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Innovative Eco-Technologies for Resource Recovery from Wastewater

INCOVER

Deliverable D3.8

INCOVER case-study 3

Work Package 3

Added-value resources production

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Executive summary

Deliverable D3.8 describes the Case-Study 3 (CS3) validated at TRL 6-7. This deliverable consists on several photos of each technology and a global photo of the CS3.

1 Description and photo gallery of case study 3

1.1 General description of the location of case study 3

Case study 3 can be described by the following flow diagram (Figure 1.1):

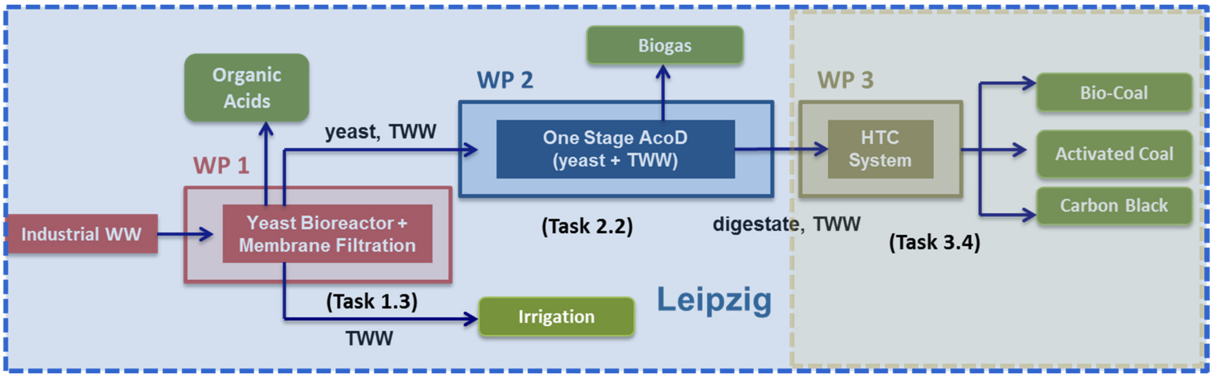


Figure 1.1 : Diagram of Case study 3, located in Leipzig and Bad Königshofen.

The demonstration plant of case study 3 is established at the Helmholtz Centre for Environmental Research - UFZ in **Leipzig** (Figure 1.2) to show the complete demonstration yeast reactor, biogas reactors and hydrothermal carbonisation at laboratory scale. The location of the UFZ is part of the Science campus which contains various research facilities. In parallel with this the demo-scale of the HTC system is established at the Renergie facilities in **Bad Königshofen** (Figure 1.6).

In Leipzig, the demonstrator is located at the Technical Hall (Figure 1.3, Figure 1.5) of the UFZ that is operated by the department Environmental and Biotechnology Center (UBZ). The technical hall is specifically managed to accommodate wastewater-based and waste experiments. Fortunately, the technical hall is also located in close proximity to the canteen of the Science campus (Figure 1.3), where the SODEXO company is operating as the campus caterer. The wastewater from the canteen and the waste frying oil produced by Sodexo catering operations are used for the demonstration of the case study 3. The used WW was taken out of the oil and grease separator of the canteen building (Figure 1.4). Thereby the direct inlet of the kitchen cleaning WW was used as industrial WW source in case study 3.

Figure 1.2 : Location of Helmholtz Centre for Environmental Research – UFZ at Leipzig (Source: UFZ, 2018).

