Testing ground for bio-innovations

Scaled-up research is difficult to execute due to the amount of expensive equipment necessary for an individual party. DSM, CSM/Purac and TU Delft have therefore set up a consortium for research into biotechnological processes. With support from the EU and the Ministry of Economic Affairs, some 100 million euros is being invested in a pilot facility at the DSM site in Delft. The scale of the facility is unique in the world. The Bioprocess Pilot Facility (BPF) opened just before the summer. Meanwhile, the first customers are starting to use it.
For more information: www.bpf.eu

A
Testing processes on a large scale

A new bioprocess that works in the laboratory cannot simply be scaled up to an industrial scale. Processes will behave differently in an industrial setting than under laboratory conditions. BPF has been specially designed for research into the scaling up of bioprocesses. Here, researchers can identify and remedy scaling-up problems. The scale of the process in the BPF is 10 to 100 times smaller than in industrial production.

EXAMPLE OF TEST PROCESS: BIOETHANOL

1 Pretreatment

Vegetable waste is prepared as raw material for fermentation.

1A Steam explosion

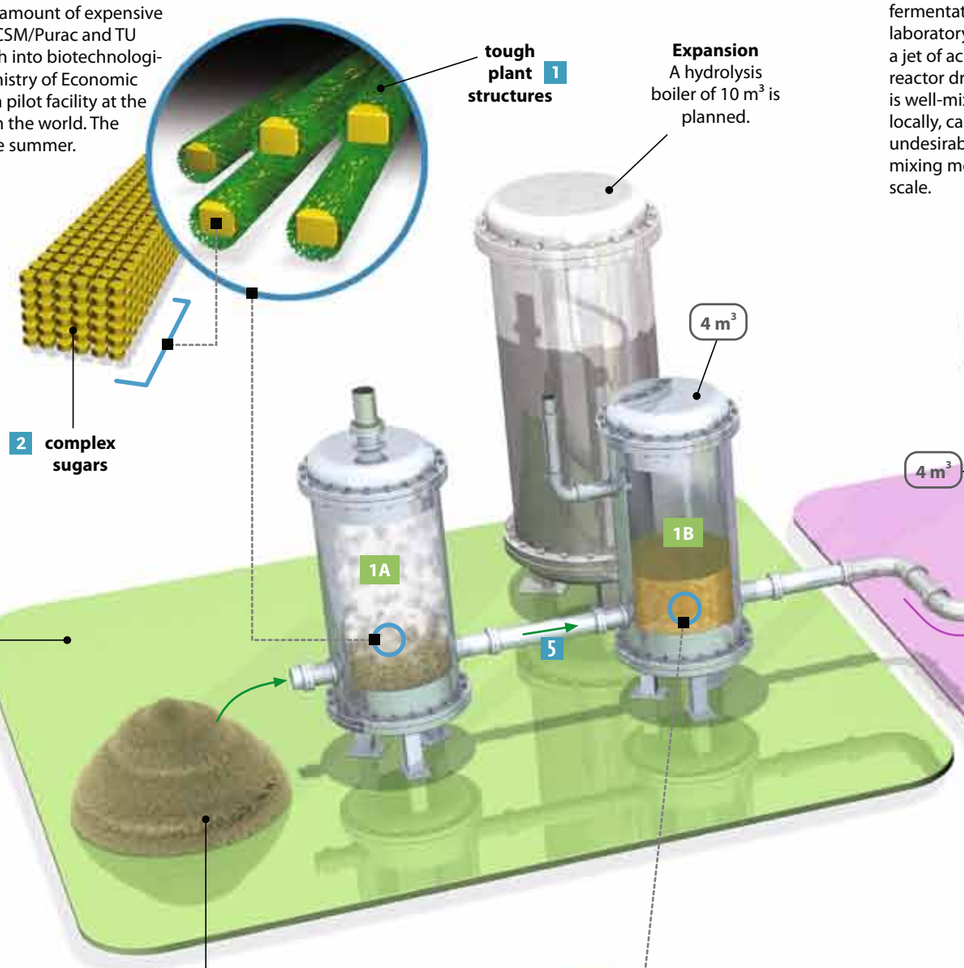
A steam explosion breaks down plant structures 1 (material is placed under high pressure before the pressure is released). This releases complex sugars 2 and enables enzymes to reach them.

