Underwater Effluent Channel

Pure-water drain device for
longitudinal and circular settling tanks

Immersed system, therefore no obstacle for
floating sludge (scum) removal

Horizontal inflow holes, therefore no suction
of floating sludge

Interference factors like wind, inaccurate
installation, ground depressions etc. do not
have any negative effects anymore

Sun protected intake holes
(therefore almost no growth of algae within
the area of the holes)

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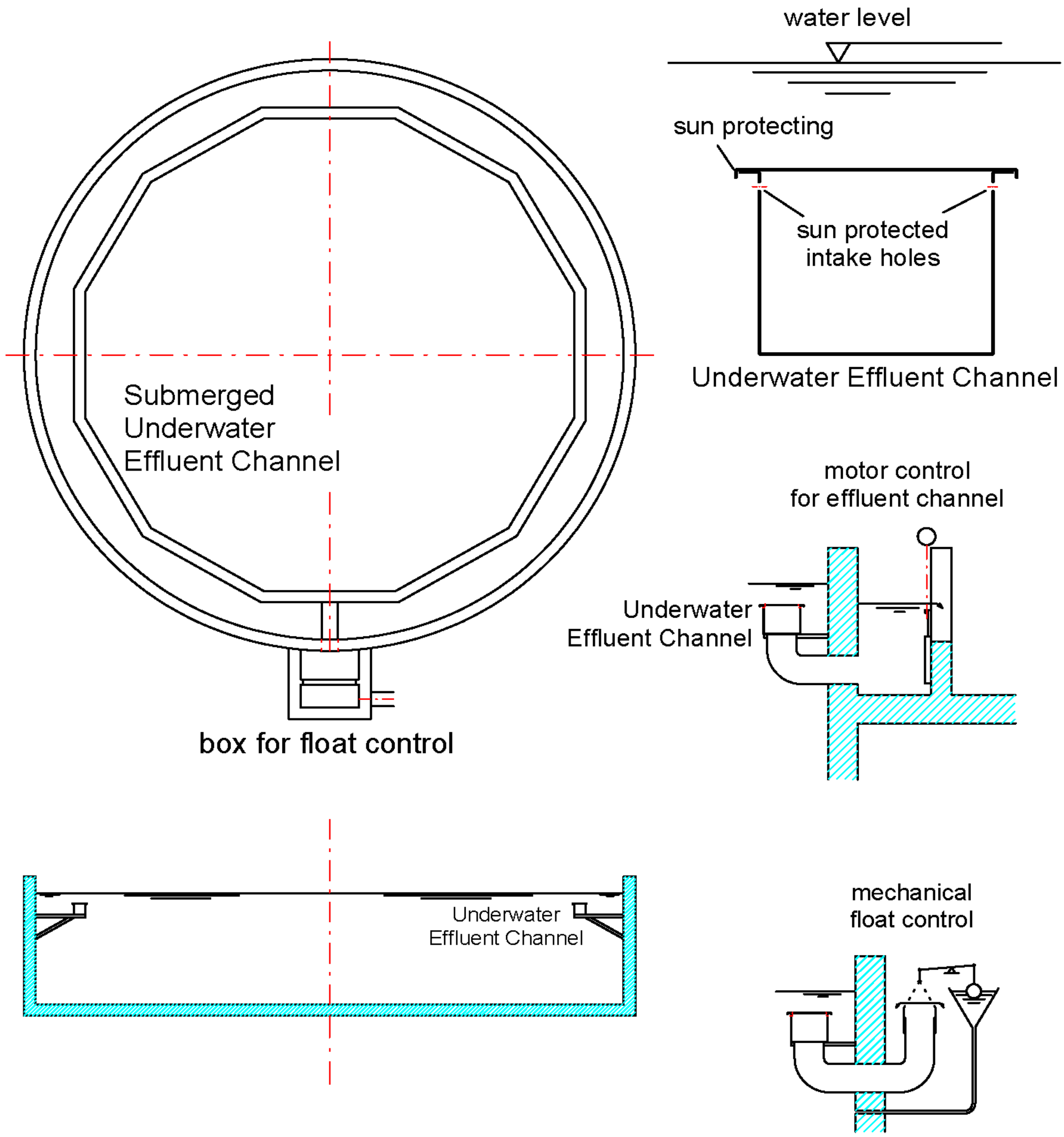

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Bauvorhaben

Komm.-Nr.