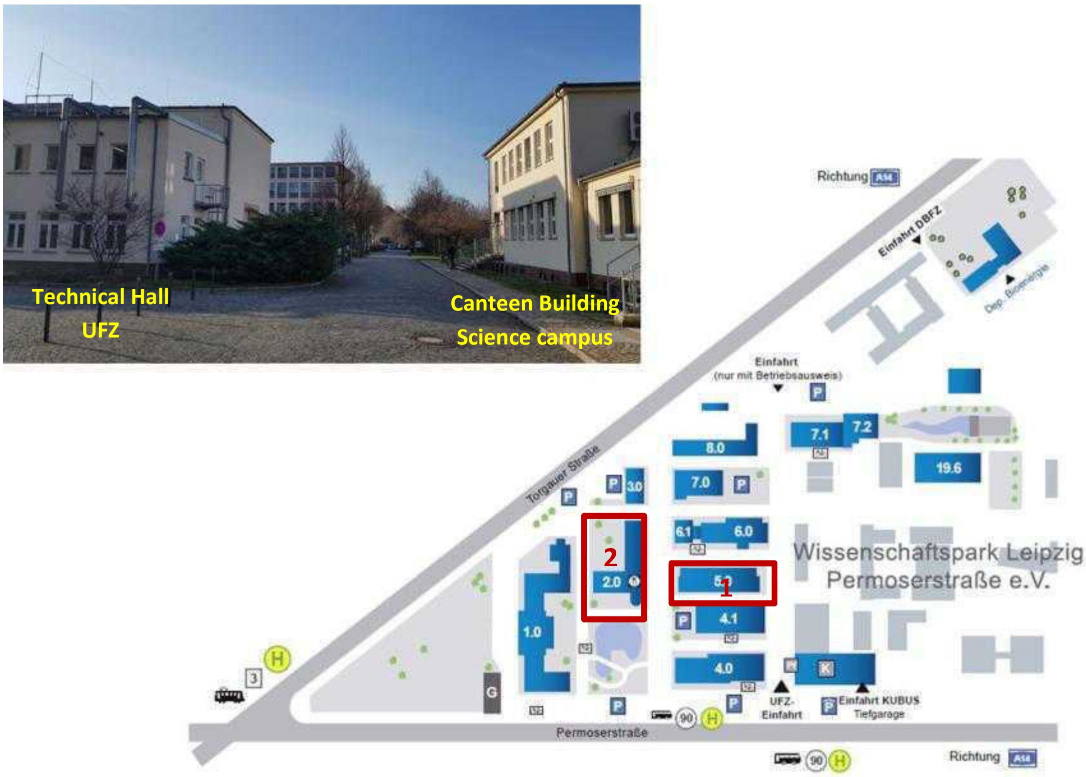


Figure 1.3 : Site plan of the UFZ with location of Technical hall (**1**) and canteen building (**2**) and partial view of both buildings (Photo: Aurich, 2019; Site plan: UFZ).

Figure 1.4 : Oil and fat separator of the canteen building (left) and influent of kitchen cleaning WW (right) (Photo: Aurich, 2019).

The location for all three technologies of Case Study 3 is the Technical hall operated by UBZ staff. Figure 1.5 shows the installation sites of the yeast reactor for citric acid production, the biogas reactors for anaerobic co-digestion and finally the hydrothermal carbonisation system at lab scale for valorisation of digestate.