1B Hydrolysis

Enzymes 3 convert complex sugars into simple sugars. 4 Micro-organisms can only feed on simple sugars.

Second generation

'First generation' biofuels and bioplastics are made from food crops (like sugar and grain). Sugars in food can be directly converted into fuels. 'Second generation' biofuels are made from biological waste, such as woodchips, straw, maize leaves and sugar-cane stems. This process is more difficult because complex sugars in sugar-cane stems, for example, first need to be converted into simple sugars. This requires extra pretreatment. Nestlé chairman Peter Brabeck recently made an appeal to stop converting food into biofuels in order to halt the explosive increase in food prices. This would require 'second generation' biofuels to be produced on a large scale. The BPF facilitates research into new 'second generation' bioprocesses.



EXAMPLE OF SCALING-UP TEST

Size of chips

Woodchips are pumped as slurry 5 in an industrial process. If the woodchips are too small, they stick together and block up the pipes. If the chips are too big, the micro-organisms will be unable to extract all the raw materials during fermentation. The optimum size of woodchips has to be tested on a realistic scale.

B
Markt research

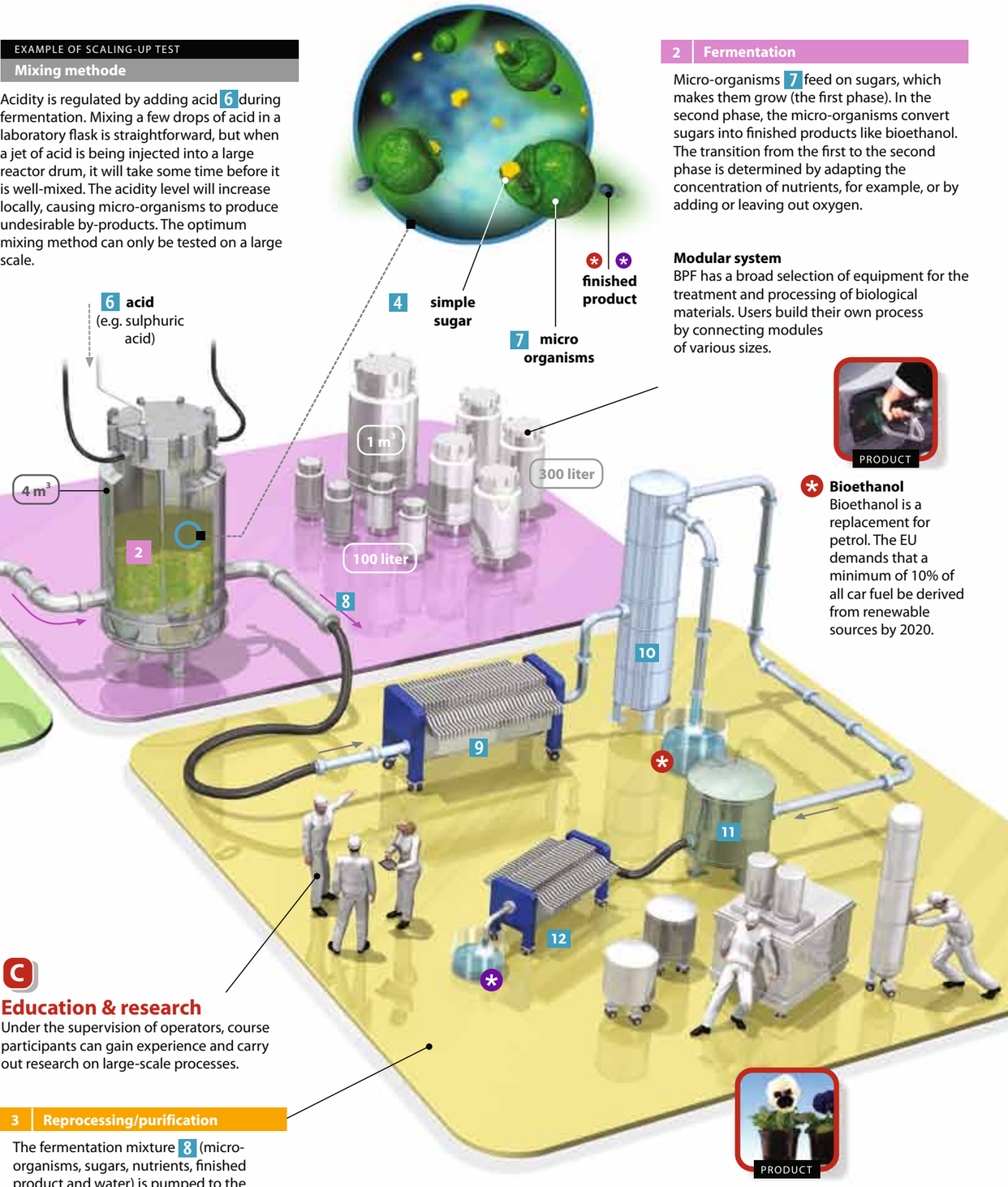
In the BPF, products are made (with quality assurance) for market research (food) and clinical studies (medicines). Quantities vary between 1 and 100 kg.

