Measurements and modelling for developing an AI-based DO control for mitigating N_2O emissions from WWTPs

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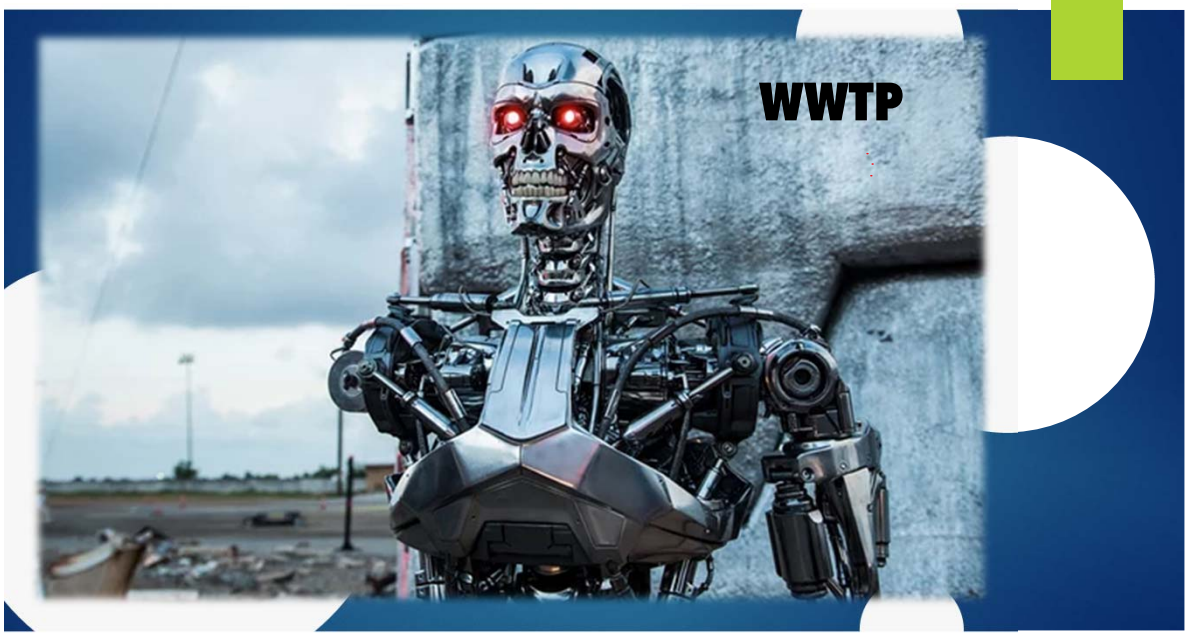
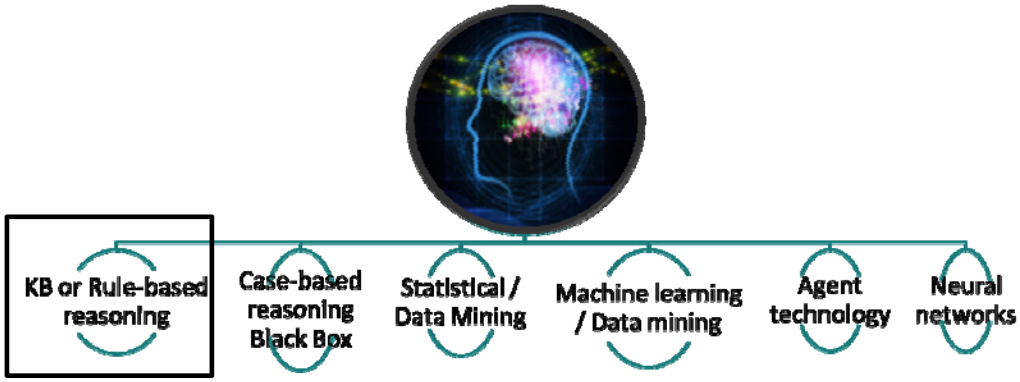
Cobalt Water Global
A Total Water Consultancy

The 3rd IWA New Developments in IT & Water Conference , 1 – 3 November, 2016, Telford, UK

