


# GICON®



**GICON® References  
in Microalgae Photobioreactor Technology  
– Market Innovations since 25 Years**



GICON® engineers have planned a broad variety of photobioreactor plants ranging from **R&D to commercial sized systems for 25 years** using their detailed expertise in plant design, approval planning, process engineering, biotechnology, biology and bio-energy systems.

GICON® has great experience in **plant design of photobioreactor systems with a total production volume of more than 2 million litres. This represents a total tube length for microalgae growth of more than 1,000 km.**

Starting with glass tubular photobioreactor systems, the construction of a microalgae plant in 1997 (Elbingerode/Germany) was **fundamental pioneering work** at that time and resulted in the planning and construction of **World's first and largest microalgae production plant** in 2000 (Kloetze/Germany, now owned by Roquette) – setting a new state-of-the-art technology in effective and stable production of microalgae mass cultures. GICON® engineers operated the plant with a production volume of 700 m<sup>3</sup> for 10 years in leading position.

In subsequent years and with intensive involvement of GICON® engineers, the IGV (Potsdam/Germany) constructed and marketed a great amount of glass tubular systems for R&D and commercial production of microalgae. GICON® (former engineers of BISANTECH NUOVA) performed the plant design and bioprocess engineering of the PBR's and harvesting systems.

Moving forward the microalgae production technologies, GICON® developed a **novel photobioreactor design**, beginning in 2011 – the **GICON®-PBR**. Using a **highly transparent and flexible double-wall tubing system**, an **effective biomimetic design for sunlight capture** and an **integrated and closed temperature control cycle** allow the maintenance of ideal growth conditions and stable production of microalgae at R&D and commercial scale. This successful technological principle in photobioreactor design was rewarded by the German Center for Research and Innovation in New York (2012). In combination with automated and predictive process control, a 2-year cultivation period without any fresh inoculation from laboratory cultures have proven this innovative concept. Once again, GICON® successfully created a higher standard in photobioreactor technology.

## Selection of planning and construction/installation services of microalgae plants (R&D and commercial)

The plant design by GICON® comprises all relevant aspects in the field of R&D and commercial plant construction – ranging from systems planning, approval planning, bioprocess engineering, basic and detail engineering, construction planning.

GICON® successfully performed various planning services in Germany and various countries around the world, e.g. the Netherlands, Poland, France, Middle East, USA, Sri Lanka, Madagascar and Mauritius.

# REFERENCES

## ELBINGERODE | GERMANY (1997)

6 m<sup>3</sup> glass tubular system – pilot plant for usage of lime kiln exhaust for microalgae production – first glass tubular system with state-of-the-art bioprocess technology.



## KLÖTZE | GERMANY (2000)

Due to their modular construction consisting of several reactors, the microalgae systems can be extended as required. Employees of GICON®'s Bitterfeld-Wolfen branch have, then still as employees of Bisantech Nuova, planned and installed the World's first and largest tubular production facility for microalgae in Germany (Saxony-Anhalt) with 20 pho-

tobioreactors and around 700,000 litres of utilization volume on a 1.2 hectares area for the client. The biological connection was realised in cooperation with IGV GmbH Potsdam Rehbruecke. Based on the experience of this project, GICON® has developed its PBR and thus improved algae cultivation.



Quelle: Roquette Klötze GmbH & Co. KG

# REFERENCES

## KÖTHEN | GERMANY (2012)

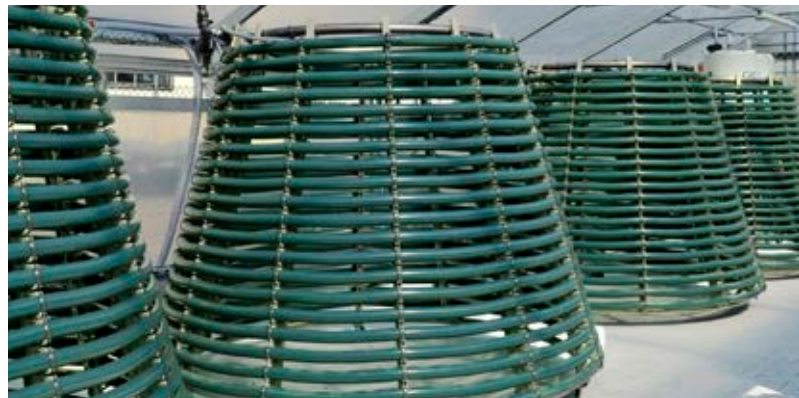
1.7 m<sup>3</sup> modular microalgae platform using novel design of GICON®-PBR using flexible and transparent double-wall tubing system in biomimetic design and integrated temperature control

The modular arrangement of four light collector modules provide a variety of operating modes - single use, in series, in parallel.

Long-term cultivation tests over a period of 2 years without fresh lab inoculum demonstrated the successful maintenance of ideal growth conditions - especially the concept of the water-conserving closed and integrated temperature control system.

The developed process control unit collects and controls the bioengineering and process engineering data of more than 70 sensors.

Predictive process control systems ensure a stable and efficient cultivation process.



## TREIZE-VENTS | FRANCE (2014)

The potential of biogas plants for the cultivation of microalgae use - this goal has been implemented by GICON® in an installation in Treize-Vents in the west of France. A 190 kW plant directs the surplus heat into

two raceway ponds, in which algae are cultivated. The heat supply stimulates the growth of microalgae. The resulting algae biomass is used, among other things, as an admixture for animal feed.



Quelle: France Biogaz Valorization S.A.R.L.

