Literature gennemgang for metoder for at øge den hydrauliske kapacitet under regn og praktiske erfaringer fra Spildevandscenter Avedøre.

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Content

- Literature review on wet-weather control at Wastewater Treatment plant
- Practical experience from Avedøre Wastewater Treatment Plant

What is the effect of wet-weather on inlet

- Increased hydraulic loads
- First flush with concentration peaks; flow peaks, mass peaks
- Diluted concentrations
- Sudden drop in temperature in cold climate

Parameter	Unit	Range of parameter concentrations			
		Rainfall	Stormwater runoff	Combined wastewater	Municipal Wastewater
Total Suspended Solids (TSS)	mg/L	<1	67-101	270-550	120-370
Biochemical oxygen demand (BOD)	mg/L	1-13	8-10	60-220	120-380
Chemical oxygen demand	mg/L	9-16	40-73	260-480	260-900
Fecal coliform bacteria	MPN/100 mL		10^3 - 10^4	10^5 - 10^6	10^5-10^7
Total Kjeldahl nitrogen	mg/L		0.43-1.00	4-17	20-45
Nitrate	mg/L	0.05-1.0	0.48-0.91		0
Total Phosphorous	mg/L	0.02-0.15	0.67-1.66	1.2-2.8	4-12
Lead, Pb	µg/L	30-70	30-144	140-600	

From Waste Water Engineering. Treatment and Reuse (2004). Tchobnoglous G. Burton, F, & Stensel H.D. McGraw –Hill; New York.

Maximum Hydraulic capacity

- The effluent of a WWTP is regulated based on 4 water quality parameters:
  - COD/BOD, TN/NH4-N, TP and SS

- The two most important factors deciding the available maximum Hydraulic Capacity during wet weather are:
  - Capacity of Secondary Clarifiers
  - Available nitrification/denitrification Capacity
  - Whereas the biological phosphourous removal capacity is compensated by chemical phosphourous removal

- In some countries (for example Germany) there are regulations on how much water is allowed to the WWTP.

Measures to Increase the Hydraulic capacity at WWTP

- Applicable both during dry/wet-weather:
  - Instrumentation and Online Control
  - Sludge Hydrolysis
  - Sludge age
  - Return activated sludge control

- During wet-weather:
  - Operational/process changes based on the existing facilities
  - Physical modifications and Construction of new facilities

Operational/process changes based on the existing facilities

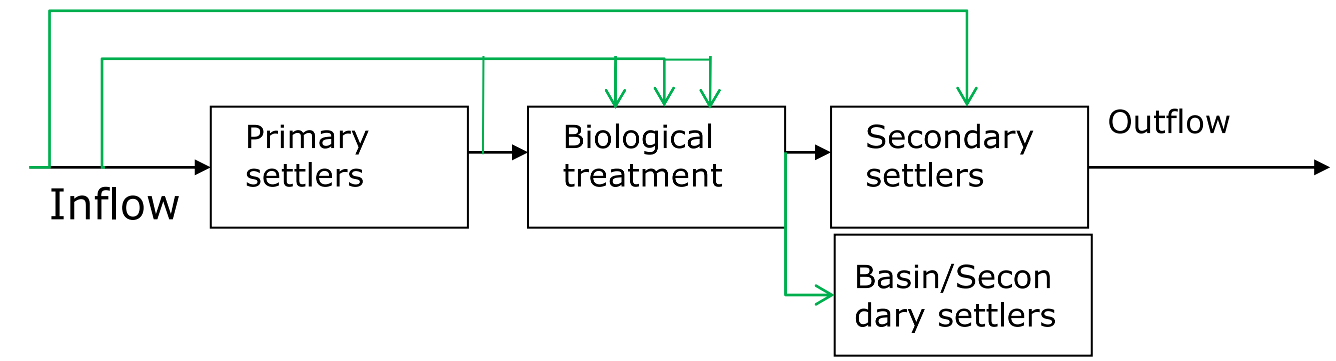
- Water Storage Management
- Step feed Operation
- Step sludge Operation
- Control of Return activated sludge
- Addition of flocculants before the secondary settlers to increase the settling properties of the sludge
- Addition of flocculants before the primary settlers to remove the SS
- Aeration tank settling

