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To cite this version:
Hélène Caillet, Alain Bastide, Graziella Chuppa-Tostain, Thomas Petit, Laetitia Adelard. ANAEROBIC DIGESTION OF VINASSE AND CFD MODELLING APPROACH CONTEXT AND OBJECTIVES OF THE WORK. WasteEng 2018, Jul 2018, Prague, Czech Republic. hal-01857314

HAL Id: hal-01857314
https://hal.archives-ouvertes.fr/hal-01857314
Submitted on 15 Aug 2018

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ANAEROBIC DIGESTION OF VINasse AND CFD MODELLING APPROACH

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CHARACTERISATION of the substrates with the PHYSICO-CHEMICAL and RHEOLOGICAL properties;

MODELLING and OPTIMISATION of WET and DRY anaerobic digestion;

CFD MODELLING of the fluids flow with the LARGE-EDDY SIMULATIONS (LES) approach with Boussinesq approximation;

Development of 3D SINGLE-PHASE model considering MECHANICAL AGITATION;

FUTURE PERSPECTIVES:

- Coupling of the two models;
- Considerations of the rheological properties of the substrates;
- Mechanical agitation optimisation.

EXPERIMENTATIONS:

Physico-chemical tests:
- Hack Lange tests are used for the chemical oxygen demand (COD), the total carbon:organic (TOC), the ammonium, the alkalinity and the Kjeldahl azote;
- BMP tests in triplicate with blanks and positives;
- I/S ratio of BMP 2;
- Mesophilic digestion (37°C);

Pilot test:
- Mesophilic digestion;
- Working volume: 7 L;
- Volume added during digestion due to medium analysis: 1.6 L;
- Initial pH: 7.2.

LITERATURE REVIEW OF PHYSICAL PROPERTIES:

The vinasse is Newtonian;
- The sludge is non-Newtonian and modelled with the Power-Law;
- The physical properties of liquid manure are used for the physical characterization of sludge;
- Studies have shown that the viscosity and shear stress increase exponentially as total solids (TS) increases.

EXPERIMENTAL RESULTS:

Materials and Methods

Table 1: Physical parameters of Newtonian fluids

<table>
<thead>
<tr>
<th>Fluid</th>
<th>Density kg.m⁻³</th>
<th>Dynamic viscosity Pa.s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vinasse</td>
<td>1044.69</td>
<td>0.001 009 7</td>
</tr>
<tr>
<td>Sludge</td>
<td>999.66</td>
<td>0.065</td>
</tr>
</tbody>
</table>

Table 2: Physical parameters of sewage sludges in pseudo-plastic model

<table>
<thead>
<tr>
<th>TS %</th>
<th>T °C</th>
<th>k *10⁴</th>
<th>n</th>
<th>Density kg.m⁻³</th>
<th>Alkalinity mmol.L⁻¹</th>
<th>Ammonium mmol.L⁻¹</th>
<th>COD mg.L⁻¹</th>
<th>TOC mg.L⁻¹</th>
<th>Kjeldahl nitrogen mg.L⁻¹</th>
<th>C0</th>
<th>C1</th>
<th>A</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.5</td>
<td>35</td>
<td>0.042</td>
<td>0.710</td>
<td>1000.56</td>
<td>0.006</td>
<td>0.008</td>
<td>4186.78</td>
<td>4186.78</td>
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<tr>
<td>5.4</td>
<td>35</td>
<td>0.103</td>
<td>0.669</td>
<td>1000.72</td>
<td>0.009</td>
<td>0.025</td>
<td>50.702</td>
<td>4185.94</td>
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<tr>
<td>7.5</td>
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<td>0.525</td>
<td>0.553</td>
<td>1001.00</td>
<td>0.03</td>
<td>0.17</td>
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<td>4185.53</td>
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<td>424.37</td>
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<td>20</td>
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<td>0.64</td>
<td>244.74</td>
<td>0.679</td>
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</tr>
</tbody>
</table>

RESULTS, DISCUSSIONS AND EXPECTED RESULTS

Figure 1: Pilot (10 L)

Figure 2: Digestor geometry (mm)

We use the same geometry of Wu (2012). The internal cylinder is the sliding zone which contains the impeller.

Figure 3: Cumulative methane production average as a function of time of vinasse in BMP (left) and pilot (right) tests

REFERENCES