

BioGasol – The Company

Who we are

BioGasol ApS is a Danish biotechnology and engineering company founded in 2006 as a spinout from the Technical University of Denmark, DTU. BioGasol, together with its sister company Estibio, has developed biochemical process technologies for the renewable energy and chemical industry including pretreatment solutions – the Carbofrac® series. The core technologies, the Carbofrac® pretreatment system and the Pentocrobe® fermentation organism, are based upon extensive research and development work which has taken place at DTU since the mid-nineties. BioGasol and Estibio have demonstrated its processes and equipment in a series of successfully pilot and demonstration plants.

The main office is located close to Copenhagen in Ballerup, where also the comprehensive laboratory and pilot facilities are accommodated.

BioGasol and Estibio dedicated employees are highly skilled within the disciplines of metabolic engineering, microbiology, fermentation, biotech research, techno-economical modelling and process, chemical, mechanical, electrical and automation engineering.

What we do

Besides the continuous research and development of new and optimised solutions for the emerging cellulosic biofuels and biochemical industry, we have a strong focus on developing durable equipment, which can accommodate the processes under continuous operation conditions.

We provide our clients with the below services and deliveries:

- Carbofrac® continuous pretreatment units delivering homogenous pretreated biomass with high sugar release
- Pentocrobe®, a thermophilic bacterium engineered to convert all sugars into ethanol simultaneously
- Laboratory & pilot tests and engineering services:
 - Techno-economical modelling
 - Feasibility engineering studies for building project specific business cases
 - Biomass composition analysis
 - Pretreatment optimisation using design of experiments methods
 - Enzymatic hydrolysis
 - C₅ and C₅/C₆ co-fermentation
 - Delivery of pretreated biomass samples produced from client supplied biomass

BioGasol is growing with the business and currently supplying Carbofrac® units with a capacity of up to 4 t/h of dry biomass with larger units planned. The Pentoferm® fermentation system which utilises the Pentocrobe® thermophilic bacterium has been demonstrated successfully and Estibio works with partners in an effort to scale-up the fermentation process.

The Carbofrac® systems are available through direct sales as well as license arrangements covering specific territories and fields of use.

Who we serve

BioGasol seeks to bridge the gap between laboratory developed processes and durable, industrial grade equipment solutions. We can provide solutions for the sugar platform and are able to optimise processes and equipment solutions which can be integrated into the clients' own developed process whether the field of use is bioethanol or biochemicals.

A long row of clients has already benefitted from BioGasol's services and deliveries and we are ready to serve a wide range of clients such as:

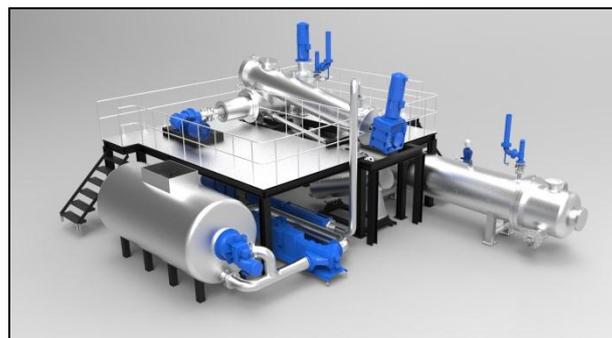
- Universities and R&D companies
- Next-generation ethanol developers
- Various end-user industries
- Biochemical companies
- Project developers
- Oil & gas and utility companies

Carbofrac® – Pretreatment System

Introduction

BioGasol has developed a highly efficient and cost effective proprietary continuous pretreatment system to overcome the recalcitrance of lignocellulosic biomass specifically for cellulosic feedstock.

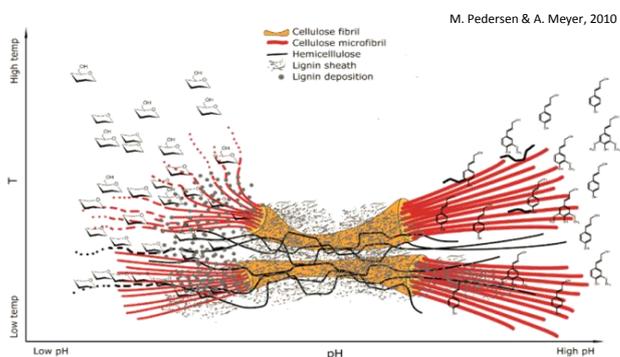
One of the main Carbofrac® features is the system's ability to perform a uniform pretreatment process utilising the patented Microreactor to ensure complete process control and achieving a completely homogeneous temperature distribution in all of the biomass. This results in high sugar release with a minimum formation of inhibitors as the system can be operated at lower temperatures compared to conventional equipment.



