DANISH
TECHNOLOGICAL
INSTITUTE

FLOW REGULATORS

CONTROL OF WATER FLOWS IN SEWER S SYSTEMS

Pipe Centre Guidelines 019
July 2015

PIPE CENTRE

Flow regulators
Control of Water Flows in Sewer Systems

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Second edition, first impression 2015

Printing and binding:

TRYKPORTALEN ApS

ISBN 978-87-996243-5-5

ISSN 1600-9894
Key title: Pipe Centre Guidelines

EAN 9788799624355

Preface

The purpose of these guidelines is to establish a common technical basis to assist consultants, municipalities, contractors and suppliers in connection with the choice, planning, installation and maintenance of solutions for control of storm and sewage water with special focus on flow regulators.

The project was financed by:

The Danish Agency for Science, Technology and Innovation
The Danish Technological Institute, Pipe Centre
Mosbaek A/S

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May 2013
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1 Introduction

Denmark has approximately 70,000 kilometres of public sewer lines. In connection with these sewer lines there are approximately 5,600 overflow structures and 4,100 basins. In addition to the public sewer lines there are practically just as many kilometres of private sewer pipes and pipes administered by governmental or municipal road authorities.

Some Danish sewer systems have inadequate capacity to cope with today's volume of storm water, due to:

- Extension of catchment areas without increasing capacity of the existing sewer system
- Increased paving of private as well as public areas
- Larger number of storm events and storms of increased intensity (extreme rain events/climate changes)

The precipitation pattern has changed in Denmark during recent years, one reason being climate changes. We have more intensive and prolonged rainfall resulting in the need for managing larger amounts of storm water. Higher percentage of impervious cover is reducing the storm water infiltration rate increasing the surface run-off. These amounts of water will also have to be managed. Many of the existing sewer systems in Denmark have not been maintained and upgraded and, are consequently, vulnerable to overloading. In addition, the sewer system has not been expanded to keep up with the increase in catchment areas. When municipalities develop land to meet housing demand, this means an increased number of sewer connections and increased load in most cases. It often turns out that the existing system does not have sufficient capacity to cope with the storm water from the developed land. This also applies to the development of industrial areas, where there will often be even larger amounts of water to be managed due to the considerably larger impervious surface associated with these sites.

The increased amounts of water may be managed by means of a combination of measures. The first attempt should be to infiltrate and discharge the largest possible amount of storm water locally. The remainder of the water should then be channelled to a sewer system, either a new one with sufficient capacity or to the existing (renovated) sewer system where the flow rate has been reduced to match its capacity. The latter solution requires a buffer capacity/volume upstream of the sewer system to collect storm water as well as a facility detaining its runoff to ensure that only a certain amount of water is conveyed to the sewer system. The requirement is the same whether the water is directed to a separate or combined system.

The consequence of not managing the larger storm water volumes is flooding and overloading of downstream systems, i.e. sewer pipes and sewage treatment plants, as well as increased amounts of water in the overflows. This may result in serious problems such as damage to infrastructure and pollution of receiving waters locally, upstream or downstream.

It is therefore important to be able to manage and regulate the storm water flows. This requires storage facilities, e.g. basins from where the runoff is regulated so that it does not exceed the capacity of the downstream system. In some situations it is also important to be able to regulate the inflow to certain components like oil separators, overflow structures and LAR-systems (Local discharge of storm water) etc. to obtain optimum performance of these components.

These guidelines will describe various generally applied means of controlling storm water and mixed storm and sewage water. The options for flow regulation in sewer systems have improved as have model calculations for these sewer systems. In addition, the municipalities have digitalised their storm sewer infrastructure, with GIS-based database systems.

2 Legislation

2.1 The legislative framework

In previous years, the municipal sewage network was administered by municipal technical and/or environmental departments. On 1 January 2010, a new service directive became effective resulting in the formation of a company consisting of municipal utility companies within the water and sewage sectors. This means that the overall planning and administration by authorities are still attended to in the municipalities, whereas in future the operation will be handled by municipally owned utility companies.

It is the duty of the municipalities to prepare sewerage schemes to form the basis of future modifications and extensions of the sewage network. In addition, the municipalities must also perform a review of receiving waters and establish requirements for sewage disposal and purification. The municipalities supervise and ensure that all requirements of the scheme are observed.

Municipal specification of functional requirements
In principle, a municipality is responsible for the correct dimensioning of the municipal sewer system so that it does not cause flooding. However, the citizens cannot insist on a sewer system designed to prevent flooding in all conceivable circumstances. Regardless of the extension of the sewer system, extremely heavy rainfall resulting in flooding is unavoidable. Even though local conditions differ, it has been the general opinion that the service level in Denmark is full flowing pipe every second year, normal basement level every five years and ground level every ten years for citizens/users of the sewer system.

Municipal obligations
The municipality must:

- Prepare a sewerage scheme for the existing and projected municipal sewage water system
- Ensure a future-oriented sewerage network involving the consideration of an increased degree of paving and climate changes
- Ensure that homeowners have gravity drains for sewage water from ground floor
- Determine the service level to ensure the compliance with these requirements
- Ensure consistency in municipal schemes and indicate those sewage system claims that may be lodged by citizens

The utility company should:

- Inform the citizens of the current functional requirements/service level
- Attend to the operation, extension and renewal of the public sewer system
- Assess the extent of damage caused by exceeding the specified service level, including decisions regarding the following questions: Where does flooding occur? To what extent? How does the water move on? Are there any alternatives? Is it possible to limit or control the extent of the damage?

2.1.1 Environmental legislation

The environmental legislation (Consolidated Act No. 879 of 26 June 2010) establishes the overall framework for the performance of the sewer systems, and the sewage water regulations (Executive Order No. 1448 of 11 December 2007) state more detailed directions for sewerage schemes, connection to sewage treatment plants, discharge from sewage treatment plants etc.).

2.1.2 The Working Environment Act

All work in connection with the sewer systems, whether operations or construction related, must meet the requirements of the Working Environment Act (Consolidated Act No. 1072 of 7 September 2010).

According to this act, the utility company shall ensure that the enterprise performing the work:

- Supervises so that the work is carried out properly as regards to health, safety and working conditions
- Provides the employees with the required training and instructions enabling them to perform the work safely

The builder/owner may be sentenced to a fine or prison for not abiding by the law, also in the case of negligence by the employees.

2.1.3 Building legislation and building regulations

The Building Act (Consolidated Act No. 1185 of 14 October 2010) contains regulations concerning the quality of the construction work and guidelines concerning the administration of the building activity. The more technical and constructional requirements will be found in the Building Code published by the Danish Business and Building Authority. The latest edition dates back to 2010.

The Building Code stipulates the overall requirements concerning drains within parcel limits and references DS 432 Standard for drainage installations.

The Building Code and the above-mentioned Standard apply to drain pipes within parcel limits (on private property). Outside the parcel limits, the owner of the sewer pipe (the municipality/the utility companies) dictate the directions.

2.1.4 The Authorisation Act

This act applies to drainage installations and sewer pipes on private property from the connection to the main drain.

As a result, work in connection with sewer systems on private property can be performed by authorised sewerage contractors only.

3 Description of regulating principles

3.1 Off-line flow regulation

The most common method of protecting overloaded sewer systems is to build a basin/reservoir outside the collection system. A basin detains and equalises the storm water or storm water and sewage water flow during storm events. After the storm event water is discharged to the collection system where it can be managed safely, see fig. 3.1.

The establishment of basins has three main purposes:

- **Protection of receiving waters**
  Here basins are used in combined systems to prevent frequent activation of overflow structures. The basins may be located before the overflow or they may be established to collect the overflow water. In separate systems, basins are used to protect the receiving water against overloading/erosion caused by large amounts of water

- **Reduction of basement flooding**
  Basins are established strategically in the sewer system to reduce the storm water load on critical pipe sections

- **Equalisation of run-off to sewage treatment plants**
  Basins are established strategically in the sewer system to equalise the storm water load on sewage treatment plant and receiving water

For protection of the sewer system after a basin it is important to keep the run-off from the basin reasonably constant, and even with a filled basin (maximum head), the run-off should not exceed the capacity of the downstream sewer system.

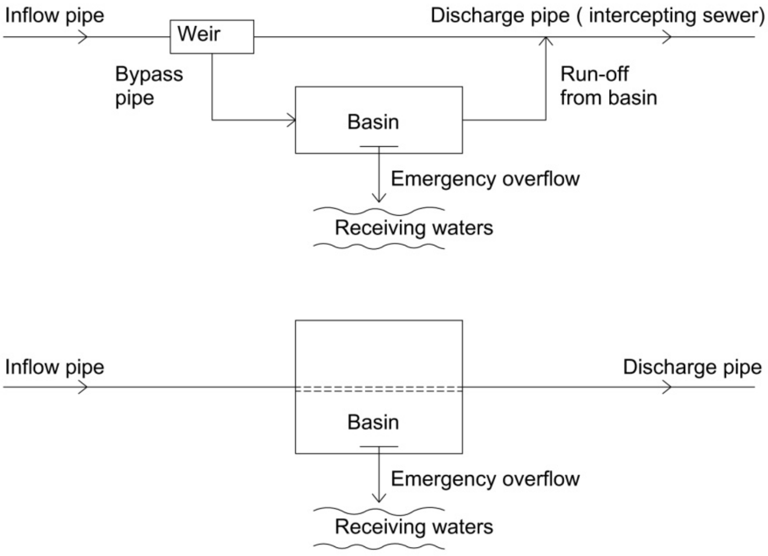


Fig. 3.1
Basic principles for location of basins
1) *Basin located parallel to discharge pipe (off-line)*
2) *Basin located direct on discharge pipe (on-line)*

3.2 In-line flow regulation

When the flow is regulated in the collection system, pipe capacity is optimised and fully utilised during storm events with short recurrence intervals. The design storm for pipe systems is a high intensity short duration storm which results in full flowing pipes for a very short period. In addition, our design practice means that only a few sections in the lower part of the system are flowing at full capacity during the design storm, and an extra volume is available in the remaining part of the system, see fig. 3.2. Therefore during low intensity storm events, only part of the pipe volume is utilised.

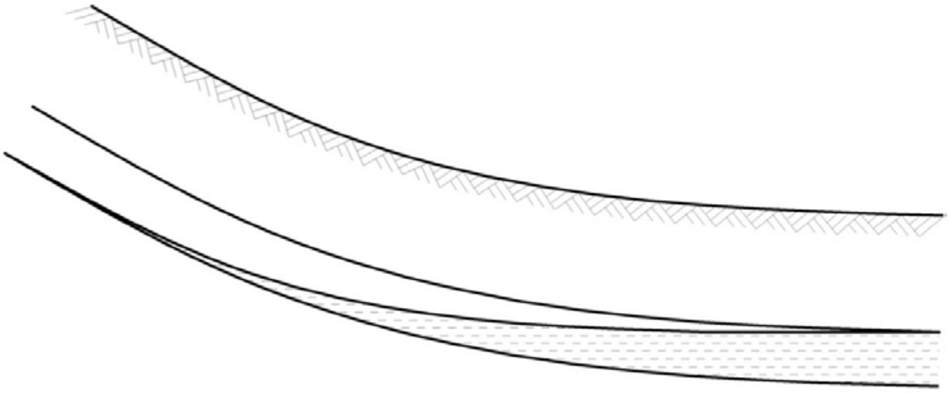
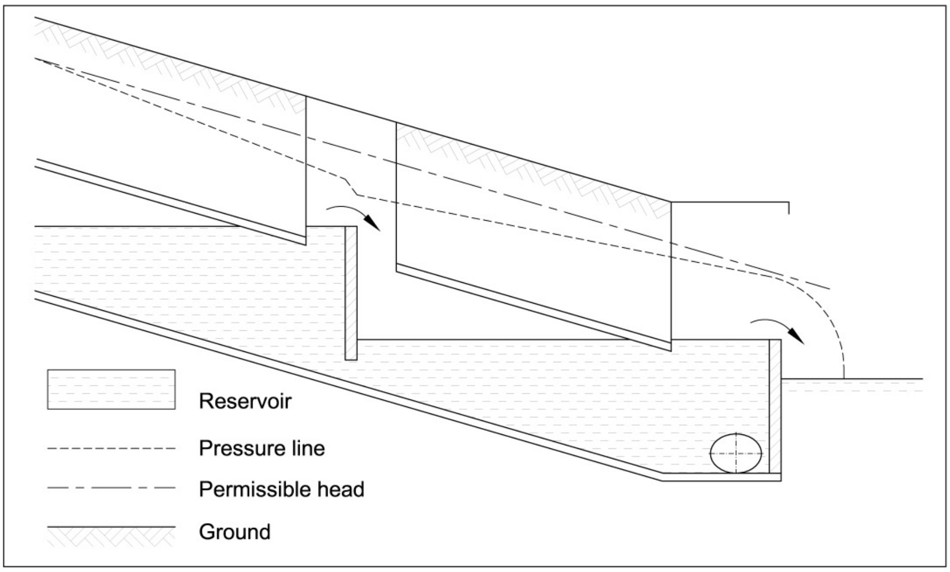


Fig. 3.2
Sewer system during a design storm event. The lower part of the system is filled, while there are empty volumes in the upper part of the system

When flow is regulated in the collection system, a controlled head is created in the pipes which mean that the maximum part of the pipe volume is utilised. Given the controlled head, the upper part of the system is filled, and flow from this part is detained. The lower part of the system is relieved of the load which results in less frequent overflow occurrences, see fig. 3.3.



Detention of the flow from the upper part of a pipe system

So far, flow regulation in pipe system has not been very common in Denmark, but due to the increased amounts of precipitation, this option should be considered.

In order to optimise basin volumes and to obtain maximum permitted flow downstream, flow regulation is important. Maximum flow rate should be obtained as quickly as possible. After that the regulated flow must be kept close to the maximum flow even if the head changes. The types of regulation allowing for this have the steepest possible head-discharge curves.

3.3 Regulating methods

There are many different means of regulating the flow in a pipe system, from a simple reduction of the pipe diameter to sophisticated regulating systems with moveable shutters and valves.

The following methods will be described here:

- Fixed regulation (sluice gate/single baffle/throttle pipe)
- Double baffles
- Vortex regulation
- Pumping

In all methods, except for pumping, the flow regulation will feature one or more of the following methods to establish an extra energy loss in the pipe system, see fig. 3.4.

