Modelling and control of a full-scale chemically enhanced primary treatment

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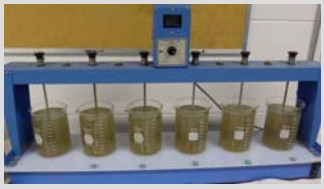
Context

To deal with high influent loads during rain events, Québec City's wastewater treatment plant chose to chemically enhance its primary treatment

Objectives:

1. Simulate the behaviour of the primary clarifier without and with alum addition
2. Propose a control strategy to achieve effluent quality requirements at minimal chemical cost

Materials and methods



This study focuses on total suspended solids removal.

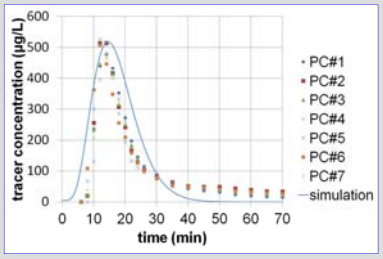
Two sources of data are used:

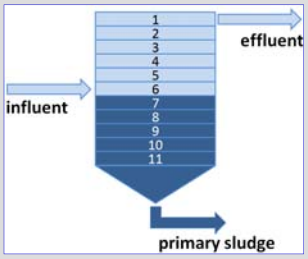
- ✓ Full-scale test
  - ➢ on-line measurements
  - ➢ high frequency composite samples
- ✓ Lab-scale experiments
  - ➢ jar-tests on a large range of alum concentrations

Hydraulic model

Full-scale tracer tests by pulse injection of rhodamine WT show that (figure below):

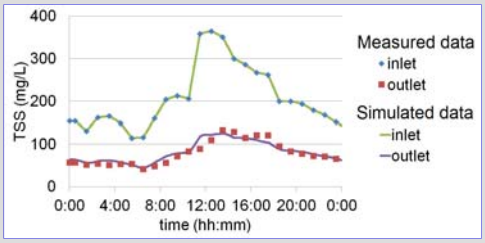
- ✓ all seven primary clarifier (PC) units have the same hydraulic behaviour and distribution is almost perfect
- ✓ the hydraulic behaviour between inlet and outlet of each PC can be modelled by a series of six homogeneous layers
- ✓ between inlet and underflow five layers are required





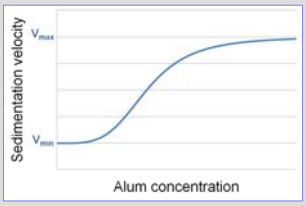
Sedimentation model

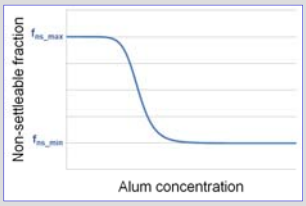
Simulation of total suspended solids (TSS) data of March 24th 2010. The daily dynamic is fairly well represented.



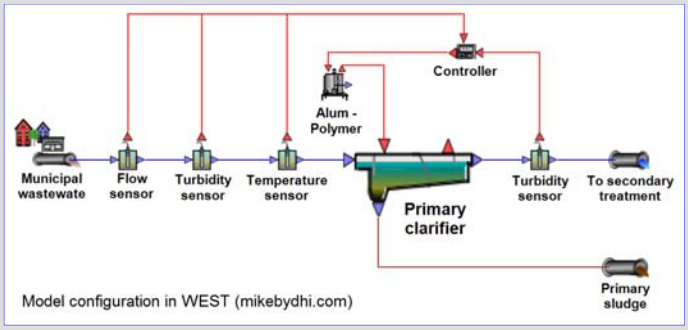
Lab experiments (range studied: 30-70 mg/L of alum) show that :

- ✓ a minimal alum concentration is needed for better clarification
- ✓ at too high alum concentrations a saturation effect is observed





Control strategy



Control strategies of alum addition are evaluated using different selections of the sensors presented in the above figure

TAKE HOME MESSAGE

- ✓ Sedimentation enhancement can be modelled by varying, depending on chemical concentration:
  - ➢ sedimentation velocity
  - ➢ non-settleable fraction of influent load
- ✓ Optimum chemical dosage depends on several conditions → a real time control strategy will provide an adequate addition automatically

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