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Sewer Biofilm Modeling for sulfide formation in sewers

(Final Report)

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Sewer Biofilm Modeling for Sulfide Formation in Sewers

FINAL REPORT

Submitted by

The Hong Kong University of Science and Technology R&D Corporation

Clear Water Bay, Kowloon, Hong Kong

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EXECUTIVE SUMMARY

DSD commissioned Hong Kong University of Science & Technology (HKUST) to conduct this project, "Minor Consultancy Agreement No. DEMP 09/06 - Sewer Biofilm Modeling for Sulfide Formation in Sewers" from 1 July 2009 to 30 June 2010. The objectives of this study are to simulate the formation and control of hydrogen sulfide (H_2S) using Sewer Process Mathematical Model for both gravity sewer and pressure main, and to evaluate the applicability of the calibrated Tung Chung Sewer (TCS) model in optimization of H_2S control by chemical dosing.

Two sewer models were developed from the Sewer Process Mathematical Model (SPMM) of HKUST: one for TCS as a pressure main (TCS Model) and the other for Tuen Mun Sewer (TMS) as a gravity sewer (TMS Model).

In order to calibrate and validate these two models, experimental investigations were conducted at the inlets and outlets of both sewers. Background sampling and analysis were conducted to collect relevant data for model development and preliminary calibration. Laboratory batch testing was then carried out to determine key parameters for the models. Three-day bi-hourly intensive sampling and analysis were further conducted for calibration and validation of these models. In order to assess the TCS Model, additional intensive sampling and analysis was conducted on 26-27 May 2010, using a "night-intensive nitrate" dosing scheme, as performance checking.

In both sewers, the calibrated models simulated sulfide formation satisfactorily. The TCS Model was further tested in evaluating and comparing different chemical dosing schemes on sulfide control in TCS. Both TCS and TMS models were finally integrated into a Generic Sewer Model System (GSMS) to simulate any generic linear sewer. Software with a simple graphical user interface (GUI) was developed for in-house use of DSD.

Major findings and observations were obtained from this project as follows:

1) The mathematical model in SPMM has demonstrated its capability in simulating sulfate-sulfide and nutrient conversion in sewer biofilm under changing conditions of sewage flow, temperature, and water quality for both pressurized and gravity sewers in this project.
2) TCS Model successfully revealed that the H_2S spikes in the inlet manhole of Siu Ho Wan Sewage Treatment Works (SHWSTW) did not originate from TCS sewage, and further deduced that these spikes were contributed mainly by the intermittent sewage discharges from the Sunny Bay sewer.
3) TCS Model was used to evaluate possible chemical dosing schemes. A "night-intensive nitrate" chemical dosing scheme was further assessed as 'Performance checking' in a field trial. TCS Model could describe the dynamic behaviors of various quality parameters during the field trial of the suggested chemical dosing scheme.
4) TCS Model simulation predicted chemical dosing rates of nitrate at 1,000L/h in daytime and 1750L/h at nighttime could completely control sulfide formation in TCS.
5) TMS Model well simulated the sulfide formation and oxidation in the gravity sewer, and revealed that sulfide oxidation process prevailed in the aerobic gravity sewer under high flow rate condition.

The GSMS developed from this project has exhibited its capability in simulating sulfide formation in a *linear* sewer under various operation conditions. The current system can be extended to model a sewer *network* for sulfide control. The extended model will have potential applications in the HATS system.