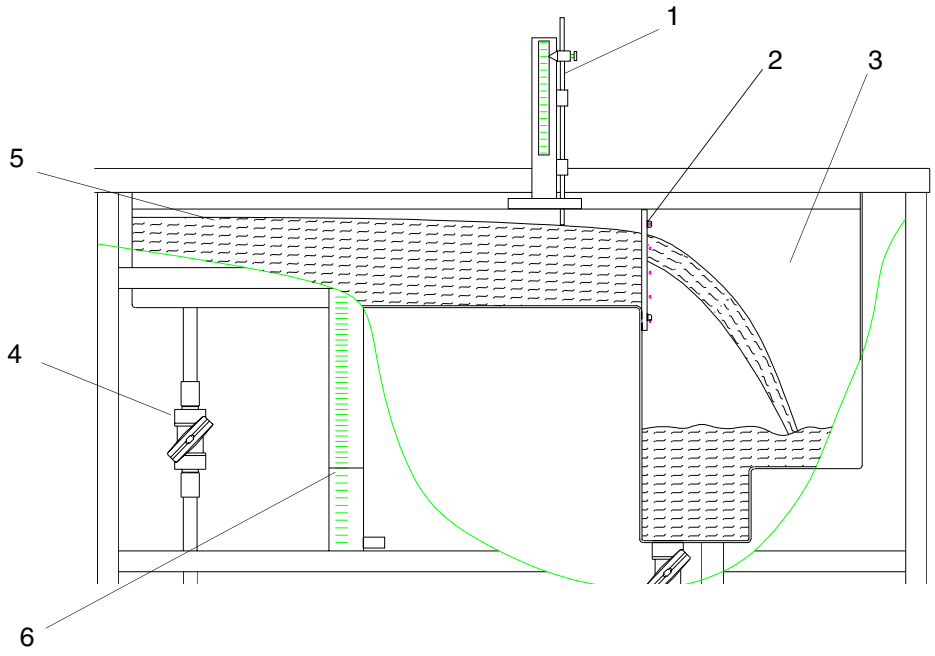
1 Unit description

The accessory set **HM150.03** Flow Over Weirs is used together with the **HM150** Fluid Mechanics Basic Module [3].

The **HM150** contains a channel section [5]. The water enters at the bottom left and then flows to the right over a weir into the volumetric tank. A weir [2] with V-profile and a weir [2] with rectangular profile are available for experimentation purposes.



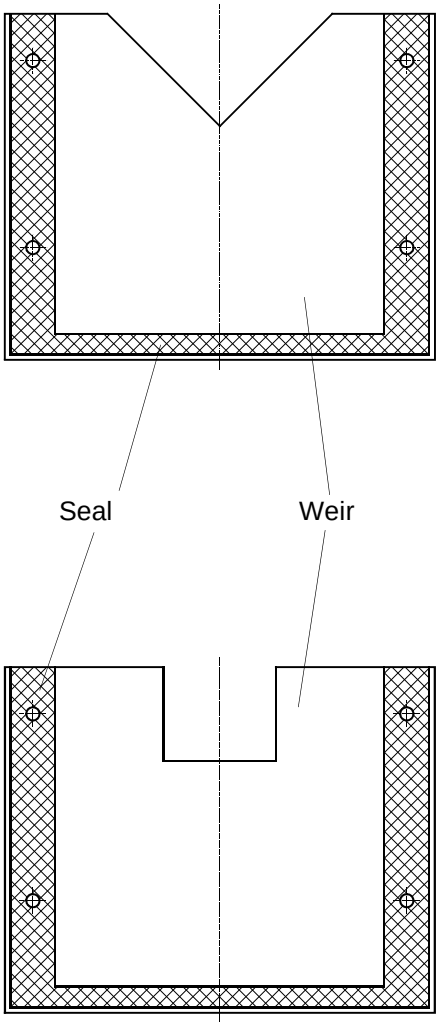
The weir head is determined with the aid of the height sensor [1]. The volumetric flow rate can then be calculated from the above.

The volumetric flow rate is determined using the volumetric tank [3] and the volume scale [6].
The volumetric flow rate is set on the ball cock [4], which regulates the pump of the **HM150**.

2 Preparation

Two weirs are provided, namely:

A V-profile weir and a rectangular-profile weir.



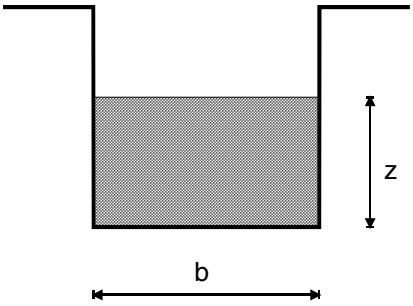
These are bolted to the outlet end of the channel, using 4 knurled screws.

The height sensor is arranged over the channel such that it faces the weir (refer to illustration on page 2).