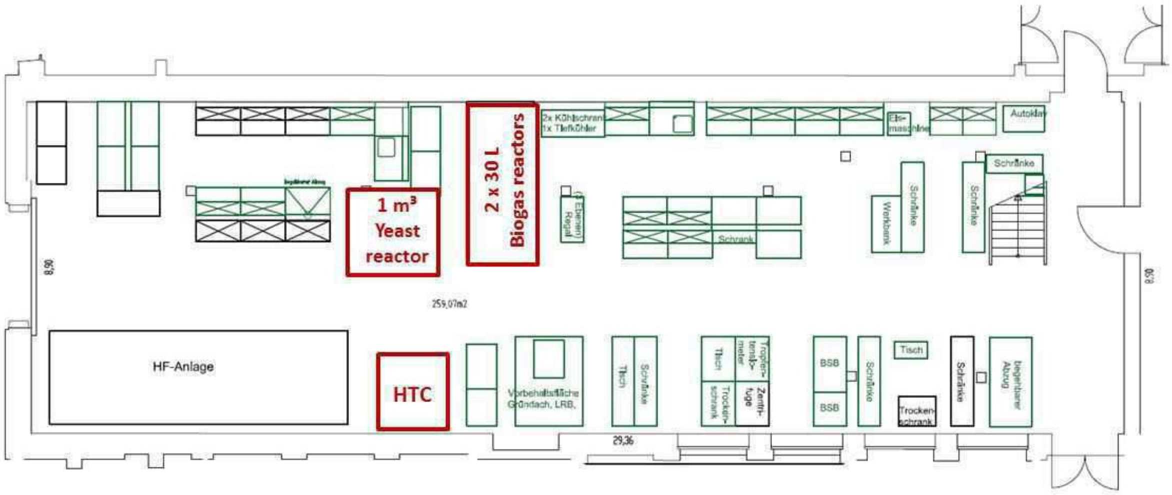
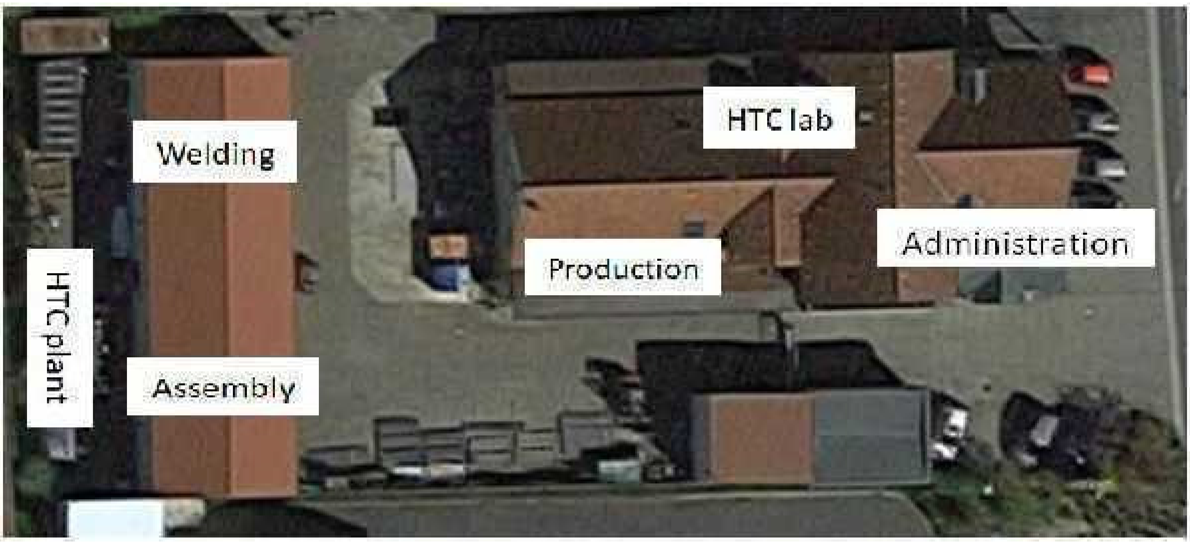
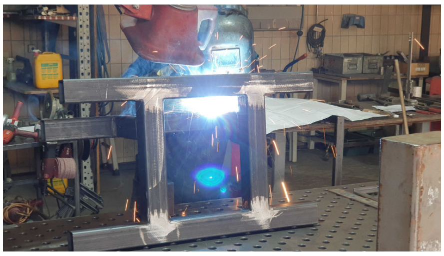


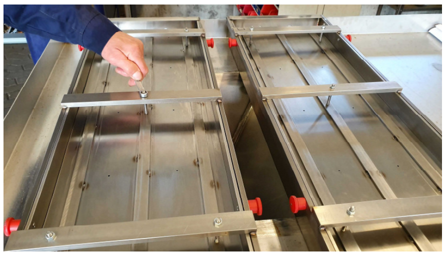
Figure 1.5 : Site plan of Technical hall with spatial arrangement of case study 3 equipment (Site plan: Bernhard, 2019).

