

# Final report

## 1.1 Project details

<b>Project title</b>	EUDP 13-II, PURSUC - Forbedret udnyttelse af energipotential i gylle_2013
<b>Project identification (program abbrev. and file)</b>	Journalnr.: 64013-0524
<b>Name of the programme which has funded the project</b>	EUDP
<b>Project managing company/institution (name and address)</b>	PurFil ApS, Blåbærvej 61, DK_5260 Odense S
<b>Project partners</b>	PurFil ApS Frichs A/S
<b>CVR</b> (central business register)	DK 34214239
<b>Date for submission</b>	2013-09-12

## 1.2 Short description of project objective and results

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## 1.2 Short description of project objective and results

- The project concerns a new solution for improved exploitation of the energy potential of manure by thermal gasification. This project will develop 1) a highly effective drying module, optimizing manure for thermal gasification, and 2) an adapted thermal gasifier which runs efficiently on manure input. The result is increased economic viability. *"However, the expected results in the project period were not achieved since first technical design / construction errors and subsequent mechanical problems during the construction of the MVR evaporator prevented the achievement of the expected project results. Simultaneously the former Thermic Sublimator - caused by the foreign supplier - could not function as expected and during this project deliver the expected heat for the evaporator."*
- Projektet omhandler en innovativ løsning til forbedret udnyttelse af energipotentialet i gylle ved termisk forgasning. I projektet udvikles 1) et højeffektivt tørringsmodul, som optimerer gyllen til termisk forgasning, og 2) en tilpasset termisk forgasser som kører optimalt på gylletørstof. Resultatet: øget rentabilitet i gylle-til-energi-processen. *"Imidlertid blev de forventede resultater i projektperioden ikke opnået, da først tekniske design-/konstruktionsfejl og senere mekaniske problemer under opførelsen af MVR-inddamperen forhindrede opnåelsen af de forventede projekterestater. Samtidigt kunne den daværende (udenlandske) termiske forgasningsenhed (Sublimator) ikke under dette projekt levere den forventede varme til inddamperen."*

## 1.3 Executive summary

### Final statement:

Due to the project's unexpected technological development problems as well as time consuming, it has not been possible to achieve the project objectives expected!

Meanwhile both companies are working "heavily" to bring our innovation costs to revenue, since we both expect to be "near the Goal" of this project for each of our technologies: Just not within the project period!

## 1.4 Project objectives

### Project description:

#### Evaporation:

The goal of this project was to develop a new MVR-evaporator, which can treat / dry humid solids: Like Fiber from PurFil®' PURROT® -module and the concentrate/Retentat from PurFil®' PURUF® (Ultra Filtration) -module when separated manure, but as well also sludge from WWTP. This, so we can reduce the "normal" power consumption (electricity) down to max. 30 kWh-electricity / ton of water. (You use 850 kWh to "boil" 1 ton of water if no reuse of the steam/condensate energy). The evaporator should have been a combination of Mechanic Vapor Recompression (MVR) and a Superheater, using the heat from a CHP' exhaust gas, fueled with gas from the Sublimator.

### **Sublimation:**

The first planned interconnection (anno 2015) of Frichs A/S' existing (American) thermal Sublimator and the first developed evaporator from PurFil® ApS failed at the expected time: The gasification plant didn't (because of failures in the Sublimator caused by the supplier), worked satisfactorily during the actual project period. For that reason, Frichs A/S had to withdraw from the project medio 2015.

### **Status of the Evaporator:**

The first evaporator designed by PurFil® ApS' engineers was too small related to heat exchange capacity. Further, the mechanical inlet and outlet system designed and produced was inefficient both for moving the solid and especially related to a needed blocking of air going inside the evaporator: "This way PurFil® ApS had to redesign and produce a total new (and significant different) MVR-evaporator (the PURDRY®-module)". This has been done, but because of several delays, it has within the project period not been possible to get in operation.

