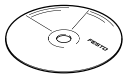
Wastewater treatment

EDS®
Water Management
Workbook



With CD-ROM

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Contents

EDS® Water Management

Description

The EDS® (Environmental Discovery System) Water Management is designed to simulate the entire cycle of human water use. This starts with water catchment by pumping from groundwater, springs or surface water and includes subsequent storage and purification. It also covers the distribution of water to consumers and its use – which causes water to become wastewater. Further on wastewater transport together with rain runoffs and wastewater treatment are reproduced.

In a real wastewater treatment plant the final effluent is discharged into surface water, normally rivers. Direct reuse is not common, but the effluent now is part of natural water bodies which again feeds the sources of water extraction. The water cycle in the EDS® Water Management is completed by reusing the final effluent as input water into the system.

The EDS® Water Management training equipment vividly simulates this "man-made" water cycle with its four systems:

1. Water Treatment
2. Water Supply
3. Wastewater Disposal
4. Wastewater Treatment

Processes such as pumping, storage, flocculation, disinfection and distribution of water can be learnt through practical exercises. After adding solid matter, we follow the stream of wastewater and discover processes such as sedimentation, aeration and sludge recirculation.

Comprehensive documentation with theoretical input additionally promotes the learning success. Four of the workbooks correspond directly to the systems, whereas two overarching workbooks additionally deliver a sound introduction into closed-loop control technology and energy efficiency.

The following workbooks are available:

1. Water treatment
2. Water supply
3. Wastewater disposal
4. Wastewater treatment
5. Monitoring, controlling and optimising operations
6. Energy optimisation in water and wastewater treatment plants

Each system can be used as stand-alone training equipment for an individual learning module. The training equipment can be modified individually as piping and sensors use are flexible. If the four systems are connected they form an integrated training equipment that covers all of the processes and exercises described in the workbooks. Using the systems together allows students to see how individual process steps interact as well as how a measure taken in one area affects one or more of the other systems.

As in the real world, the processes interact. The wastewater treatment plant, for example, has to process the amount and composition of wastewater delivered by the sewer system. Similarly, the single systems of the training equipment are connected by pipes which transport the water, whereas the control process is separate for each system. So the EDS® Water Management invites students to 'try things out' and even simulate problems, using different settings and system states. This experimentation can be done without incurring costs or causing damage, something not possible in a real water or wastewater treatment plant.

After completion of the learning modules described in the workbooks, the student's expertise will be significantly increased. The strong practical orientation helps to transfer the knowledge and skills acquired during the training directly to their work environment. Professional training actively contributes to safe and efficient operation of treatment plants and improves the availability of clean drinking water.

EDS® systems data

Dimensions of the EDS® Water Management without main storage tank, worktable and PC desk

- Width: 2660 mm (minimum); 3500 mm (optimum)
- Depth: 400 mm
- Height: 1150 mm from table top

The EDS® Water Management training equipment with all four systems

The four systems of the EDS® Water Management

Water Treatment

The System has been designed for use in the learning modules:
- Water treatment
- Monitoring, controlling and optimising operations
- Energy optimisation in water and wastewater treatment plants

Conducting the exercises on the Water Treatment System, students learn the principles, function and operation of a variety of water purification processes. Subsequently, they apply the acquired skills to create an environmentally safe effluent on one side and to ensure drinking water purification on the other side.

Water Supply

The system has been designed for use in the learning modules:
- Water supply
- Monitoring, controlling and optimising operations
- Energy optimisation in water and wastewater treatment plants

As the system is used in three learning modules, its range of applications is wide and students perform many exercises on it. The learning module “Water Supply” pumps are one of the main topics, other exercises deal with control technologies in water transport to achieve the optimum distribution of drinking water to the consumer. In addition, the flow of water from the source to the public is examined.

Wastewater Disposal

The system has been designed for use in the learning modules:
- Wastewater disposal
- Monitoring, controlling and optimising operations
- Energy optimisation in water and wastewater treatment plants

Using the system in the learning module “Wastewater Disposal”, students are familiarised with control technologies of wastewater removal and the related processes. The flow of wastewater from urban settlements to the wastewater plant is examined.