Renergie Systeme GmbH&CoKG has 17 employees, including 3 trainees, 3 part-time employees and 3 temporary workers. The area of the company is approx. 2000 m². A site plan with location of the HTC and representation of the different company areas are shown in Figure 1.6.





Welding



Assembly

Administration

Figure 1.6 : Site plan and photo gallery Renergie Systeme GmbH &CoKG, Bad Königshofen.

1.2 Photo gallery of yeast reactor for Citric acid production

Yeast based citric acid production is carried out in a bioreactor system which is based on a conventional 1 m^3 IBC container made of stainless steel (Figure 1.11).

Figure 1.7 : Yeast bioreactor system based on IBC container (in the foreground) and biogas reactors (right in background).

Figure 1.8 illustrates the equipment of the yeast reactor with measuring, cooling and sampling points on the front. Meanwhile the Figure 1.9 shows the mixing motor and openings on the top side.

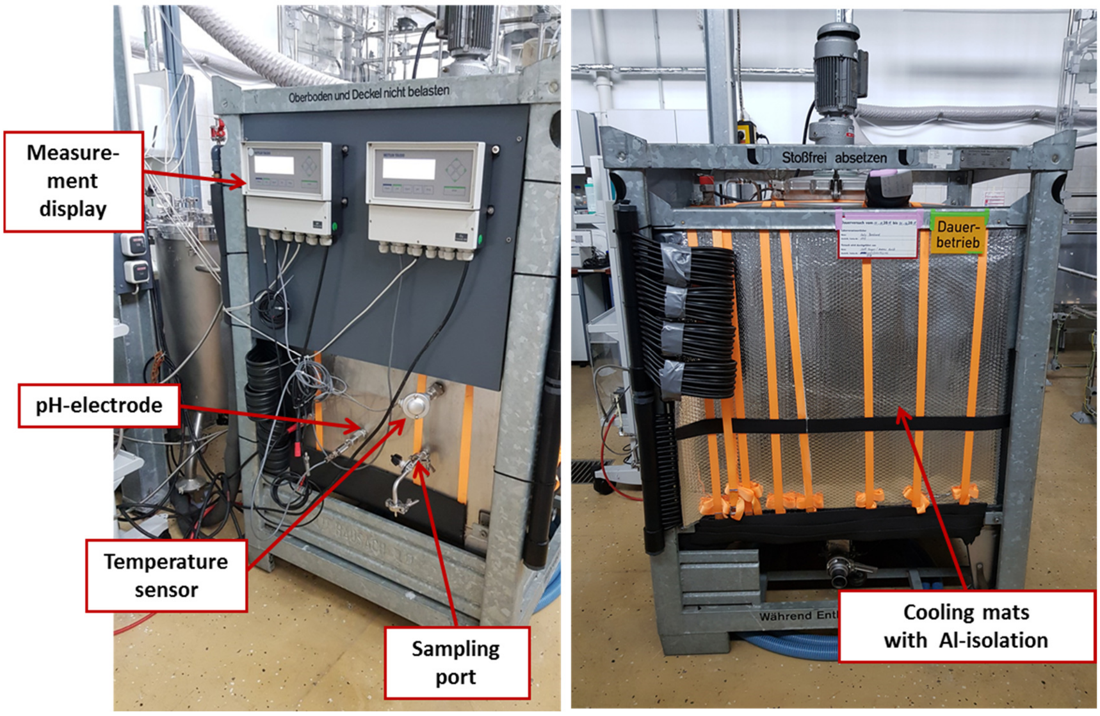


Figure 1.8 : Arrangement of the devices for measurements and sampling at the reactor.