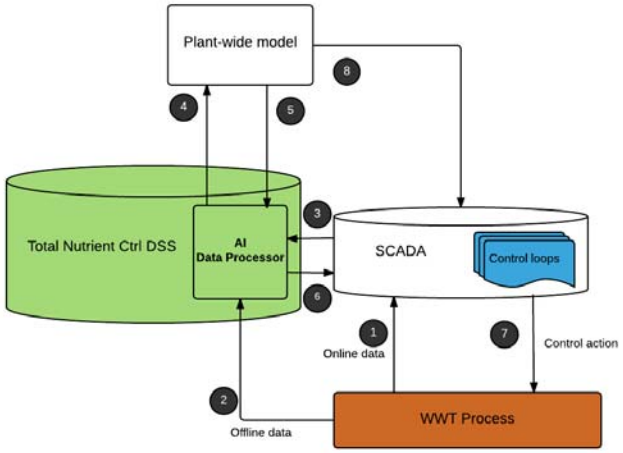


Artificial Intelligence (AI) Techniques for for Online WWTP Supervision and Control

Mimic human perception, learning and reasoning to solve complex problems (Chen et al., 2008)

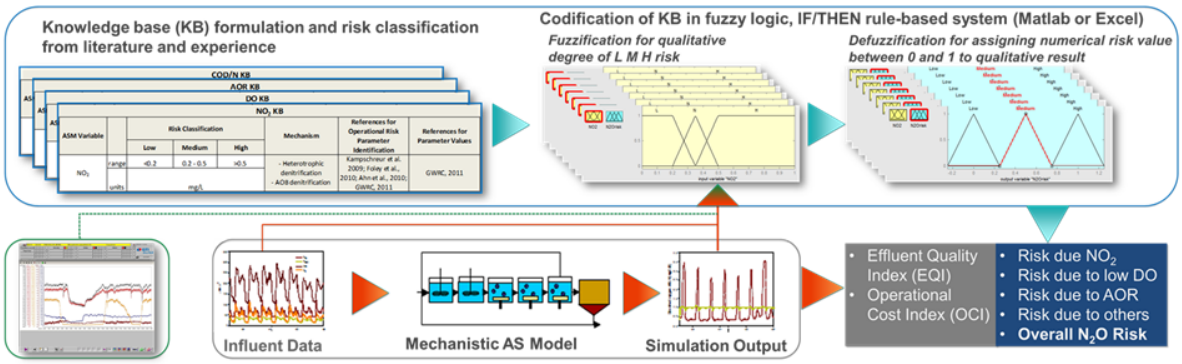


Artificial Intelligence (AI) Techniques for for Online WWTP Supervision and Control



