ULTRAWAVES BIOSONATOR FOR IMPROVEMENT OF BIOGAS PRODUCTION ON FARMLAND BIOGAS PLANTS (FBP)

Ense FBP, Germany – Case Study

I. Specifications of the plant	
Plant size	• Power capacity 3.556 MW • Power production: 20,000 MWh/a • 3 Main digesters à 1,880 m^3 / 1,880 m^3 / 5,650 m^3 • 1 Secondary digesters à 5.650 m^3 • 1 Storage tank à 8.000 m^3
Substrates	• Maize Silage, Liquid Manure, Ground Ear Maize, Sugar Beet, Dry Chicken Manure, Whole Crop Silage

II. Objectives of the high-power ultrasound installation

- Intensification of the anaerobic digestion process
- Increase in power production
- Substrate savings

III. Installation of the BIOSONATOR

- In December 2015 a BIOSONATOR (4 ULTRAWAVES high-power ultrasound systems each with 5 kW power, thus in total 20 kW power) has been installed.
- Partial flow treatment (3.6 m^3/h) from the secondary fermenter and recirculation into the main digester 1 in automated 24-hour operation (see figure 1).

IV. Phases of operation

The analysis has been divided into three operating phases:

- P1: Beginning of the data recording from 1st of November 2015 to 29th of February 2016 (commissioning of the BIOSONATOR on 10th of December 2015)
- P2: Step-by-step emptying of the secondary digester and the storage tank from 1st of March 2016 to 30th of April 2016 (BIOSONATOR in continuous operation)
- P3: Resumption of the undisturbed biogas plant operation and reduction of the plant power capacity

from 2.6 MW to 1.6 MW (heat-operated summer operation) by a stepwise reduction of the feeding

V. Results of the high-power ultrasound installation

- Increase in the specific power production by relatively 10% (+0,15 MWh absolute per ton of organic dry matter; the analysis of the company Ultrawaves serves as the underlying data (laboratory at the Technical University of Hamburg); see figures 2, 3 and 4).
- Increase of the actual power production by absolutely 5 to 7% compared to the theoretical power production (data basis is the evaluation of Enser Biogas GmbH & Co.KG (quotient of actual power production / theoretic power production); see figures 4 and 5).
- Improvement of the biogas quality by increasing the methane content by 2 % (see figure 6).
- Reduction of the viscosity of the biomass suspension in the main digesters (up to relatively 57%; see figures 7, 8 and 9) and in the secondary digester (up to relatively -44%, see figure 10). The material is more capable of being pumped and the stirring times of the agitators may be reduced.
- More stable operation of the biogas plant and less disturbance when extracting fermentation residue in comparison with previous years.

VI. Summary and feasibility analysis

- By operating the BIOSONATOR, the actual current output on Ense FBP is increased by an average of 0.15 MWh per ton of organic dry matter fed to the plant or 5.45 MWh/d respectively. The additional electricity revenue leads to a significant improvement in profitability. The amortization period is approx. 3 years for the investment made without taking into account the increase in methane content.
- Considering the increase in the combustion capacity due to the increase in methane content, the amortization period is reduced by another year to approx. 2 years.
- Due to the fact that the operator was very satisfied he decided to install two more high-power ultrasound systems in his plant.