Carbofrac® 400, 4t/h pretreater final design

The Carbofrac® can accommodate a variety of known pretreatment processes including the cost efficient reference process – steam explosion combined with dilute sulphuric acid – the Carbofrac® system in pilot and small demonstration scale has proven feedstock flexible and capable of production of homogeneous pretreated biomass. Ranging from laboratory scale and up to 1 ton per hour, BioGasol has tested more than 20 different feedstocks including corn stover, corn fibre, corn cob, sugarcane bagasse, wheat straw and woody biomass.

Optimal performance is obtained through maximal release of C₅ sugars (arabinose, and xylose), low inhibitor production, optimal accessibility of cellulose (C₆ sugars) to cellulase enzymes, a high degree of process control and maximum lignin value. The pretreatment technology, which is covered by several patents, is based on more than 3 years of pilot scale operation and is furthermore characterized by low water consumption and a compact design resulting in a small footprint.



Process optimisation model, pH vs. temperature impact on biomass

Process Flexibility

The Carbofrac® is developed for feedstock flexibility, but the system is also able to accommodate various processes, so the Carbofrac® can be optimised to meet the specific requirements for the clients' downstream processes e.g.:

- Steam explosion
- Dilute acid hydrolysis
- Wet explosion
- Hot-water pretreatment
- Various alkali pretreatment processes

The Carbofrac® is furthermore delivered with an advanced PLC based control system, so the key parameters required for optimal pretreatment conditions can be controlled and achieved throughout the system:

- Temperature
- Pressure
- Flow rate
- DM content
- pH adjustment
- Retention time

Carbofrac® Advantages

- Specifically developed for biochemical conversion of lignocellulosic feedstock
- A continuous thermal-mechanical pretreatment system
- Process control – limited temperature and pH variation enables constant operation in sweetspot
- A feedstock and process flexible system
- A scalable solution
- Homogenous pretreatment process achieved by BioGasol's patented Microreactor
- Low operating cost, i.e. steam and electrical consumption
- Short start-up and shut-down time
- Efficient sugar platform suitable for biochemical and ethanol production due to high sugar releases and low inhibitor levels
- Modular pre-assembled system on skid mounts that offer a small physical footprint and easy installation
- Novel and patent protected design solutions
- Operation of continuous Carbofrac® pretreatment systems since 2010, from 20kg/h to 1 ton/h



Carbofrac® 10 (and Carbofrac® 100 in the background)

Pentocrobe® – High Yield Fermentation

BioGasol and its sister company Estibio have developed a unique proprietary technology for the conversion of C₅- and C₆-sugars into ethanol, which can be optimised for the client's own pretreatment system, integrated with BioGasol's Carbofrac® system or as a bolt-on system to existing 1G-facilities.

The Pentocrobe® production organism is a thermophilic bacterium, which offers high yields and minimizes contamination risks, due to the high operating temperature. The fermentation is carried out in the proprietary process, Pentoferm® and can be used in parallel with a traditional industrial C₆ yeast process, or in a "one-pot" co-fermentation process, since it converts all biomass sugars into ethanol. In biomass such as wheat straw, corn stover and sugarcane bagasse the C₅-sugars can contribute with up to 40% of the bioethanol potential. Consequently, the total yield of ethanol can be increased significantly, up to approximately 350 l/t dry biomass, depending on the actual feedstock.



Pentocrobe® under a microscope



Pentoferm® 2.5m³ fermentor

The Pentoferm® process has successfully been tested on several lignocellulosic biomasses such as wheat straw, sugarcane bagasse, corn cob, corn stover and has even been proven to be competitive with yeast on molasses feedstock.

Pentoferm® is also applicable for conversion of co-products or product intermediates such as corn fibre, wheat bran and barley spent grain in which the C₅-sugars xylose and arabinose typically constitute up to 50% of the total sugars.

References

BioGasol and Estibio have serviced and delivered to clients worldwide. The first Carbofrac® 10 pilot unit is already delivered to an American client and two Carbofrac® 400 units for commercial use will be delivered in 2014.

In addition, various tests including pretreatment optimisation, separation, enzymatic hydrolysis, fermentation, etc. and delivery of samples have been performed for more than 25 international clients, who have benefitted from BioGasol's and Estibio's experiences within the field of cellulosic biofuels and biochemicals.

Contact

Address: Lautrupvang 2A
2750 Ballerup
Denmark

Phone: +45 8820 4879

E-mail: info@biogasol.com

Web: www.biogasol.com