Operational/process changes based on the existing facilities

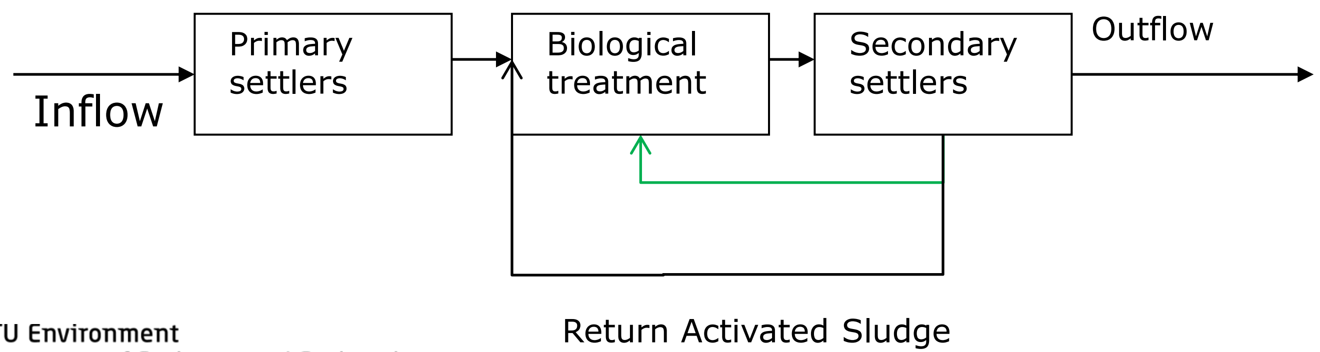
- Water Storage Management
- **Step feed Operation**
- **Step sludge Operation**
- **Control of Return activated sludge**
- Addition of flocculants before the secondary settlers to increase the settling properties of the sludge
- Addition of flocculants before the primary settlers to remove the SS
- Bypassing preliminary settling and treatment to remove TSS
- **Aeration tank settling**

Step Feed & Step Feed Operation

Step Feed: Depending on the inflow characteristics the position of the feed is changed to the optimal position



Step Sludge: Depending on the requirements the position of mixing of return activated sludge is changed.