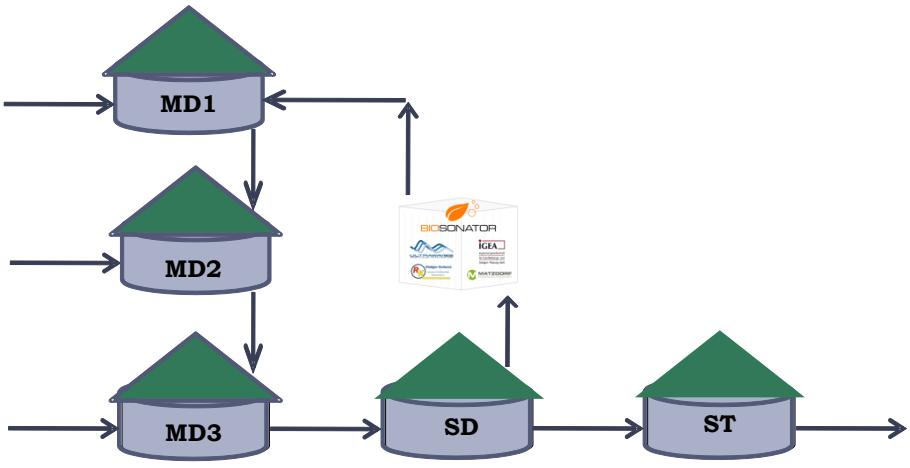

Figure 1: Plant scheme of the FBP Ense and integration of the BIOSONATOR

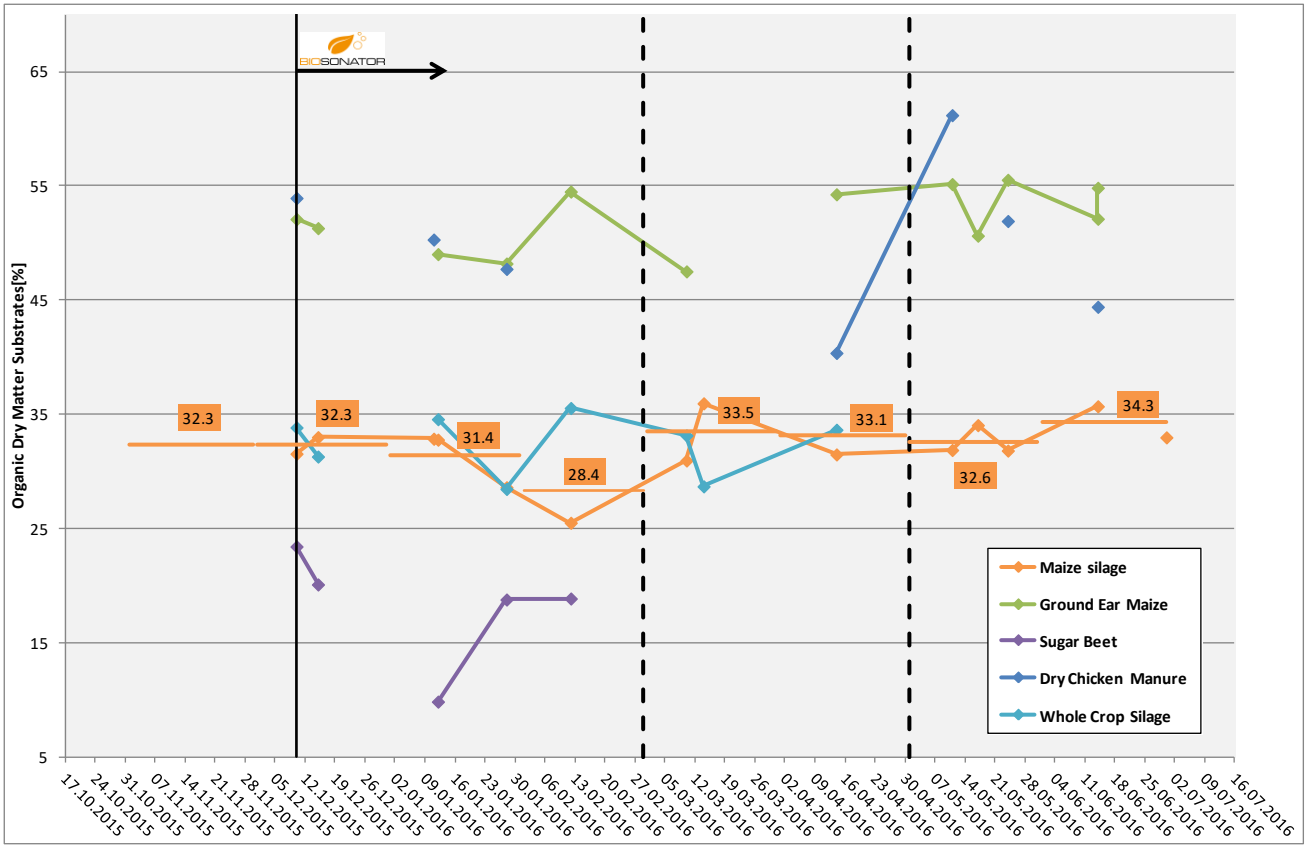

Figure 2: Organic dry matter content of the substrates used and the calculated monthly mean values for the quality of the main substrate maize silage