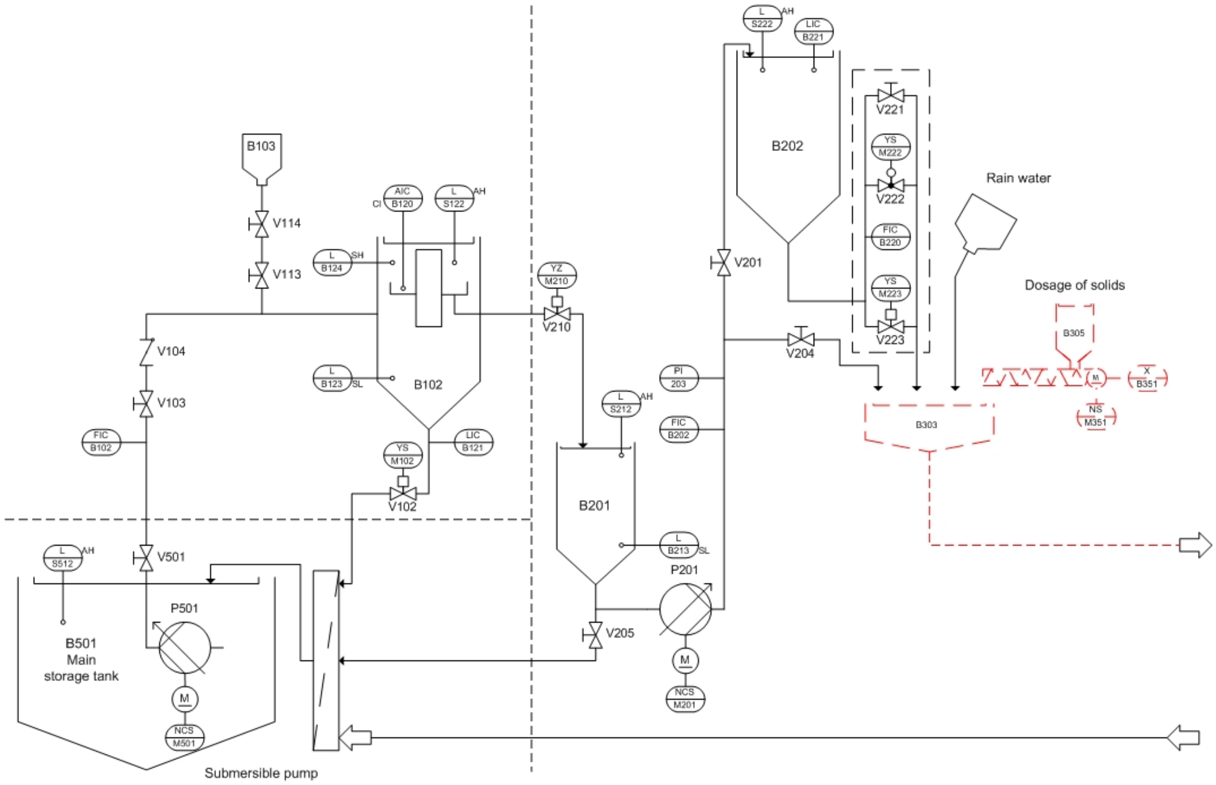
Wastewater Treatment

The system has been designed for use in the learning modules:

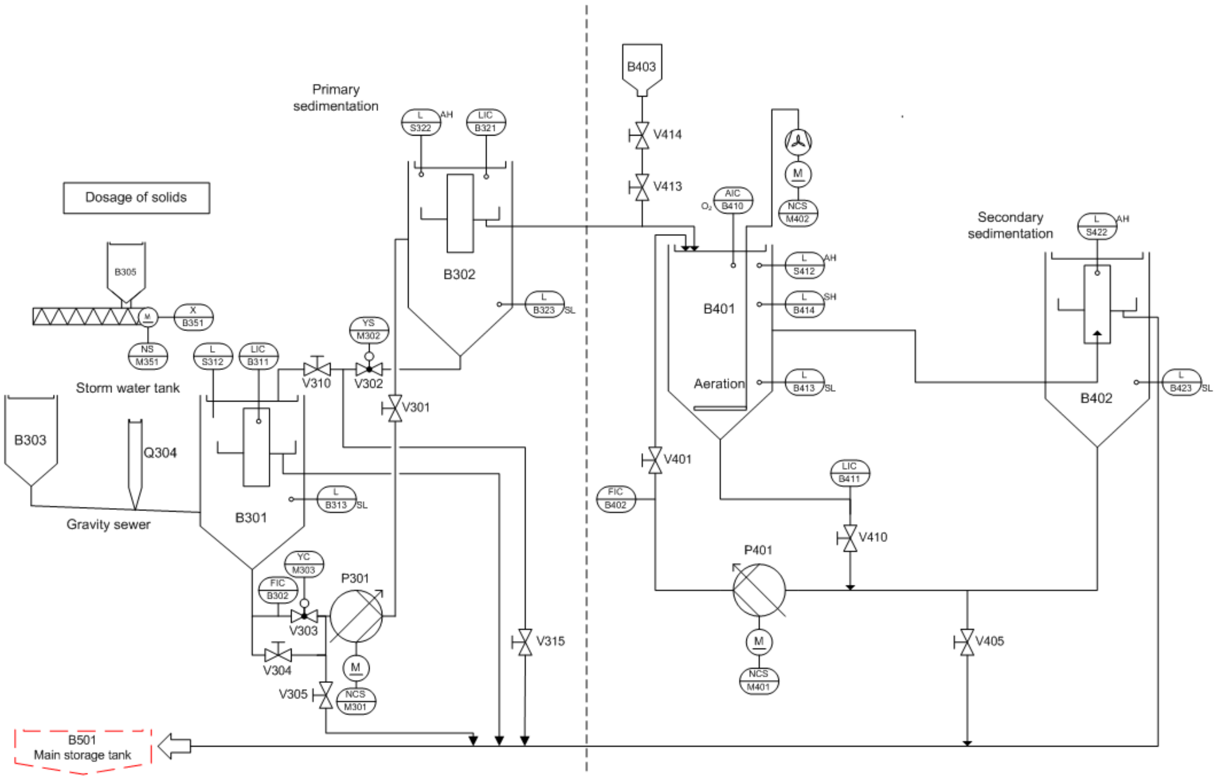
- Wastewater treatment
- Monitoring, controlling and optimising operations
- Energy optimisation in water and wastewater treatment plants

In the learning module "Wastewater Treatment", the system is used to illustrate the principles of wastewater treatment processes focused on sedimentation, biological treatment and sludge recirculation. In learning module "Energy Optimisation" the system illustrates processes and measures related to energy efficiency in the water and wastewater treatment, especially aeration. For the module "Monitoring, controlling and optimising operations" the topics flow control, aeration and fill level control can be treated.

Piping and instrumentation diagrams



The Water Treatment system and the Water Supply system



The Wastewater Disposal system and the Wastewater Treatment system

Correlating the exercises with the EDS® Water Management systems

The table below shows which of the EDS® systems can be used for which exercise. The systems concerned are marked with **"X"**. If there is no **"X"** in a line, the respective exercise is knowledge driven and none of the EDS® systems is required. "(X)" means that it is possible to conduct the exercise with this system. However the systems marked with **"X"** are to be preferred.

