A 3D model of the plant layout has been designed with SketchUp software based on the double-step extraction process. It consists in six separated zones that include: bioreaction and distillation train for 1,3-Propnaediol and 2,3-Butanediol and auxiliary facilities. It has been considered the possibility of a future extension of the production zone.

**INTRODUCTION & OBJECTIVES**

All along this project, several options have been considered in order to improve an eco-friendly 1,3-propanediol production process.

- **Batch process**
- **Continuous process**
- **E. coli genetically modified**

In the process alternatives studied, the most feasible plant designs are those which have two products that can be sold, which are 1,3-propanediol and Sodium bicarbonate [2]. The last option that is going to be discussed is the purification of some other fermentation products, lactic acid and 2,3-BDO, which can also be sold as revenues. This way, our plant becomes a real biorefinery plant. In summary, all the options to improve the 1,3-propanediol, 2,3-butanediol and lactic acid production processes will be discussed, and the economic and environmental analysis will be performed for each of them so as to demonstrate its feasibility.

**FLOW DIAGRAM**

Both processes has been simulated with SuperPro Designer Software. The following is the double-step extraction process flow diagram which show the detailed upstream, bioreaction and downstream of the process selected. All data equipment, stream and analysis are able in Super Pro Designer file.

**PROCESSES ANALYSIS**

<table>
<thead>
<tr>
<th>Stream</th>
<th>One-step extraction process (mass %)</th>
<th>Double-step extraction process (mass %)</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solid waste</td>
<td>1.11</td>
<td>1.42</td>
<td>Anaerobic digestion</td>
</tr>
<tr>
<td>Liquid waste</td>
<td>0.86</td>
<td>0.01</td>
<td>Anaerobic treatment</td>
</tr>
<tr>
<td>Aquous waste</td>
<td>1.78</td>
<td>18.37</td>
<td>Waste water treatment plant</td>
</tr>
</tbody>
</table>

**ENVIRONMENTAL ANALYSIS**

Outflows are less harmful for the environment due to the simplicity of their treatments. All of them can be treated in a waste water treatment plant.

- **One-step extraction process**
- **Double-step extraction process**

More quantity of outflows need to be treated. The main stream is the salty bottom phase of the extraction that has the most complex and expensive treatment.

**ECONOMIC ANALYSIS**

A significant number of by-products can be sold as revenues due to their purity. The less production of lactic acid is the cause of the lower profitability. In addition, higher investment is needed.

The amount of lactic acid produced along with the 1,3-PDO and 2,3-BDO production makes the plant extremely rentable in economical terms.

**CONCLUSIONS**

Having analyzed six processes to produce 1,3-Propanediol during the whole project, the double step-extraction process is the most profitable process among the others:

- It is a eco-friendly process due to the substrate used and the non-aggressive procedures and reagents
- Three valuable products are obtained with high purity
- The outflow treatments are slightly complex but there are no hazardous streams to deal with
- It gives the biggest economic benefits

**SELECTED REFERENCES**

- Song, S; Sun, Y; Wei, B; Xiu, Z. “Two-step salting-out extraction of 1,3-propanediol and lactic acid from the fermentation broth of Klebsiella pneumoniae on biodiesel-derived crude glycerol”, Engineering in Life Sciences, (2013).