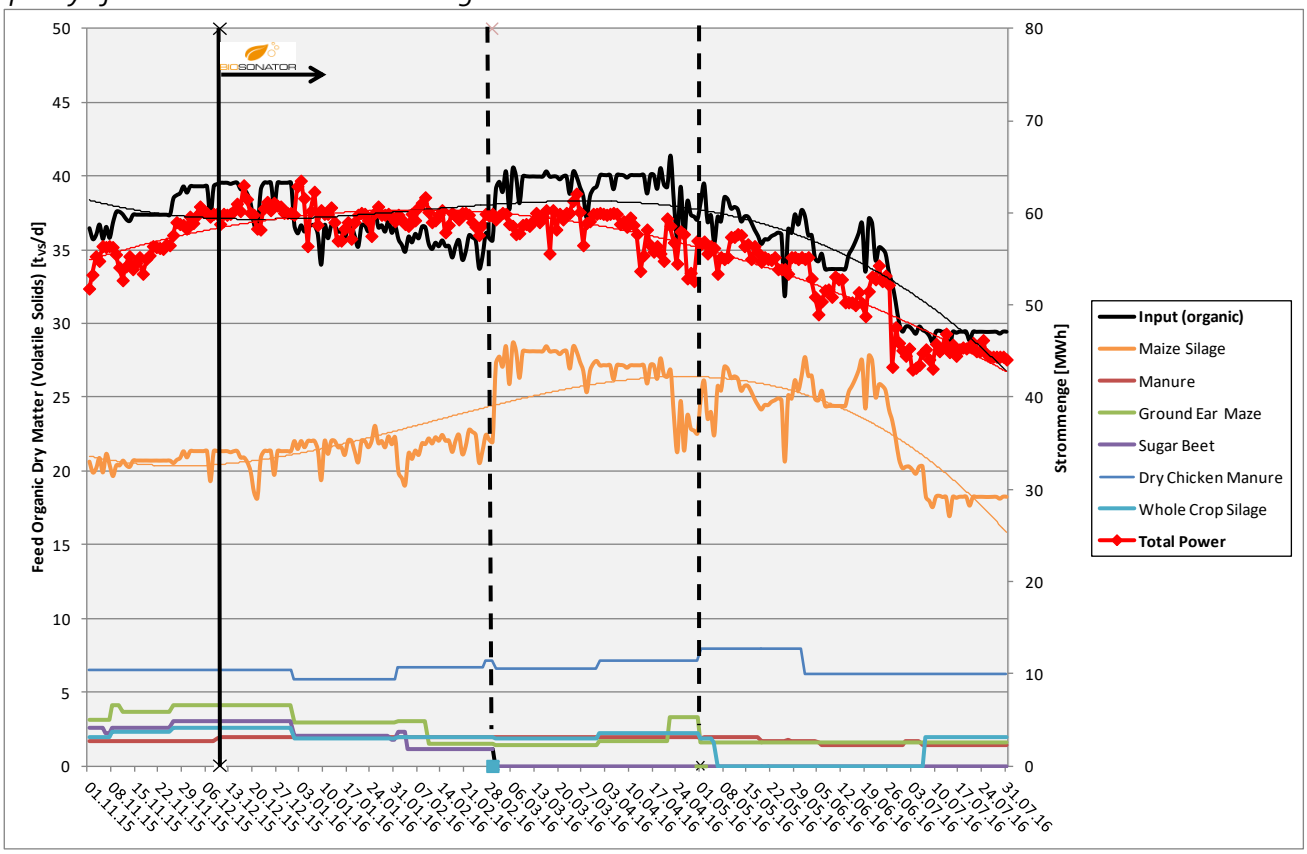

Figure 3: Feeding of organic dry matter (volatile solids) and total production of electricity during the three operating phases considered