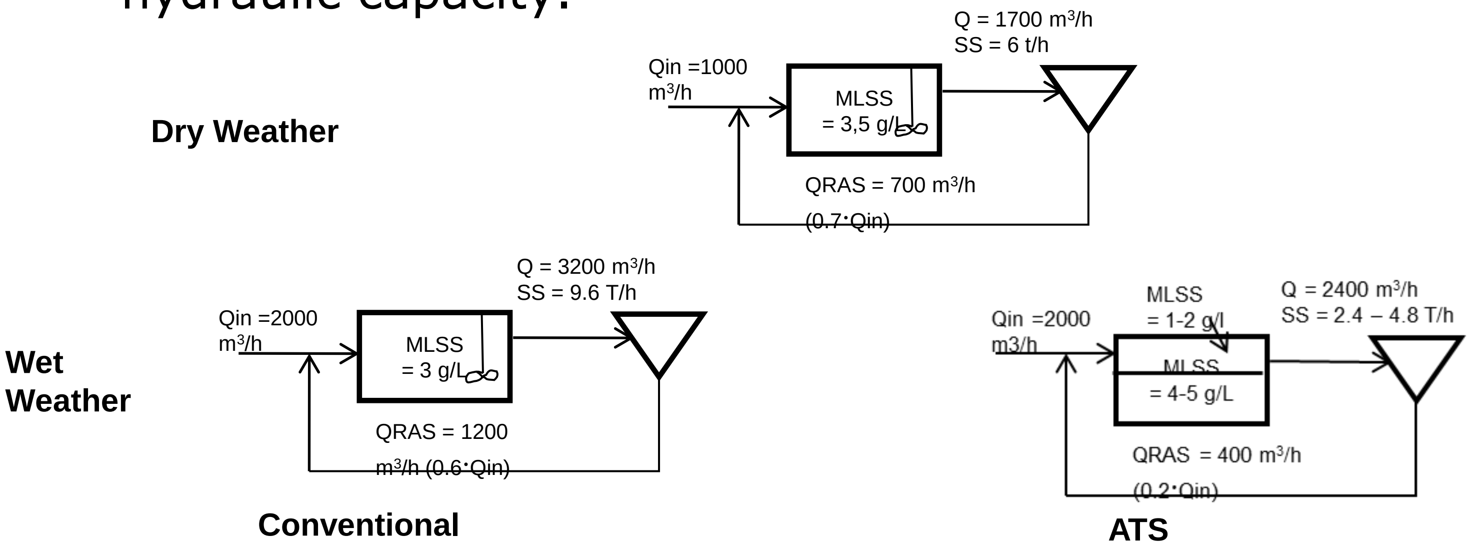
Control of Return Activated Sludge

Strategies for Control of Return Activated Sludge (RAS) flow rate are:

- Fixed RAS flow control
- Variable RAS flow control based on
  - Blanket level control
  - Settled sludge method
  - Solids flux theory

Aeration Tank Settling

- Settling is allowed in aeration tanks in order to decrease the solids load on the secondary settlers and hence increase the hydraulic capacity.



- Settling in aeration tanks
  - Less MLSS-concentration to settling tanks
  - Less flow to settling tanks
- Decreased sludge load to settling = increase hydraulic capacity