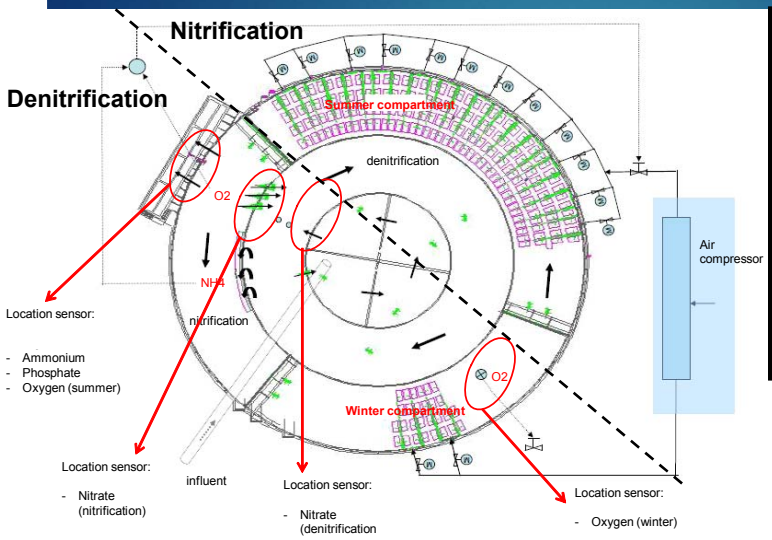
Background on N_2O Risk

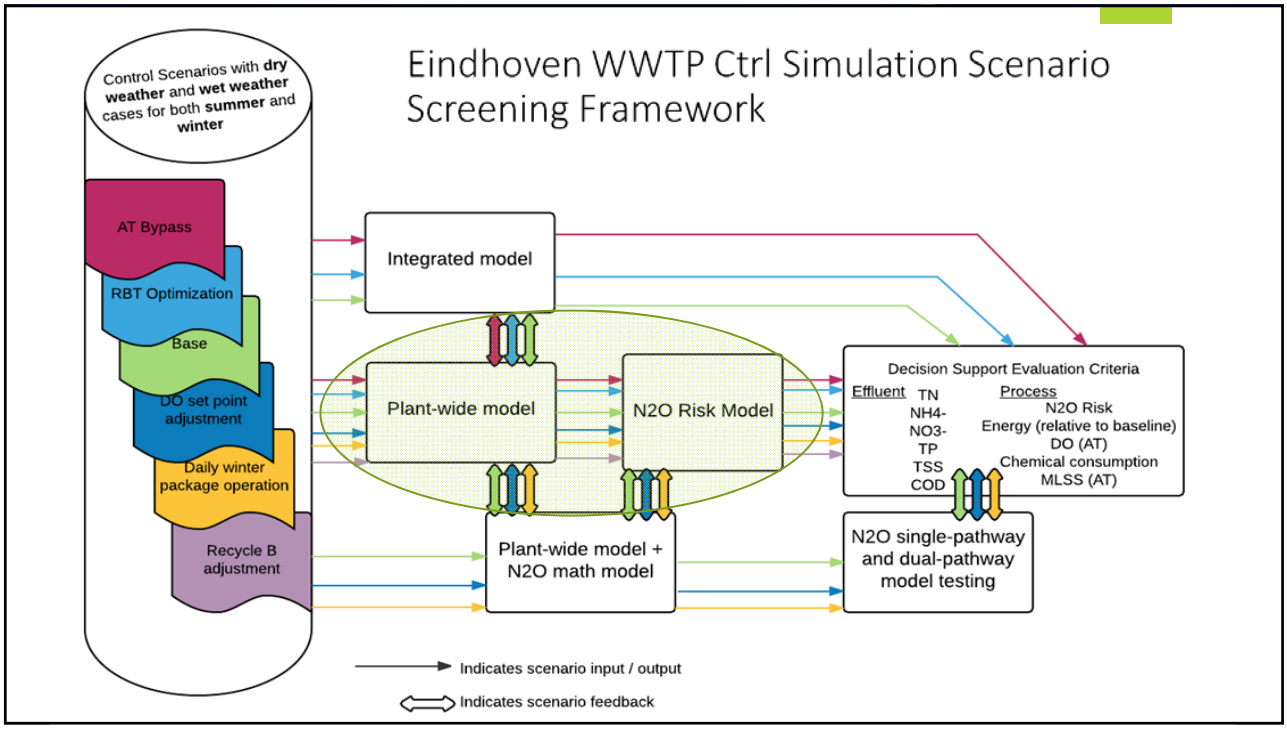
N_2O Risk Assessment Modelling Framework (Porro et al., 2014)