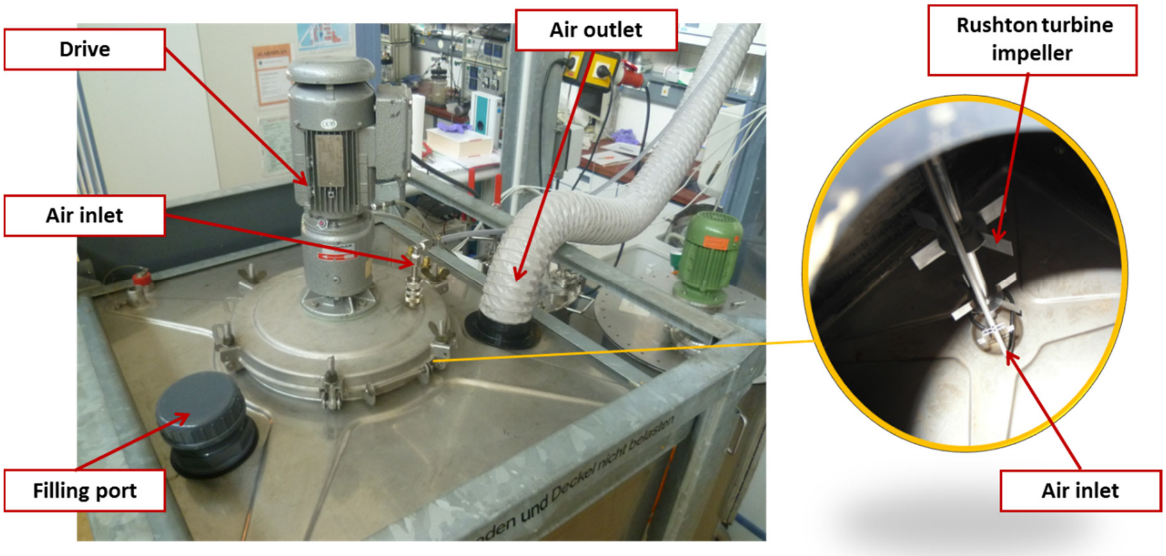


Figure 1.9 : Equipment on the top side of the yeast reactor.

Additional equipment of the yeast reactor includes storage tanks for lye and waste frying oil, a pump station for dosage, and a cooler (Figure 1.10).

Figure 1.10 : Additional reactor equipment including storage tanks, pumps and a cooler.

A Cross flow filtration system (CFF) is used to harvest the yeast biomass from the CA fermentation broth (Figure 1.11). The resulting concentrated yeast biomass (Figure 1.12 C) is then transferred as substrate to the biogas reactors (Figure 1.13).

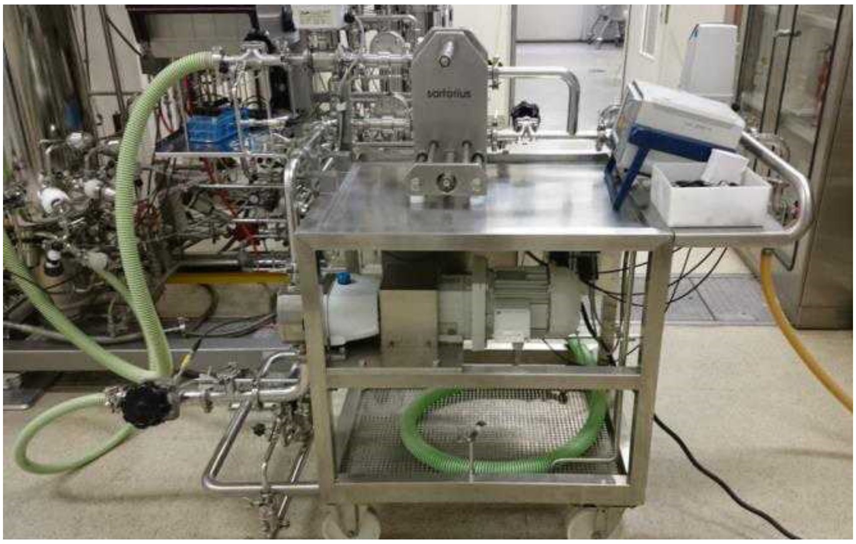


Figure 1.11 : Cross Flow Filtration (CFF) module for harvesting of yeast biomass by microfiltration.