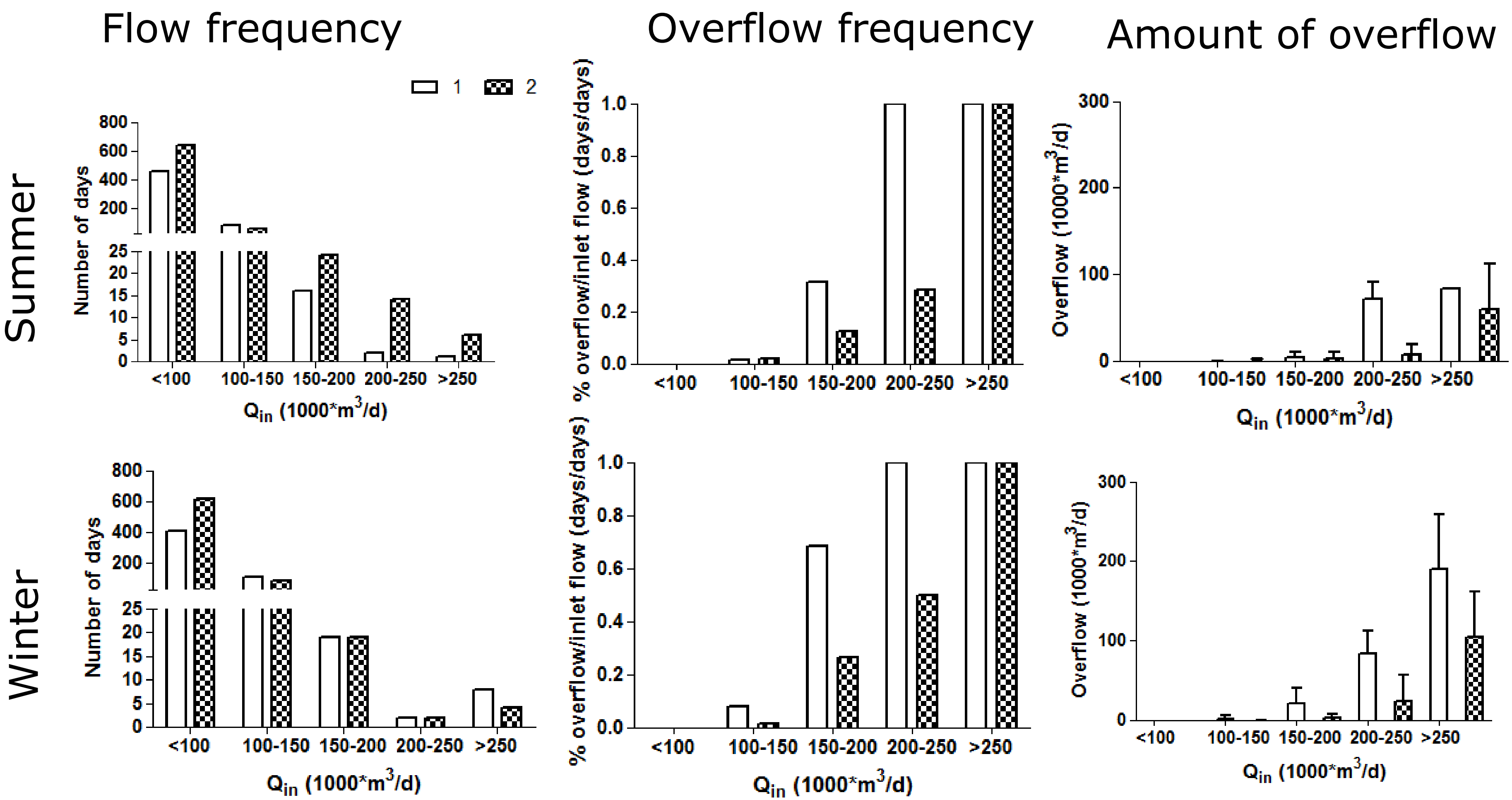
Sharma et al. (accepted). WS&T

Evaluating ATS and RTC at Avedøre

- Strategies:
  - Advanced online Control
  - RAS Control
  - Sludge age control
  - ATS
- Aim was to investigate the effect of ATS and RTC:
  - Hydraulic capacity
  - Treatment efficiency
    - SS, COD, TN, NH4-N, TP, Electricity consumption, Iron dosage
  - Differences between summer and winter operations
- Data:
  - 7 years data from full scale operation
    - Period 1: 3 years data without ATS and RTC
    - Period 2: 4 years data with ATS and RTC
    - Summer: May – October
    - Winter: November – April

Hydraulic capacity

- Design capacity: Summer: 148,800 m3/d and Winter: 108,000 m3/d.



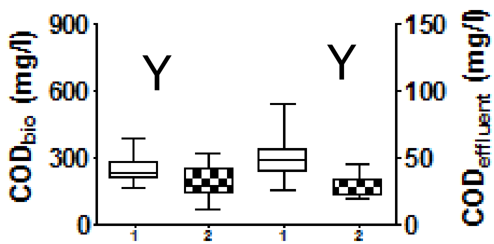
Treatment Efficiency (COD, TN Vs. Electricity consumption)