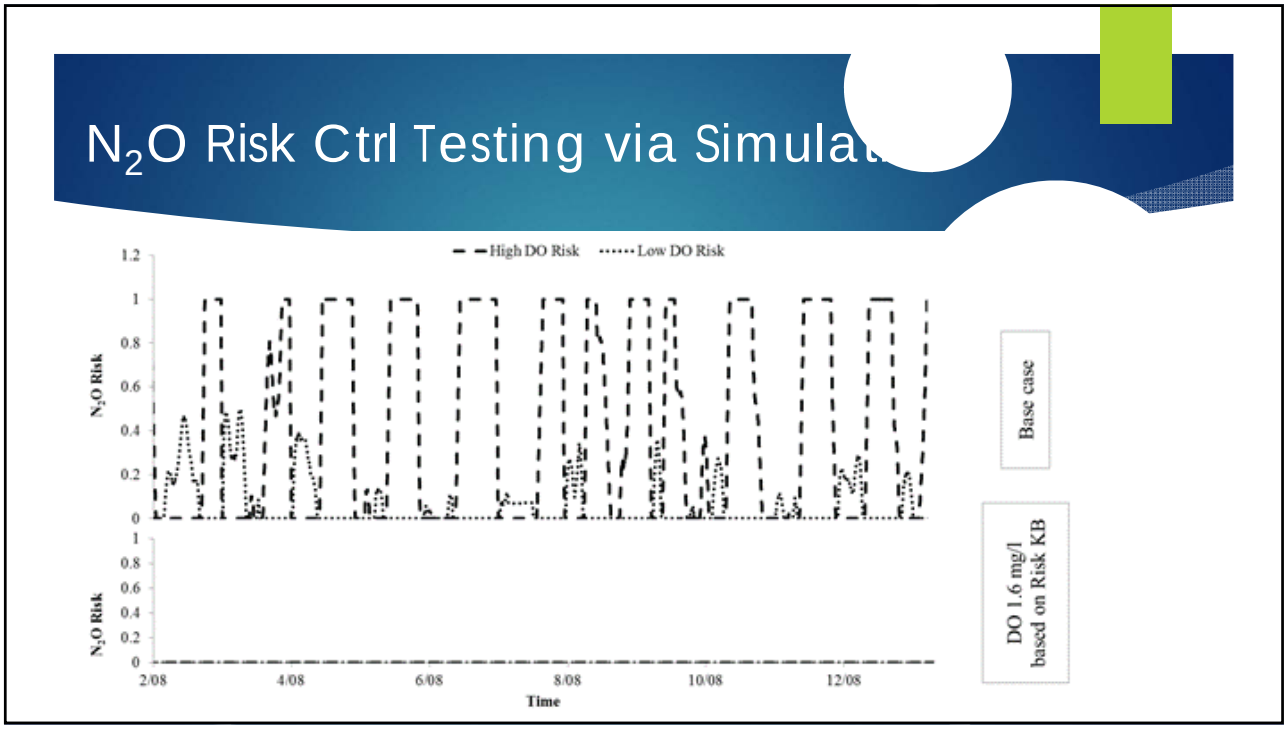


Online/SCADA Data -OR- Mathematical Modelling **Decision Support**

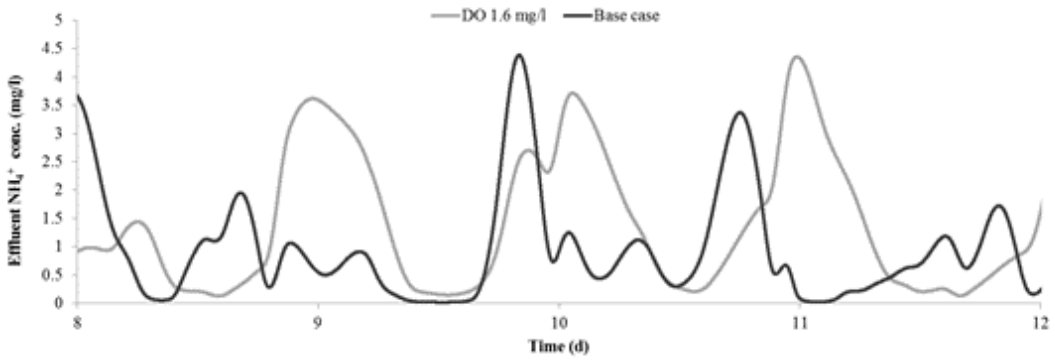
Eindhoven WWTP N_2O Risk Assessm



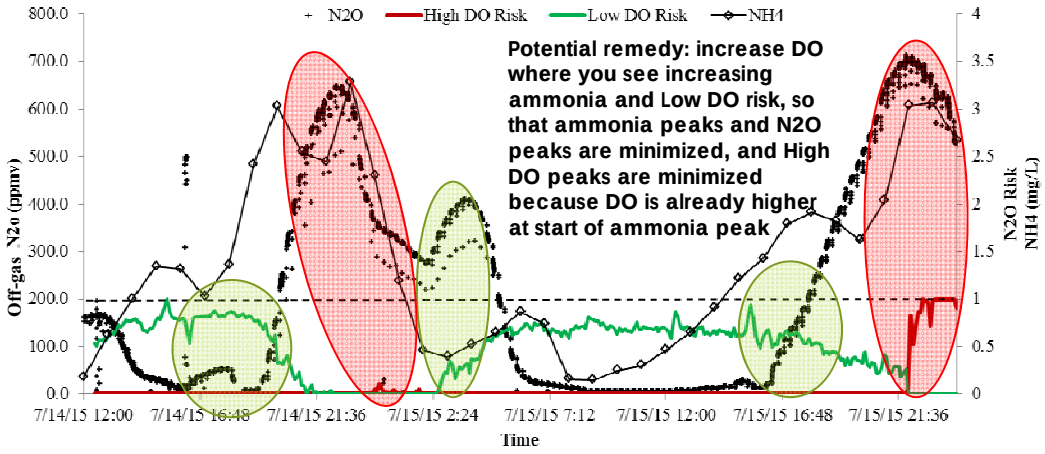

Eindhoven WWTP Ctrl Simulation Scenario Screening Framework
Control Scenarios with dry weather and wet weather cases for both summer and winter
AT Bypass
RBT Optimization
Base
DO set point adjustment
Daily winter package operation
Recycle B adjustment
Integrated model
Plant-wide model
N2O Risk Model
Plant-wide model + N2O math model
Decision Support Evaluation Criteria
Effluent
TN
NH4-
NO3-
TP
TSS
COD
Process
N2O Risk
Energy (relative to baseline)
DO (AT)
Chemical consumption
MLSS (AT)
N2O single-pathway and dual-pathway model testing
Indicates scenario input / output
Indicates scenario feedback


N_2O Risk Ctrl Testing via Simulat
High DO Risk
Low DO Risk
N_2O Risk
Time
2/08
4/08
6/08
8/08
10/08
12/08
Base case
DO 1.6 mg/l based on Risk KB

