1. Network-wide control of sulfide in sewers

1.1 Application criteria

Analysis of the sewer network should be conducted to identify odour and corrosion hot-spots through monitoring campaigns (costly and highly time consuming) or using modelling tools (cost-effective). The potential critical points identified by the model can then be validated in the field with minimal monitoring effort.

A network is suitable for network-wide control if:

- Multiple corrosion and odour hot-spots
- Hot-spots geographically spreading across the network

1.2 Choices of chemicals

Not all the chemicals are suitable for network control.

Oxygen and nitrate cannot be used in a network control approach because they are consumed quickly when flowing through the network. Persistent chemicals like magnesium hydroxide ($Mg(OH)_2$) and iron salts are suitable for network control.

The cost-effectiveness between iron salts or magnesium hydroxide is dependent on:

- Specificities of the network
- Sewage buffering capacity
- Sulfide concentration

1.3 Dosing locations

For network-wide sulfide control, dosing should be conducted in a pipe/wet well with large daily flows when possible. The reasons are:

- Help to convey adequate amounts of chemicals
- Minimise the over-dilution of chemicals due to the mix with side-streams after the dosing point
- Provide flexibility on the potential operation control of sewage pumping station (SPS), see 1.4 for details.

1.4 Online control of chemical dosing and SPS operation

The control of chemical dosing and the operation of the SPS where this chemical dosing is conducted are critical for the success of the network control. Online dynamic control is employed to:

- Prevent wastewater slugs to reach the control point (discharge point) without receiving adequate dosing
- Avoid excessive dilution of the chemical to ensure a suitable concentration/pH at the discharge point

1.4.1 Hybrid Automata (HA) control strategy.

The HA strategy is based on Discrete Events System (DES) and Hybrid system theories. The approach controls the operation of a large SPS, located upstream the control points and receiving chemical dosing, using a HA which takes into account the present state of the sewer network (requiring telemetry signals from all the SPSs in the network).

HA achieves the network control by applying two main rules:

1. The controlled SPS is ON when any of the SPS downstream is operative, and
2. The flow delivered by the controlled SPS has to be at least *n* times higher than the combined flow of the SPSs downstream that are ON at the time of the control action, where the value of *n* needs to be defined based on the characteristics of each network and total flows of the SPSs located downstream the control point.

Further information can be obtained as follows:

Paper: Liu, Y., Ganigue, R., Sharma, K. and Yuan, Z. (2013) Controlling chemical dosing for sulfide mitigation in sewer networks using a hybrid automata control strategy. Water Science and Technology 68(12), 2584-2590.

1.4.2 Event-based Model predictive control (EBMPC)

The EBMPC relies on the Auto-Regressive Moving-Average (ARMA) models for future flow prediction. On the other hand, the concentration and position of all the slugs within the network can be estimated based on a network-state model, which can be run online. All these information is made available to the control which decides which actions need to be taken (i.e. SPS pumps turned ON or OFF) to ensure all the slugs reaching the control point have a suitable chemical concentration.