2.2.1.3 Biological Oxidation of Sulfide

A batch model was setup in MATLAB considering the following processes:

1. Chemical sulfide oxidation using the expression presented earlier (consumption of both sulfide and oxygen)
2. Oxygen consumption due to heterotrophic growth
3. Biological sulfide oxidation assuming the following double Monod type kinetic expression (consumption of both sulfide and oxygen)

Rate of oxidation of sulfide to intermediate product (S_1):

$$r_{oxi,bio,\ H2S\text{-}S1} = k_{max,\ bio,\ H2S\text{-}S1} \times \frac{[H_2S]}{K_{H2S} + [H_2S]} \times \frac{[DO]}{K_{O2} + [DO]}$$

Rate of oxidation of intermediate product (S_1) to sulfate:

$$r_{oxi,bio,\ H2S\text{-}S1} = k_{max,\ bio,\ H2S\text{-}S1} \times \frac{[S_1]}{K_{S1} + [S_1]} \times \frac{[DO]}{K_{O2} + [DO]}$$

Where, $r_{oxi,bio}$ is the sulfide oxidation rate in mg S/L-h, $[H_2S]$ is the H_2S concentration in mg S/L, $[S_1]$ is the S_1 concentration in mg S/L and [DO] is the DO concentration in mg/L.

The rate of oxygen consumption due to heterotrophic growth was taken from a separate batch experiment, in which oxygen was added at the start and there was no sulfide present. The consumption of oxygen in this case was assumed to be due to heterotrophic growth.

Data collected in six sets of experiments using lab reactor with different initial sulfide and DO concentrations were used to determine the parameters of the model through optimization using MATLAB. The parameters were adjusted so as to minimize the sum of the error between the measured and the simulated values of H_2S concentration, and the results are presented in the following table.

Parameter	Value	Determination
$k_{max, bio, H2S-S1}$	19.2	Optimization
$k_{max, bio, S1-SO4}$	3.0	Assumed
K_{H2S}	2.0	Optimization
K_{S1}	2.0	Assumed
K_{O2}	2.0	Assumed

Considering the A/V ratio of laboratory reactor system (1.25×50), the rate of sulfide oxidation to the intermediate, and the rate of oxidation of intermediate to sulfate was found to be 6.3 and 1.1 g S/m^2 biofilm-day.

An approach similar to the one used in chemical sulfide oxidation was used to determine stoichiometric requirement of oxygen for the oxidation of sulfide to intermediate sulfur product and it was found to be 0.8 mol O_2/mol S through data fit. Since this value is the same as in the case of chemical oxidation, similar intermediate products are expected in both the cases.

A comparison of the measured H_2S and DO concentrations with corresponding model results is presented in Figure 13. As the figure shows, the fit between the measured and model predicted values was good.

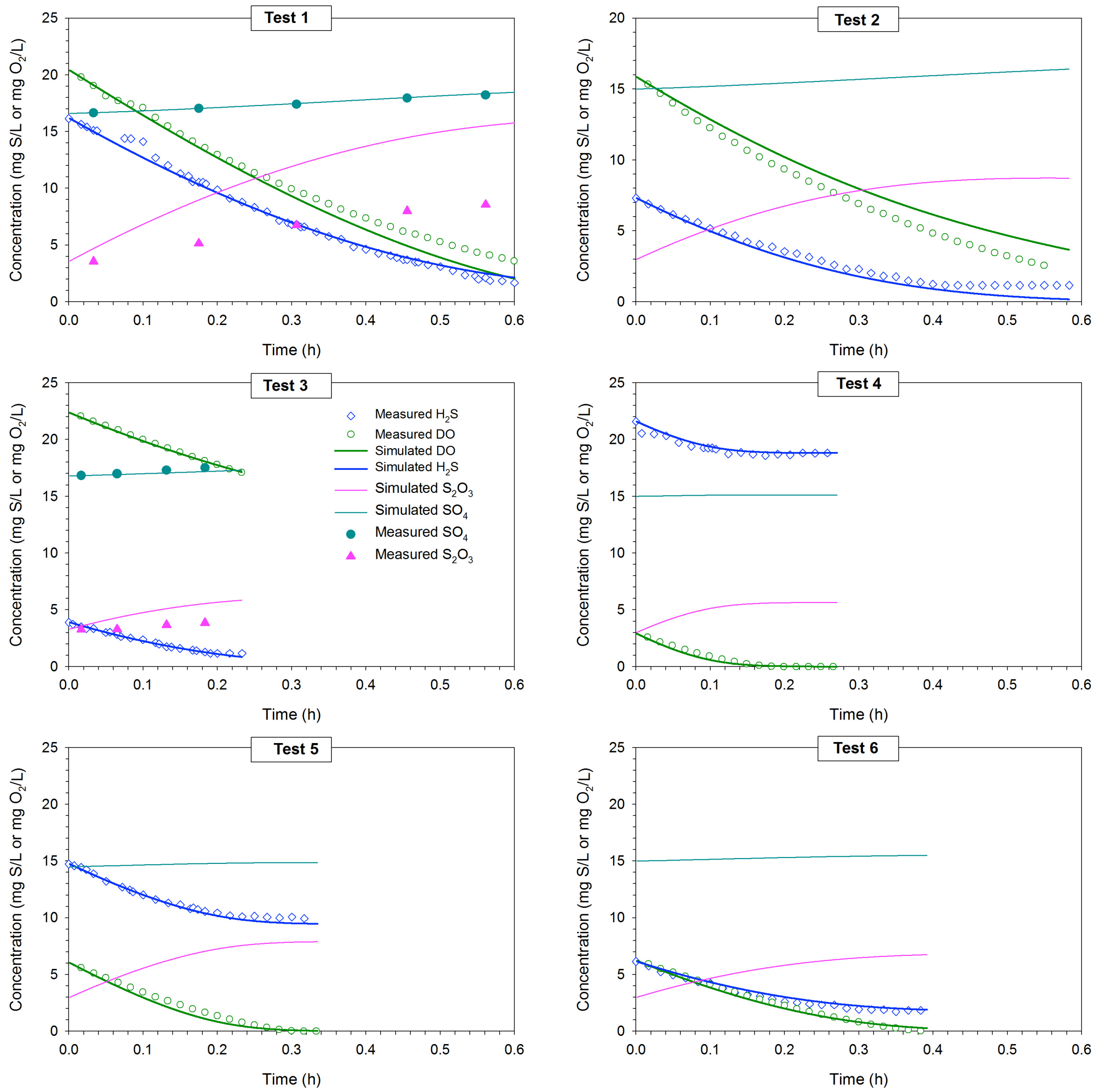

Figure 13. Comparison of the model predicted and measured DO and H_2S concentration for biological oxidation experiments

The models for chemical and biological oxidation of sulfide with oxygen have now been included into both the gravity and rising main sewer models to be applied to different sewer systems.