Zeichng-Nr.

Underwater Effluent Channel

(2-sidet perforated channel)

Clear-water drain systems in settling tanks
Basics of the drain functions of systems which operate with free overflow respectively according to the flow-through law

Clear-water drain systems are basically distinguished according to following laws:
Drain system operating according to the law of free overflow
Drain system operating according to the law of free or detained effluent

Systems operating according to the law of free overflow

This is the case for all overflow sills (with straight or indented overflow edge)
Example: Indented sill according to DIN 19 558
With conventional indented sill the clear water to be drained falls in free overflow into the channel.
With f.i. an overflow weir model A, this free overflow obeys following law:

$$\boxed{Q = \frac{8}{15} * \mu * \sqrt{2g} * h^{5/2}}$$

This formula shows that the overflow volume „Q“ increases or decreases overquadratically with the overflow height „h“.
If f.i. with an overflow height of 2 cm the overflow volume is 1,8 m^3/h per running meter, the new overflow rate because of a change of overflow height due to wind influence, increases from 2 cm to 3 cm, = 5 m^3/h running meter
This means that small water-level variations have a strong effect on the overflow volume. In this case the fault is bigger than 170 %, i.e. the overflow volume is more than 2,7 times of the required overflow volume.
Therefore the indented sill requires accurate adjustment in millimeters.
Still we cannot exclude big sources of faults created by wind influences or later ground sediments.

Systems operating according to the law of free or detained effluent

Systems with baffled flow-through holes behave completely different.
These systems adhere in principle to the law of the free overflow:

$$\boxed{Q = A * \mu * \sqrt{2gH}}$$

Here we can see immediately that the fault is not overquadratic as above, but only increases or decreases as root value.
If for instance the holes are 20 cm below the water level and the number and size permit a flow rate of 1,8 m^3/h per running meter and also here the wind raises the water level on one side for 1 cm, the flow rate becomes 1,845 m^3/h running meter.
The fault which was originally 170 %, is now only 2,5 %.

Functions of an underwater trough channel

The function of the underwater trough channel can be compared to underwater clear-water drain pipes.
The design is similar to a perforated channel.
The main difference to above systems is the self-specific mode of construction.
This channel incorporates the advantages of both discharge systems.
Underwater drain pipes have, beside the advantage of submergence, an easy discharge characteristic. The result is a completely free tank area which allows an easy skimming of floating scum.

The disadvantage however, is:

a) The water inlet holes are relatively unprotected against the sun and can quickly be covered and contaminated by algae.

b) When the holes are located at the side, much height and clarifying volume is lost. Also a deposit of algae due to sun light cannot be excluded.

Sophisticated and expensive pipe cleaning equipment is needed for both versions.
If according to recommendation of ATV (Association of Waste-Water Technics) a 2-sided channel is required, the consequences would be 2 rows of holes in the horizontal vertex of the pipe. For a pipe of 600 mm ∅, this causes a loss of height of 300 mm.

The **underwater trough channel** - as the name says - is submerged in the water and so presents no disturbance for a floating scum removal.
Further the inlet holes can be placed on the side just below the cover plate.
No clarifying volume is lost and still a sufficient depth of immersion of the complete trough is warranted.
The scum removal can be executed above the trough without any trouble.
Due to the fact that the holes are bored on both sides of the channel, same can be classified as a channel with 2-sided overflow, this in opposite to a pipe with holes or orifices in the upper vertex.
This allows to reduce the so-called weir-edge loading rate.
Additionally the cover plate (welded or screwed) can be provided with any width.
This makes it possible to protect the holes against sun and contamination.
Expensive cleaning equipment is not required.
If the cover plate is screwed, the channel can even be opened for inspections.
A continuous inclination inside the channel bottom towards the outlet can easily be provided. Sludge deposits can be reduced considerably.
Due to the fact that the holes - in opposite to the pipe - are located at the side, the clear water flows horizontally to the channel. This means that floating scum which has collected above the channel, is not forced downward.
A pipe with holes on the upper vertex has a suction direction vertically upward.
This means that floating scum collected at the top can easily be forced downward into the holes.
The underwater trough channel can be combined with any common discharge control (manual adjustment, mechanical float control, motor control etc.).
The exact hydraulic lay-out is guaranteed for each individual case.