Correlation of the exercises with the EDS® Water Management systems		**W-PUR**	**W-SUP**	**WW-TRA**	**WW-TRE**
Getting started					
	The "Getting started" also includes exercises for the commissioning of electronic sensors, pumps and valves.	**X**	**X**	**X**	**X**
Workbook "Water treatment"					
2. Precipitation and Flocculation					
2.2.1	Iron flocculation using iron hydroxide	**X**			
3. Chlorine dosing and disinfection					
3.2.1	Chlorine dosage and measurement of chlorine concentration	**X**			

W-PUR: Water Treatment System
W-SUP: Water Supply System
WW-TRA: Wastewater Disposal System
WW-TRE: Wastewater Treatment System

Correlation of the exercises with the EDS® Water Management systems		W-PUR	W-SUP	WW-TRA	WW-TRE
Workbook "Water supply"					
3. Operation of pumps					
3.2.1	Setting up the pump	(X)	**X**	(X)	(X)
3.2.2	Pressure measurement		**X**		
3.2.3	Flow measurement	**X**	(X)	**X**	(X)
3.2.4	Controlling water supply using hand valves	**X**	(X)	**X**	(X)
4. Water transport to high tower					
4.2.1	Control of the filling level while simultaneously withdrawing water		**X**		
4.2.2	Manual control of the filling level using 2-way ball valve with pneumatic actuator		**X**		
5. Water supply to different pressure zones					
5.2.1	Simulation of two settlement zones located on different altitudes (both systems are used)	**X and X**			
6. Water loss					
6.2.1	Identification of water loss		**X**		
Workbook "Wastewater disposal"					
2. Principles of water flow in pipes					
2.2.1	Wastewater disposal in gravity sewers – Hydraulic capacity, impounding and backwater			**X**	
3. Transport of solids					
3.2.1	Transport of solids in sewers with varying flow rates			**X**	
4. Operation of sewer systems					
4.2.1	Flow control simulating a rain overflow basin			**X**	
4.2.2	Drain Control – closed loop control using the proportional media valve			**X**	
Workbook "Wastewater treatment"					
2. Sedimentation					
2.2.1	Analysis of factors affecting sedimentation				
2.2.2	Simulation of the sedimentation of sludge (granulate)				**X**
2.2.3	Analysis of flow rates			**X**	
2.2.4	Influence of solids load on sedimentation			**X**	
3. Biological treatment (activated sludge)					
3.2.1	Keeping solids concentration in the aeration tank high				**X**
3.2.2	Aeration				**X**

W-PUR: Water Treatment System
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Correlation of the exercises with the EDS® Water Management systems		W-PUR	W-SUP	WW-TRA	WW-TRE
Workbook “Monitoring, controlling and optimising operations”					
2. Closed loop control technology: Pump					
2.2.1	Controlling the fill level using a two-step controller		**X**		
2.2.2	Controlling the fill level using a continuous controller		**X**		
2.2.3	Flow control using a proportional-integral controller	**X**		**X**	**X**
3. Closed loop control technology: Proportional media valve					
3.2.1	Volumetric Flow Control			**X**	
3.2.2	Drain Control			**X**	
4. Closed loop control technology: Aeration					
4.2.1	Controlling the oxygen concentration using a two-step controller				**X**
4.2.2	Controlling the oxygen concentration using a continuous controller				**X**
Workbook “Energy optimisation in water and wastewater treatment plants”					
2. Energy consumption and power generation					
2.2.1	Consumption of primary energy				
2.2.2	Energy saving in daily life				
2.2.3	Energy consumption in facilities for water- and wastewater treatment				
2.2.4	Assessment of electrical energy consumption in a wastewater treatment plant				
3. Forms of energy, efficiency and power					
3.2.1	Examination of electrical energy consumption of the EDS® Water Management	**X**	**X**	**X**	**X**
3.2.2	Forms of energy				
3.2.3	Efficiency of the pump	**X**	**X**	**X**	**X**
3.2.4	Energy monitoring of the solenoid valve	**X**	**X**		**X**
4. Interference and water supply					
4.2.1	Effects of interference in the piping system	**X**	**X**	**X**	**X**
5. Energy optimisation of pumping: closed-loop control					
5.2.1	Optimising energy consumption in fill level control		**X**		
5.2.2	Optimising flow control	**X**		**X**	**X**

W-PUR: Water Treatment System
W-SUP: Water Supply System
WW-TRA: Wastewater Disposal System
WW-TRE: Wastewater Treatment System

Correlation of the exercises with the EDS® Water Management systems		W-PUR	W-SUP	WW-TRA	WW-TRE
6. Energy optimisation of aeration and costs					
6.2.1	Energy consumption of the air blower at different power settings				X
6.2.2	Controlling the oxygen concentration using a two-step controller				X
6.2.3	Controlling the oxygen concentration using a continuous controller				X
6.2.4	Energy consumption of aeration				X
6.2.5	Calculation of aeration cost				
7. Causes for waste of energy					
7.2.1	Excessive energy consumption and counter measures				
8. Energy management					
8.2.1	Permanent control of the measures and energy optimisation				
8.2.2	Cost optimisation				
9. Energy generation in wastewater plants					
9.2.1	Estimate the power generation				

W-PUR: Water Treatment System
W-SUP: Water Supply System
WW-TRP: Wastewater Disposal System
WW-TRE: Wastewater Treatment System

Appropriate use and disclaimer

The EDS® Water Management may only be used:

- For its intended purpose in teaching and training applications
- When its safety functions are in flawless condition

The components included in the training equipment have been designed in accordance with the latest technology, as well as recognised safety rules. However, life and limb of the user and third parties may be endangered, and the safe functioning of the components may be impaired, if they are used improperly.

