Experimental analysis by P.I.V. and P.L.I.F of the local hydrodynamic environment of animal cells cultivated in a stirred tank bioreactor


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**THE BIOENGINEERING ASPECT OF THE RESEARCH**

- The research is a collaboration between the company GlaxoSmithKline Biologicals and Laboratory of Chemical Engineering of Liege University.
- GSK BIO develops an industrial scale culture of animals cells in stirred tank, in which cells are adsorbed on microcarriers (non-porous beads made of reticulated dextran, mean size = 250 μm, density=1.03)
- The choice of agitation conditions (impeller type, rotating speed…) is complex in order to optimize the culture productivity which depends on local cell environment
- The agitation conditions have to be chosen to:
  - maintain microcarrier beads in suspension in order to maximize the external surface available for cellular development
  - get rid of concentrations gradient
- But they must not be too severe in order to limit mechanical constraints imposed to animal cells
- The aim of this study is to collect experimental data in a 20 L tank by P.I.V. and P.L.I.F measurements on the influence of the agitation conditions on the cell local environment.

**RESULTS**

1. Experimental characterization of the local cell environment

Results obtained for impellers A315 150 at 38 rpm

- Time average velocity field (m/s) for a half tank
- Macro-shearing field computed by \( \sqrt{\text{S}_{ij} \cdot \text{S}_{ij}} \)
- Kolmogorov scale field: \( L_{k} = \frac{\text{S}_{ij}}{\text{S}_{ij}} \)

2. Impellers comparison at just-suspended speed \( N_s \)

<table>
<thead>
<tr>
<th>Propellers</th>
<th>( N_s ) (rpm)</th>
<th>( V_{max} ) (m.s(^{-1}))</th>
<th>( V_{max} ) (m.s(^{-1}))</th>
<th>( \text{Shear}_{ij} ) (s(^{-1}))</th>
<th>( \text{Shear}_{ij} ) (s(^{-1}))</th>
<th>Relative size of area where microsiping is important (%)</th>
<th>( \phi^2 ) (°)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SD Dantec 2500 (Dantec Dynamics, DK):</td>
<td>53</td>
<td>0.032</td>
<td>0.065</td>
<td>1.541</td>
<td>3.6</td>
<td>3.48</td>
<td>18</td>
</tr>
<tr>
<td>A310</td>
<td>49</td>
<td>0.031</td>
<td>0.06</td>
<td>1.387</td>
<td>3.4</td>
<td>1.45</td>
<td>22</td>
</tr>
<tr>
<td>A315/125</td>
<td>54</td>
<td>0.030</td>
<td>0.06</td>
<td>1.409</td>
<td>4.2</td>
<td>5.16</td>
<td>21</td>
</tr>
<tr>
<td>A315/150</td>
<td>38</td>
<td>0.029</td>
<td>0.055</td>
<td>1.405</td>
<td>3.6</td>
<td>3.72</td>
<td>20</td>
</tr>
<tr>
<td>TTP 150</td>
<td>40</td>
<td>0.030</td>
<td>0.055</td>
<td>1.457</td>
<td>3.4</td>
<td>1.97</td>
<td>22</td>
</tr>
<tr>
<td>TTP 125</td>
<td>50</td>
<td>0.024</td>
<td>0.043</td>
<td>1.299</td>
<td>3.0</td>
<td>0.90</td>
<td>21</td>
</tr>
</tbody>
</table>

3. Variation of characteristic quantities as a function of rotating speed

- Linear dependency to impeller tip speed
- Power law evolution
- TTP125: smallest slope

**CONCLUSIONS**

At the just-suspended speed, the propeller TTP125 creates the most suitable local cell environment. The evolution of its hydrodynamic characteristic parameters is such that it remains the best impeller at higher rotating speed.

**ACKNOWLEDGEMENT**

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