Experiment Instructions

HM 160.36   Syphon Spillway
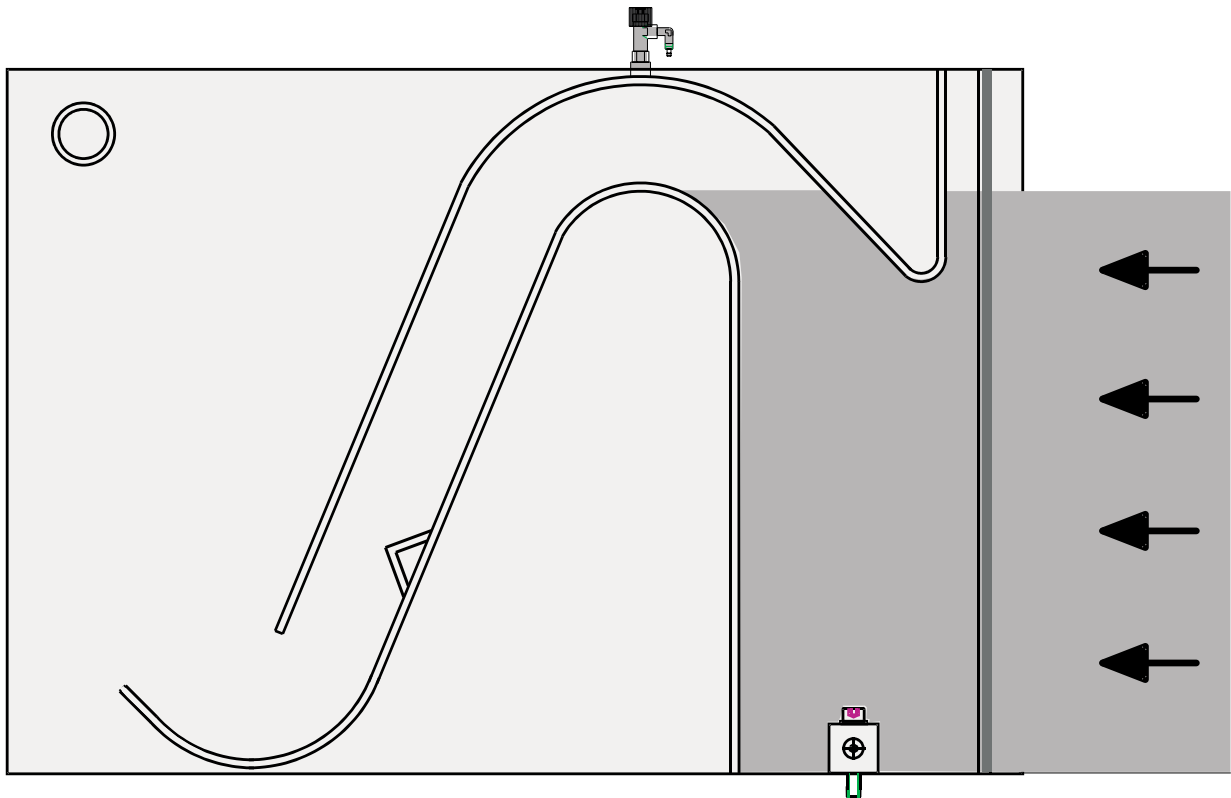
Experiment Instructions

Please read and follow the instructions before the first installation!

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1   Introduction

The hydraulic processes on the Heyn siphon can be investigated with the accessory unit **HM 160.36 siphon spillway.** Precise observations of the „start-up process" and the surge phenomena which occur at the end of the siphon action can be made. A ventilation valve fitted at the top of the siphon allows a precise comparison to be made between the siphon action and the normal overflow weir.

In addition, quantitative measurements of the flow rate capacity of the siphon and its overflow coefficient can be determined.

The material plexiglass guarantees a very good view of all flow processes.

The siphon spillway HM 160.36 is intended for installation in the modular flow channel HM 160 and can be assembled and disassembled very easily.

The following **subject areas** are covered by the siphon spillway HM 160.36 in combination with the modular flow channel HM 160:

• Method of operation of a siphon weir

• Outflow coefficients and flow rate of a siphon weir

• Pipe flows

• Cavitation processes at overflow and siphon weirs

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2   Unit description

The unit **HM 160.36 siphon spillway** is the model of a Heyn weir and has a ventilation facility on the top. It is intended for installation in the modular flow channel HM 160.
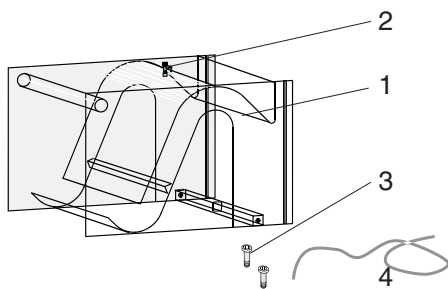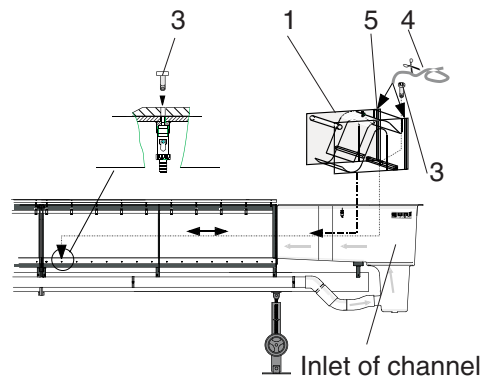
2.1   Components

