ETV Verification Statement

Technology type	Decanter centrifuge	
Application	Post-treatment of digested biomass	
Technology name	UCA 501-00-02	
Company (vendor)	GEA Westfalia Separator DK A/S	
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DANETV, The Danish Centre for Verification of Climate and Environmental Technologies, undertakes independent tests of environmental technologies and monitoring equipment.

DANETV is a co-operation between five technological service institutes, DHI, Danish Technological Institute, FORCE Technology, Delta and AgroTech. DANETV was established with financial support from the Danish Ministry of Science, Technology and Innovation. Information and DANETV documents are available at www.etv-denmark.com.

AgroTech Verification Centre undertakes verifications of environmental technologies for the agricultural sector. The verifications and tests are planned and conducted in accordance with the guidelines for the ETV Scheme currently being established by the European Union.

This verification statement summarizes the results from the ETV test of the GEA Westfalia decanter centrifuge model UCA 501-00-02 applied for post-treatment of digested biomass.

Description of technology

GEA Westfalia UCA 501-00-02 is a decanter centrifuge that can be used to separate solids from digested biomass at a biogas plant. There are two end products from the post-treatment: A liquid fraction with lower concentrations of solids and nutrients than in the input digested biomass and a solid fraction with higher concentrations.

The digested biomass is led into a closed horizontal cylinder with a continuous turning motion. Inside the cylinder solids and liquids are separated at the wall into an inner layer with a high dry matter concentration and an outer layer consisting of a liquid containing a suspension of colloids, organic components and salts. The solid and liquid phases are transported to either end of the centrifuge by

rotating the entire centrifuge at high speed and by simultaneously rotating the conveyor at a speed that differs slightly from the speed of the bowl.

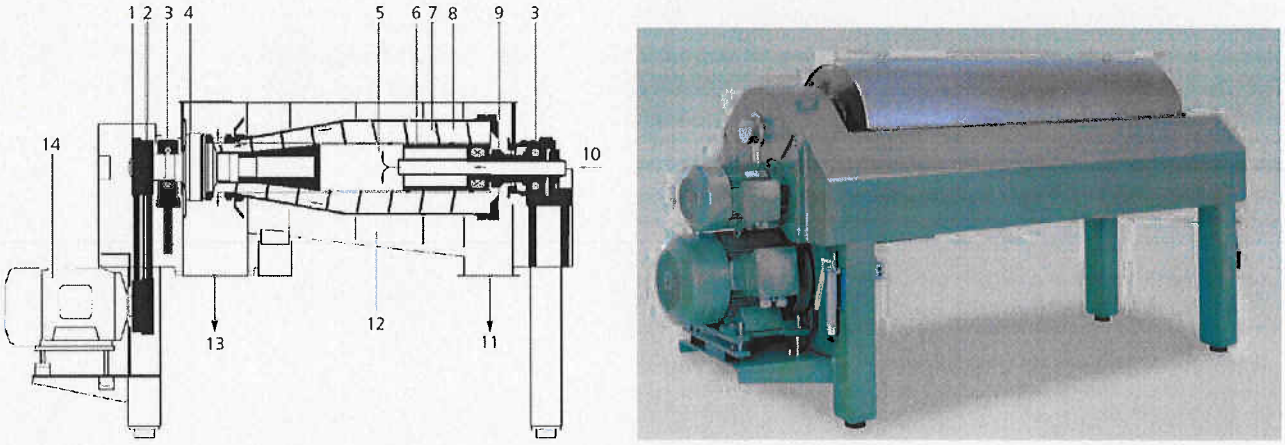


Figure 1. Constructional features (to the left) and a photo (to the right) of GEA Westfalia UCA 501. 1) Conveyor screw drive. 2) Bowl drive. 3) Bowl bearings. 4) Gear. 5) Distributor. 6) Conveyor screw. 7) Centrifugation space. 8) Bowl. 9) Regulating plate. 10) Feed. 11) Discharge of the clarified liquid. 12) Frame. 13) Solids discharge. 14) Drive motor.

Application of technology

The intended application of the GEA Westfalia UCA 501-00-02 is defined in terms of the matrix, the target and the effect of the decanter centrifuge.

The matrix is the type of material that the decanter is intended for. Targets are the measurable properties that are affected by the decanter. The effects describe how the targets are affected by the decanter.

Matrix	The UCA 501-00-02 decanter was tested and performance verified for post-treatment of digested biomass at a biogas plant using manure as the main substrate and operated at approximately 38° C. Typically, the total solids content of digested biomass at such biogas plants is within the range of 4,0 – 8,0 %.
Targets	• Concentrations of total solids (TS), volatile solids (VS) and suspended solids (SS) in digested biomass, liquid output fraction and solid output fraction. • Concentrations of total nitrogen (N_{Tot}), ammonium nitrogen (N_{Amm}), phosphorous (P), potassium (K) and sulphur (S) in digested biomass, liquid output fraction and solid output fraction. • Weight of liquid output fraction and solid output fraction. • Particle size distribution in liquid output fraction.
Effects	• Increased concentrations of total solids (TS) and volatile solids (VS) in solid fraction compared to input digested biomass. • Increased concentrations of total nitrogen (N_{Tot}) and phosphorous (P) in solid fraction compared to input digested biomass. • Removal of the large particles in liquid output fraction.
Exclusions	The results of the verification of GEA Westfalia decanter centrifuge for post-treatment of digested biomass are not necessarily valid for treatment of pig slurry or cattle slurry. Additional tests are necessary to verify the performance of UCA 501-00-02 for separation of such biomasses.