- Contraction
- Cascade
- Vortex

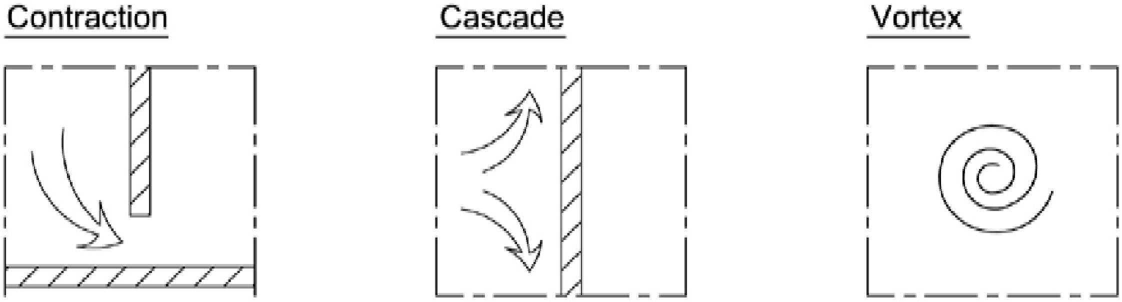


Fig. 3.4
Regulating methods by means of energy loss

3.4 Fixed regulation

The simplest type of fixed regulation is a narrowing of the pipe cross section by means of a sluice gate positioned in the middle of a manhole with an outlet hole at the invert, or by means of a baffle fitted at the outlet from a manhole in front of a larger pipe. The energy loss is obtained by contraction.

3.4.1 Sluice gate

The simplest type of fixed regulation is a narrowing of the pipe cross section by means of a sluice gate with an outlet hole at the invert, see fig. 3.5.

At times of low flow, the water passes unimpeded through the opening at the invert. When it starts raining, the water dams up behind the sluice gate and fills the pipe volume upstream. In case of heavier storms, the water level will be so high that the sluice gate also acts as a weir. Therefore, the sluice gate elevation should be set so that it does not submerge low lying basements or other upstream structures and cause flooding.

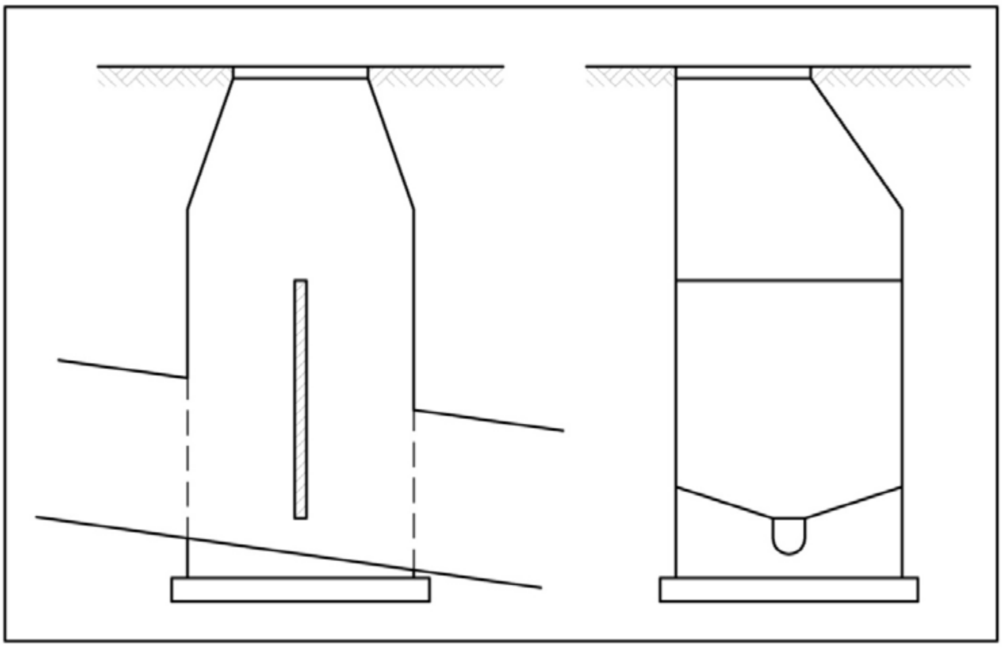


Fig. 3.5
Sluice gate. The structure consists of a sluice gate in an ordinary manhole

When the outlet opening is small in relation to the maximum head, the current flow rate may be calculated by means of the formula:

$$Q = \mu \cdot A \cdot \sqrt{2g \cdot H} \qquad (1)$$

where A is the area of the opening, H is the head, see fig. 3.6, g is the acceleration of gravity and μ is a discharge coefficient fixed at 0.6 for sharp-edged openings.

Fig. 3.6
The head for discharge through a sharp-edged hole

In practice this will often submerge the outlet (increasing the head in the discharge pipe) occurring at the design storm.

The characteristic curve for this type of discharge is a parabola, see fig. 3.7.

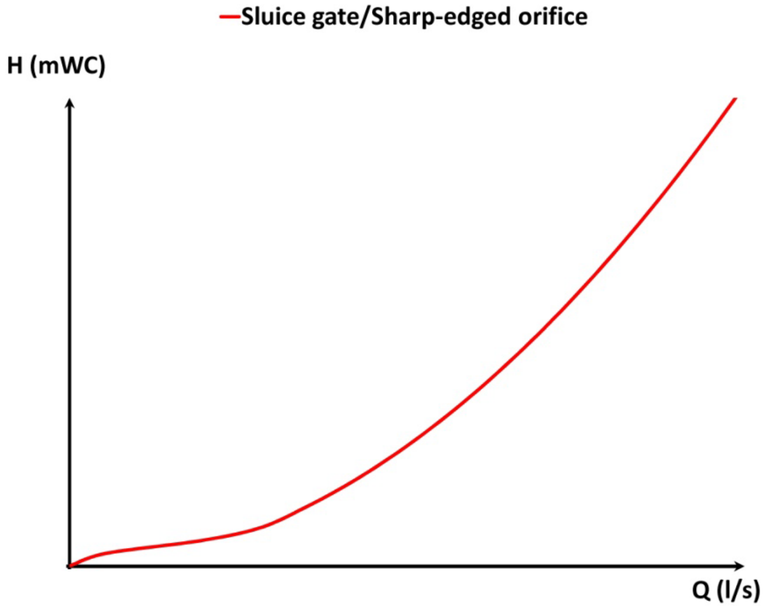


Fig. 3.7
The curve for discharge through a sharp-edged hole

The solids content of sewage water requires a lower limit on the minimum size of the water passage area (150 – 200 mm). Therefore, if a lower flow rate is required, another solution must be chosen.

3.4.2 Baffle

A baffle reduces the outflow from a manhole. The reduction is effected by placing a baffle in front of the outlet. Normally, the baffle can only be regulated by entering the manhole. Thus, a baffle is a form of sluice gate positioned at the discharge pipe of a manhole, see fig. 3.8.

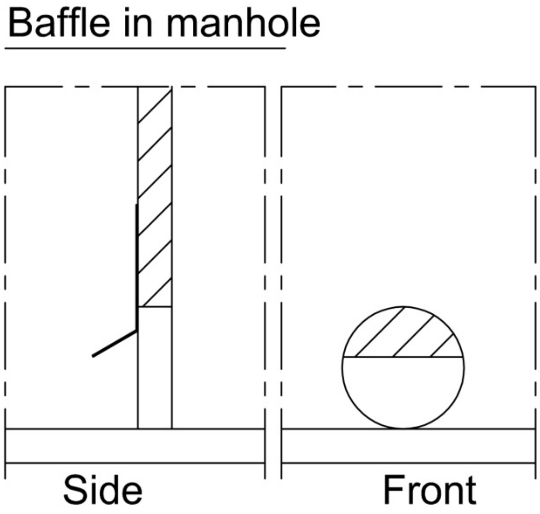


Fig. 3.8
Baffle in the outlet of a manhole

The head-discharge curve for a baffle is a parabola (similar to that of the sluice gate), see fig. 3.7.

3.4.3 Double baffles

A double baffle consists of two baffles placed one after the other. The baffles are installed at the inlet and outlet of a rectangular chamber mounted at the outlet of a manhole, see fig. 3.9.

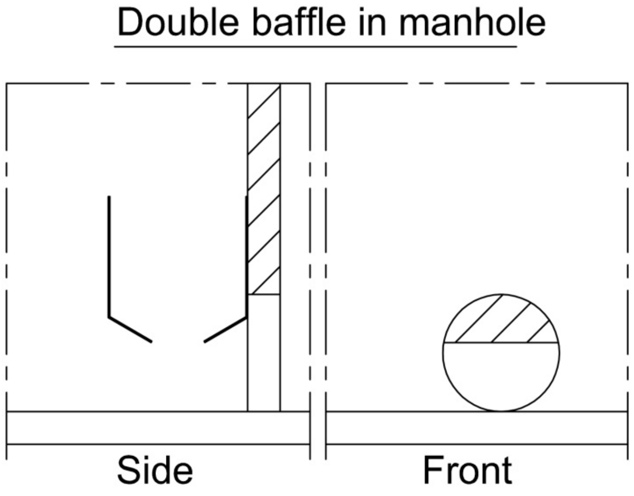


Fig. 3.9
Double baffles. Two baffles placed one after the other at the outlet of a manhole

At times of low flow, the water passes unimpeded through the opening at the invert. As the storm builds, the water dams up behind the first baffle and is stored in the upstream pipe volume. The baffle causes a pressure loss (contraction), which is smaller than for a sharp-edged opening, and thus a larger flow rate is obtained at low heads. When the water level reaches the upper edge of the baffle, the chamber will be filled and the water will primarily be throttled by the second baffle, see fig. 3.10. This baffle causes a pressure loss (contraction), which exceeds that of a sharp-edged opening. The head-discharge curve of a double baffle is also a parabola, but with a higher energy loss, when the overflow is activated, see fig. 3.11.

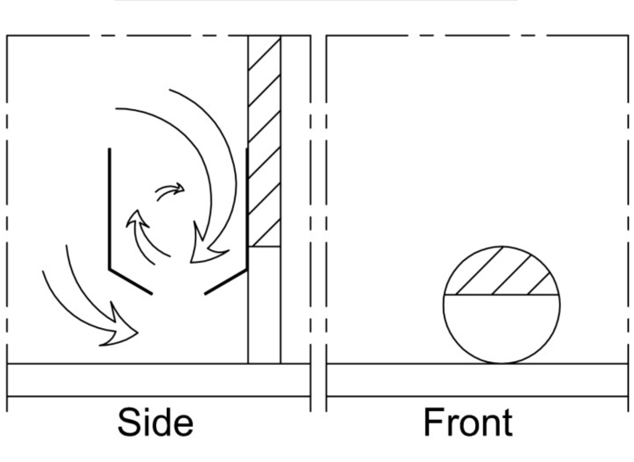


Fig. 3.10
Principle of operation of a double baffle, see the vortices

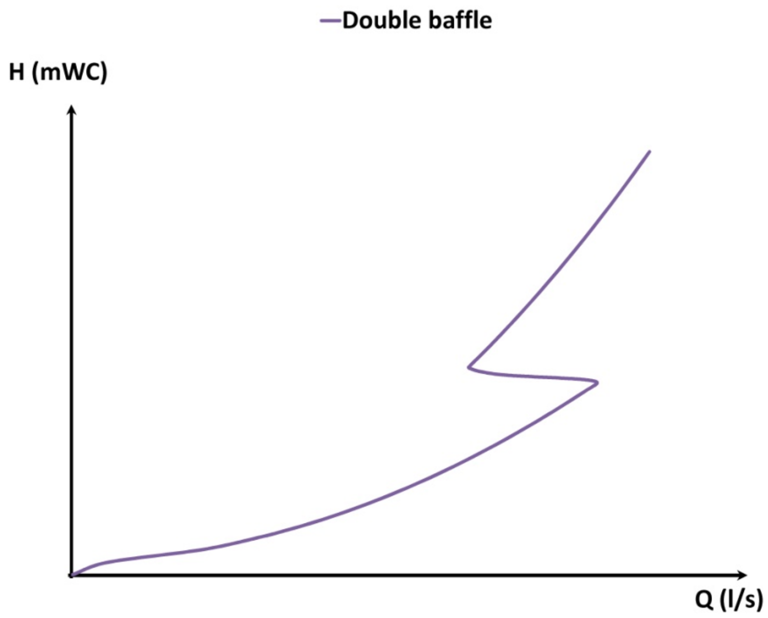


Fig. 3.11
Head-discharge curve of a double baffle

3.4.4 Level-controlled sluice gates/baffles

For a more sophisticated type of regulation, level-controlled sluice gates/baffles may be used. It could be a simple manual control (e.g. the sluice gate may be removed in case of an extreme storm event) or control by means of a float/sensor.

3.4.5 Throttle pipe

In a throttle pipe, the energy loss in the pipe system is increased by discharge through a long pipe with a small diameter. The energy loss is obtained by means of friction.

The energy loss for the flow through the throttle pipe may be calculated by means of the energy equation and the Manning formula and may be expressed by:

$$\Delta H = Q^2 \left(\frac{L}{M^2 \cdot R^{4/3}\, A^2} + \frac{\sum \zeta}{2 \cdot g \cdot A^2} \right) \qquad (2)$$

where L is the length of the pipe, M is the Manning number of the pipe, R is the hydraulic radius, A is the cross section of the pipe, Q is the flow rate, g is the acceleration of gravity and $\sum\zeta$ is the sum of individual losses through the pipe.

The equation may be converted to:

$$\Delta H = Q^2 \cdot K \qquad (3)$$

where K is called the specific resistance of the pipe
The flow rate of the throttle pipe may be calculated as:

$$Q = \sqrt{\Delta H / K} \qquad (4)$$

From the formula it is clear that the smaller the flow rate the larger the required specific resistance in the piping. As there is also a practical lower limit for pipe diameter, the pipe resistance is best increased by increasing the length of the throttle pipe.

In practice, standard throttle pipe diameters must be used, and it may sometimes be difficult to obtain a completely satisfactory solution due to what is commercially available. If a change in flow rate is necessary, it will not be possible to increase the capacity if a throttle pipe has been installed. Only a capacity reduction is possible. Thus, an increase can only be obtained by adding other regulating methods as described.

Fig. 3.12 shows regulation by means of a throttle pipe supplemented with a central overflow. At times of low flow, the water passes from the ø 800 mm pipe, through an ø 300 mm throttle pipe and then downstream to a ø 800 mm pipe. Moderate showers will cause backwater inside the central overflow and at the same time, the pipe volume upstream of the throttle pipe will be used as a reservoir. In case of more intense storm events, the increased water level will cause the central overflow to be activated and consequently, to direct storm water into the downstream system.