Fig.: 2.1

The scope of delivery of the HM 160.36 includes the following individual parts:

- transparent **siphon weir** (1) made of plexi-glass with **ventilation valve** (2)

- **Hexagon socket-head screws** M8 (3)

- **Sealing hose** (4)

2.2   Assembly

Inlet of channel

Fig.: 2.2

- Push the **siphon weir** (1) into the channel from the inflow side (pay attention to the direction) and secure it to the bed of the channel with the **hexagon socket-head screws M8** (3). The siphon weir can be secured in various positions.

- Seal the siphon weir at the sides by pushing an appropriately shortened **plastic hose** (4) into the longitudinal **grooves** (5).

- During assembly, you should ensure that the side surfaces of the siphon weir are not scratched.

Important: Carry out assembly and disassembly only when the channel is empty, so that dropped screws or similar items cannot be rinsed into the outflow.

3   Safety

In all circumstances, it is essential to prevent screws or other small parts from being rinsed into the outlet opening of the the flow channel HM 160 by water. This would destroy the centrifugal pump. Therefore, always follow the safety instructions below:

- Assembly and disassembly of the siphon weir may only be carried out when the water has drained off.

- After assembly do not leave any tools in the flow channel.

- Always secure channel fittings securely in order to prevent damage.

- The siphon weir consists of fragile plexiglass which is not scratch-resistant. Therefore, do not use any abrasive cleaning agents to clean it.
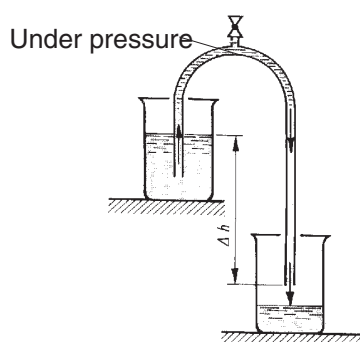
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4   Theory and experiments

4.1   The purpose and function of a siphon weir
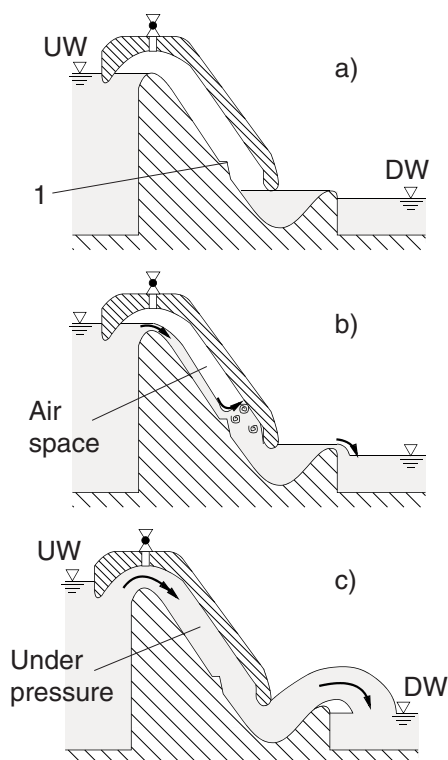
Fig.: 4.1   Physical siphon

Fig.: 4.2   Heyn syphon

Urban or industrial inflow channels must always be protected from an excessive water level so that neither people or goods are put at risk. Relief channels are therefore used, having relief structures such as side weirs which can immediately divert an excessive amount of water. The **siphon weir** is one such relief structure.

As the name implies, it operates on the principle of the physical siphon (Fig. 4.1). In an equally ingenious move, the inventor, whose name was Heyn, reconstructed a physical siphon to meet the demands of hydraulic engineering. This siphon, known as the **Heyn siphon** is today indispensable in hydraulic engineering.

Compared with all other relief structures, the Heyn siphon has the advantage that it „starts up" as early as when the build-up is slight, and can remove the excess water very quickly.

How does this Heyn siphon function?

It is shown in Fig. 4.2a. The ingenious thing is the small edge (1) on the bottom end of the siphon section. The falling water jet jumps onto the edge, thereby closing off the air space above it (Fig. 4.2b). As a result, the water jet captures air from this air space until the air has been completely removed and an under-pressure exists in the siphon. We now have the same situation as with the physical siphon in Fig. 4.1. The siphon has „started up" and sucks water with great energy from the upstream water to the downstream water (Fig. 4.2c).

In this case, it is actually no longer accurate to talk of an „overflow weir". Rather, a pipe flow exists. The water is raised via an overflow crown on the upstream water level and is diverted to the downstream water.

When the inflow on the upstream water side levels off, the water level falls again and frees a gap, causing air to flow to the siphon and the outflow to end abruptly. Surge phenomena occur which, in practise, are extremely undesirable and which in most cases can be remedied by subdividing the damming height with several siphons arranged one behind the other.