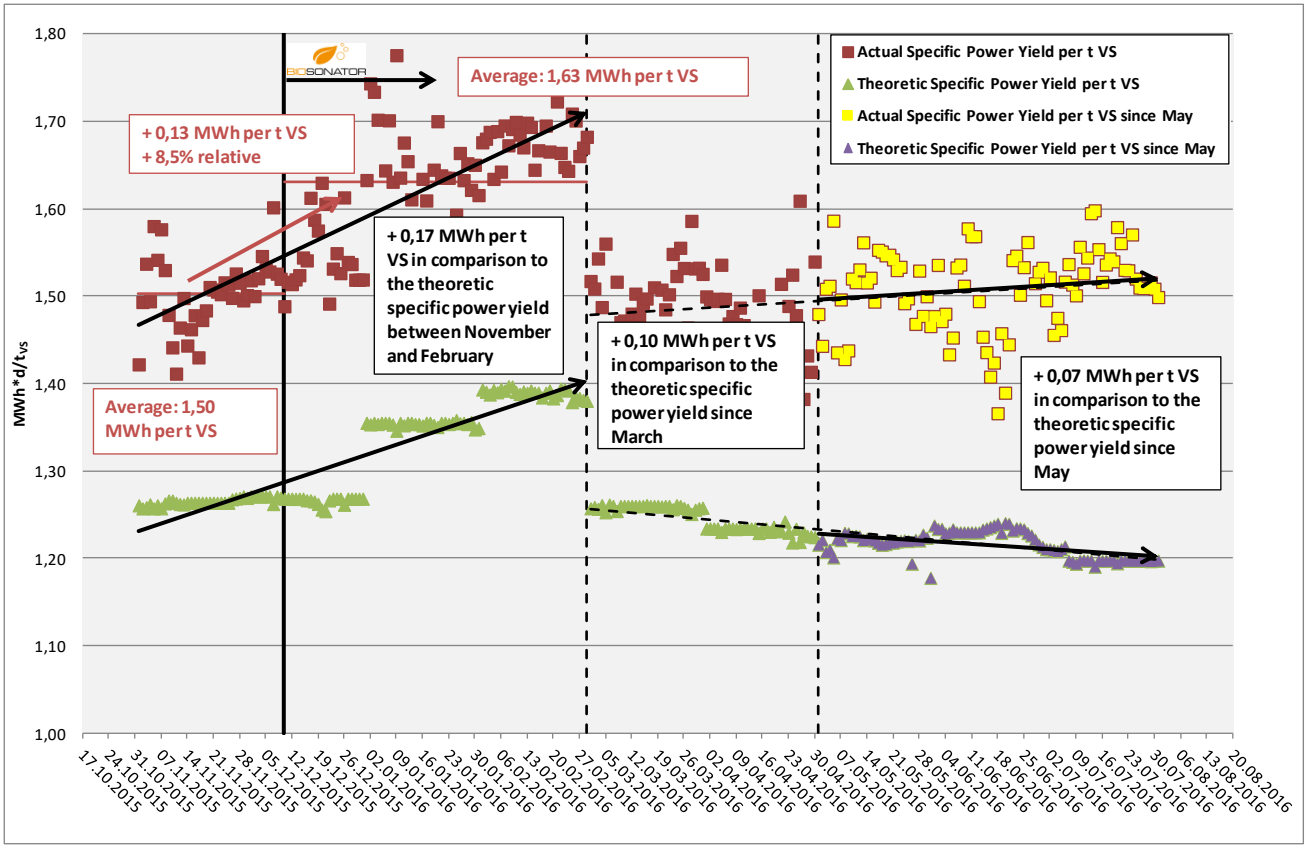

Figure 4: Increase in the specific power yield by using the BIOSONATOR in comparison to the period without high-power ultrasound disintegration as well as to the theoretic power yield