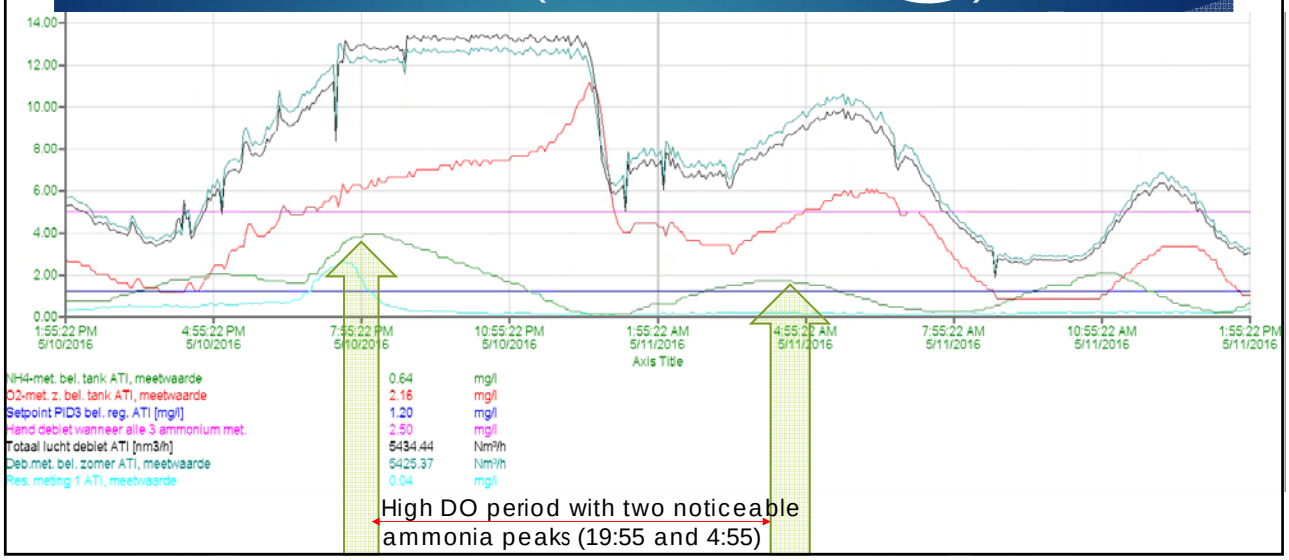
N_2O Risk Ctrl Testing via Simula



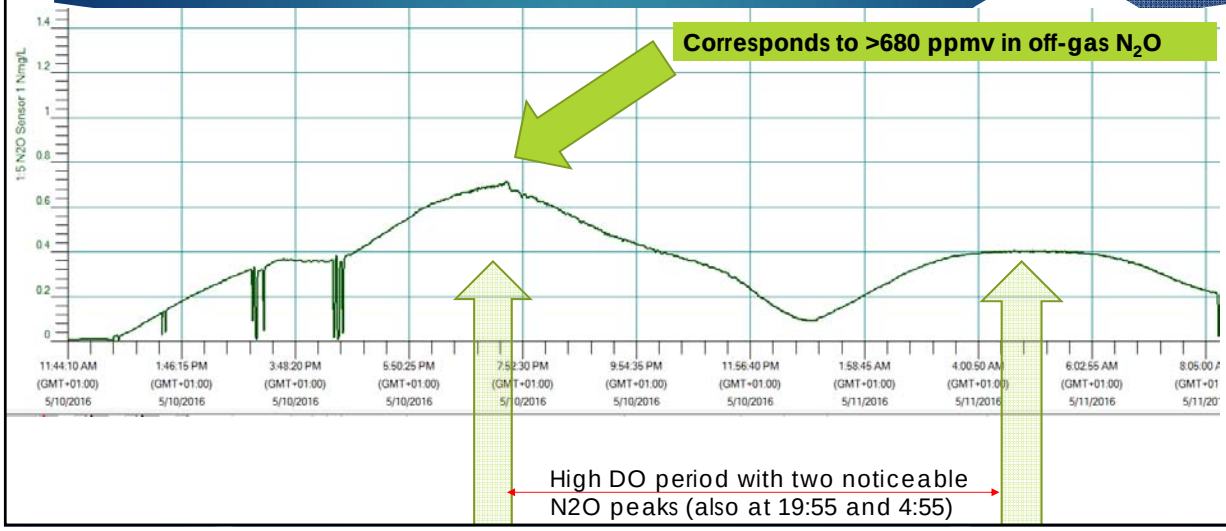
N_2O detailed risk diagnosis