The EDS® Water Management has been developed and manufactured exclusively for technical and vocational education and training (TVET). The respective educational institutions and their instructors must ensure that all students observe the safety precautions described in this workbook.

Festo Didactic hereby excludes any and all liability for damages suffered by students, the educational institution and/or any third parties, which occur during use of the training equipment in situations which serve any purpose other than education and training, unless such damages have been caused by Festo Didactic due to malicious intent or gross negligence.

Notes for the trainer/instructor

- Please observe the specifications in the data sheets for the individual components carefully and in particular all safety instructions in the previous chapter. Before the exercises are conducted, please assess their possible hazards to avoid accidents and emergency situations.
- Electrical components are pre-wired at the factory, and are mounted onto an H-rail for direct attachment to the rectangular profile. Alternatively, they can be shipped unwired as a kit. In either case, wiring work must only be carried out by qualified personnel.
- Like all training products of Festo Didactic, the learning systems of the EDS® are strongly practice focussed. Their prime objective is to increase the professional competence of students by giving them tasks and challenges that reflect actual work conditions. During the training the instructor should strictly focus on the learning outcomes and design the learning process in a way that at the end the learning outcomes are achieved.
- As the EDS® Water Management training equipment simulates real processes, it represents an ideal tool to deliver relevant and state-of-the-art know-how and skills to students. Consequently, the conduction of the exercises should form the core of the learning process. Theoretical explanations and presentations should only be used to support the knowledge and skill transfer resulting from the exercises.
- Since the knowledge of students usually differs, the degree how in depth the contents of the learning module should be treated might vary considerably. Thus, there is no concrete recommendation concerning the duration of a learning module. Generally, the instructor should plan and conduct the learning module in a way that the students have enough time to execute the exercises, ask questions and share their experience and knowledge.

Structure of the exercises

The training equipment and workbooks of Festo Didactic facilitate a didactic approach that is oriented towards hands-on learning. To support the practice-driven approach of the learning process, the exercises play a crucial role. They reflect real work challenges and problems. Therefore it is important that they are always explained in the context of work. Consequently, the exercises are composed of the following structural elements:

- **Problem description**
  The problem description creates a scenario from the work place and places the students into a work environment.
- **Layout**
  Sometimes an instruction is given on how to prepare an exercise, which materials are needed and how to assemble the EDS® Water Management system that is used for the respective task(s).
- **Learning outcomes**
  The learning outcomes allow evaluating students' learning success and giving employers an orientation of the students' competence level. Moreover they are guidelines for the learning process.

- **Tasks**
  Tasks contain a short and precise task description and give a clear explanation of what has to be done, to be solved or achieved.
- **Training notes**
  Training notes give additional tips or information that help the students to successfully work on the tasks. A description of software tools for calculation, measuring, etc., which are useful for the solution of the tasks, might also be included.
- **Training notes for the trainer / instructor**
  The trainer / instructor notes provide further recommendations, suggestions and information to professionally execute the training and support students effectively in their learning.

Exercises and solutions

1 Wastewater treatment

1.1 The training equipment

The System has been designed for use in the learning modules **Wastewater treatment, Monitoring, controlling and optimising operations** and **Energy optimisation in water and wastewater treatment plants.**

In the learning module "Wastewater treatment", the system is used to illustrate the principles of wastewater treatment processes focused on sedimentation, biological treatment and sludge recirculation. In learning module "Energy optimisation" the system illustrates processes and measures related to energy efficiency in the water and wastewater treatment, especially aeration.