Figure 1.12 summarizes the quality of all raw materials and products used or produced in the yeast bioprocess stage, including the downstream processing stage.

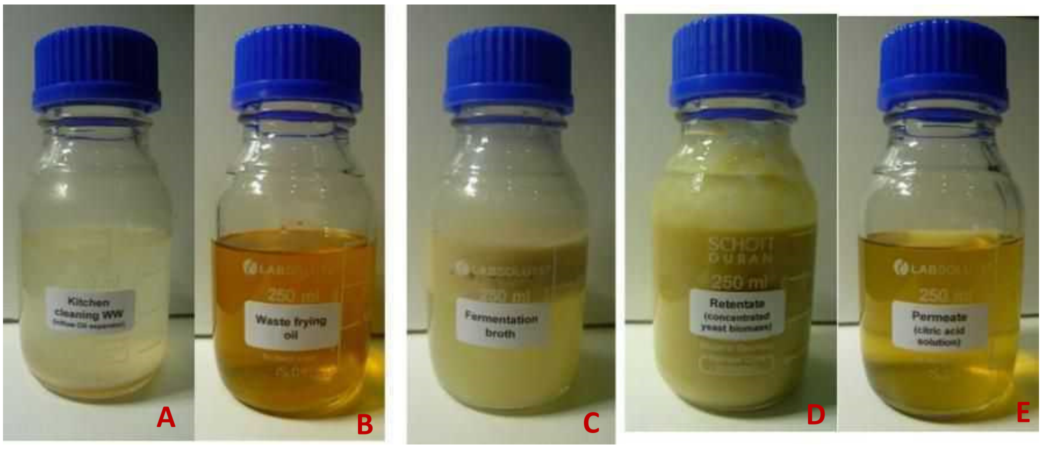


Figure 1.12 : Qualities of input (A, B), output(C) of yeast bioreactor stage and products (D, E) after microfiltration by CFF.

1.3 Photo gallery of biogas reactors for anaerobic co-digestion

Residual yeast biomass from CA production and promising Co-substrates are transformed into biogas in two identical 31 L digesters (Figure 1.13, Figure 1.14). A 2-L Multi jar tube system was used for preliminary tests to determine the potential for biogas generation under batch conditions (Figure 1.15).