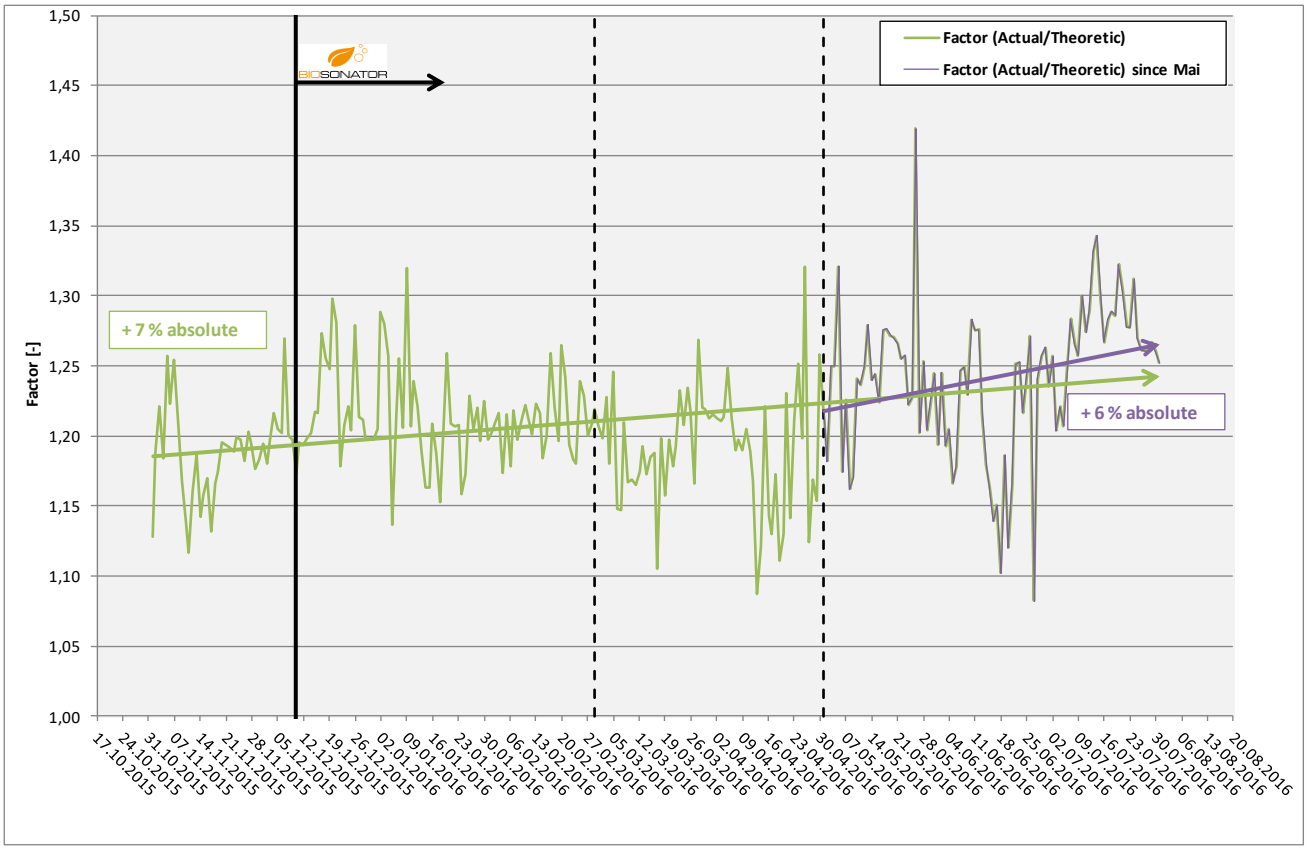

Figure 5: Enhancement of the power production compared to the theoretic power production

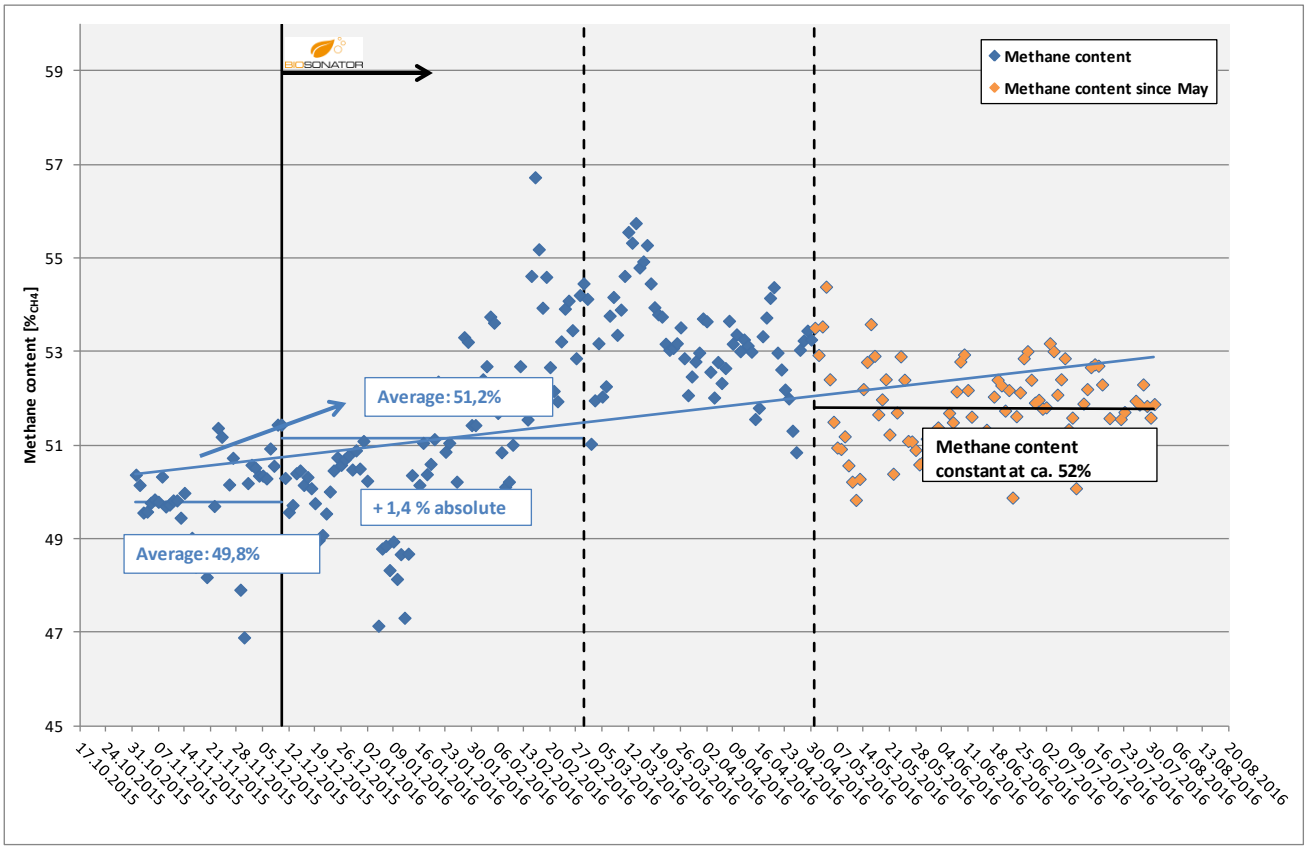

Figure 6: Enhancement and stabilization of the methane content by applying the BIOSONATOR