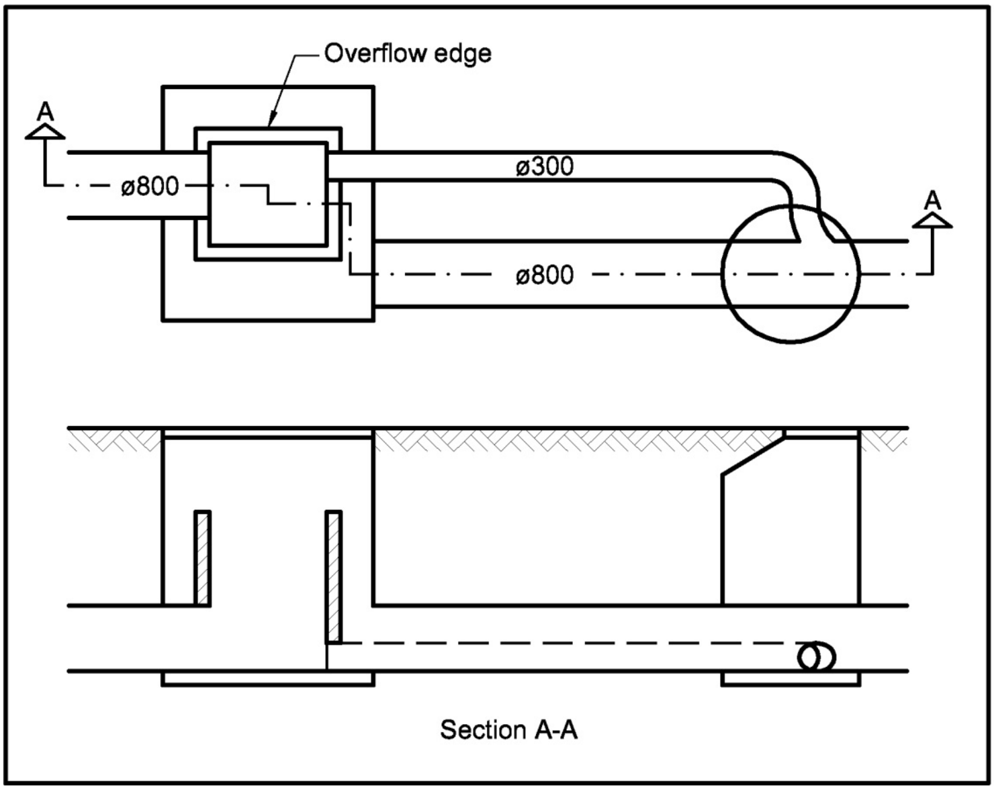


Fig. 3.12
Central overflow with throttle pipe

The head-discharge curve of a throttle pipe will be a parabola, which is a little steeper than for the sluice gate/baffle, see fig. 3.13.

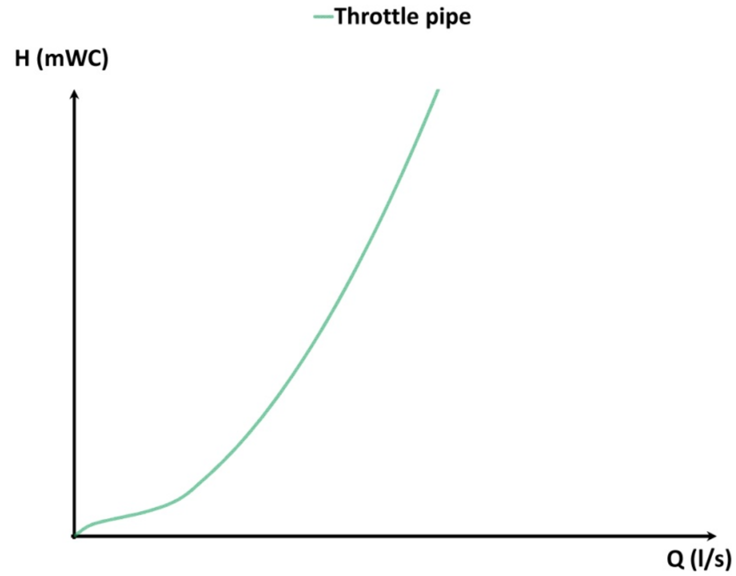


Fig. 3.13
Curve for discharge through a throttle pipe

3.5 Vortex regulation

Using vortex flow regulation, a very effective means of controlling water flow may be obtained.

In Denmark a regulating device called a ”water brake” or flow regulator was developed in the 1960’s. The flow regulator has a high hydraulic resistance (large energy loss), a large water passage area and a compact design. It has no moving parts and works on the principle of gravitation without the supply of energy.

The principle operation of the flow regulator will appear from fig. 3.14. It consists of a vortex chamber, in which the flow becomes tangential and the water is caused to rotate. The rotational direction of the vortex is almost perpendicular to the flow direction, which causes the flow rate to be reduced.

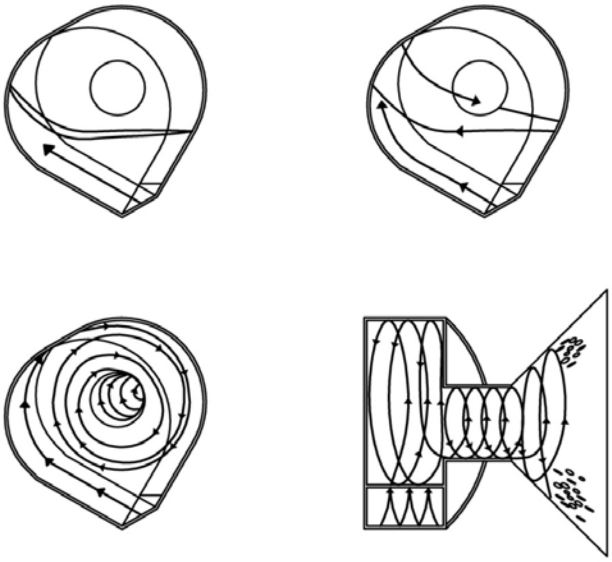


Fig. 3.14
Filling process in a flow regulator with vortex effect

Due to this vortex formation in the flow regulator, the flow volume will be smaller than that corresponding to a simple orifice with the same diameter as the flow regulator outlet opening. A flow regulator has a considerably steeper head-discharge curve than the other types of regulators, see fig. 3.18.

During low flow events, the flow regulator acts like an over-sized orifice with no noticeable braking effect (0-1). As head builds on the flow regulator water reaches the top of the flow regulator housing. At this point a vortex forms and the hydraulic braking effect commences. At heads above the top of the flow regulator housing the head-discharge curve bends upward and backward (1-2-3), after which is becomes parabolic, which may be designated ”the braked curve” (3-4). This parabola has a μ-value specific for the flow regulator. At decreasing heads, the curve will follow the parabola, until the vortex collapses (4-3-5-1), see fig. 3.15.

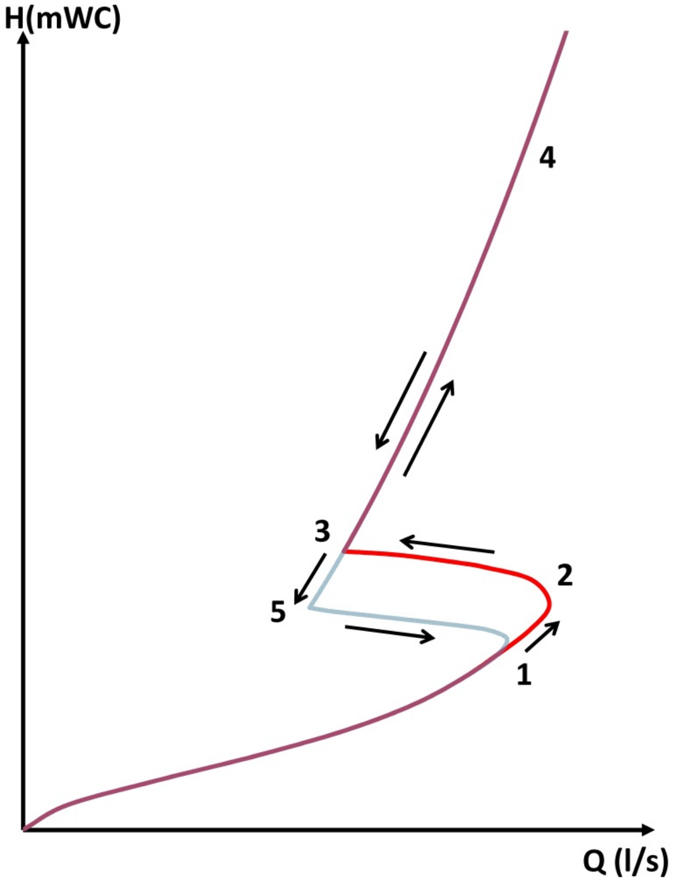


Fig. 3.15
Head-discharge curve for cyclone valves

When the water level sinks below the top of the flow regulator housing, the rotation becomes unstable, which results in a momentary increase of the flow rate (5-1). This sudden increase of the flow rate is favourable as it causes a “flushing” of the system.

The average flow rate of a flow regulator will be approximately 0.85 of Qmax compared to 0.67 of Qmax for a normal parabola-shaped curve (baffle, throttle pipe). As is seen on the curve above, Qmax is obtained twice during flow regulator operation; once at low head and again at the design Q.

3.6 Pumping

Pumps are primarily used when the water must be channelled to a higher level for disposal to receiving water or sewage treatment plant.

The pumping unit consists of:

- Pump sump
- Pump with control system and power supply
- Pressure pipe with valves and non-return valves

The characteristics will depend on the type and number of pumps. However, the flow rate will be known for a given design, as each pump has its own head-discharge curve, see fig. 3.16.

Normally, storm water flows by gravity into the pipe system. However, in low-lying areas it may be necessary to pump storm water. Pumps can be used in these situations to create the throttle effect.

Pumping of storm water is only used when no other solution is feasible because the storm water volumes cannot be determined accurately (i.e. huge storm events) and because the operating and maintenance costs are high.

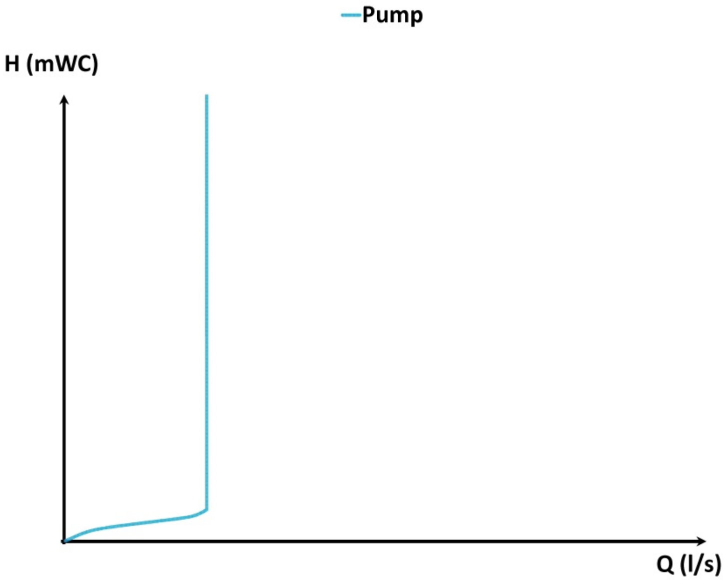


Fig. 3.16
Head-discharge curve of pump

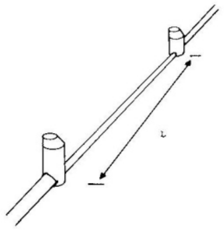
3.7 Calculation example

The three flow regulation examples described on the following page are based on the design conditions below:

Desired difference in water level	1.50 m
Desired flow rate	52.0 l/s

1. Regulation of the flow through a **sluice gate** or **a sharp-edged hole with a diameter of ø 140 mm**

2. Regulation of the flow using a **throttle pipe** may be obtained in different ways. The three examples below all meet the design criteria

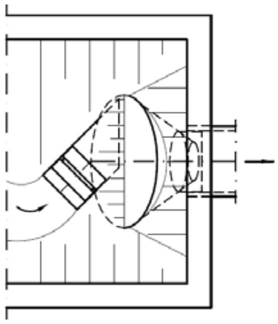


D = 250 mm, length 180 m

D = 200 mm, length 51 m

D = 150 mm, length 9 m

3. Regulation of the flow rate by means of a **flow regulator** may be obtained by using the following type and size, which has a water passage area of ø 250mm:



The cyclone valve CY 870 – 250/250 may be installed in an ø 1500 manhole

From the example will be seen that only the throttle pipe and the flow regulator have acceptable water passage openings. Solution costs will have an impact on the selection process. A flow regulator will often be cheaper, as it requires no special modifications to the infrastructure as it can be installed in an ordinary (or existing) manhole.

3.8 Discharge characteristics and μ–values

As mentioned previously, the discharge characteristics of sluice gates/baffles may be calculated as discharge through a sharp-edged outlet:

$$Q = \mu \cdot A \cdot \sqrt{2g \cdot H} \tag{1}$$

where A is the area of the opening, H is the head, g is the acceleration of gravity and μ is a discharge coefficient, which is normally fixed at 0.6 for a sharp-edged outlet, see fig. 3.7. The μ–value may be used to compare discharge characteristics as practically all head-discharge curves are parabolas.

Characteristic μ–values are:

Sluice gate:	0.6
Double baffle:	0.55 – 0.75
Flow regulator:	0.13 – 0.33

A low µ–value means a steeper head-discharge curve, as the braking effect is more significant. Fig. 3.17 shows the head-discharge curves of a sluice gate and a flow regulator with corresponding µ–values.

