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Modelling Hydrogen Sulphide removal in a new Rotating Bed Biofilm Reactor
The tannery wastewater
(Munz et al. 2007)

Table 1
Influent wastewater characteristics – analyses were made according to Standard Methods (1995)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Mean</th>
<th>Maximum</th>
<th>Minimum</th>
<th>σ</th>
</tr>
</thead>
<tbody>
<tr>
<td>COD (mg/L)</td>
<td>3690</td>
<td>5680</td>
<td>1280</td>
<td>782.1</td>
</tr>
<tr>
<td>TN (mg/L)</td>
<td>306</td>
<td>420</td>
<td>190</td>
<td>62.1</td>
</tr>
<tr>
<td>N-NH₄ (mg/L)</td>
<td>222</td>
<td>324</td>
<td>102</td>
<td>46.9</td>
</tr>
<tr>
<td>Phenols (mg/L)</td>
<td>225</td>
<td>422</td>
<td>85</td>
<td>85.1</td>
</tr>
<tr>
<td>pH</td>
<td>6.9</td>
<td>7.5</td>
<td>5.8</td>
<td>0.24</td>
</tr>
<tr>
<td>Conductivity (mS/cm)</td>
<td>9.6</td>
<td>12.1</td>
<td>6.3</td>
<td>1.42</td>
</tr>
<tr>
<td>Cl⁻ (mg/L)</td>
<td>5760</td>
<td>7410</td>
<td>3690</td>
<td>953</td>
</tr>
<tr>
<td>S⁻ (mg/L)</td>
<td>27</td>
<td>80</td>
<td>3</td>
<td>13.1</td>
</tr>
<tr>
<td>TSS (mg/L)</td>
<td>976</td>
<td>1840</td>
<td>160</td>
<td>357</td>
</tr>
</tbody>
</table>

Biological and chemical oxidation

O₂: 15 ton/d of pure oxygen

Electricity: (600 MWh/year)

scrubber: 300.000 €/year

Oxygen: 500.000 €/year

The BTF main critical point is the high head loss when operating at high load.

The tannery wastewater (Munz et al. 2007)
Tested conditions

- pH setpoint (3-6.5)
- Recirculation flow rate (3 to 10 m$^3$ h$^{-1}$)
- Biodisc rotation speed (velocity from 0.1 to 3 rpm)
- Intermittent rotation (Gap time: 1, 5, 15, 60, 90, 180, 240, 720)

- After 1 month the startup was done.
- The rotation was able to remove excess biofilm.
- pH = 3 the prototype consumed 3 m$^3$ of water (alkalinity 700 mg l$^{-1}$ CaCO3) per kg of S-H$_2$S removed.
Prototype performance

- removal efficiency: average higher than 80%;
- elimination capacity: average around 90 g H₂S m⁻³ bed h⁻¹;
- Pressure drop between inlet and outlet were found to be very low (1-3 mbar) compared to the clean bed condition;
- The sulphate concentrations in recirculation water shown a slighty decrease from the first sector to the last one.
Modelling with Aquasim 1/2

Conceptual model of a sector in Aquasim:

- a) inlet flow of polluted gas,
- b) outlet flow of treated gas,
- c) inlet flow of make-up water,
- d) outlet flow of make-up water,
- e) H₂S mass flow from water to gas phase,
- f) Advective flow of water from biodiscs to the water pool below the biodisc.

Prototype scheme:

- a) inlet gas stream,
- b) outlet gas stream,
- c) recirculation water tank,
- d) first sector biodiscs,
- e) second sector biodiscs,
- f) third sector biodiscs,
- g) fourth sector biodiscs,
- h) water level,
- i) recirculation water flow,
- j) discharge water,
## Modelling with Aquasim 2/2

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Value</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum specific growth from $\text{H}_2\text{S}$ to $\text{SO}_4$</td>
<td>$\mu_{\text{max}}$</td>
<td>8</td>
<td>d$^{-1}$</td>
</tr>
<tr>
<td>Half saturation constant for $\text{H}_2\text{S}$</td>
<td>$K_{\text{hs}}$</td>
<td>0.068</td>
<td>mg $\text{H}_2\text{S}$ L$^{-1}$</td>
</tr>
<tr>
<td>Decay coeff.</td>
<td>$b_t$</td>
<td>0.13</td>
<td>d$^{-1}$</td>
</tr>
<tr>
<td>Yield coefficient from $\text{H}_2\text{S}$ to $\text{SO}_4$</td>
<td>$Y_t$</td>
<td>0.15</td>
<td>mg $X_t$ mg $\text{H}_2\text{S}$</td>
</tr>
</tbody>
</table>

Monod equation:

$$\frac{dX_t}{dt} = \mu_{\text{max}} X_t \frac{H_2S}{H_2S + KHS} - b_t X_t$$

$\text{H}_2\text{S}$ flux:

$$J = -K(C_a - C_L)$$

![Graph showing parameter values and elimination capacity](image)
• Process modelling and prototype optimization;
• Evaluation of the compounds (other than hydrogen sulphide) removed like ammonia;
• Use respirometric and titrimetric tests to estimate the kinetics coefficients of prototype biomass.
• These results suggest that the limits of the technology have not yet been achieved and so further studies needs to be done
Thank you