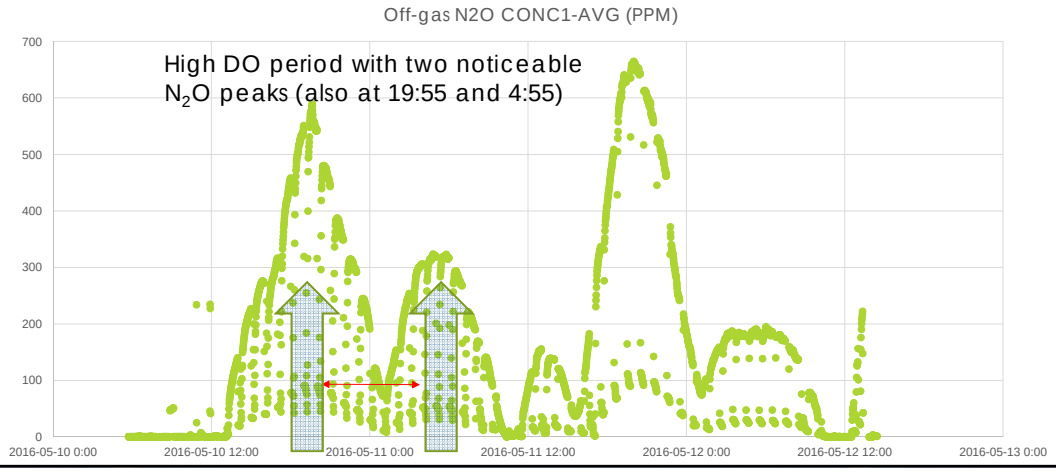
Current situation (DO and ammonia)



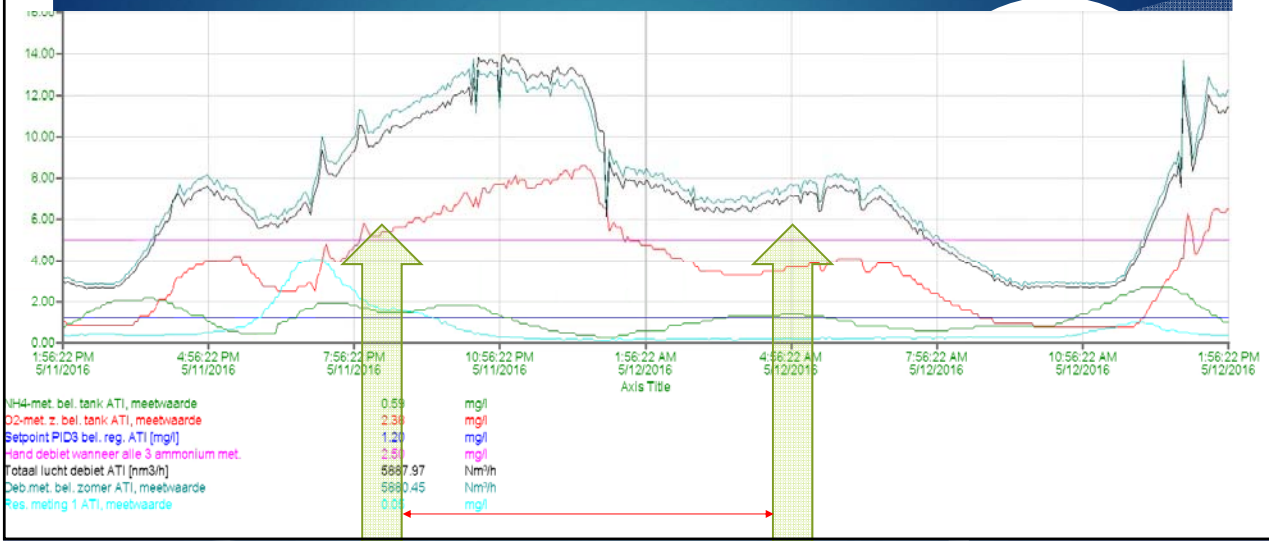
Current situation (N_2O for same period)



