Out: February 01, 2018
Recommended completion: February 07, 2018

NTNU – Trondheim
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# Modelica Project Assignments
## TTK4130 Modeling and Simulation

Wastewater treatment is a common form of pollution control consisting of collection sewers, pumping stations and treatment plants. The treatment plants are built to clean the wastewater to return the water into streams or for reuse. In the first stage of wastewater treatment solids are removed by sedimentation, while in the second stage biological processes are exploited to further purify the water.

This project aims to model the second stage in Dymola, which is a highly nonlinear and challenging process to operate. The simulation model used in this project is based on the report "Benchmark Simulation Model no. 1 (BSM1)" by J. Alex et al. (2008), which can be found under `http://apps.ensic.inpl-nancy.fr/benchmarkWWTP/Pdf/Description_BSM1_20080619.pdf`.

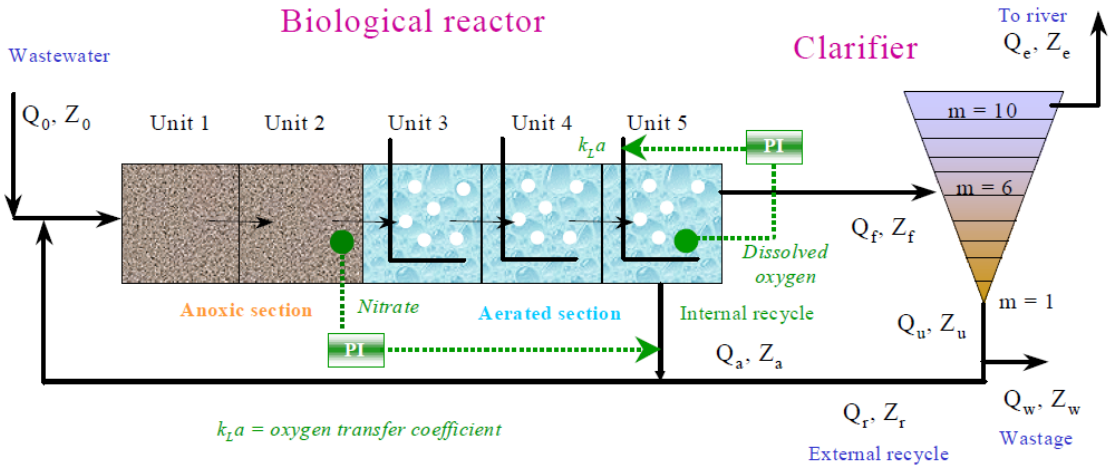


Figure 1: Wastewater treatment plant from "Benchmark Simulation Model no. 1 (BSM1)" by J. Alex et al. (2008)

**Assignment 1 (Implementation of wastewater treatment plant simulation)**

(a) Download the wastewater treatment package for Dymola by Gerald Reichl from: `https://github.com/modelica-3rdparty/WasteWater/tree/master/WasteWater`

(b) Familiarise yourself with the wastewater treatment package by following the steps given in the readme file and run the examples in ASM1, ASM2d or ASM3 using the provided script files (.mos).

(c) Develop a simulation model for the BSM1 benchmark in Dymola with the help of the wastewater treatment package.

(d) Test your dynamic model of the plant on different process conditions.

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**Assignment 2 (Dynamic open-loop simulations)**

Open-loop refers to the simulation of the plant without employing active controllers and disregarding process noise. This is generally a good first step to verify your simulation, since the simulation data is then always identical for the same conditions.

(a) Run your dynamic simulation for 100 days to reach steady-state based on the in-fluent data given in the introduction, Table 5 and the specifications in section 4 of the BSM1 report. The flow rate of $Q_a$ is $18446 m^3 d^{-1}$. Compare your simulation results with those in the file "Verificationdata.pdf" using the component names as shown in Figure 2. Save your results as .mat file to be used later as initialization.

(b) Initialize your next simulation using the previous data and run it for 14 days using the influent data contained in the file "$Inf\_dry.txt$" on `https://github.com/modelica-3rdparty/WasteWater/tree/master/WasteWater` for ASM1. In a separate file reformulate the equation system in tank5 to automatically change Kla to give an output concentration of dissolved oxygen "SO" of exactly $2g(COD).m^{-3}$. Explain the observations on Kla.

(c) To gauge the performance of the wastewater treatment plant several performance indices have been proposed in literature. Implement the following performance indices given in section 6 to be calculated by Dymola: EQ, PE, AE, and IQ (hint: integral definitions can be reformulated as differential equations with zero initial conditions).

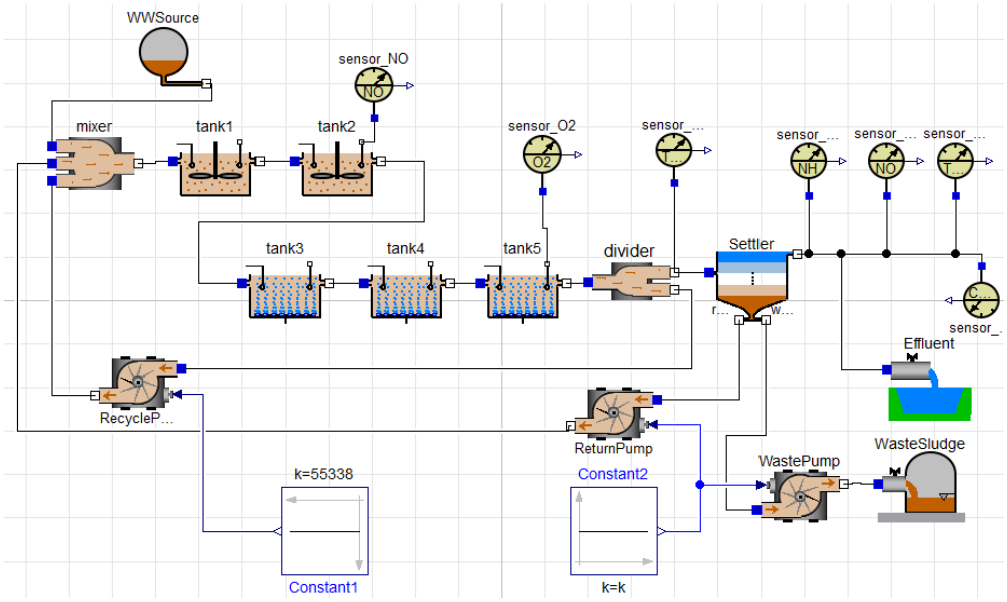


Figure 2: BSM1 Open-loop Dymola Implementation