Filling the **HM150** with water and establishing the power supply completes the preparatory work.

3 Experiments

3.1 Rectangular-profile weir



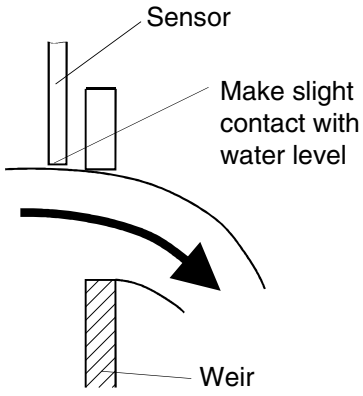
The volumetric flow rate can be derived from the weir width b and the weir head z .

The width b is constant.

b = 6.0 cm

The weir head z is measured indirectly.

3.1.1 Determination of weir head z

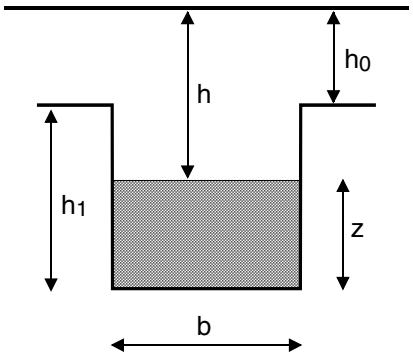


The height h of the water level is measured.

Given the constants:

h_0= 4.7 cm

h_1= 5.0 cm



the weir head z is calculated as follows:

$z = h_0 + h_1 - h.$

3.1.2 Determination of volumetric flow rate

The theoretical volumetric flow rate $\dot{V}_{th}$ is calculated as follows:

$$\dot{V}_{th} = \frac{2}{3} \cdot \mu \cdot b \cdot z \cdot \sqrt{2gz}$$

where μ= 0.63 for sharp-crested weir discharge

The actual volumetric flow rate $\dot{V}_M$ can be determined with the aid of the volumetric tank of the **HM150** using a stopwatch.

It is advisable to measure the filling time t for 10 litres. A good volume display is obtained in the scale range between 20 and 30 litres.

3.1.3 Measured values

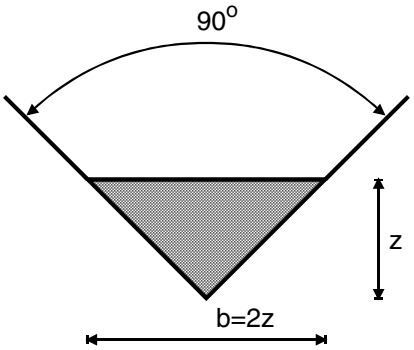
The following values were obtained for comparison between calculated and measured volumetric flow rates:

h [cm]	z [cm]	Time t for 10 l [sec.]	$\dot{V}_{th}$ [l/s]	$\dot{V}_M$ [l/s]	Deviation [%]
8,60	1,10	93,43	0,128	0,107	-16,4
8,05	1,65	44,26	0,236	0,225	-4,66
7,20	2,50	22,42	0,441	0,446	+1,13
6,00	3,70	12,85	0,794	0,778	-2,02
5,50	4,20	10,36	0,960	0,965	+0,52

Determination of the volumetric flow rate with a rectangular-profile weir ensures a high level of coincidence with the actual volumetric flow rate.

3.2 V-profile weir

The volumetric flow rate can be derived from the weir width b and the weir head z.

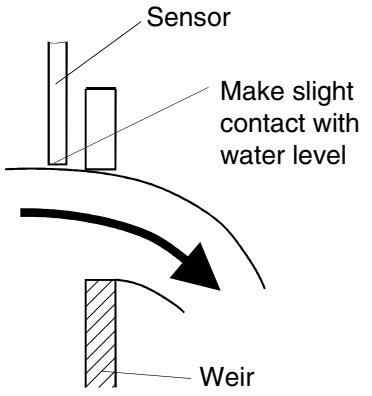


The width b is a function of the weir head z.

$b = 2z$

The weir head z is measured indirectly.

3.2.1 Determination of weir head z

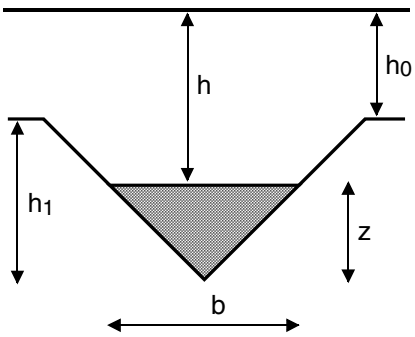


The height h of the water level is measured.

