# Model Predictive Control of a Sewer System

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Group 1030

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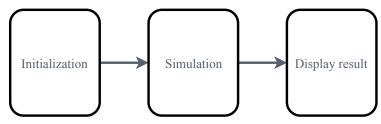


Figure: Chosen structure of simulation environment.



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# 1. Pipe

- Length [m]
- Sections (Number of sections the pipe should be split in to)
- ► S<sub>b</sub> (Slope) [‰]
- $ightharpoonup \Delta x = \text{Length/Sections [m]}$
- ▶ Diameter [meter]
- ► Theta (parameter used in Preissmann scheme)
- ightharpoonup Q<sub>f</sub>[m<sup>3</sup>/s]
- ► Side/lateral inflow present
- Section location in data

## 2. Tank

- ► Size [m³]
- ► Height [m]
- ► Area = Size / Height [m²]
- ► Maximum outflow [m³/s]
- ► Section location in data

Table: List of parameters for pipe and tank.



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Fields	length	== sections	<b>⊞</b> Dx	⊞ Sb	⊞ d	H Theta	<b>⊞</b> Qf	■ side_inflow	data_location
1	700	35	20	0.0030	0.9000	0.6500	0.9730	0	1
2	303	15	20.2000	0.0030	0.9000	0.6500	0.9730	0	3
3	27	2	13.5000	0.0030	1	0.6500	1.2843	1	4
4	155	8	19.3750	0.0041	1	0.6500	1.5014	0	5
5	295	14	21.0714	0.0122	0.8000	0.6500	1.4386	0	6
6	318	15	21.2000	0.0053	0.9000	0.6500	1.2932	1	7
7	110	5	22	0.0036	0.9000	0.6500	1.0658	1	8
8	38	2	19	0.0024	1	0.6500	1.1487	1	9
9	665	30	22.1667	0.0030	1	0.6500	1.2843	1	10
10	155	7	22.1429	8.0000e-04	1	0.6500	0.6632	0	11
11	955	47	20.3191	0.0029	1.2000	0.6500	2.0415	1	12
12	304	15	20.2667	0.0030	1.2000	0.6500	2.0764	0	13
13	116	5	23.2000	0.0021	1.2000	0.6500	1.7373	1	14
14	283	12	23.5833	0.0017	1.4000	0.6500	2.3463	1	15
15	31	2	15.5000	0.0019	1.4000	0.6500	2.4805	1	16
16	125	6	20.8333	0.0021	1.6000	0.6500	3.7075	0	17
17	94	4	23.5000	0.0013	1.5000	0.6500	2.4609	0	18
18	360	18	20	0.0046	1.6000	0.6500	5.4872	1	19
19	736	38	19.3684	0.0012	1.6000	0.6500	2.8026	0	20

Figure: Setup in MATLAB of pipe specification of the main line in Fredericia.



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Field 🔺	Value
isize size	90
Height	10
area area	9
Q_out_max	0.9730
data_location	2

Figure: Setup in MATLAB of tank specifications.



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Fields	type type	component	
1	'Pipe'	1	35
2	'Tank'	1	1
3	'Pipe'	18	245
4	'Total'	20	281

Figure: Display of structure showing system setup information in MATLAB.



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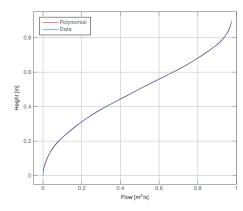


Figure: Comparison between data obtained by equation ?? and the same data curve fitted to a ninth order polynomial.



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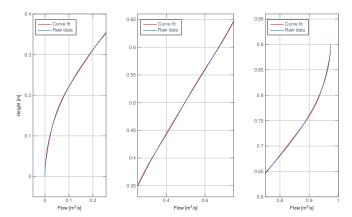


Figure: Comparison between data obtained by equation ?? and the same data curve fitted to a ninth order polynomial.



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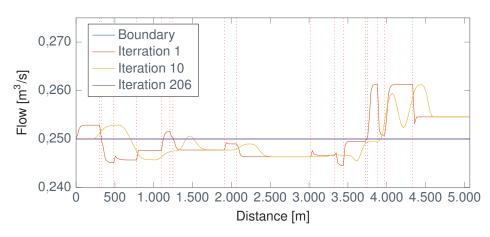


Figure: Height and flow of pipe setup from part of Fredericia where boundary conditions is found by fitted polynomial. Various amount of iterations, with constant flow input of 0,25 m³/s, is performed. The dotted line indicates pipe intersections.



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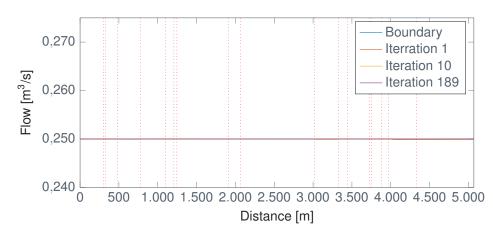


Figure: Height and flow of pipe setup from part of Fredericia where boundary conditions is found by lookup table. Various amount of iterations, with constant flow input of 0,25 m<sup>3</sup>/s, is performed. The dotted line indicates pipe intersections.