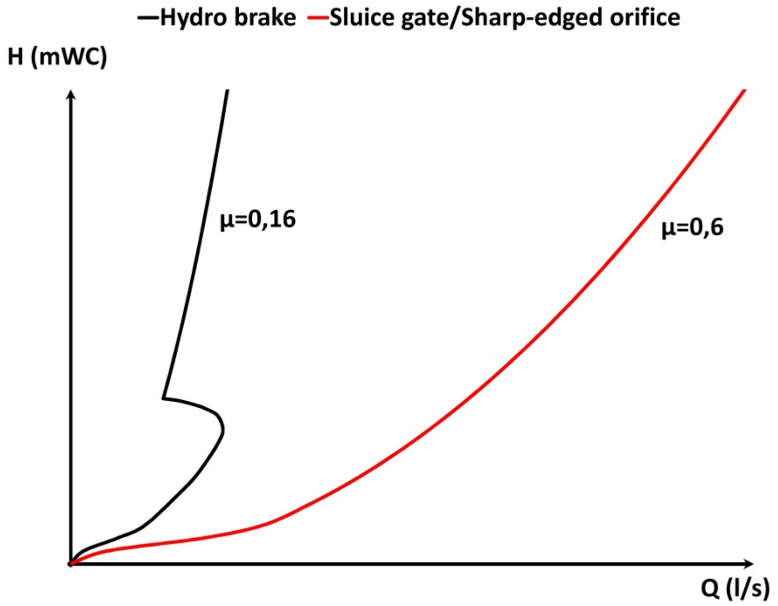


Fig. 3.17
The µ–value of the curve may be used to assess the braking effect of control structures. The figure shows an unbraked curve (sluice gate) and a braked curve (flow regulator)

3.9 Summary

The regulation of the water flow in a sewer system will normally increase the potential risk of a blockage in the system. In order to reduce this risk the openings in the flow control solutions must be as large as possible.

To optimise basin storage and to obtain the maximum permitted flow downstream, regulation of the flow is important. Maximum flow rate should be obtained as quickly as possible, after which the regulated flow must be as close to maximum as possible even as the head increases. The types of regulation allowing for this have the steepest possible head-discharge curves.

Energy consumption and operating and installation costs are also important parameters.

Head-discharge curves for the described solutions are shown in fig. 3.18.

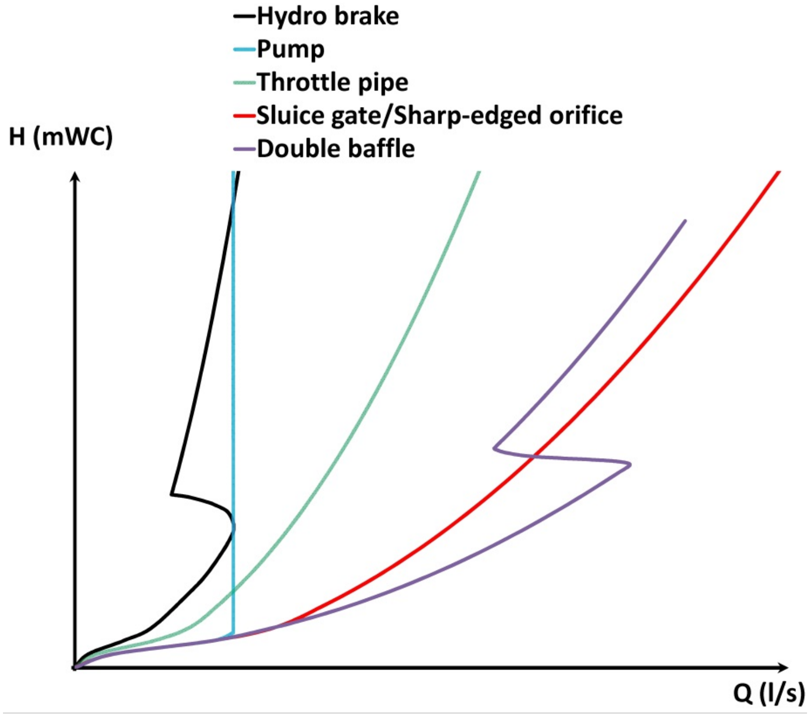


Fig. 3.18
The figure shows head-discharge curves for five flow regulation solutions

In the following sections installation and specific regulating methods listed below will be described:

- Baffles and throttle chambers
- Flow regulators

Sluice gates and throttle pipes are well known methods and will not be described in further detail. Pumps as a method of regulation will seldom be an applicable solution owing to the considerable operating and maintenance costs. Consequently, they will not be described in further detail either.

4 Installation terminology

There are different methods of installing flow control components in a sewer system. These methods are described below.

Submerged installation (outlet-mounted); the regulator will be installed at the outlet from the manhole. The flow is fed through an open invert and discharged through a closed pipe, see fig. 4.1.

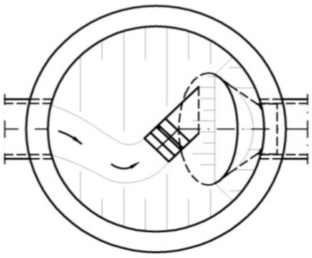


Fig. 4.1
Submerged installation/outlet-mounted

Semi-dry installation (inlet-mounted); the regulator will be installed at the inlet of the manhole with free discharge to the invert. Increased head may occur in the manhole in case of backwater in the discharge pipe, see fig. 4.2.

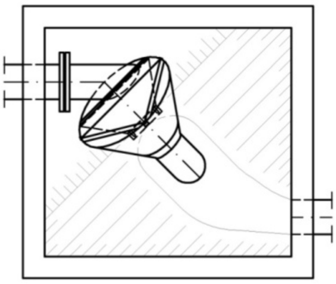


Fig. 4.2
Semi-dry installation/inlet-mounted

Dry installation (inlet as well as outlet-mounted); the regulator will be positioned on the inlet side of the structure and the discharge will be directed through the manhole in a closed pipe, see fig. 4.3. Dry installation is not very common in Denmark because of the lower efficiency.

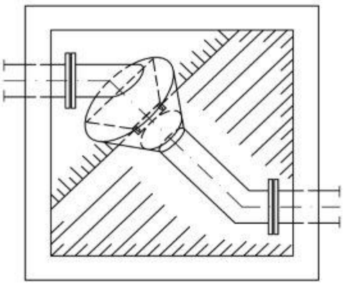


Fig. 4.3
Dry installation

5 Regulation by means of baffles etc.

5.1 Single baffle controller

Application
Single baffle controllers are typically installed in the outlets of detention basins and structures and are used to control large flow rates at low heads.

The controller is used for regulation in storm water systems and combined systems. It is available in various sizes and capacities ranging from approximately 10 l/s up to 4,500 l/s. Single baffle controllers are normally made of acid-resistant stainless steel.

Principle of operation
The single baffle controller works on the principle of gravitation. It has no moving parts, no mechanical components and no power requirement. A single baffle controller limits the flow because of the small discharge orifice. An example is shown in fig. 5.1.

Dry weather run-off passes under the baffle. When it starts raining and the inflow to the regulator increases, the baffle will increase the resistance to the flow and thus limit the passing flow. At the desired maximum head, the single baffle controller will have the desired maximum flow.

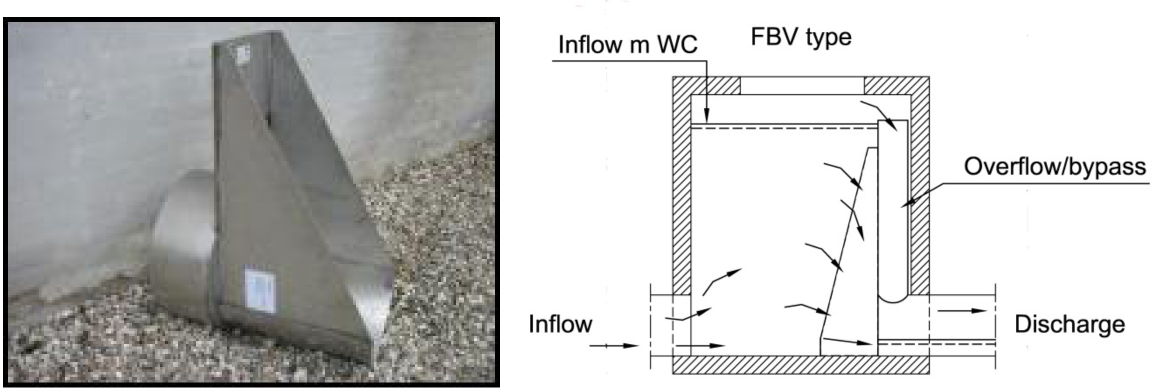


Fig. 5.1
Single baffle controller as fixed regulation

Characteristics
The head-discharge curve of a single baffle controller is a parabola, see fig. 5.2.

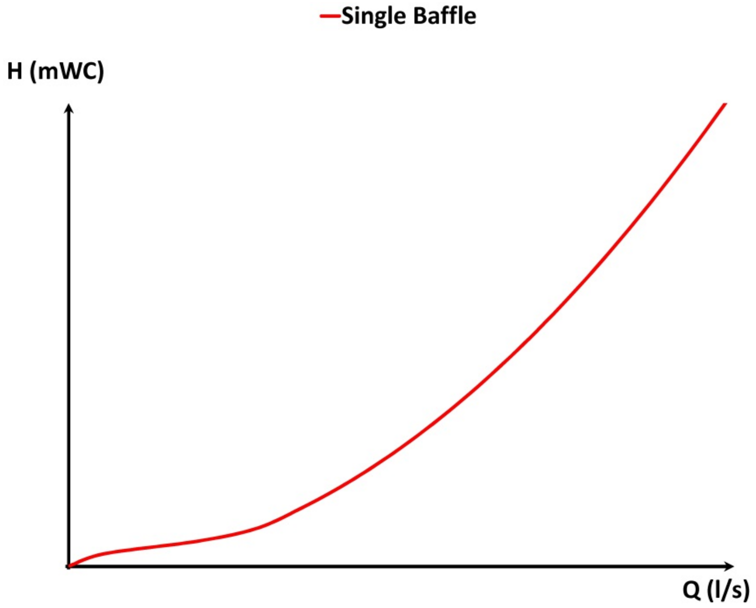


Fig. 5.2
Head-discharge curve of a single baffle controller

Installation
The single baffle controller is designed for submerged operating conditions. It is installed at the outlet of the structure located downstream of the detention facility from where the flow must be regulated. The regulator takes up little space and may usually be installed in existing structures/manholes.

The single baffle controller is adjustable, but will be pre-set by the supplier. The setting of the baffle should be checked after installation. If a change in flow rate is required, the baffle may be adjusted by loosening a few screws, adjusting it according to the supplier's instructions and retightening the screws.

Principle of operation
As is the case with the sluice gate, the application of the single baffle controller will be limited due to the size of the passageway. The braking effect is only a little better than that of a sharp-edged orifice. The size of solids in the sewage water puts a lower limit on the size of the water passage area. Therefore, if very low flow rates are required, another solution must be chosen.

The single baffle controller has a straight passage and a rounded invert, which contributes to excellent self-cleaning.

After installation, the controller should be inspected at regular intervals in order to determine the need for maintenance on site.

5.2 Double baffle controller

Application
Double baffle controllers are installed in the outlet of detention basins, in structures, in watercourses and are primarily used to regulate large flows at low heads.

The controller is designed to regulate flows in storm water systems and combined systems. It is available in various sizes and the capacity ranges from approximately 30 l/s up to 10,000 l/s. Double baffle controllers are usually made of acid-resistant stainless steel, see fig. 5.3.

Fig. 5.3
Double baffle controller

Principle of operation
The principle of operation of the double baffle controller is described in section 3.4.3. It works on the principle of gravitation. It has no moving parts, no mechanical components and has no power requirement.

Flow characteristics
Fig. 5.4 shows the head-discharge curve of a double baffle controller.

Fig. 5.4
Head-discharge curve of a double baffle controller

Installation

Designed for submerged operating condition, the double baffle controller is installed at the outlet of the structure as illustrated in fig. 5.5. The structure is located downstream of the basin from where the flow must be regulated. The invert should have a 20‰ slope with benching sloping towards the invert.

The regulator takes up little space and may usually be installed in existing structures/manholes.

A double baffle controller is adjustable and both baffles have been pre-set by the supplier. The setting should be checked after installation. If a change in flow rate is required, the baffles may be adjusted by loosening a few screws, adjusting it according to the instructions of the supplier and retightening the screws.

Thanks to the adjustable baffles, the flow rate may be increased/reduced by approximately 25% relative to the medium capacity of the regulator.

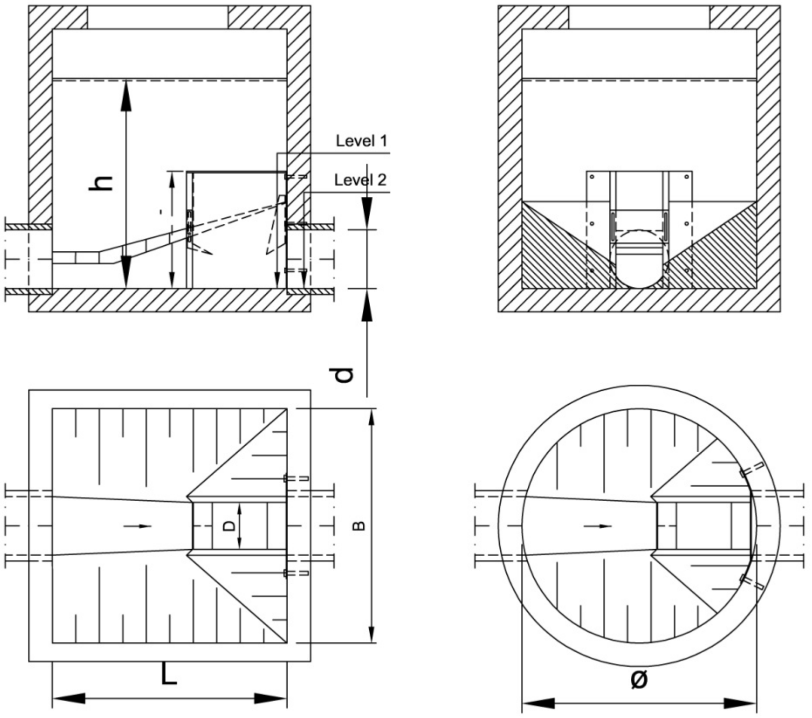


Fig. 5.5
Plan and cross section of the double baffle controller

Principle of operation

The double baffle controller has a straight passage and a rounded invert resulting in excellent self-cleaning. It may easily be flushed from ground level.

After installation the controller should be inspected at regular intervals in order to determine the need for maintenance on site.

5.3 Throttle chamber

Application

Throttle chambers are installed in gullies receiving storm water from private lots/car parks and are used for regulation of small flow volumes. They are only intended for gullies with silt traps.

Throttle chambers are designed for regulation of storm water only. They are available in various sizes and have capacities up to 3 l/s. The throttle plate is normally made of stainless steel.