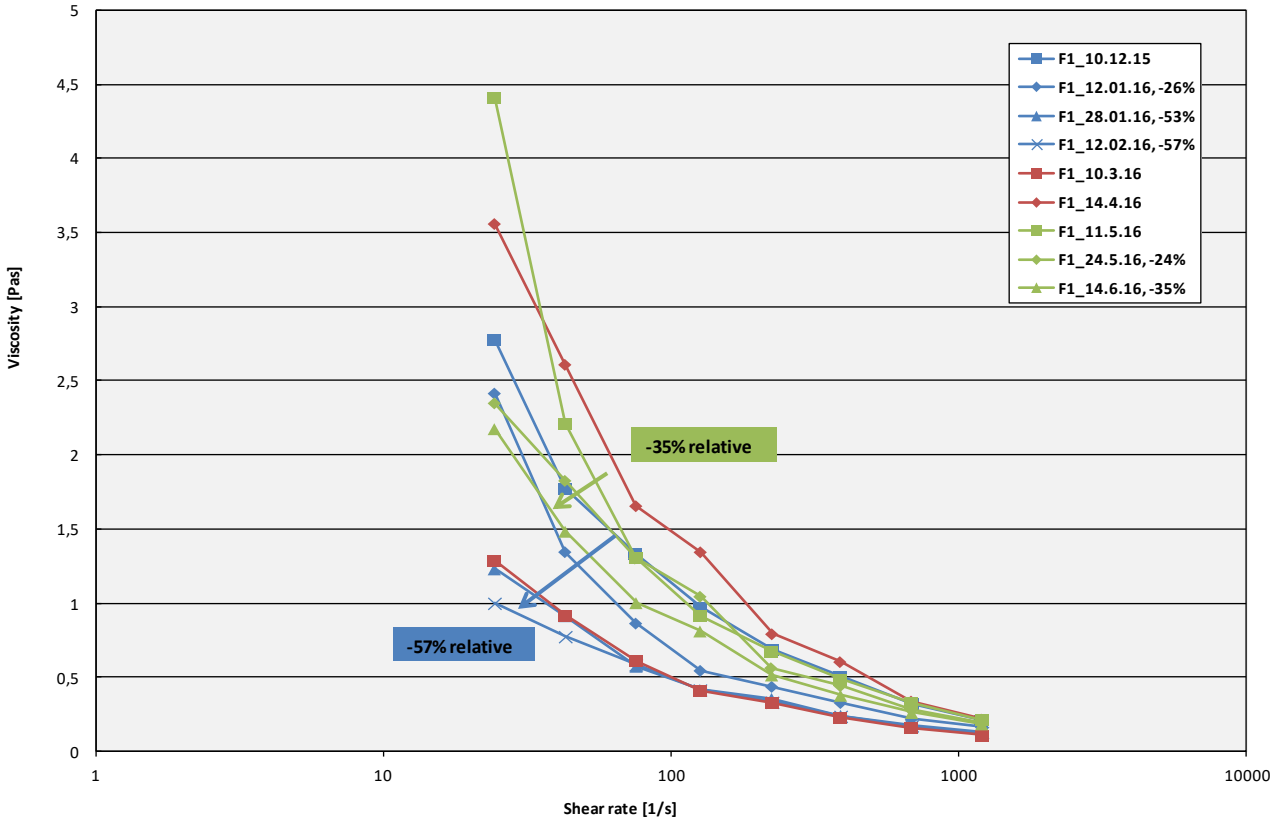

Figure 7: Reduction of the viscosity in the main digester 1 at Ense FBP by applying the BIOSONATOR

