DYNAMIC MODELLING OF HYDROGEN SULPHIDE IN AUCKLAND'S SEWER SYSTEM

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ABSTRACT

Introduction

The formation of Hydrogen Sulphide (H_2S) is a serious problem in sewer systems worldwide. H_2S in sewers leads to a hazardous work environment for the maintenance crew, and the corrosion of sewer infrastructure can necessitate premature repair or replacement. The problem is increasing due to a combination of climate change, water saving programmes, increased urbanisation with separate sewer systems, and centralised wastewater treatment with long rising mains, resulting in higher retention times and anaerobic conditions in pressurised sections of the network. As H_2S is the primary source of corrosion and odour problems, it is essential to understand the dynamics of its formation and mitigation measures.

To understand and tackle H_2S in a city-wide network, a biokinetic H_2S modelling approach has been developed and integrated into a fully dynamic hydraulic and advection-dispersion model. The approach is based on the state-of-the-art Wastewater Aerobic/anaerobic Transformations in Sewers (WATS) conceptual model (Hvitved-Jacobsen 2013) and is integrated with a hydraulic and advection-dispersion model.

The application of the methodology was piloted on the Army Bay sewer network, which experiences severe problems with the formation of hydrogen sulphide. The project objective was to establish if a standard calibrated hydraulic model can be used to assess the current state of the H_2S formation and develop and test mitigation measures.

Methodology

A hydraulic model of the wastewater network was available, developed and calibrated using MIKE URBAN software suite. MIKE ECO Lab WATS module was used to predict H_2S and associated constituents in the system.

Water quality data such as Temperature, pH, and others were required inputs into the process representation.

Results and Discussion

The H_2S model was used to simulate three important aspects: the formation of H_2S in the water phase, the release of H_2S gas to the air phase, and retention time in the water phase. The processes implemented in the model include sulphur transformation, precipitation, aeration, electron acceptor transformation, and organic matter transformation.

All the H_2S results can be visualised together with all other hydraulic results providing a full overview of the processes and hydraulic conditions involved in the formation of H_2S. Risk maps were generated for different results - hydraulic retention time, H_2S release, and total-HS.

In the modelling results, we observed that the sulfide is mainly formed in a low-velocity state. The release of H_2S occurs when air is available in the pipes and where the velocity is high: steep pipes immediately after rising main, steep sections after long flat gravity sections, and pumping stations that receive sewage containing H_2S.

Conclusion

The study showed that the formation of H_2S can be modelled with a fully hydraulic, advection-dispersion model integrated with a biokinetic process model. In addition, various mitigation strategies may be analysed with the model, including chemical dosing. A suitable hydraulic model, which includes pressurised parts of the network, such as rising mains and syphons, is the basis of the process model.

To improve the model calibration, H_2S should be measured in water samples. Measuring other water quality parameters will also reduce the uncertainty in model results improve the model outcomes. Measurements should be taken across the sewer network, not only at the locations exhibiting issues with odour or excessive corrosion.

References

Hvitved-Jacobsen T., Vollertsen J. and Nielsen A. H. (2013). Sewer Processes. Microbiological and Chemical Process Engineering of Sewer Networks, Second Editon. ISBN-13: 978-1-4398-8178-1