Principle of operation

The throttle chamber shown in fig. 5.6 is a specially designed gully with a throttle plate fitted in the outlet for regulating flow from the chamber.

Fig. 5.6
Throttle chamber

The size of the hole of the throttle plate is determined in each individual case. The chamber is made of corrugated pipe with dimensions of ø 315 mm and ø 425 mm. The inlet and outlet are positioned in the chamber according to the customer's requirements. The throttle plate is fitted in a rail in the outlet and fastened to a pipe. This makes it possible to get access to the valve manually or to remove it for inspection.

The throttle chamber works on the principle of gravitation. It has no moving parts and no power requirement. A throttle chamber limits the flow by means of a small discharge orifice.

As the storm intensifies and flow to the regulator increases, the throttle plate will gradually increase the resistance to the flow and the flow rate will be reduced. At the design head, the throttle chamber will allow the required maximum flow.

Flow characteristics
Fig. 5.7 shows the head-discharge curve of a throttle chamber.

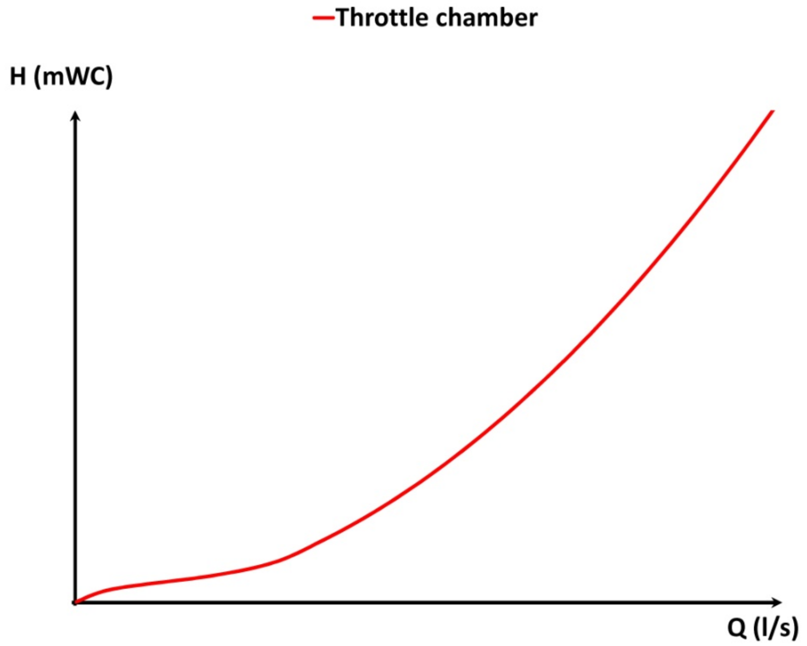


Fig. 5.7
Head-discharge curve of a throttle chamber

Installation
The throttle plate is positioned at the outlet of the throttle chamber. The throttle chamber is located downstream of the detention facility, from where the flow must be regulated. This may be an infiltration trench or reservoir/basin on the property or a dip in the ground.

Principle of operation
As is the case with the sluice gate, the use of the throttle chamber is limited by the size of the passageway. The size of solids in the storm water puts a lower limit on the size of the passageway. Therefore, if very small flow rates are needed, another solution must be chosen.

Under regular operating conditions, the throttle plate should be inspected and cleaned at least once a year. In case of increased risk of blockage, inspection and cleaning intervals should be adjusted accordingly.

6 Flow regulators

Fig. 6.1 shows three main types of flow regulators with vortex regulation.

- Cyclone valve
- Centrifugal valve, vertical
- Centrifugal valve, horizontal

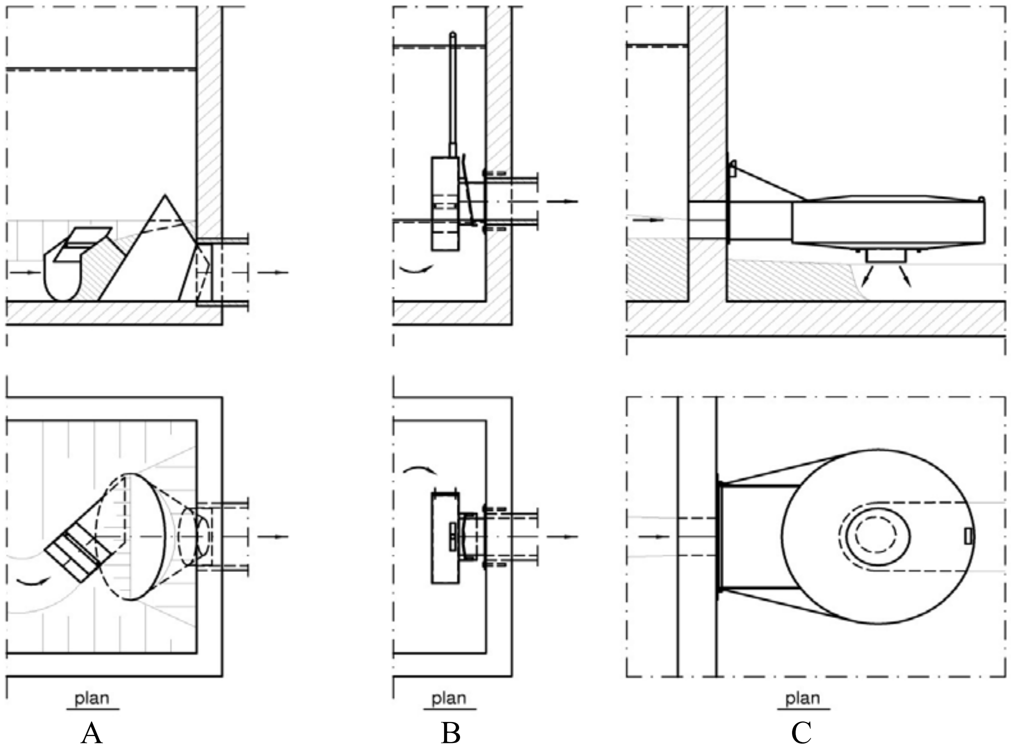


Fig. 6.1
The three main types of flow regulators with vortex regulation:
A: Cyclone valve
B: Centrifugal valve, vertical
C: Centrifugal valve, horizontal

6.1 The cyclone valve

Application
This type of flow regulator is normally installed in a manhole located in connection with the discharge from detention basins and other structures and is used to regulate all flow rates except for the very small volumes. The regulator is designed for application in storm water systems and combined systems. It is available in various sizes and the capacity ranges from approximately 6 l/s up to 600 l/s. The cyclone valve is normally made of acid-resistant stainless steel, see fig. 6.2.

The cyclone valve is widely popular, one reason being that it may be installed in existing manholes without head loss. The most common sizes will pass through a manhole, which makes the regulator applicable for new installations as well as existing systems where it may often be installed without excavation.

Fig. 6.2
The cyclone valve

Principle of operation
The cyclone valve works on the principle of gravitation as described in section 3.5.

The regulator has a horizontal inlet with a truncated cone-shaped chamber. The head must be at least 300-400 mm above the housing to obtain the braking effect. The cyclone valve has no moving parts, no mechanical parts and no power requirement.

Characteristics
Fig. 6.3 shows the head-discharge curve of the cyclone valve. The mechanisms behind are described in section 3.5.

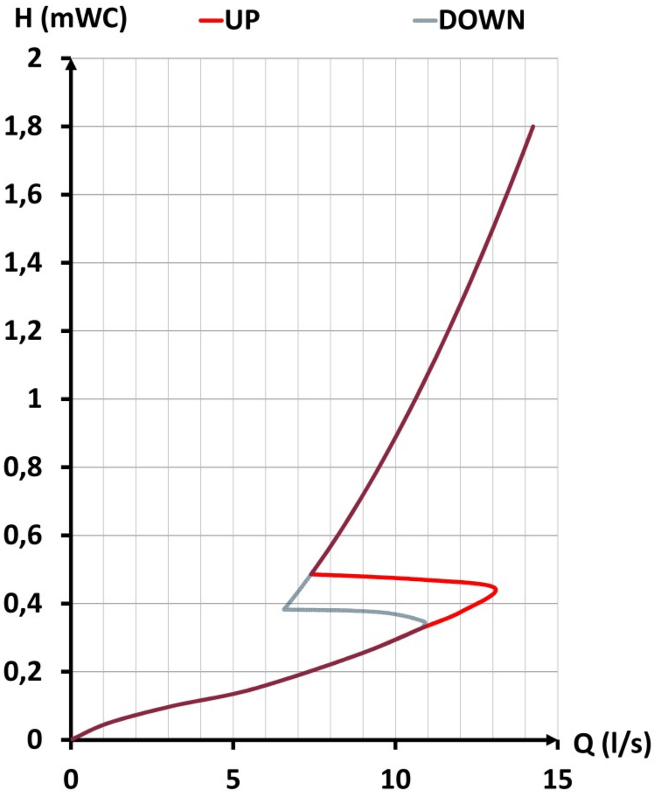


Fig. 6.3
Head-discharge curve of the cyclone valve

Installation

Designed for submerged operating conditions, this type of regulator is installed at the outlet of the structure as illustrated in fig. 6.4. If required this regulator can also be used in dry and semi-dry applications, see chapters 4 and 8. The regulator is located downstream of the detention facility from where the flow is to be regulated. If there is a risk of backwater on the outlet side, it is recommended that the regulator is vented.

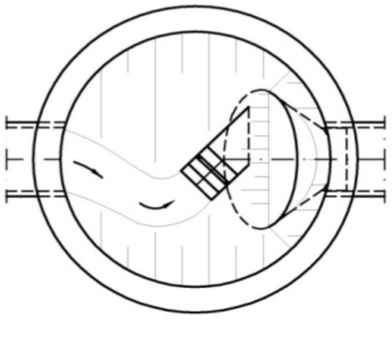


Fig. 6.4
An invert must be concreted up to the inlet of the cyclone valve

The regulator is typical installed in existing structures/manholes. In structures an invert with a slope of 20 ‰ must be provided up to the inlet of the regulator and benching sloping towards the invert must be concreted. The cyclone valve must have an almost horizontal (mired) flow.

The flow rate on cyclone valves can be modified using an adjustable baffle which is pre-set by the manufacturer. The setting of the baffle should be checked after installation. If a change in flow rate is required, the baffle may be adjusted by loosening a few screws, adjusting it according to the instructions of the supplier and retightening the screws.

Thanks to the adjustable baffle, the flow rate may be increased or reduced by approximately 25 % relative to the medium capacity of the regulator.

Principle of operation

The cyclone valve is designed for maximum self-cleaning. The passageway creates only one change of direction (45 degrees) through the valve. This is the lower limit for the cyclone valve and the invert is rounded. It has the largest possible passageway. Owing to these features, the risk of blockage is smaller compared to other types of regulators. This installation may easily be flushed from ground level.

After installation, the regulator should be inspected at regular intervals in order to determine the need for maintenance on site.

Overflow

If there is a risk that the cyclone valve may be blocked, an emergency overflow or a bypass facility may be installed in connection with the regulator.

An emergency overflow may also limit the water level upstream. In this case, the overflow should be designed as a weir, which must be as long as possible.

6.2 Centrifugal valve

The centrifugal valve is available in both a vertical as well as a horizontal design configuration.

6.2.1 Vertical centrifugal valve

Application
The vertical centrifugal valve is installed in a manhole with sump/silt trap. The manhole is located downstream or at the outlet of detention basins and other structures. The vertical centrifugal valve is designed to control small and moderate flows. It is used in storm water systems, but may be also regulate certain types of industrial sewage as well as the inflow and outflow from oil separators. It is available in various sizes and the capacity ranges from approximately 0.2 l/s up to 80 l/s. Centrifugal valves are normally made of acid-resistant stainless steel, see fig. 6.5.

Fig. 6.5
Vertical centrifugal valve

The vertical centrifugal valve is the most commonly used flow regulator for storm water. It has the largest passageway and has a coupling for mounting and demounting the valve using a lifting rod. With no moving parts, energy requirements or regular maintenance needs the regulator has virtually no operating costs. The most common sizes may pass through a manhole, which makes the regulator ideal for new installations as well as existing systems, where it can often be installed without excavation.

Principle of operation
The centrifugal valve works on the principle of gravitation as described in section 3.5.

The regulator has a flat teardrop-shaped housing. The inlet of the centrifugal valve is submerged as it is below the bottom level of the outlet. If the regulator is to be used for oily storm water, it must be delivered with the teardrop-shaped housing and, consequently, the inlet turned through 45 degrees to allow free passage of the oil through the regulator, see fig. 6.6.

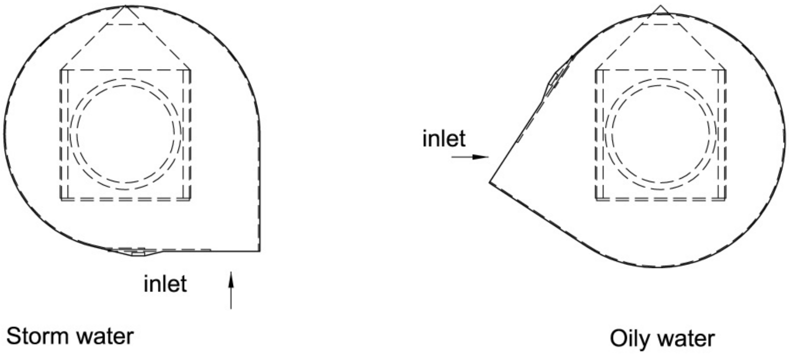


Fig. 6.6
Vertical centrifugal valve for normal and oily storm water

Characteristics
The head-discharge curve of the centrifugal valve is similar to that of the cyclone valve (flow characteristics are described in section 3.5). This centrifugal valve has a better braking effect compared to the cyclone valve and, consequently, a steeper curve. The head-discharge curve is shown in fig. 6.7.