Current situation (off-gas N_2O for same period)



Current situation (pattern repeats next day)



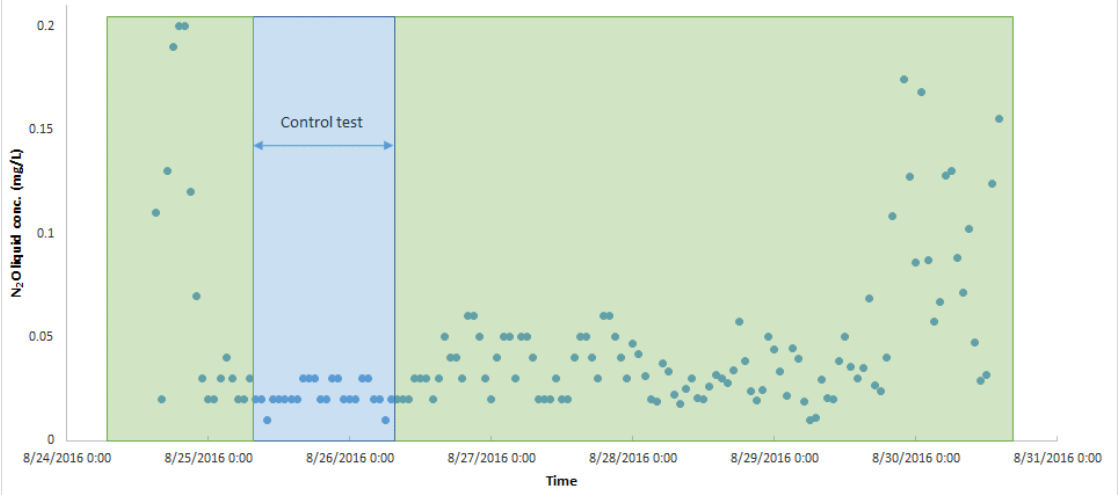
Current situation (N_2O data from cloud)