Picture of the Wastewater Treatment System

1.1.1 System data

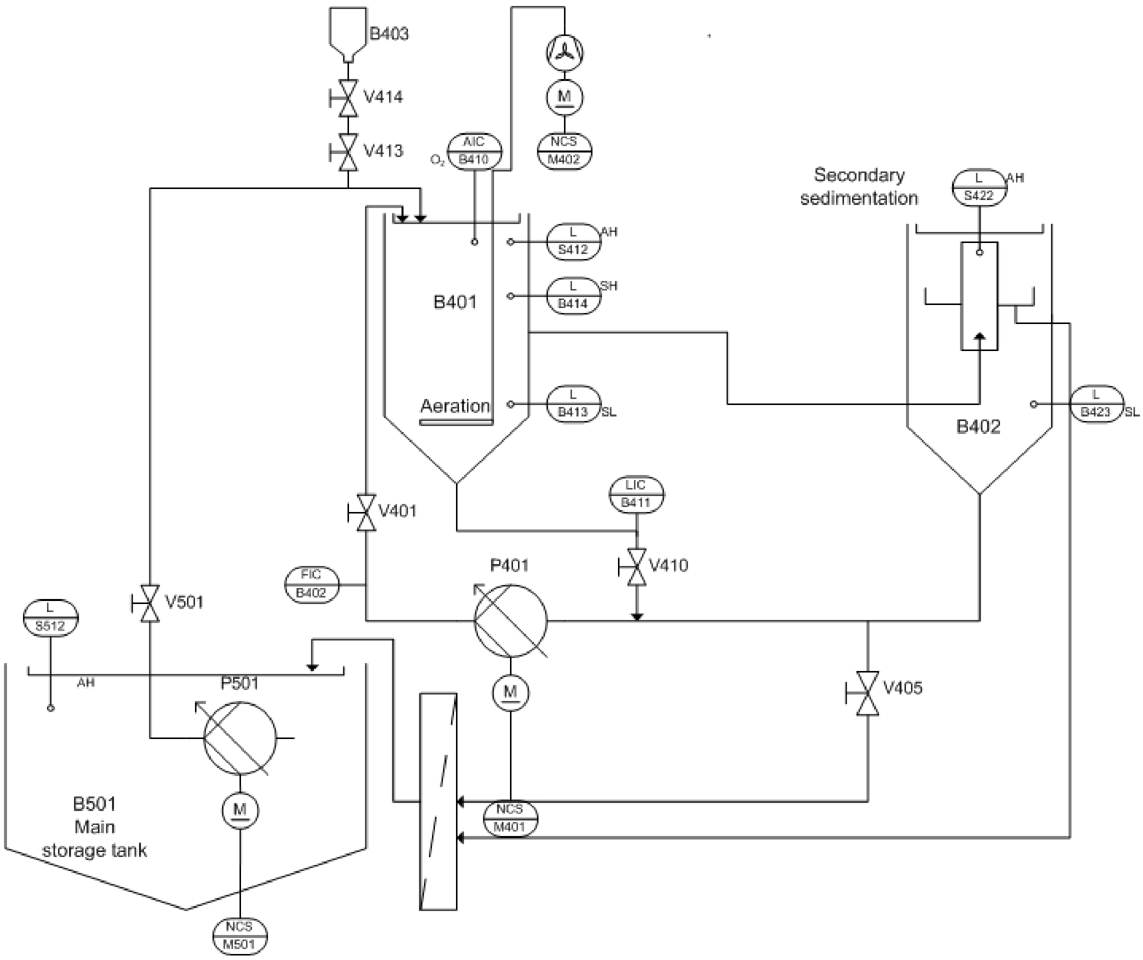
Main components

- Tank, 3 l
- Tank, 10 l
- Aeration
- Overflow edge
- Capacitive proximity sensor
- Float switch
- Flow sensor
- Dissolved oxygen sensor (optional accessory)
- Recirculation pump
- 2-way solenoid valve
- I/O interface
- Aluminium profile plate

Dimensions
- Width: 710 mm
- Depth: 400 mm
- Height: 900 mm from table top

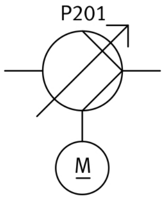
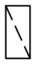
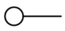
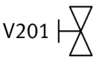
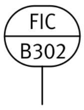
Order number of the Wastewater Treatment System: 8024507

1.1.2 Piping and instrumentation diagram of the Wastewater Treatment System



1.2 The most important P&I symbols used for the EDS® Water Management

Piping and Instrumentation (P&I) diagrams show the functional layout of a plant or facility. P&I diagrams contain different symbols for sensors, valves, actuators, motors, pumps, tanks and pipes. The P&I diagrams in this workbook are based on EN 62424 respectively EN 10628. To keep the diagrams easy to read, a simplified form is used.

Symbol	Meaning
	Pump with electric motor
	Tank (sedimentation tank shape)
	Filter
 	Pipe Branching pipe
 	Actuator (general symbol) Manual actuator
	Manual valve
	Sensor Top: FIC means flow sensor (F) which shows the current value (I) and can be used for closed loop control (C) Bottom: numbering **Further explanation of the characters in the top of the symbol: see table below**

Symbols – Examples from the EDS® systems

First character		Following character(s)	
F	Flow	A	Alarm
L	Level	C	Controller
P	Pressure	I	Instantaneous value
Q	Quality	O	Optical signal
T	Temperature	R	Registration
D	Difference	+/-	Threshold

Denomination of sensors

1.3 Learning outcomes correlated with exercises

With exercise 2.2.1 “Analysis of factors affecting sedimentation” the student can:

- name purposes of the sedimentation process
- find causes for poor sedimentation and conditions for good sedimentation
- list problems which may occur and name corrective actions

With exercise 2.2.2 “Simulation of the sedimentation of sludge (granulate)” the student can:

- explain basic processes involved in sedimentation
- sketch effects of an excessive (surface) input to a sedimentation tank
- describe effects of an excessive concentration of solids in the input to a sedimentation tank .

With exercise 2.2.3 “Analysis of flow rates” the student can:

- describe and explain the behaviour of floc (in the exercise granulate) in the tanks under different flow rates.

With exercise 2.2.4 “Influence of solids load on sedimentation” the student can:

- describe the behaviour of granulate with rising concentrations in tank
- explain how settleability of particles and particle concentration influence the sedimentation process.

With exercise 3.2.1 “Keeping solids concentration in the aeration tank high” the student can:

- describe the basic function of aerobic water treatment and the role of sludge recirculation
- explain the significance of sludge recirculation to the aeration tank
- name the consequences of hydraulic overload of a wastewater treatment plant.

With exercise 3.2.2 “Aeration” the student can:

- explain the basic function of aerobic wastewater treatment using the activated sludge processes
- measure and name the amount of oxygen dissolved in water without bubble aeration
- describe the significance of oxygen injection into the aeration tank
- explain the benefits of constantly measuring dissolved oxygen in an aeration tank.

1.4 Introduction to the learning module "Wastewater treatment"

In nature, water bodies normally have the power to purify themselves due to the presence of certain microorganisms such as bacteria and algae, which decompose the organic compounds in the wastewater, breaking and transforming them into simple substances such as carbon dioxide or nitrogen. If the microorganisms have enough time to decompose organic compounds and consequently keep their concentrations within certain limits, then the self-purification process does the job. Treatment becomes necessary as soon as discharge volume and consequently, concentrations rise. In this case, bacteria growth and the oxygen demand in the water will also increase.