Error rate (streaming behaviour)

Comparison Clear-water effluent channels

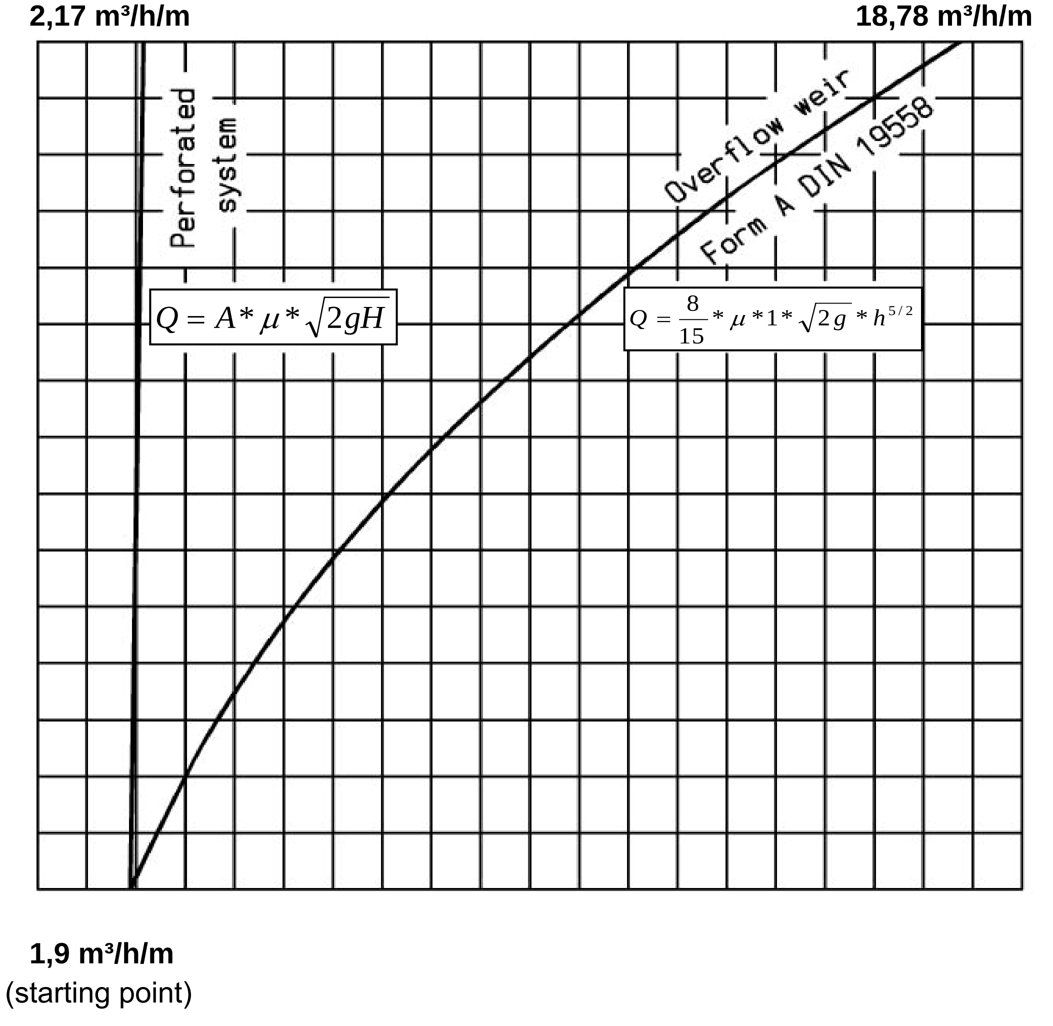
formula free overflow (weir)

$$Q = \frac{8}{15} * \mu * 1 * \sqrt{2g} * h^{5/2}$$

formula perforated system (underwater effluent channel)

$$Q = A * \mu * \sqrt{2gH}$$

Sources of faults: wind - ground depression - inaccurate assembly



Starting basis:

Overflow weir 2 cm (1,9 m³/h/lfm)
perforated system ΔH 10cm (also 1,9 m³/h/lfm)

Main characteristics of the underwater trough channel
Technical comparison to other systems

