1 Free Nitrous Acid (FNA)

1.1 Mechanism

Dosing of nitrite solution to sewer at a pH below 7 produces free nitrous acid (FNA). FNA is toxic to the organisms in sewer biofilms thereby reducing sulfide and methane production. The equilibrium between the concentrations of FNA and nitrite ion in water is given by:

$$FNA = \mathrm{NO_2^-}\text{–N} \Big/ (K_a \times 10^{pH})$$

where Ka is the ionization constant of the nitrous acid given by the following expression: and T is temperature (°C).

The expressions above indicate that the equilibrium between FNA and nitrite ion is pH dependent. The molar ratio of the two species at pH 7 is 0.02%. This ratio increase by a factor of 10 for every unit decrease in pH. Thus the ratio is 2% when pH = 5.

1.2 Actions

Dosing of FNA kills the micro-organsims resonsible for the production of sulfide, thereby reducing the biofilm activity and effectively controlling sulfide production. The level of the biocidal effect has a much stronger correlation with the FNA concentration than with the nitrite concentration or with the pH level, suggesting that FNA is the actual biocidal agent.

1.3 Dosing arrangement and typical dosing rates

Due to the biocidal effects of FNA, intermittent dosing (typically once in 7 days) is sufficient to control the hydrogen sulfide production. FNA dosing rate of 0.26 mg N/L with the exposure time of 12 hours is found to achieve 80% sulfide control over 4.5 days.

1.4 Cost of FNA dosing

FNA dosing requires storage facility for titrate, hydrochloric acid, and proper dosing facilities. Estimated cost of FNA dosing is $30.0/ML, which is much lower than the coast of the dosing of other common chemicals. The saving in chemical cost is mainly achieved through the short term FNA dosing followed by a long term recovery period.

1.5 Impacts on WWTP

In real application, FNA should be added section by section in a sewer network rather than at all sections simultaneously. Nitrite will thus be diluted by the wastewater not receiving FNA dosing before arriving at the wastewater treatment plants. This can avoid the adverse shock to biological treatment processes by high nitrite concentrations. No other impacts have been identified so far.

1.6 Major limitations

- Lower pH during dosing period can enhance the H_2S transfer from liquid to the sewer gas phase. However, there will be negligible H_2S in the liquid when FNA is present, when the FNA is dosed to relatively fresh wastewater.
- FNA dosing requires pH adjustment, which would need a very good pH control at the dosing location.

1.7 Case studies

FNA dosing in UC09 Sewer System in Gold Coast

1.8 Additional Reading

Further information can be obtained as follows:

- Biocidal effects and cost of dosing
  - Paper - Biocidal effects of FNA by Jiang et al. (2011)
- Optimisation of dosing
  - Paper: Optimization of intermittent, simultaneous dosage of nitriteand hydrochloric acid to control sulfide and methaneproductions in sewers by Jiang et al. (2011)
- Summary report
  - SP6 Summary Report - SCORe