Wastewater treatment accelerates the natural decomposition by optimising the conditions for decomposing bacteria.

The efficient and economic layout of a wastewater treatment plant requires a careful design based on aspects such as flow rates, components of the raw wastewater and organic load, end use of the treated water, economic viability, site area available for installation and climatic patterns as temperature and rainfall. This is why, there is no standard solution, but the selection of processes and the type of wastewater treatment plant will vary depending on each specific case. However, the usual process of treating domestic wastewater can be divided into the following standard stages:

- Pre-treatment
- Primary or physical treatment
- Secondary or biological treatment and
- Tertiary treatment usually involving chlorination.

1.4.1 Pre-treatment

This step does not affect dissolved organic material in wastewater. The aim is the separation of very coarse particles and sandy or easily separable materials whose presence would disrupt the overall treatment and efficient functioning of machines, equipment and facilities of the treatment plant. The headworks are the initial receiving area for raw wastewater from the conveyance system. Screens filter out large materials and grit chambers allow heavy sand and rocks to settle before wastewater is sent to the primary clarifiers. In addition, there is sieving to eliminate coarse solids in suspension, settling to remove dense sand as well as a degreasing to get rid of fats, oils, foams and other floating materials lighter than water, which may distort the subsequent treatment processes.

1.4.2 Primary Treatment

The primary treatment mainly consists of removing suspended flocculent solids by sedimentation or flocculation, neutralizing the acid and eliminating inorganic material by chemical precipitation. In some cases coagulation is used to support the sedimentation process. In this workbook special focus is laid upon sedimentation as primary treatment process.

1.4.3 Secondary or biological treatment

Once passed the pre-treatment and primary treatment stages, the aim of secondary or biological treatment is to reduce the organic material in the wastewater. Secondary treatment has been designed based on the biological process of self-purification – mentioned above – which occurs naturally. It helps to prevent water bodies from being polluted by natural born wastewater.

In the corresponding processes, the biodegradable organic matter from domestic wastewater acts as nutrient for a bacterial population which is provided with oxygen in controlled conditions. In summary, the biological treatment, is so to say, an accelerated natural oxidation process were biodegradable organic matter is decomposed by bacteria. Biological wastewater treatment subsequently avoids the entry of contaminants which could induce a lack of oxygen in water bodies.

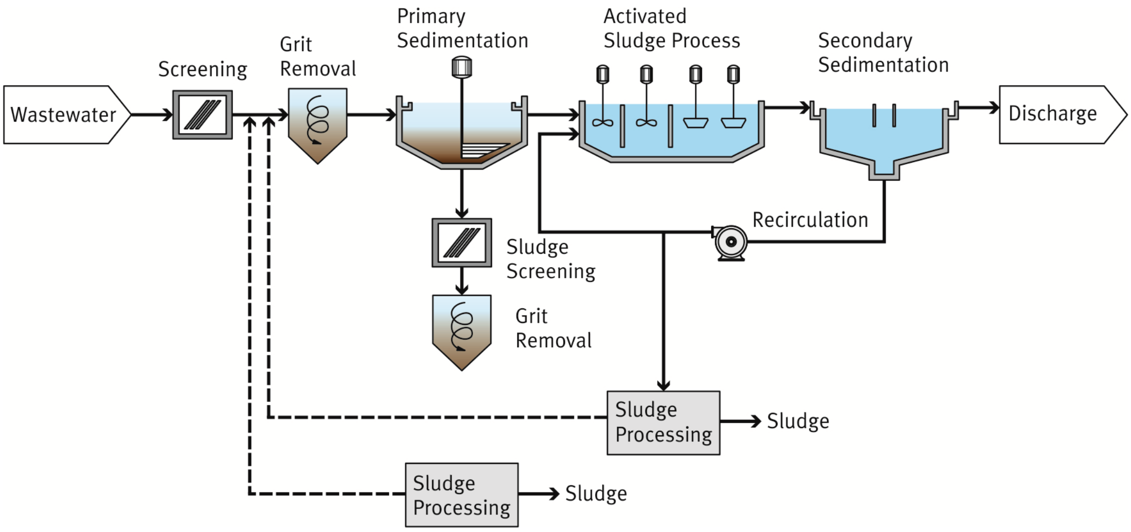
The most common aerobic processes with suspended biomass, are the aerated lagoon and the activated sludge or aeration tank which is treated in detail in this workbook.

1.4.4 Tertiary treatment

Tertiary treatment goals are to eliminate the remaining organic load of secondary treatment, to remove pathogenic microorganisms, to eliminate undesired colour and odour and to remove residual detergents, phosphates and nitrates causing waste foam and eutrophication. Chlorination is part of tertiary or advanced treatment that is used to achieve purer water, even down to drinkable if desired.

In wastewater treatment it is important to take into account the handling of sludge from the primary and secondary treatments. These sludges can cause damage to the environment and have to be treated and discharged in a controlled fashion.