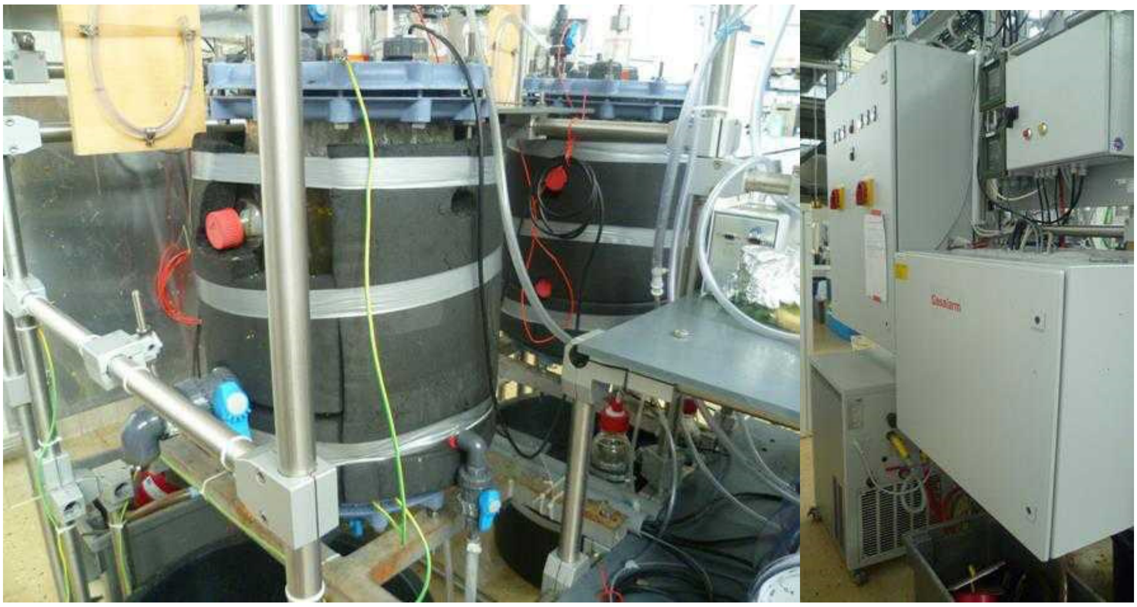


Figure 1.13 : 2 x 31 L Fermenters for one-stage biogas production (left) and control cabinet (right).

The different experimental setup for continuous biogas production at demo scale – AcoD with yeast biomass and waste frying oil and AD with yeast biomass as mono-substrate are shown in Figure 1.14.

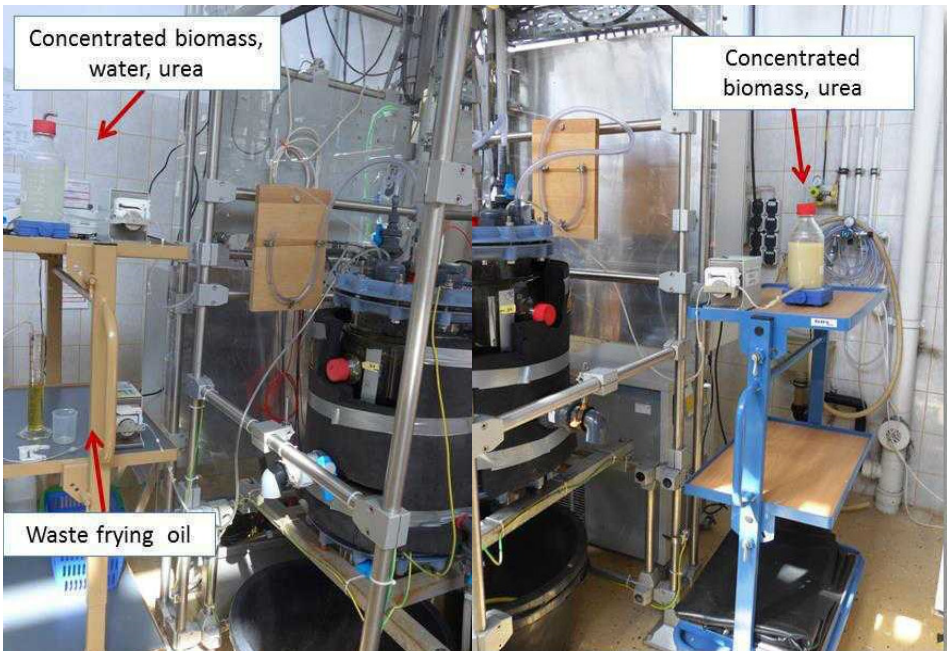


Figure 1.14 : Setup for biogas production in co-digestion (left) and mono-digestion mode (right).

Figure 1.15 : 2 L Multi jar tube fermenters for biogas production under batch conditions.

1.4 Photo gallery of Hydrothermal carbonization

After the anaerobic co-digestion (AcoD) the residual digitates and other biomasses are treated in a hydrothermal carbonization system (HTC). A 50 L demonstration plant is installed with the following equipment at Bad Königshofen (Figure 1.16).

Figure 1.16 : 50 L demo HTC installation specifications and design.

Additionally, a 2.0-liter laboratory HTC reactor is implemented at the UFZ facilities in Leipzig to show the complete demonstrator of all technologies included in Case-study 3 (Figure 1.17).

Figure 1.17 : 2 L laboratory scale HTC reactor system Autoclave Art. coal 2.0.