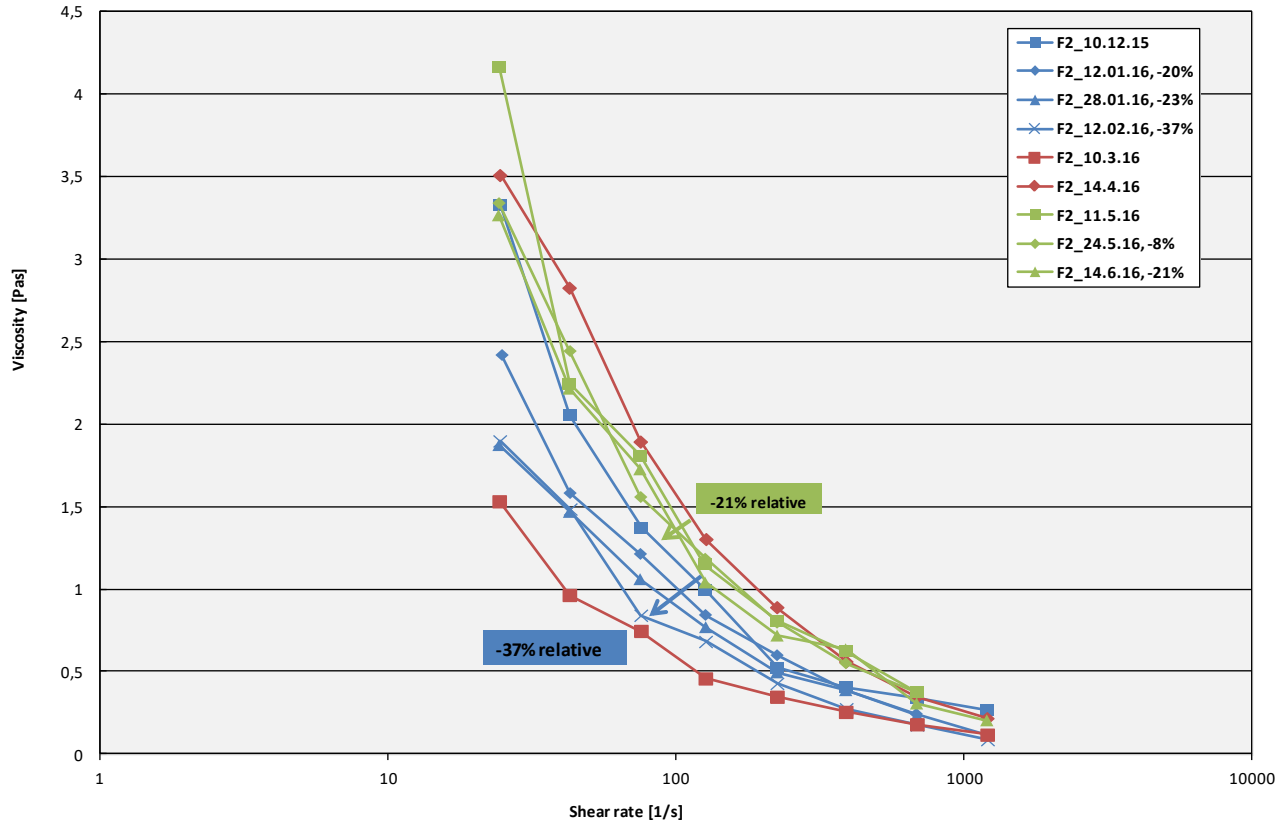

Figure 8: Reduction of the viscosity in the main digester 2 at Ense FBP by applying the BIOSONATOR