A summary of generic treatments that can be applied to domestic wastewater and industrial wastewater is represented in this scheme:



Generic wastewater treatment process (basis source:University of Pretoria, Prof. EMN Chirva)

Exercises and worksheets

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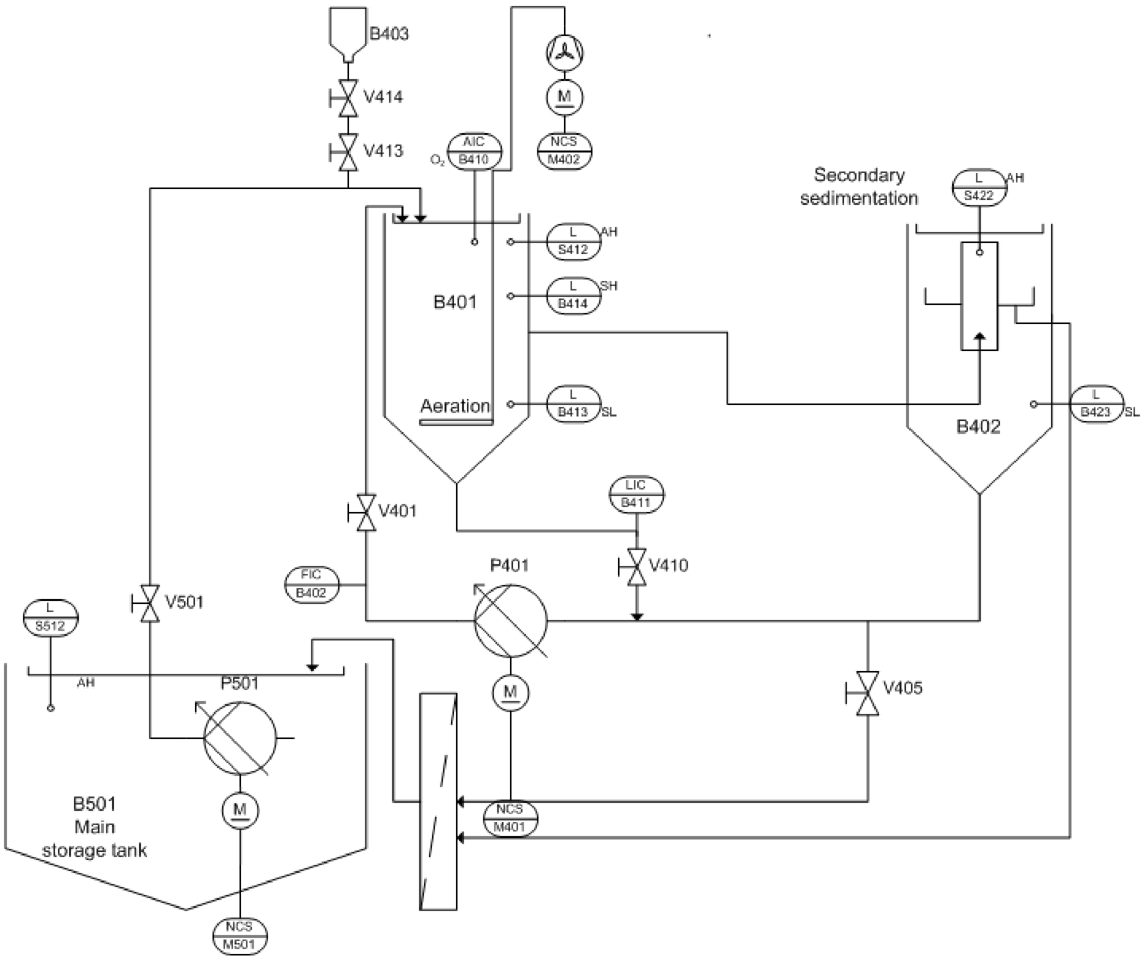

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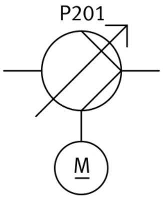
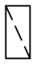
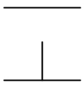
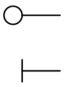
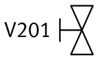
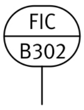
	Pump with electric motor
	Tank (sedimentation tank shape)
	Filter
	Pipe Branching pipe
	Actuator (general symbol) Manual actuator
	Manual valve
	Sensor Top: FIC means flow sensor (F) which shows the current value (I) and can be used for closed loop control (C) Bottom: numbering **Further explanation of the characters in the top of the symbol: see table below**

Symbols – Examples from the EDS® systems

First character		Following character(s)	
F	Flow	A	Alarm
L	Level	C	Controller
P	Pressure	I	Instantaneous value
Q	Quality	O	Optical signal
T	Temperature	R	Registration
D	Difference	+/-	Threshold

Denomination of sensors

1.3 Learning outcomes correlated with exercises

With exercise 2.2.1 “Analysis of factors affecting sedimentation” the student can:

- name purposes of the sedimentation process
- find causes for poor sedimentation and conditions for good sedimentation
- list problems which may occur and name corrective actions

With exercise 2.2.2 “Simulation of the sedimentation of sludge (granulate)” the student can:

- explain basic processes involved in sedimentation
- sketch effects of an excessive (surface) input to a sedimentation tank
- describe effects of an excessive concentration of solids in the input to a sedimentation tank .

With exercise 2.2.3 “Analysis of flow rates” the student can:

- describe and explain the behaviour of floc (in the exercise granulate) in the tanks under different flow rates.

With exercise 2.2.4 “Influence of solids load on sedimentation” the student can:

- describe the behaviour of granulate with rising concentrations in tank
- explain how settleability of particles and particle concentration influence the sedimentation process.

With exercise 3.2.1 “Keeping solids concentration in the aeration tank high” the student can:

- describe the basic function of aerobic water treatment and the role of sludge recirculation
- explain the significance of sludge recirculation to the aeration tank
- name the consequences of hydraulic overload of a wastewater treatment plant.

With exercise 3.2.2 “Aeration” the student can:

- explain the basic function of aerobic wastewater treatment using the activated sludge processes
- measure and name the amount of oxygen dissolved in water without bubble aeration
- describe the significance of oxygen injection into the aeration tank
- explain the benefits of constantly measuring dissolved oxygen in an aeration tank.