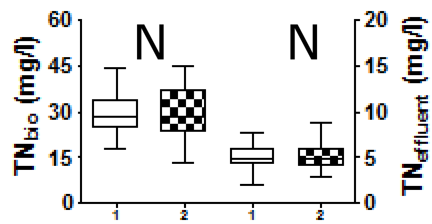
COD

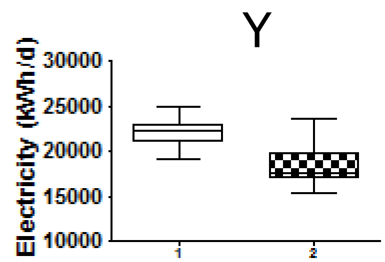
TN

Electricity consumption

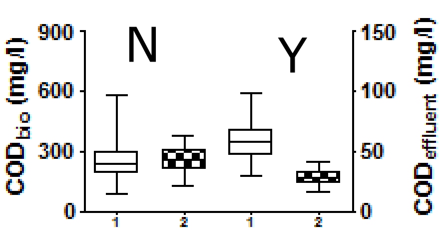
Summer

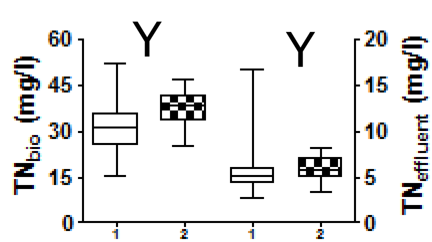


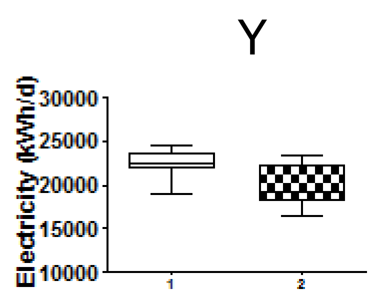




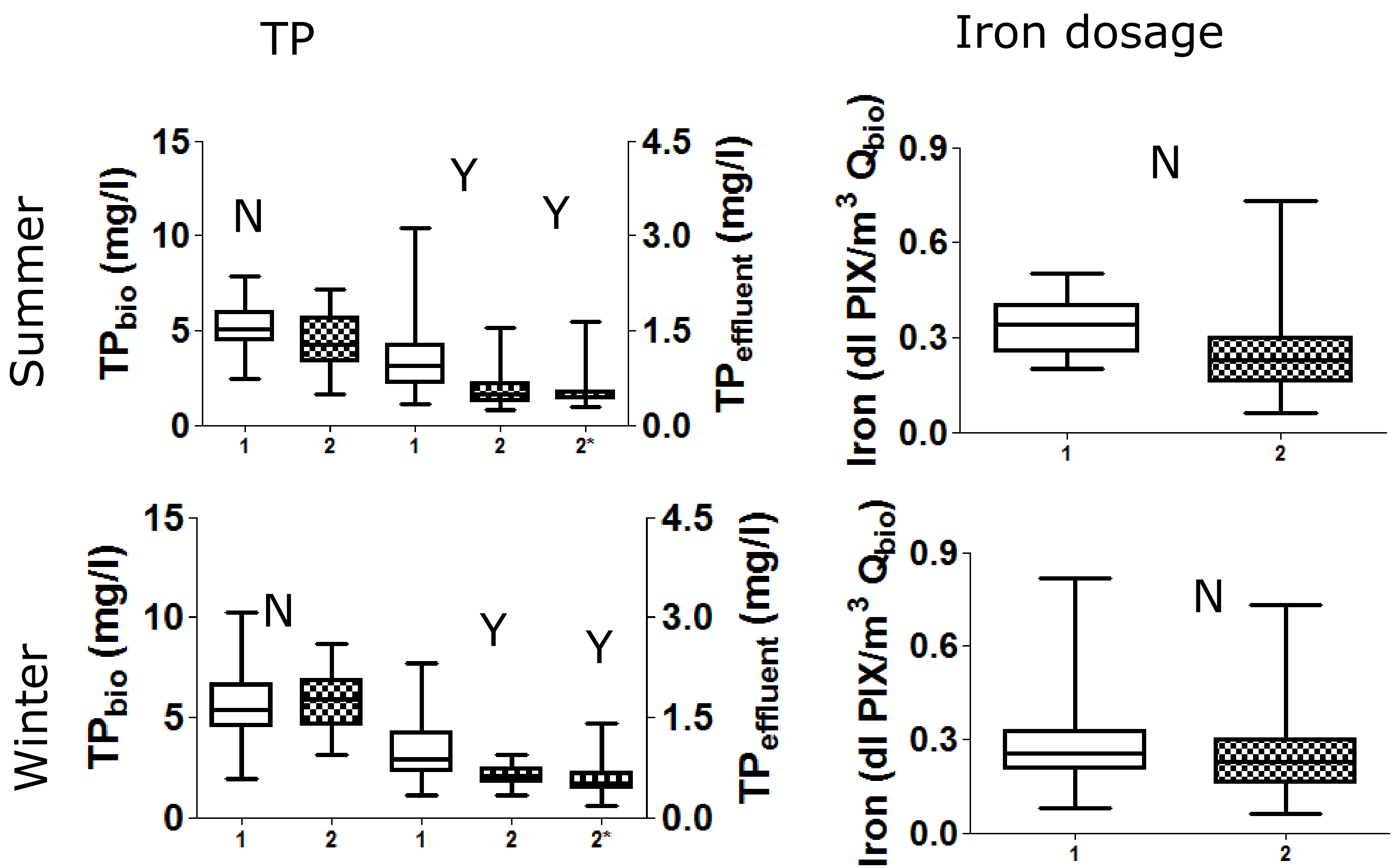
Winter







Treatment Efficiency (TP vs Coagulant dosage)



Conclusions

- Hydraulic capacity
  - The beneficial effect of RTC and ATS performance was higher during winter compared to summer especially at Q_{in} > 150,000 m^3/d
  - hydraulic capacity increased with up to 150% and 67% of the design capacity during winter and summer
  - However, some overflows occurred even at inlet flows below the design capacity

- Treatment efficiency
  - reductions in the effluent COD (30-50%), SS (30-60%) and TP (40-50%) concentrations both during summer and winter
  - No changes in TN
  - electricity savings (7-12%) mainly due to stopping of mixers

Thank you for your attention