Open facility
BPF is an independent company where everyone can carry out scaled-up research. The BPF is presently situated at the DSM site, but this area is going to be transformed into a technology campus, comparable to the Chemelot Campus at the former DSM site in Sittard-Geleen.

EXAMPLE OF SCALING-UP TEST

Mixing methode

Acidity is regulated by adding acid 6 during fermentation. Mixing a few drops of acid in a laboratory flask is straightforward, but when a jet of acid is being injected into a large reactor drum, it will take some time before it is well-mixed. The acidity level will increase locally, causing micro-organisms to produce undesirable by-products. The optimum mixing method can only be tested on a large scale.



C
Education & research

Under the supervision of operators, course participants can gain experience and carry out research on large-scale processes.

3 Reprocessing/purification

The fermentation mixture 8 (micro-organisms, sugars, nutrients, finished product and water) is pumped to the reprocessing facility and connected to mobile equipment. The objective is to isolate the finished product from the mixture.

3A Filtration and distillation

All biomass is removed through filtration 9 Then, about 100 kg of ethanol is produced through distillation 10 of 2.5 m³ of a water-ethanol mixture (5% ethanol).

2 Fermentation

Micro-organisms 7 feed on sugars, which makes them grow (the first phase). In the second phase, the micro-organisms convert sugars into finished products like bioethanol. The transition from the first to the second phase is determined by adapting the concentration of nutrients, for example, or by adding or leaving out oxygen.

Modular system
BPF has a broad selection of equipment for the treatment and processing of biological materials. Users build their own process by connecting modules of various sizes.

Bioethanol
Bioethanol is a replacement for petrol. The EU demands that a minimum of 10% of all car fuel be derived from renewable sources by 2020.

EXAMPLE OF TEST PROCESS: BIOPLASTICS

3B Crystallisation and filtration 11 12

Up to and including fermentation, the process for bioplastics is identical to that for bioethanol. In the fermentation phase, the micro-organisms and process conditions are different because a different finished product is being made. Other final processing steps are necessary for reprocessing the monomer.

Bioplastics
A synthetic polymer is made elsewhere from the 50 kg of monomer. Examples of products made from this polymer are biodegradable organic-waste bags and plant pots.

illustration & text: Erik Verdult
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