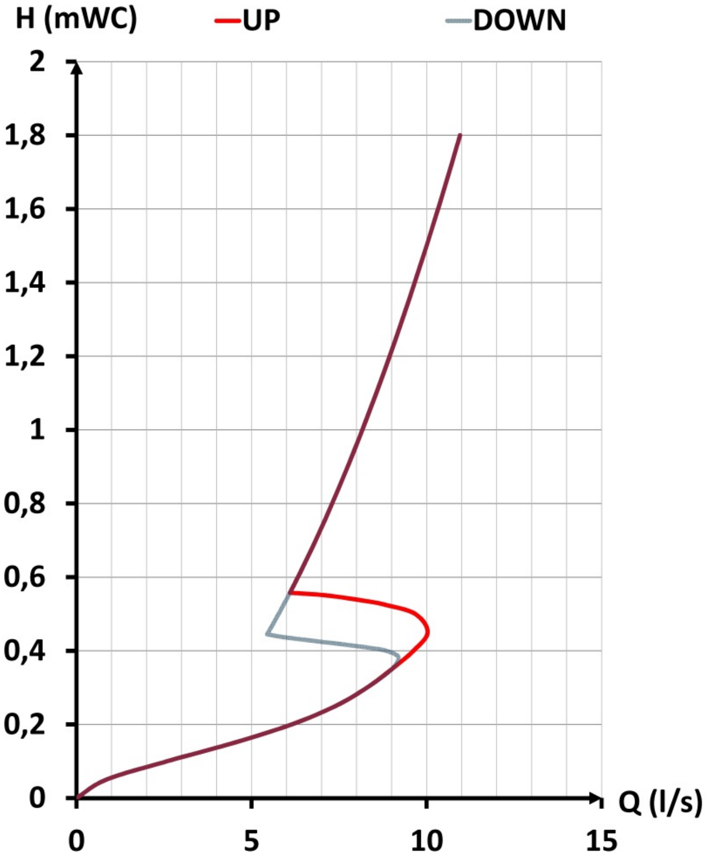
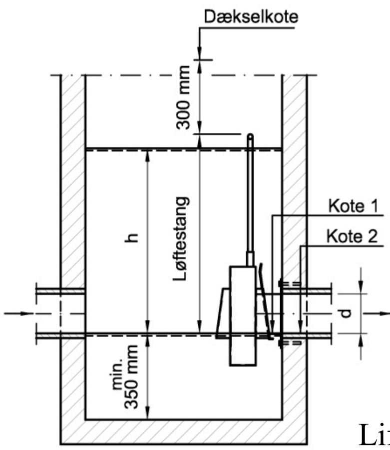


Fig. 6.7
Head-discharge curve of a vertical centrifugal valve

Installation
Designed for submerged operating conditions, the vertical centrifugal valve is installed at the outlet of the structure above a sump as illustrated in fig. 6.8. The sump acts as a sediment trap. The structure is located downstream of the basin or dip, from where the flow must be regulated. If there is a risk of backwater on the outlet side, it is recommended that the regulator is vented.

Usually this type of regulator is applicable for existing structures/manholes with sump.

The vertical centrifugal valve is available for fixed installation or with a coupling claw and lifting rod enabling mounting and demounting from ground level.



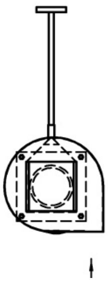

Lifting rod for demounting and mounting

Fig. 6.8
The vertical centrifugal valve with coupling claw may be removed by means of the lifting rod

A vertical centrifugal valve is adjustable by means of a baffle pre-set by the supplier. The setting of the baffle should be checked after installation of the regulator. If a change in flow rate should be required, the baffle may be adjusted by loosening a few screws, adjusting it according to the supplier’s instructions and retightening the screws.

Thanks to the adjustable baffle, the flow rate may be increased/reduced by approximately 25 % relative to the medium capacity.

Principle of operation
The combination of a large passageway, submerged inlet and sump significantly reduces the risk of blockage. A grating may be installed to further reduce this risk in the case of small flow volumes and larger objects in the water.

The regulator is also available with a lifting rod enabling mounting and demounting from ground level, see fig. 6.8. Inspection, service or change of capacity may therefore be carried out at surface level under clean, safe conditions.

After installation, the regulator should be inspected at regular intervals in order to determine the need for inspection/maintenance on site. However, the regulator is virtually maintenance-free, whereas sediment traps and sumps located below the regulator will require visual inspections and should be cleaned out when required (e.g. bi-annually).

6.2.2 Horizontal centrifugal valve

Application

The horizontal centrifugal valve is typically installed at the inlet of a manhole to control the discharge from basins of combined systems and overflow structures, regulating small to moderate flows. The regulator is primarily used to control flow in sewage water systems. Normally the horizontal centrifugal valve is made of acid-resistant stainless steel, see fig. 6.9.

This type of regulator is used in special cases only, and is not a very common solution.

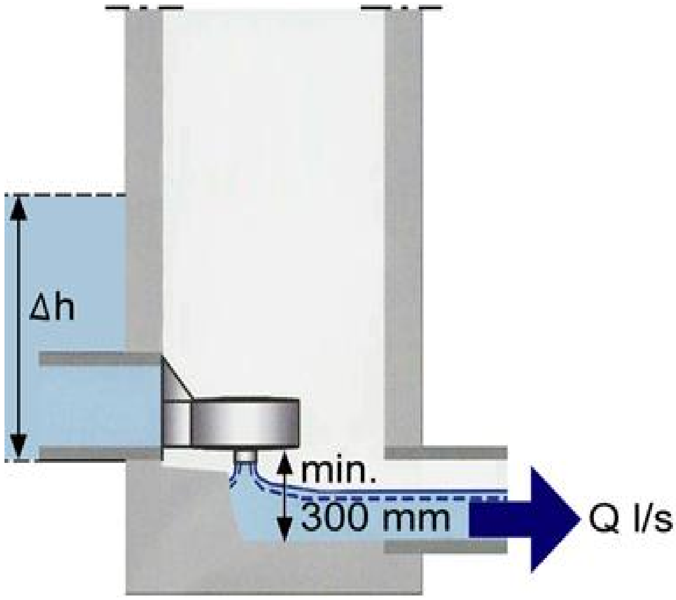


Fig. 6.9
Horizontal centrifugal valve

Principle of operation

The horizontal centrifugal valve is the most effective of the vortex valves.
It works on the principle of gravitation as described in section 3.5.

The centrifugal valve has a flat and, viewed from the surface, drop-shaped housing. It has no moving parts, no mechanical parts and no power requirement.

Characteristics

The characteristics of the horizontal centrifugal valve are described in section 3.5. The curve does not have the characteristic “bump” like other vortex regulators, and the braking effect therefore starts earlier than for the vertical design and the cyclone valve. Fig. 6.10 shows the head-discharge curve.

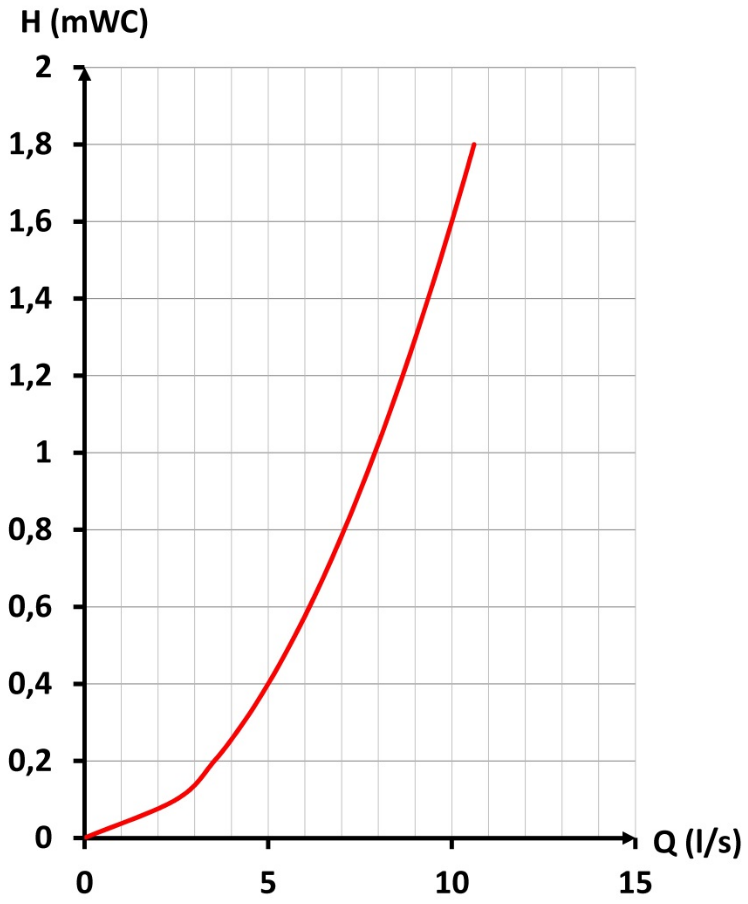


Fig. 6.10
Head-discharge curve of a horizontal centrifugal valve

Installation
Designed for semi-dry operating conditions, the horizontal centrifugal valve is installed at the inlet of the structure as illustrated in fig. 6.9. The structure is located downstream of the basin or dip, from where the flow will be regulated.

Usually, this type of flow regulator is applicable for existing structures/manholes. In order to obtain a free outflow there must be a distance of at least 300 mm between the bottom of the vortex chamber and the invert, which is established to optimise the flow further down the sewer system.

A horizontal centrifugal valve is adjustable by means of a changeable outlet baffle. If a change in flow is required, the adjustment may be made by replacing the baffle according to the supplier’s instructions. Thanks to the changeable baffle, the flow rate may be increased/reduced by 25 % relative to the medium capacity.

Principle of operation
Due to the large braking effect of the horizontal centrifugal valve, the largest possible passageway is obtained, whereby the risk of blockage is significantly reduced.

With the semi-dry installations, clogging of the inlet presents special challenges. It may therefore be a good idea to:

1. Place an inspection chamber in front of the regulating manhole

2. Choose a special design enabling the regulator to be tipped up for access to the inflow
3. Provide the regulator with an inspection cover to facilitate access to the inflow

After installation the valve should be inspected at regular intervals in order to determine the need for inspection and maintenance on site.

6.3 Flow control chambers

Application
The flow control chamber is typically a plastic manhole, in which the supplier has prefitted a flow regulator in a chamber with silt trap.

The regulator is used to control storm water flows. It is available in various sizes and the capacity ranges from approximately 0.1 l/s up to 25 l/s. These regulators are normally made of acid-resistant stainless steel, see fig. 6.11.

Thanks to the sump, the largest possible passageway and, if desired, the possibility of mounting and demounting by means of a lifting rod, this is a regulator offering low operating costs.

The smaller flow control chambers are intended for use on individual residential sites, particularly in connection with overflow from infiltration trenches, rain gardens above ground, small basins and reservoirs.

Fig. 6.11
Flow control chamber

Principle of operation
The vertical centrifugal valve works on the principle of gravitation as described in section 3.5.

The centrifugal valve has no moving parts, no mechanical parts and no power requirement.

The inlet of the centrifugal valve is submerged as it is below the bottom level of the outlet.

The design of the flow control chamber is based on the project specifications. The chamber is typically made of corrugated pipe with dimensions ranging from ø 200 to ø 600mm.

Using a flow control chamber and a flow regulator preassembled by the supplier very low flow rates can be achieved. Flow rates as low as 0.1 l/s are possible. However, these flow rates may require filters in order to prevent objects from blocking the regulator.

Characteristics
The regulator installed in the flow control chamber is a vertical centrifugal valve, therefore the same descriptions used in sections 3.5 and 6.2.1 would apply to this design.

Installation
The flow control chamber is buried to a given level and connected to the inlet and outlet of the connecting pipes.
The regulator is designed with a submerged inlet. It has been pre-fitted at the outlet of the manhole, which includes a sump, cf. fig. 6.12, acting as a silt trap. The structure is located downstream of the detention facility from where the flow must be regulated. If there is a backwater potential on the outlet side, it is recommended that the regulator is vented.

The vertical centrifugal valve is available for fixed installation or provided with a coupling claw and lifting rod enabling mounting and demounting from ground level.

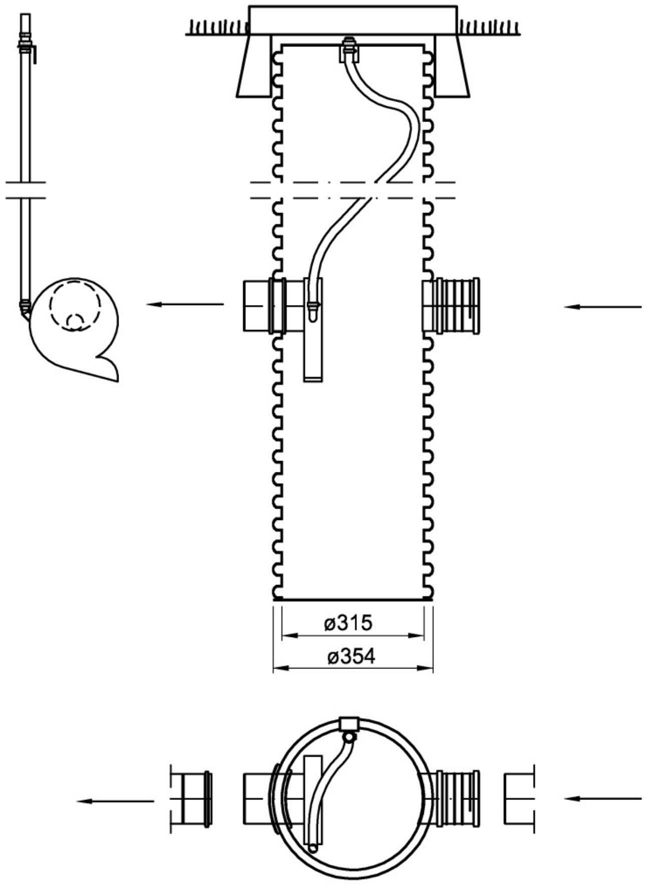


Fig. 6.12
The vertical centrifugal valve pre-installed in a chamber by the supplier.

As a rule, the regulator of the flow control chamber is not adjustable.

Principle of operation

The small fixed valve types used in the flow control chambers may be provided with a flushing tube enabling flushing from ground level.

The regulator is available with a lifting rod for mounting and demounting from ground level. Inspection and service may therefore be carried out under hygienic conditions considering the working environment.

After installation, the regulator should be inspected at regular intervals in order to determine the need for inspection and maintenance on site. However, the regulator is virtually maintenance-free, whereas the sump below it may require cleaning to remove sediments.

7 Planning considerations

7.1 Location of the regulator

Generally, the purpose of the regulator is to protect the downstream part of the pipe system against overloading and flooding. This is accomplished by allowing a certain defined flow to pass, regardless of the variation of the upstream conditions (i.e. inflow and the water level).

The use of flow regulators will require sufficient storage facilities for the water to be detained upstream.