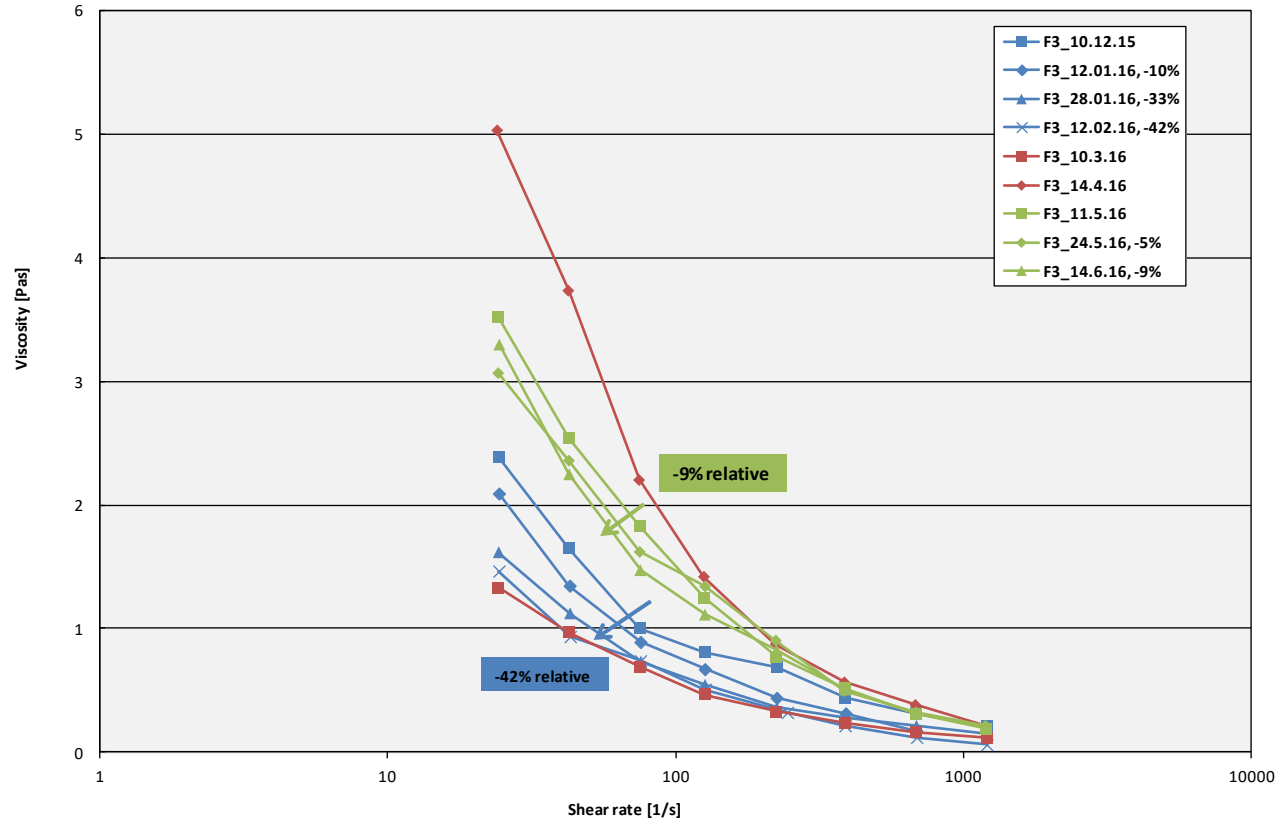

Figure 9: Reduction of the viscosity in the main digester 3 at Ense FBP by applying the BIOSONATOR

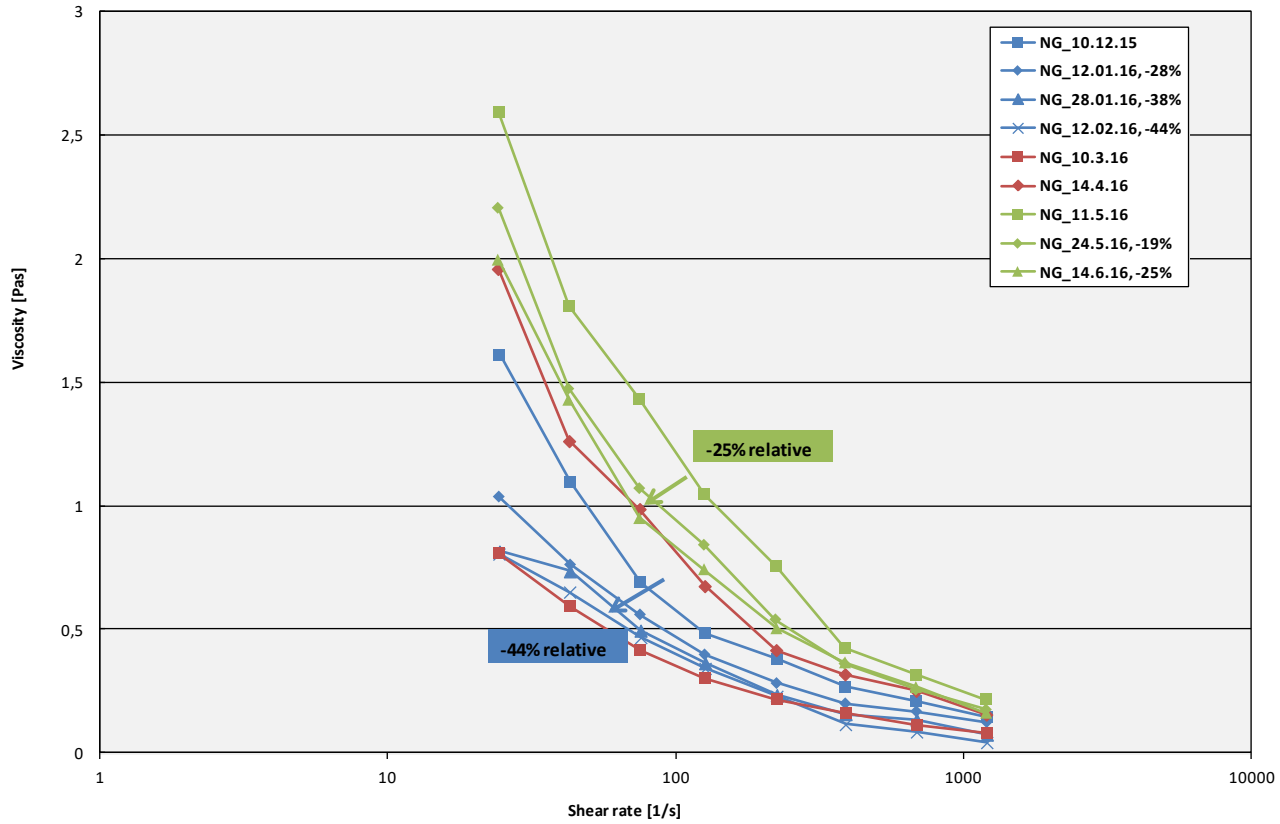

Figure 10: Reduction of the viscosity in the secondary digester at Ense FBP by applying the BIOSONATOR

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