

Steam explosion in a nutshell

BPF - Bioprocess Pilot Facility – is without a doubt a unique site. At DSM's former penicillin development factory in Delft (NL), industry and education have joined forces to conduct research into the potential for upscaling of innovative biotech processes. One important study in the BPF pre-processing module is investigating the use of biomass as a source of sugars for fermentation processes. For the front-end processes, BPF can now has a recently-installed turnkey plant at its disposal, for which the reactor vessels and in-line filter were supplied by Büchi. Suurmond assumed the role of prime contractor.

It is now five years since the Bioprocess Pilot Facility (BPF) was officially opened. This facility is an independent entity, where a partnership of DSM, Corbion and TU Delft undertakes research and education in support of the next generation of biotech processes. The main focus is on the upscaling of laboratory-proven processes in the pharmaceutical, nutrition and biochemical fields.



Reactors and in-line filter by Büchi Glas Uster AG

Fermentation

One of the fields of research at BPF is fermentation. In this process, sugars are first extracted from biomass by means of steam explosion and hydrolysis. These sugars are then fermented by microorganisms to produce new products.

Because the BPF is housed at the site of the former DSM penicillin development works, it has an extensive pool of machines and installations at its disposal for a variety of processes. These range from blending and crystallization to separation of substances by filtration and centrifuge. However, because there was no equipment on hand for the steam explosion process, the BPF approached Suurmond for a turnkey solution.

Coordination

Suurmond was designated primary contractor for this project, coordinating all contact with and between the various suppliers. The parties involved were:

- Büchi, responsible for the reactor and in-line filter
- AARTEC Engineering for the process control equipment and systems
- Lauda for the steam generator
- Huber for the TCU (Thermo Control Unit)
- Process & Industritechnik for the steam gun

Cooperation with the various parties was essential due to the specialized know-how required for much of the installation. For example, the reactor vessel must be able to withstand extremely high pressures and temperatures, and there is a relatively heavy emphasis on safety. Moreover, the entire setup has to comply with occupational safety legislation, such as the European Pressure Equipment Directive (PED).

Flexible end result

The supplied installation comprises two 50 litre reactor vessels for the processing of 4 kg of biomass per batch. The first reactor vessel is a stirred pressure vessel of Hastelloy steel that can withstand pressures as high as 40 bar, and temperatures of up to 230 °C. This reactor is equipped to hold the biomass during pre-processing with steam and chemicals. The second pressure vessel is identical to the first, and intended for impregnation or cleaning processes.



Thermo control unit by Huber Kältemaschinenbau GmbH

Versatility for variety of projects

The steam explosion process has been applied in two Horizon 2020 (EU Research & Innovation programme) projects. The first project - Agrimax - looks at the potential for using food that would otherwise be lost in the chain from farm to consumer (as much as one-third!), by extracting valuable substances from the biomass. These substances could then find new uses in e.g. the packaging industry, nutrition, or agri-materials such as organic fertilizers.

The second project goes by the name BIOFOREVER, which stands for: BIO-based products from FORestry via Economically Viable European Routes. This project aims to develop five different value chains (technical and economic) based on the conversion of lignocellulose (e.g. wood) into chemical building blocks. The aim is to demonstrate the feasibility of the envisioned processes.

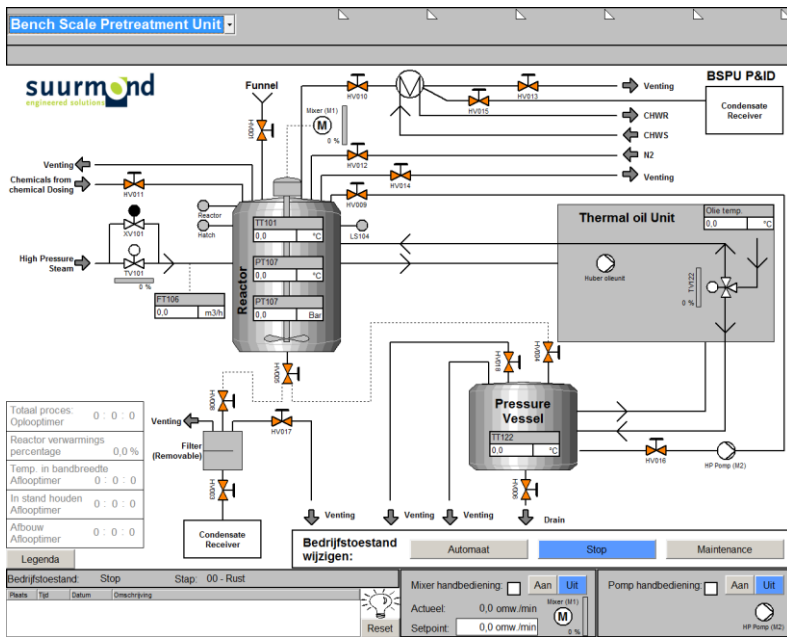
The Büchi unit is regularly used on both of these projects. Certain partners are so impressed by the unit that they have also applied it in their own projects.

In addition, Büchi has also provided a spiral condenser for flash cooling and a portable in-line filter for filtration of the biomass after processing in the reactor vessels.

Process control

Because the installation is to be used for a wide range of research, it is important that every new process can take place under safe and controlled conditions.

With this in mind, AARTEC has provided a sophisticated but generic control system that can be quickly and easily configured for any required process.



Even under the most extreme conditions of pressure difference, temperature and process variation, the control system always ensures that the process proceeds safely and efficiently, through precise, real-time monitoring and if necessary, adjustment of the process parameters.

The installation was commissioned in 2016, and has already been used successfully in several projects (see box).