Listed below are some methods:

- Detention basins (open/closed/pipe basins etc.)
- Overflow structures which bypass to receiving waters, e.g. a watercourse/lake/sea

When possible, storm water should be attenuated or infiltrated where it falls (at the source). This can be achieved using LAR-plants like rain gardens, green rooftops and green percolation areas, which can be flooded without causing drainage issues. Read more in the Pipe Centre Guidelines 016, Håndtering af regnvand på egen grund 2012.

Suggested locations of flow regulators:

- Downstream of unutilised storage volumes in basins and sewer systems to allow utilisation of their storage capacity later on
- After basins and overflow structures
- For regulation of the drainage from private infiltration trenches, rain gardens and basins until the water level requires overflow to the public sewer system
- Control of run-off from larger car parks or rooftops
- Control of inflow to waste water treatment plants, oil and grease separators, pumping stations etc.
- Control of run-off from flat rooftops used as basins

It requires preparation and thought to determine the right positioning of the flow regulators as, depending on the type, these components require inspection and maintenance and must be accessible for flushing.

7.2 Planning

To specify the correctly sized flow regulator, the customer must consider certain specific details relating to the desired flow and the physical site conditions.

For clarification, some questions are listed below.

Design criteria – flow rate and head?
Using computer simulation the flow in the sewer system, the maximum/desired flow rate, Qmax (l/s), allowed through a certain point – a hydraulic nodal point – will be determined. The observance of this value is the very purpose of installing a flow regulator/flow regulator, and it must therefore be advised.

As the flow regulator works by gravitation and is driven by the water pressure, h(m), built up upstream of it, it is essential to state a value for the computational head. This is the maximum water level difference that may occur in front of the regulator and it is determined on the basis of the difference between the following two levels:

- The maximum water level affecting the regulator, e.g. the level of a weir in the control structure, the level of the lowest catch basin +5-10 cm, if flooding on ground is provided for (e.g. a car park), or the expected maximum water level in an upstream basin
- The level of the invert in the discharge pipe of the control structure, where the outlet tube of the regulator is positioned, or the water level right in front of the regulator when the sewer system has been emptied

In case of considerable and frequent flooding downstream of the control structure this must be stated for consideration in connection with the preparation of a solution and a case-by-case feasibility evaluation will need to be made.

Based on this information the desired flow rate and the computational head will define the solution to be provided by the supplier. If one of the parameters changes, a new solution will have to be calculated.

If the planning phase determines that there needs to be a different capacity at a later date, this can be accommodated for in the flow regulation design.

Type of drainage water to be regulated?
There may be a need for the regulation of various types of drainage water: Storm water, sewage water, industrial sewage, drainage water containing oil or grease or mixed storm and sewage water. The composition of the drainage water is important for the choice of flow regulator, particularly for small and medium flow rates. The following factors must be considered for the various types of drainage water:

- Storm water: generally all types of regulators are applicable
- Storm water containing larger objects (e.g. branches/organic debris in watercourses): special measures must be considered, e.g. grating or a regulator with a oversized passageway
- Sewage water: systems must not include structures with silt trap or water seal preventing the passage of floating objects. Some solutions will not be suitable. Due to the larger objects in sewage water, special requirements regarding the size of the passageway may occur
- Industrial sewage: If the water contains chemical substances with corrosive or sedimentation issues, certain measures may be taken to extend the durability of the flow regulator. Basically, regulator types corresponding to storm water will be suitable

- Mixed storm and sewage water: the composition of the water (e.g. the ratio of storm to sewage water and the occurrence of larger objects) will affect the choice of regulator
- Sewage water containing oil or grease: this should be stated in the design criteria as the regulator specification will include an installation note showing an inlet orientation which will allow further passage of oil and grease, e.g. to an oil or grease separator, prior to vortex flow regulation, and optimise the solution so that the emulsification of oil and grease is minimised.

Existing or new control structure?
It should be stated whether the structure into which the flow regulator will be installed is existing or proposed. Sketches of the structure should be submitted to the supplier early in the planning phase.

The following questions should be clarified:

- Is a sump/silt trap available or can it be provided?
- Is a minimum opening required?
- Will it be possible to establish the required head loss (relevant to semi-dry and dry installations)?
- Is the slope through the control structure, inlet and discharge pipes sufficient to ensure self-cleaning?
- Shape and dimension of the manhole?
- Inlet and outlet pipe orientation?
- Are there existing benching and straight passageways to be considered?
- Do space limitations make it necessary to choose a less optimal solution?
- How should the flow regulator be installed?
- Is a flow regulator with the ability to be mounted/demounted from surface level required?
- What is the capacity of the outlet pipe? It should be at least 10 % higher than the regulator's peak design flow.
- What is the outlet pipe dimension?
- What is the elevation of the manhole cover? Has it been ensured that the water level will not exceed this level?
- What is the inside dimension of the manhole opening, and will the regulator be installed before the curb or cone is installed?

In special cases, it may be necessary to establish a new structure.

Appendix A shows a list of applications for the various types of regulators.

Appendix B is an example of an information sheet to be completed by the customer to enable the supplier to choose the right regulator for the job.

7.3 Examples of the application of centrifugal valves

7.3.1 Installation of vertical centrifugal valves

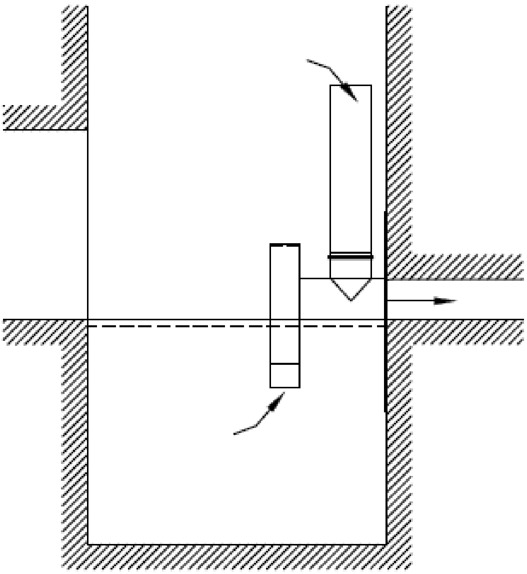


Fig. 7.1
A typical application for this type of regulator is at the outlet from an underground storm water detention facility, built up of pipes, for instance. It may be equipped with an emergency overflow as illustrated. Without emergency overflow this regulator may be used in connection with, for instance, petrol and oil separators, maybe with an inlet tube facing downward.

7.3.2 Installation of horizontal centrifugal valves

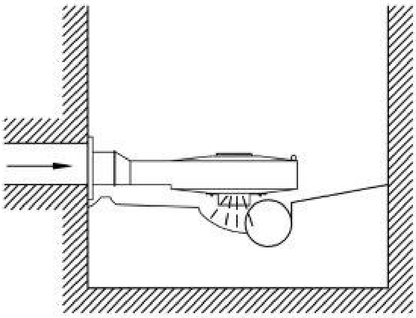


Fig. 7.2
A horizontal centrifugal valve may be used for drainage of storm water erroneously connected to a sewage water system (dry weather drainage), or for the first, often heavily polluted, rain from the storm water pipes of a separate system connected to the sewage water pipes.

7.3.3 Examples of the application of cyclone valves

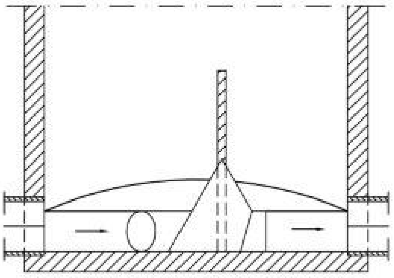


Fig. 7.3
Installation in existing manholes application of partition walls may be possible

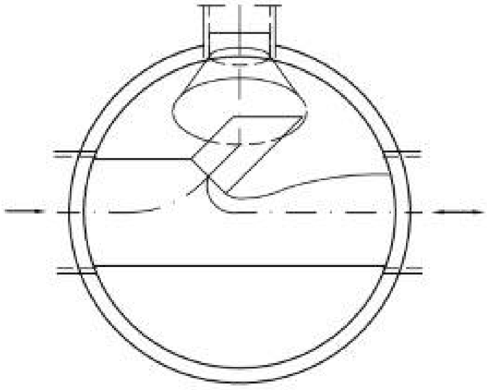


Fig. 7.4
This illustration shows a principle for drainage from a depth where the excessive volume continues to a basin from where it returns, wholly or partly, as the system is emptied

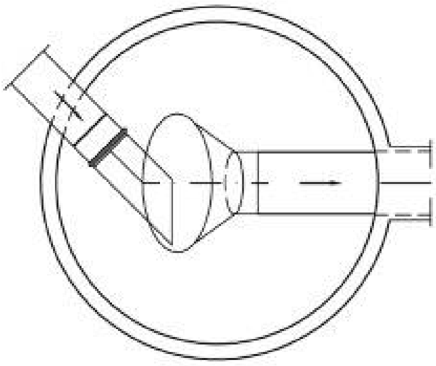


Fig. 7.5
Cyclone valve connected to the inlet of the manhole. The valve is visible from the invert and may be inspected from here in case of blockage

7.3.4 Examples of overflows

The overflow option is often necessary due to the capacity of the system and with small passageways as a precaution.

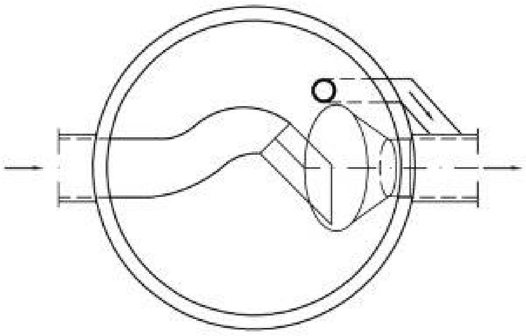


Fig. 7.6
Overflow connected to a branch pipe after the manhole. In case of blockage of the flow regulator, the standing part of the overflow may be lifted off so that the system may be emptied for inspection of the regulator

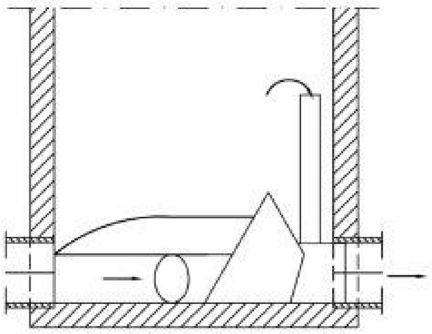


Fig. 7.7
If the discharge pipe of the manhole has been amply dimensioned, the overflow may be connected to a large outlet tube bypassing the outlet of the regulator

7.3.5 The cyclone valve for parallel and serial installation

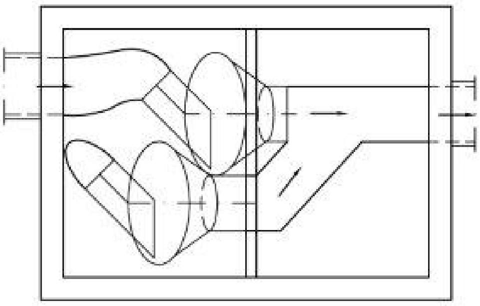


Fig. 7.8
Parallel installation of two or more cyclone valves is advantageous where the application has a high flow rate at a low head. The size of the regulator housing may be reduced in relation to the cross section of the passageway, whereby a timely air exhaust will be obtained so that the operating point reaches the 'braked' curve. This ensures a very high average discharge without exceeding the permitted maximum, which may result in considerable savings

8 Installation

Installation instructions provided by the supplier must be followed to ensure proper function of the flow regulator.

An example of installation instructions for a double baffle controller is shown below:

8.1 Installation instructions – double baffle controller

General
To ensure performance, the flow regulator must be installed and inspected in accordance with the instructions and the drawings/sketches provided.

The double baffle controller is applicable for all types of drainage water, i.e. storm water, sewage water and mixed storm and sewage water.

The regulator is equipped with two infinitely adjustable baffles. On delivery, the baffles have been set to allow passage of the desired flow volume. Therefore, the settings should not be changed. The dimensions of the specific flow regulator will be detailed in the instructions and drawings/sketches provided.

Installation
The regulator is designed for installation in a manhole/chamber with a diameter or side length of at least four times the diameter of the regulator. For instance, a double baffle controller 300 requires a structure with a diameter of 1.2 m or dimensions of 1.2 m x 1.2 m. If the regulator is installed in a partition wall, the same space requirements will apply to the side on which the regulator will be installed.

The regulator must be positioned at the outlet on the inside face of the chamber or manhole (submerged installation). The mounting plate is fastened to the wall of the manhole/chamber opposite the outlet opening using bored-in or cast-in bolts/threaded rods made of acid-resistant steel. The mounting plate should be so installed that the bottom of the regulator is at a level with the invert of the discharge pipe. The space between the mounting plate and the wall of the manhole/chamber must be tightened with water-resisting sealing compound or sealing strip. Sealing material and bolts must be supplied by the constructer.

After correct installation, the regulator must be encased. Inlet, invert and benching are shaped to create a slope to the invert from all sides. If the wall of the manhole is curved, benching must be concreted in the hollow space between the mounting plate and the hole in the wall. The slope of the invert in front of the controller should be at least 20 ‰. If the installation is temporary, dismounting may be facilitated by placing sand-filled plastic bags around the regulator before encasing it in 50 – 60 mm concrete.

Control of the baffle setting is recommended after installation of the regulator, per instructions from the supplier.