Given the constants:

$h_0 = 4.7$ cm

$h_1 = 6.0$ cm



the weir head z is calculated as follows:

$z = h_0 + h_1 - h.$

3.2.2 Determination of volumetric flow rate

The theoretical volumetric flow rate $\dot{V}_{th}$ is calculated as follows:

$$\dot{V}_{th} = \frac{8}{15} \cdot \mu \cdot z^2 \cdot \tan\frac{\alpha}{2} \cdot \sqrt{2gz}$$

where μ= 0.63 for sharp-crested weir discharge and tan 45°= 1

The actual volumetric flow rate $\dot{V}_M$ can be determined with the aid of the volumetric tank of the **HM150** using a stopwatch.

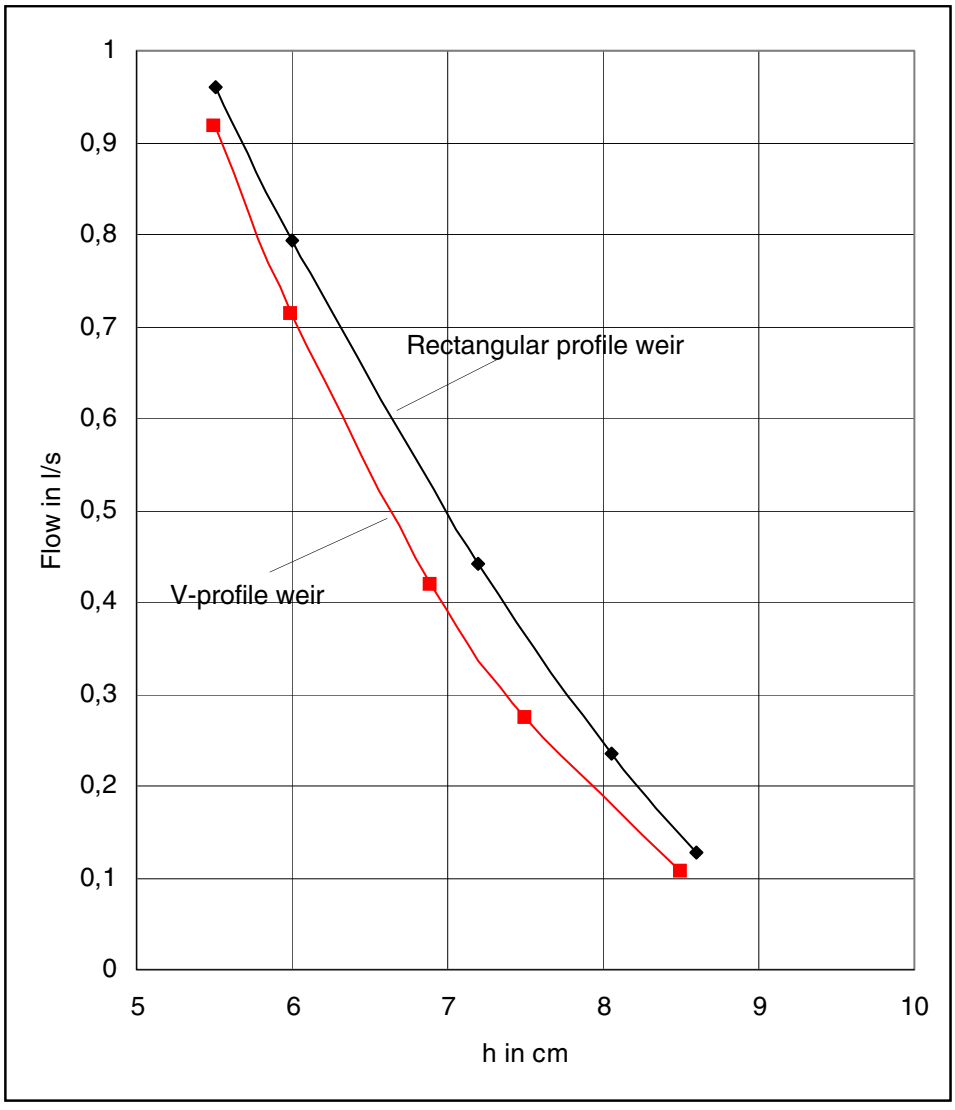
It is advisable to measure the filling time t for 10 litres. A good volume display is obtained in the scale range between 20 and 30 litres.

3.2.3 Measured values

The following values were obtained for comparison between calculated and measured volumetric flow rates:

h [cm]	z [cm]	Time t for 10 l [sec.]	$\dot{V}_{th}$ [l/s]	$\dot{V}_M$ [l/s]	Deviation [%]
8,50	2,20	91,68	0,106	0,107	+0,93
7,50	3,20	34,08	0,272	0,225	-17,28
6,90	3,80	21,95	0,418	0,446	+6,70
6,00	4,70	13,86	0,712	0,778	+9,27
5,50	5,20	10,83	0,917	0,965	+5,23

Determination of the volumetric flow rate with a V-profile weir ensures a high level of coincidence with the actual volumetric flow rate.



3.3 Flow over weirs

The graph shows the calculated volumetric flow rate $\dot{V}_{th}$ as a function of the measured height h.