Name: ______________________________ Date: ___________

1.4 Introduction to the learning module "Wastewater treatment"

In nature, water bodies normally have the power to purify themselves due to the presence of certain microorganisms such as bacteria and algae, which decompose the organic compounds in the wastewater, breaking and transforming them into simple substances such as carbon dioxide or nitrogen. If the microorganisms have enough time to decompose organic compounds and consequently keep their concentrations within certain limits, then the self-purification process does the job. Treatment becomes necessary as soon as discharge volume and consequently, concentrations rise. In this case, bacteria growth and the oxygen demand in the water will also increase.

Wastewater treatment accelerates the natural decomposition by optimising the conditions for decomposing bacteria.

The efficient and economic layout of a wastewater treatment plant requires a careful design based on aspects such as flow rates, components of the raw wastewater and organic load, end use of the treated water, economic viability, site area available for installation and climatic patterns as temperature and rainfall. This is why, there is no standard solution, but the selection of processes and the type of wastewater treatment plant will vary depending on each specific case. However, the usual process of treating domestic wastewater can be divided into the following standard stages:

- Pre-treatment
- Primary or physical treatment
- Secondary or biological treatment and
- Tertiary treatment usually involving chlorination.

1.4.1 Pre-treatment

This step does not affect dissolved organic material in wastewater. The aim is the separation of very coarse particles and sandy or easily separable materials whose presence would disrupt the overall treatment and efficient functioning of machines, equipment and facilities of the treatment plant. The headworks are the initial receiving area for raw wastewater from the conveyance system. Screens filter out large materials and grit chambers allow heavy sand and rocks to settle before wastewater is sent to the primary clarifiers. In addition, there is sieving to eliminate coarse solids in suspension, settling to remove dense sand as well as a degreasing to get rid of fats, oils, foams and other floating materials lighter than water, which may distort the subsequent treatment processes.

1.4.2 Primary Treatment

The primary treatment mainly consists of removing suspended flocculent solids by sedimentation or flocculation, neutralizing the acid and eliminating inorganic material by chemical precipitation. In some cases coagulation is used to support the sedimentation process. In this workbook special focus is laid upon sedimentation as primary treatment process.

1.4.3 Secondary or biological treatment

Once passed the pre-treatment and primary treatment stages, the aim of secondary or biological treatment is to reduce the organic material in the wastewater. Secondary treatment has been designed based on the biological process of self-purification – mentioned above – which occurs naturally. It helps to prevent water bodies from being polluted by natural born wastewater.

In the corresponding processes, the biodegradable organic matter from domestic wastewater acts as nutrient for a bacterial population which is provided with oxygen in controlled conditions. In summary, the biological treatment, is so to say, an accelerated natural oxidation process were biodegradable organic matter is decomposed by bacteria. Biological wastewater treatment subsequently avoids the entry of contaminants which could induce a lack of oxygen in water bodies.

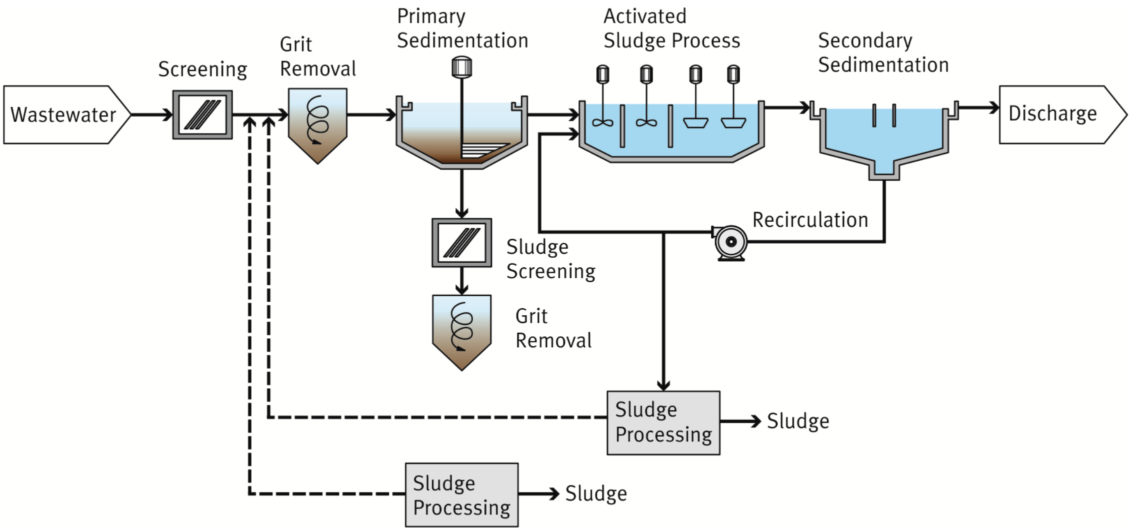
The most common aerobic processes with suspended biomass, are the aerated lagoon and the activated sludge or aeration tank which is treated in detail in this workbook.

1.4.4 Tertiary treatment

Tertiary treatment goals are to eliminate the remaining organic load of secondary treatment, to remove pathogenic microorganisms, to eliminate undesired colour and odour and to remove residual detergents, phosphates and nitrates causing waste foam and eutrophication. Chlorination is part of tertiary or advanced treatment that is used to achieve purer water, even down to drinkable if desired.

In wastewater treatment it is important to take into account the handling of sludge from the primary and secondary treatments. These sludges can cause damage to the environment and have to be treated and discharged in a controlled fashion.

A summary of generic treatments that can be applied to domestic wastewater and industrial wastewater is represented in this scheme:



Generic wastewater treatment process (basis source:University of Pretoria, Prof. EMN Chirva)