two noticeable N2O peaks each evening (also at 19:55 and 4:55) 25 May – 30 May

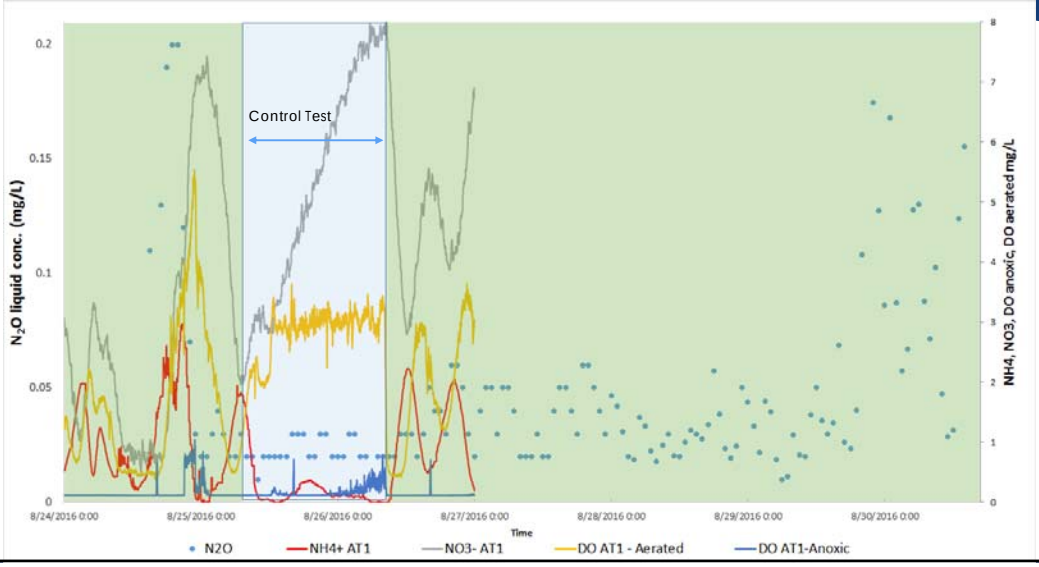
Proposed control adjustments

- Maintain DO at 2 mg/L or lower for nitrate during day when ammonia is lower – same as now
- Afternoon increase DO to 3 mg/L at around 12:00 – before peak
- If ammonia exceeds high-high setpoint, override and go to normal DO control – override should always be active
- The idea is to already have DO at a higher conc when ammonia peak arrives to see if it can prolong the time before DO has to go up really high, or even prevent DO from increasing to 6 mg/L, and prevent peaks in both ammonia and N2O

Full-scale N_2O mitigation control strategy test results - Eindhoven WWTP



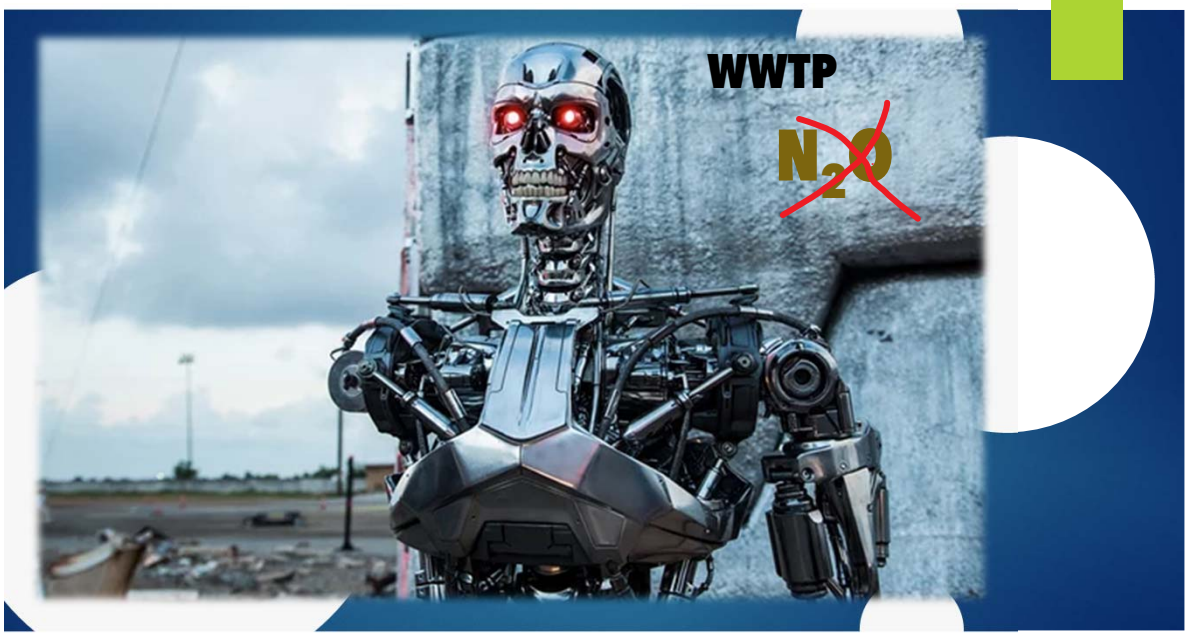
Full-scale N_2O mitigation control strategy test results - Eindhoven WWTP



Conclusions

AI-based (N_2O Risk) DO control:

- Eliminates N_2O peaks
- Eliminates peaks in ammonia
- Eliminates periods of over aeration
- NO_3^- not substantially higher, but N_2O in anoxic needs to be checked
- Full-scale N_2O mitigation strategy proved successful!




THANK YOU
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