Deposit of algae

With conventional open U-type channels the complete internal channel surface is a fertile soil for algae. With each channel cleaning this refuse is transferred into the clear-water effluent of the clarifying plant.
A channel with the dimension of 0,5x0,5 m offers an area for growth of algae of 1,5 m^2 per running meter of the channel.
With clear-water effluent pipes the drain holes are located at the upper vertex.
When the diameter of the holes or the width of the long holes is 2-3 cm, the part which is transferred during the cleaning into the clear-water outflow can be judged with a width of 10 cm.
The logic consequence is a surface available for a growth of algae of 0,1 m^2 per running meter of the channel.
In practice this means an open channel creates approximately 15 times more algae which are transferred into the clear-water effluent.
This guarantees already a considerable technological advantage compared to the open channel. Unfortunately however, these holes are in the upper part of the pipe and thus are exposed to light.
With our underwater trough channel the drain holes are in the heavy shadow of the protruding cover.
Algae deposit and contamination of the holes is excluded, at least greatly reduced.
Channel cleaning is not necessary or can be executed very simply.

Weir edge loading (1- and 2-sided perforated channel)

A pipe with holes or slots in the upper vertical vertex is - thinking of the weir edge loading -a discharge channel with 1-sided overflow edge.
If according to the ATV-recommendation the effluent system shall be equipped with a small weir edge loading, the conclusion is that also the pipes should be equipped with 2 rows of holes in the horizontal vertex. This however, would result in an enormous loss of clarifying volume because the holes bored horizontally into a pipe, move down laterally.

The holes of a submerged clear-water channel are bored on the top at the side.
Here we have practically a 2-sided channel according to ATV-recommendation without any loss of clarifying volume.

Contamination inside the effluent pipe

If a small water volume is to be expected for a longer period of time, a reduction of the cross section of the channel's or pipe's high reference point might be advisable, in order to avoid deposits.
With pipes this cannot be done easily, with a channel however, a continuous slope towards the outlet can be realized without great difficulties.

Forced transfer of floating scum

Normally underwater-suction pipes have their holes or orifices at the upper vertex.
That means that the suction flow passes into the pipe vertically from top to bottom.
As the scum is floating on the top, a forced transfer of it is possible.
This cannot happen in case of the „underwater trough channel“ due to the fact that the holes are located at the side and therefore the suction flow travels in horizontal direction.

Submerged Clear-Water Effluent systems
as

Under-Water Trough Channel

view when
tank is empty

Under-Water Trough Channel with unscrewed cover

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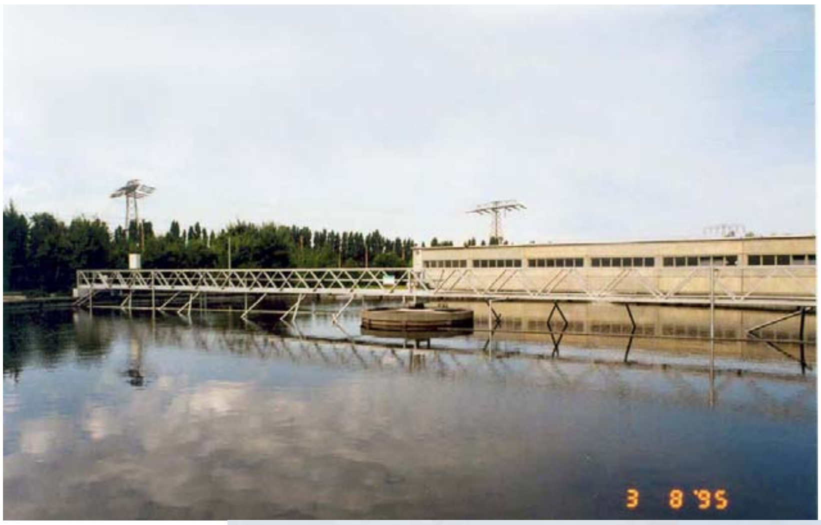
Submerged Clear-Water Effluent systems
as

Under-Water Trough Channel



after
filling
complete
submerged ----

---- so unproblematic
Floating Sludge Removal

Underwater
Effluent Channel

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Underwater Effluent Channels for Rectangular Clarifiers

Here: 2 Units of Rectangular Final Clarifiers
8 Units Underwater Effluent Channels with 2-sided inflow and with Sun protected intake holes
(Per Clarifier 4 Units Underwater Channels).
Sludge Collecting System as Chain and flight sludge collectors.
Cleaning of the Covers of the Effluent Channels with rubber blanket fixed at the flight sludge collectors.

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