► Preissmann scheme

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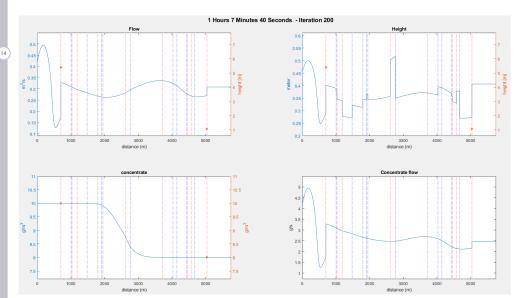
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▶ Flow profiles



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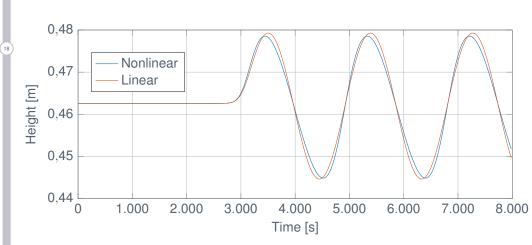


Figure: Comparison of the nonlinear and linear model at the last pipe in the setup.



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- ► Cost function
- ► Constraints
- ► Linear model



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► Bestemmelse af Prediction horizon

- ► Flow profiler
- ▶ Industri
- ► Begrænsning af Prediction horizon





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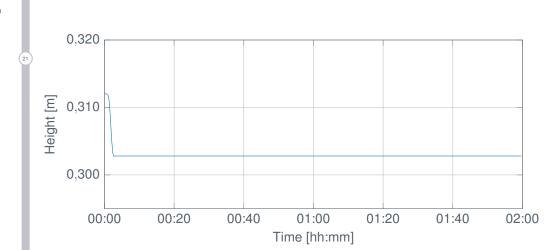


Figure: Output of the last pipe.

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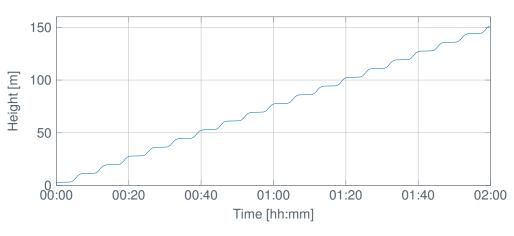


Figure: Height in the tank.



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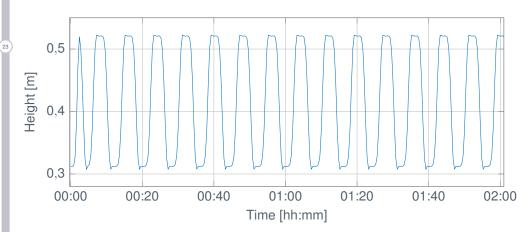


Figure: Output of the last pipe in the second simulation run.



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► System setup

► Flow profiles

Туре	Component	Sections
Pipe	1	35
Tank	1	1
Pipe	17	207
Tank	1	1
Pipe	1	38
Total	21	282

Table: System setup.



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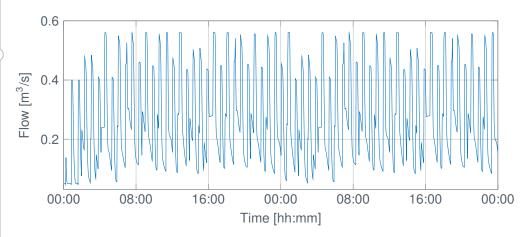


Figure: Output of the last pipe into the WWTP.

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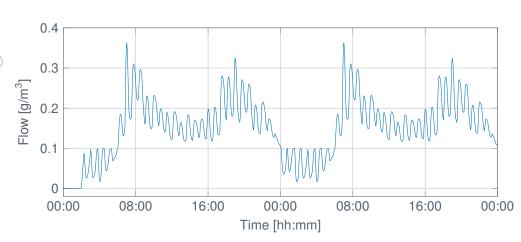


Figure: Simulation of COD output of the last pipe into the WWTP.



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► Over dimensioneret tank

► Konstant output af tank



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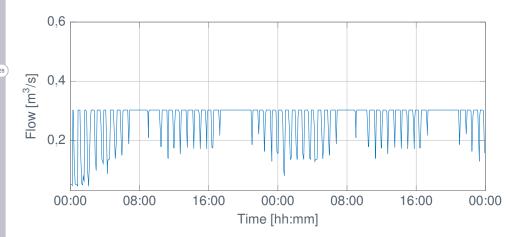


Figure: Output of the last pipe in to the WWTP, where a tank has been placed in front to reduce variation in flow into WWTP.



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► Courant's number

▶ Model reduction



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► Simulation

► MPC