8.2 Installation instructions – cyclone valve

The illustrations below show installation examples:

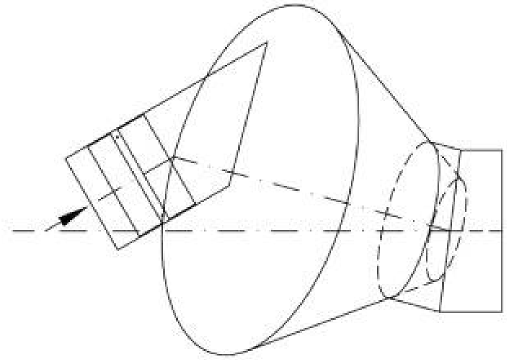


Fig. 8.1
The inlet is 45° and right or left-oriented. 15° bend on outlet tube at straight inflow

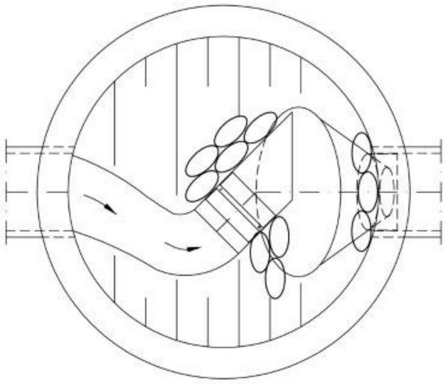


Fig. 8.2
Encasing with benching. For temporary installations plastic bags filled with sand may be placed around the regulator, after which the benching are concreted

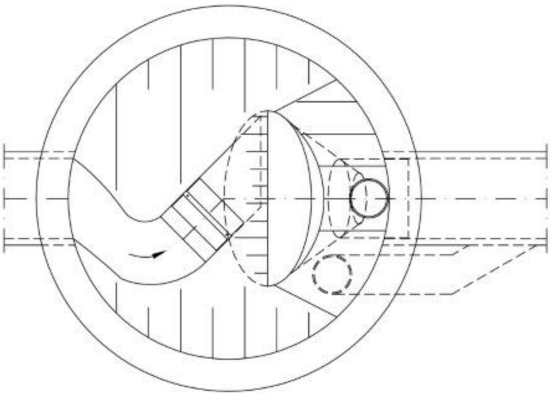


Fig. 8.3
A bypass/overflow may be placed on the outlet tube. Alternatively, the bypass/overflow may be positioned beside it with discharge through a branch pipe. The overflow must be at a level with the highest water level and the bypass/vent must be above it

- Upstream manholes/structures should be inspected for blockage of the flow regulator at regular intervals. Frequent inspection is recommended, if no overflow facility has been established immediately upstream of the flow regulator

As some types of flow regulators have one or more moving parts, more frequent operating supervision, maintenance and adjustment will be required.

Larger objects such as:

- Branches
- Foreign bodies (screw drivers, hangers, cutlery etc.)
- Dropped manhole covers
- Paving stones and other objects dropped through open manhole covers
- Bricks from manholes
- Torn-off parts of piping in case of pipe fracture

may result in blockage of the flow regulator.

Special attention will also be required in areas where many businesses are draining grease down the sewer pipe, such as:

- Catering establishments
- Restaurants
- Butchers
- Enterprises with grease-producing sewage
- Urban areas with residents from countries known for using a lot of cooking oil

This may result in grease deposits around the inlet of the regulators as the flow regulators create quiescent flow conditions in front of them. Consequently, the grease may be separated out from the water and eventually form a plug in the inlet to the flow regulator.

It is therefore imperative to choose the right regulator and to consider the type of installation, whether submerged, semi-dry of dry. In a dry installation, it will be difficult to see whether deposition occurs in the pipe upstream of the regulator, unless an inspection chamber is installed. In semi-dry installations with the possibility of relief over a weir and in submerged installations, inspection of the installation manhole may indicate whether there are grease deposits to be removed before they cause sewer overflows.

Other possible damage may be caused by:

- Flushing heads from gully suckers getting stuck in the flow regulators in connection with cleaning
- Incorrect installation/adjustment of the regulators
- In connection with blockage, the omission of an emergency overflow may cause serious flooding upstream
- If the flow regulator is installed in a poorly constructed manhole it may work loose
- Insufficient maintenance and inspection may result in flooding problems

At the beginning, it is important to inspect the flow regulators at regular intervals in order to avoid any problems, which were not considered in the planning phase.

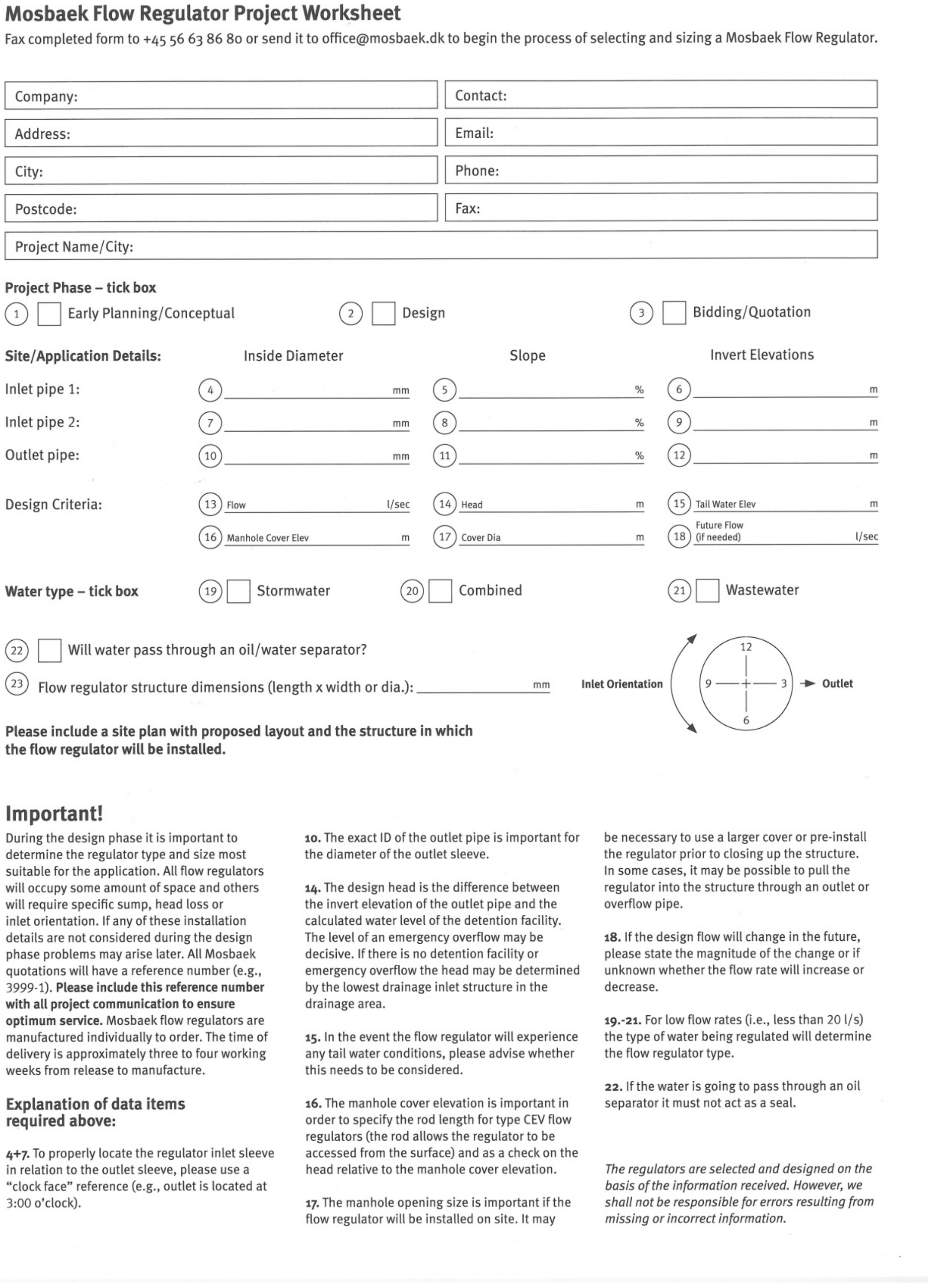
Appendix A

Diagram for the choice of flow regulator

	For flow rates l/s	Application **C**ombined system/ **S**torm water/ **W**atercourse	Installation **S**ubm./ **Se**mi-**D**ry/ **D**ry	Remarks	μ-value
Single baffle controller	10-4,500	C/S/W	S	Fixed regulation	0.6
Sluice gate	All	C/S/W	S	Fixed regulation	0.6
Throttle pipe	All	C/S/W	S	Fixed regulation	
Throttle chamber	Up to 3.0	S	S	Only storm water and small flows	0.6
Double baffle controller	30-10,000	C/S/W	S	Low head and large flow. Infinitely adjustable (+/-25%)	0.75/ 0.55
Centrifugal valve vertical	0.2-80	S	S	Not for sewage owing to sump. Infinitely adjustable (+/-25%)	0.13/ 0.33
Centrifugal valve horizontal	4-30	C/S/W	SD	Min. 300 mm height interval betw. in and outlet. Shift of baffle	0.12/ 0.15
Cyclone valve Submerged	6-600	C/S/W	S	Infinitely adjustable (+/-25%)	0.18/ 0.35
Cyclone valve Semi-dry + Dry	8-600	C/S/W	SD/D	Infinitely adjustable (+/-25%)	0.21/ 0.40
Pump	All	C/S	S/SD/D	Capacity of pumping station	

Appendix B

Information sheet from customer to supplier when ordering flow regulator



Mosbaek Flow Regulator Project Worksheet

Fax completed form to +45 56 63 86 80 or send it to office@mosbaek.dk to begin the process of selecting and sizing a Mosbaek Flow Regulator.

Company:	Contact:
Address:	Email:
City:	Phone:
Postcode:	Fax:
Project Name/City:	

Project Phase – tick box

(1) ☐ Early Planning/Conceptual (2) ☐ Design (3) ☐ Bidding/Quotation

Site/Application Details:	Inside Diameter	Slope	Invert Elevations
Inlet pipe 1:	(4) ______ mm	(5) ______ %	(6) ______ m
Inlet pipe 2:	(7) ______ mm	(8) ______ %	(9) ______ m
Outlet pipe:	(10) ______ mm	(11) ______ %	(12) ______ m
Design Criteria:	(13) Flow ______ l/sec	(14) Head ______ m	(15) Tail Water Elev ______ m
	(16) Manhole Cover Elev ______ m	(17) Cover Dia ______ m	(18) Future Flow (if needed) ______ l/sec

Water type – tick box (19) ☐ Stormwater (20) ☐ Combined (21) ☐ Wastewater

(22) ☐ Will water pass through an oil/water separator?

(23) Flow regulator structure dimensions (length x width or dia.): __________ mm

Inlet Orientation
12
9 3
6
Outlet

Please include a site plan with proposed layout and the structure in which the flow regulator will be installed.

Important!

During the design phase it is important to determine the regulator type and size most suitable for the application. All flow regulators will occupy some amount of space and others will require specific sump, head loss or inlet orientation. If any of these installation details are not considered during the design phase problems may arise later. All Mosbaek quotations will have a reference number (e.g., 3999-1). **Please include this reference number with all project communication to ensure optimum service.** Mosbaek flow regulators are manufactured individually to order. The time of delivery is approximately three to four working weeks from release to manufacture.

Explanation of data items required above:

4+7. To properly locate the regulator inlet sleeve in relation to the outlet sleeve, please use a "clock face" reference (e.g., outlet is located at 3:00 o'clock).

10. The exact ID of the outlet pipe is important for the diameter of the outlet sleeve.

14. The design head is the difference between the invert elevation of the outlet pipe and the calculated water level of the detention facility. The level of an emergency overflow may be decisive. If there is no detention facility or emergency overflow the head may be determined by the lowest drainage inlet structure in the drainage area.

15. In the event the flow regulator will experience any tail water conditions, please advise whether this needs to be considered.

16. The manhole cover elevation is important in order to specify the rod length for type CEV flow regulators (the rod allows the regulator to be accessed from the surface) and as a check on the head relative to the manhole cover elevation.

17. The manhole opening size is important if the flow regulator will be installed on site. It may be necessary to use a larger cover or pre-install the regulator prior to closing up the structure. In some cases, it may be possible to pull the regulator into the structure through an outlet or overflow pipe.

18. If the design flow will change in the future, please state the magnitude of the change or if unknown whether the flow rate will increase or decrease.

19.-21. For low flow rates (i.e., less than 20 l/s) the type of water being regulated will determine the flow regulator type.

22. If the water is going to pass through an oil separator it must not act as a seal.

The regulators are selected and designed on the basis of the information received. However, we shall not be responsible for errors resulting from missing or incorrect information.

Other guidelines from the Pipe Centre:

Rørcenter-anvisning 001
Ressourcebesparende afløbsinstallationer i boliger, juni 1999

Rørcenter-anvisning 002
Ressourcebesparende vandinstallationer i boliger, juni 1999

Rørcenter-anvisning 003
Brug af regnvand til wc-skyl og vaskemaskiner i boliger, september 2012

Rørcenter-anvisning 004
Renovering af afløbsledninger. Paradigma for udbud og beskrivelse inkl. vejledning 2 udgave, januar 2005, inkl. Indlagt cd-rom

Rørcenter-anvisning 005
Fedtudskillere. Projektering, dimensionering, udførelse og drift, marts 2000

Rørcenter-anvisning 006
Olieudskilleranlæg. Vejledning i projektering, dimensionering, udførelse og drift, marts 2004

Rørcenter-anvisning 007
Dæksler og Riste. Dæksler og riste af støbejern til kørebane og gangarealer, maj 2005

Rørcenter-anvisning 008
Acceptkriterier. Retningslinier for vurdering af nye og fornyede afløbsledninger ved hjælp af TV-inspektion, maj 2005

Rørcenter-anvisning 009
Nedsivning af regnvand i faskiner.
Vejledning i projektering, dimensionering, udførelse og drift af faskiner, maj 2005

Rørcenter-anvisning 010
Tømning af bundfældningstanke (septitanke). Paradigma for udbudsmateriale, marts 2006

Rørcenter-anvisning 011
Vacuumsystemer i bygninger.
Vejledning i projektering, udførelse og drift, marts 2006

Rørcenter-anvisning 012
Nye afløbssystemer samt omlægninger.
Paradigma for udbud og beskrivelse, maj 2007

Rørcenter-anvisning 013
Erfaringer med nedsivningsanlæg, februar 2007

Rørcenter-anvisning 014
Afløbssystemer.
Oversigt over undersøgelses-, måle- og fornyelsesmetoder, april 2007

Rørcenter-anvisning 015
Tilbagestrømningssikring af vandforsyningssystemer, oktober 2009

Rørcenter-anvisning 016
Anvisning for håndtering af regnvand på egen grund, maj 2012

Rørcenter-anvisning 017
Legionella.
Installationsprincipper og bekæmpelsesmetoder, april 2012

Rørcenter-anvisning 018
Store nedsivningsanlæg.
Dimensionering og udførelse, august 2012

Rørcenter-anvisning 019
Vandbremser.
Regulering af vandstrømme i afløbssystemer, maj 2013

Rørcenter-anvisning 020
Skybrudssikring af bygninger, september 2013

Rørcenter-anvisning 021
Kælderoversvømmelser.
Sikring mod opstigende kloakvand, september 2013

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ENERGY AND CLIMATE
ISBN 978-87-996243-5-5