4.2   Experiment of the function of the siphon weir

The siphon weir HM 160.36 has a ventilation valve (Fig.4.3 /1) on its apex which can be opened in order to remove the under pressure of the outlet flow (Fig. 4.2c).

We recommend that you first carry out the experiment with the **valve closed**:

- Set the water level in the upstream water so that the water is slightly below the upper edge of the weir crown (Fig.4.3). Next, close the throttle valve again.

- Set a low flow rate and observe the processes during the subsequent „start-up procedure"; if necessary, increase the flow rate.

- Reduce the flow rate and observe the inflow of air and the end of the outflow.

Repeat the experiment with the **ventilation valve open.**

Note: Opening the ventilation valve can also be replaced by a connected hose, the opening of which is closed and opened manually.
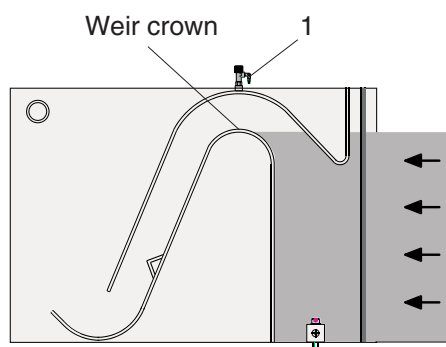

Weir crown   1

Fig.: 4.3

4.3   Calculating the outflow rate of a siphon weir

Every siphon weir has a maximum drainage capacity **Q** at a given water level difference. It is calculated by

$$Q = \mu \cdot A \cdot \sqrt{2gh} \qquad (4.1)$$

Fig.: 4.4

with

    μ - Outflow coefficient (normal Heyn siphon, achieved values of μ=0.5 - 0.6)

    A - Outflow cross section of the siphon

    h - Fall height of the siphon

    g - Acceleration due to gravity (g=9.81 m/s^2)

To derive (4.1), a Bernoulli stream thread must be laid between the intake and outlet cross-section. The derivation itself is not shown here.
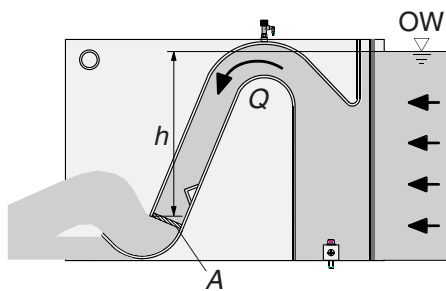
4.4   Experiment to determine the outflow co-efficient of a siphon weir

The outflow coefficient which applies to the siphon (4.1) can be obtained experimentally by conversion:

$$\mu = \frac{Q_{tats}}{A \cdot \sqrt{2gh}} \qquad (4.2)$$

Example calculation:

Set flow rate: Q_{real} = 9 m^3/h

Drop height of the siphon (difference of upstream water level to outflow opening): h = 190 mm

Outflow cross-section, siphon: A =72 x 35 mm^2

This gives an overflow coefficient of

$$\mu = \frac{9m^3}{3600s \cdot 0.072m \cdot 0.035m \cdot 193\,{}^m\!/_s} = 0.51$$

This is an acceptable value for this siphon weir.

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Notes on this experiment:

- Close the ventilation valve so that the function of the siphon is not impaired

- If a build-up occurs in the downstream water, the reason is incomplete outflow. The height difference between the upstream water and downstream water must then be assumed as the suction head *h*

- Do not set flow rates which are too high, otherwise the pump will switch itself off due to the water level limit being triggered

- To precisely measure the water levels, it is recommended to use the hook and point gauge HM 160.52

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5   **Appendix**

5.1   **Technical Data**

Material: Transparent plexiglass

Outflow cross section of the siphon:

(L x W)   72 x 35   mm

Suction head of the siphon: 150 mm
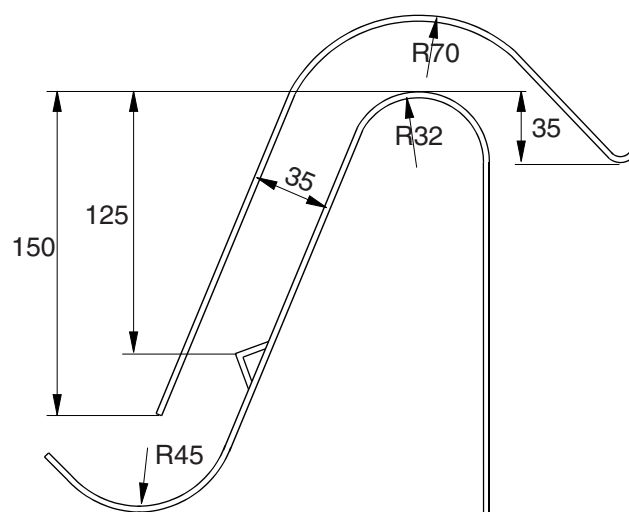
Dimensions:

(L x W x H)   320x240x84 mm

5.2   **Shape of the siphon**

Fig.: 5.1