Description of test

The GEA Westfalia decanter centrifuge used in the test is installed at Morsoe Bioenergi, Naessundvej 234, DK-7990 Redsted, Denmark. Morsoe Bioenergi is a commercially operated anaerobic digestion plant using manure as the main substrate for biogas production.

The test was designed so that mass balances of total solids, volatile solids, suspended solids, total nitrogen, ammonium nitrogen, phosphorous, sulphur and potassium could be calculated. This was done by testing the decanter centrifuge in 5 batches with a fixed start and end time for each batch.

For each batch the weight or volume of input digested biomass, liquid output fraction and solid output fraction was measured and concentrations of solids and nutrients were determined by analyzing representative samples of the inlet and the two outlet flows. The test included 5 batches lasting minimum 4 hours each. The first batch was undertaken on the 28-12-2009 and the final batch (number 5) was completed on the 21-01-2010.

During the 5 batches the decanter centrifuge treated 283 m^3 of digested biomass corresponding to an average capacity of 13,72 m^3 biomass treated per hour. The UCA 501-00-02 decanter can operate at higher capacities but it was not part of the test to verify the maximum capacity.

Verification results

This section summarizes the results of the test and verification as described in the test report and verification report respectively (available at www.etv-denmark.com).

In average for 5 batches the solid output fraction constituted 12 % of the input digested biomass and the liquid output fraction constituted 88 %. In table 1 and table 2 the average concentrations of solids and nutrients are presented together with the pH value of each fraction.

Table 1. Average content of total solids, ashes, volatile solids, suspended solids and pH over 5 batches.

Fraction	Total solids (%)	Ash content (%)	Volatile solids* (%)	Suspended solids (mg/L)	pH (ph units)
Input digested biomass	4,85	1,46	3,39	35.000	7,64
Liquid output fraction	2,31	0,82	1,49	8.400	7,94
Solid output fraction	27,66	6,46	21,20	Not relevant	8,12

* Values for volatile solids are not measured but calculated as the difference between total solids and ash content.

Table 2. Average concentrations of nutrients over 5 batches.

Fraction	Total Nitrogen (Kg/ton)	Ammonium Nitrogen (Kg/ton)	Organic Nitrogen* (Kg/ton)	Total phosphorous (Kg/ton)	Total sulphur (kg/ton)
Input digested biomass	4,08	2,87	1,21	0,94	0,42
Liquid output fraction	3,49	2,63	0,86	0,31	0,29
Solid output fraction	8,15	4,50	3,65	6,52	1,56

* Values for organic nitrogen are not measured but calculated as the difference between total-N and ammonium-N.

The primary performance parameters of this test and verification are the separation efficiencies with respect to total nitrogen, total phosphorous, total solids, volatile solids and suspended solids. In this test separation efficiency is defined as the proportion of a given component in the input biomass that is recovered in the solid fraction. In addition to the separation efficiencies particle size distribution in the liquid output fraction was selected as a performance parameter of this test and verification. Table 3 summarizes the evaluation of the performance parameters on the basis of this test.

Table 3. Evaluation of performance parameters.

Performance parameter	Claimed performance	Verified performance
Total nitrogen separation efficiency	Min. 20 %	25 %
Total phosphorous separation efficiency	Min. 70 %	72 %
Total solids separation efficiency	Min. 60 %	63 %
Volatile solids separation efficiency	Min. 75 %	68 %
Suspended solids separation efficiency	Min. 80 %	Not sufficient data to verify performance
Share of particle volume in liquid output fraction with a diameter below 40µm	Min. 90 %	92 %

On the basis of this test the technology producer´s claims on total nitrogen, total phosphorous, total solids and particle size distribution have been verified. For volatile solids the test results showed a slightly lower performance than claimed by the technology producer. For suspended solids analytical results from 2 batches had to be omitted because quality criteria were not met. As a result there is not sufficient data to verify performance with regard to suspended solids.

Table 4 presents the average electricity consumption of the UCA 501-00-02 during test.

Table 4. Electricity consumption measured during the test.

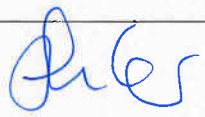
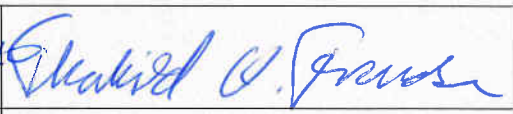
Batch no. 1 - 5	Electricity consumption* (kWh / ton input digested biomass treated)
Average	1,67

* Average capacity of decanter during test was 13,72 m^3 per hour.

The user manual for UCA 501-00-02 was evaluated and all relevant topics were sufficiently described.

Quality assurance

The test and verification have been performed according to the AgroTech Test Centre Quality Manual. As a part of the quality assurance two technical experts provided review of the planning, conducting and reporting of the verification and tests.

	29.04.10		29.04.10
Signed by Lars Byrdal Kjær AgroTech management representative	Date	Signed by Thorkild Q Frandsen Verification responsible, AgroTech	Date