## **1.5 Project results and dissemination of results**

### **Alternative estimation of thermic gasification and evaporation.**

To be able to design the second evaporator, the project participants achieved an alternative drying of 2.5 tons Dry Matter -fiber fraction (Aug. 2015) from PurFil' new mechanical separator (PURROT®), for testing the gasification of the fiber fraction. This brought very positive results. More than 30% more biogas were produced ( $\text{CH}_4 + \text{H}_2 + \text{CO}$ ), than the best performing biogas plants in Denmark and a Biochar fraction including more than 10 mass-% and 100% citrate-soluble Phosphorus (directly plant available) and a weight reduction of the fiber fraction (transport-saving) of over 85%. (Less than 3 Vol-% of the raw manure)!

### **MVR with a Turbo charger.**

One of the "new" elements in the recompression of steam (before condensation to deliver heat to new evaporation of the humid matter) is, that this is done by a high efficient turbine (a high-speed turbo charger running more than 150.000 RMP). This concept has been tested with humid air in the new evaporator and has proved that the concept is working well.

### **Preheater before the Evaporator.**

Together with the new evaporator, a new preheater / cooler was designed and produced to preheat the raw humid solid fraction to the boiling point (100°C), going into the evaporator. This with the 120-130°C warm condensate from the evaporator.

Unfortunately, the preheater has disclosed mechanical problems related to the feeding system, why we could not within the project period, bring it to operate as expected. It has been established based on aluminum-based heat / sandwich plates, which during construction and subsequent restructuring have shown considerable deviations in relation to the mechanical requirements for dimensions and stability. Therefore, the established mechanical feeder parts have not been able to function without clogging and blocking of the feeder.

## **Final project results.**

PurFil® ApS expect the new PURDRY®-module will be final developed during 2018 and we will bring the EUDP-program a test rapport, expected before the end of 2018. Because of the delay, PurFil® ApS has (still) not got any revenue of this project.

Today, Frichs has produced 3 new Sublimators, which are under installation at the moment and starts being tested in China, Turkey and DK this spring.

## **Dissemination of the project.**

Since we haven't succeeded the project yet, we haven't published anything yet.

## **1.6 Utilization of project results**

### **Expectations.**

After having been granted the project an extension of 2 years - and PurFil® ApS has used more than DKK 1.0 million extra in the period to get the PURDRY® in function and nearly 2.000 manhours more:

"We definitely hope, it will be successfully operating in 2018"!

Our market researches during the project period, both within agriculture and Waste Water Treatment Plans tells us, that the potential customers are still calling for the dryer, we believe in the future for our products/concepts.

### **Patents.**

PurFil® ApS expect to submit a patent review, when we "hopefully" get the evaporator PURDRY® module fully developed in 2018.

Similar Frichs A/S expect to bring new IPR to the company in the nearest future, related as well to the experience from their earlier participation in this project.

### **Market shares.**

Related to our expectations for the future market, we (PurFil® ApS and Frichs A/S) are even now 4 years after the project start still convinced, that our products are worth DKK > several Billions, why we are searching and being linked to partners worldwide, who are showing very big interests for our new products

### **How to reduce our CO<sub>2</sub>- loads/-emissions?**

Since both companies continue our product development and have invested a lot of technical and chemical knowledge during the actual project process, we both consider, that the expected results after this project termination have a high potential for future development (we consider ourselves very close to the project target).

As the existing (biological) gasification technologies for biomass and other organic waste, only have an efficiency of up to 60% digestion/gasification, the implementation of our technologies can, for example as post-treatment of the "digested" biomass, reduce the total CO<sub>2</sub> emissions in DK with estimated 10-15%: This estimate is based on current estimates from the "public" biogas industry, when we implement / expanding our products in the Danish renewable energy supply chain during the next years. With our assembled technologies, we can double the total CO<sub>2</sub> reduction related to "Green gasses".

## **1.7 Project conclusion and perspective**

The companies market today separately as well the sublimation plants and the separation modules for slurry and sewage. Our expected "symbiosis" from "Waste to Power", we expect to be able to market by the end of 2018. This is primarily expected to happen in the export market, with emphasis on Germany, Spain, the Netherlands and in Asia, especially China.

Today we are negotiating with a German investor, who wishes to implement our concept as soon as possible at 6 existing German biogas plants, all of which will get a whole new economic potential with our technologies. (If success, then we have "only" 6.000 more installations in Germany to optimize with our technologies)!