# REFERENCES

## COTTBUS | GERMANY (2019)

4 m<sup>3</sup> GICON®-PBR demonstrating modular-scalable commercial application according to highest industry standards

The GICON®-PBR is designed for use as a basic module for large commercial systems as well as a self-sufficient small system as a pilot plant for R&D. By combining individual modules, any number of scalable reactor systems are accessible. Using the double wall tubing

concept, stable production is ensured even under extreme climatic conditions. The systems are tailor-made to the needs of the customer. Consequently, they guarantee a continuous production of high quality, defined algae biomass. The unified tubular collector system enables the integration into other biotechnological processes (e.g. the material coupling with biogas plants).



## HALLE | GERMANY (2017)

Commercial microalgae production plant for yearly production size of 125 t Chlorella biomass – plant design ranging from fully equipped laboratories for

culture collection, starter cultures and process control to downstream processing and marketable products.



## Additional highlights of GICON® services in PBR plant design

Location	Plant size	GICON services	Application
Netherlands	GICON®-PBR, 100 t/a	Plant design	Commercial
Middle East	GICON®-PBR, 20 t/a	Plant design	Commercial
Middle East	GICON®-PBR, 1,000 t/a	Plant design	Commercial
USA	Open pond, 1.6 ha	Design of Harvesting system	Commercial
Sri Lanka	GICON®-PBR, 4 m <sup>3</sup>	Plant design	R&D
Madagascar	GICON®-PBR, 4 m <sup>3</sup>	Plant design	R&D
Mauritius	GICON®-PBR, 4 m <sup>3</sup>	Plant design	R&D
Poland	GICON®-PBR, 0.5 m <sup>3</sup>	Plant design & Construction	R&D

## R&D innovations (in collaboration with research partner institutes)

In order to keep its position as one of the leading engineering companies in the field and according to its business philosophy, GICON® continuously invests in R&D projects to level up the boundaries of state-of-the-art technologies. In collaboration with research institutes and universities, innovative solutions and marketable products ranging from technology development to market applications provide contin-

uous and groundbreaking progress for microalgae biotechnology. More than 10 research projects in less than 10 years are proof of GICON®'s own expectations as an innovative engineering service provider in order to meet the company's self-imposed demands. The exploitation of the R&D knowledge into markets is one core business of GICON®.

### A selection of active research areas:

- Development of GICON®-PBR, design, operation, process automation
- Gentle and effective cell disruption using biological treatments
- Material and energetic combination of biogas process and microalgae production
- floating modules for producing microalgae at offshore sites
- Novel process for application of microalgae as feed supplement for pigs using stable and continuous on-site production
- Microalgae production as remediating step in agriculture
- Solutions for understanding and preventing of environmental-immanent contaminants in microalgae mass cultures
- Functional milk-based drink with microalgae and more

## Selected R&D projects:

Year	Title	Innovation
2011	Development and process engineering design of a novel photobioreactor as a closed system and module to erect microalgae production sites for biorefinery approaches.	Design of GICON®-PBR with biomimetic design and flexible and transparent double-wall tubing system with integrated temperature control
2014	Erection of a platform for photobioreactor systems using "Christmas tree" principle.	Development of process automation and predictive growth control 2-year long-term cultivation of microalgae
2016	Development of basics of a process focusing on the material and energetic coupling of microalgae biotechnology and two-step biogas generation.	Development and realization of a concept for the energetic coupling of cost-reduced microalgae production and innovative two-stage biogas process with regard to improved material and energy balance of both processes
2016	Development of an agent-gentle treating process for a continuous digestion and agent recovery in microalgae biomass.	Development of extrusion process for continuous cell disruption of microalgae biomass with high throughput and gentle treating of active agents ensuring an increased availability of intracellular agents.
2019	Development of a non-denaturing, biological digestion process for enhancing the bioavailability of thermolabile agents in microalgae biomass.	Development of a process with gentle treatment of active agents by using enzymatic perforation of microalgae cell walls. In doing so, bioavailability of cell ingredients is enhanced without disrupting the algal cell walls.
2020	Development of a novel process for the continuous production of active agents in microalgae on the basis of the platform technology using the "Christmas tree" principle.	Development of a continuous process for targeted multi-stage induction of high-value products in microalgae with optimal product yield.
2020	Space@Sea - Multi-use affordable standardised floating space at sea	Work package aquaculture: Planning, construction and commissioning of industrial-sized modular GICON®-PBR for onshore and offshore use. Concept design of floating microalgae cultivation modules for offshore sites.
ongoing	Microalgae as feed supplement in pig farming	Development of an on-site continuous microalgae production and use as novel feed supplement in pig farming.
ongoing	Development of a biological process to control parasitic contaminants in commercial microalgae cultures	Process development for resistant microalgae cultures for commercial production using synthetic ecology principles.
ongoing	Bioeconomic process chains – Algae as concept module in Northern Germany	Bioremediation of surface water using GICON®-PBR technology and microalgae

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## List of active patents

### **Tubular photobioreactor**

- DWO2011048108A2
- US8586344B2
- EP2491107B1
- CN102575211A
- DE102009045851A1

### **Method and device for the targeted feeding of gases or gas mixtures in a liquid suspension or emulsion in a reactor**

- WO2013030340A1
- US9732312B2
- EP2751255A1
- CN103827287A
- DE102012215476B4

### **A method for solid-liquid separation of a suspension as well as the use of a self-consuming filter made of biodegradable material for solid-liquid separation of suspensions, in this method**

- EP2895431B1
- DE102012216339B4
- WO2014041063A1

### **Method and system for heterotrophic and mixotrophic cultivation of microalgae**

- Patent Application No. 10 2017 218 001.3 / Germany

GICON® Mitglied der European Algae Biomass Association (EABA)





# THE DOUBLE-WALL TUBE

## ADVANTAGES OF THE DOUBLE-WALL TUBE SYSTEM

### ECONOMIC VIABILITY

- Length of the systems can be scaled as required (extrusion)
- Connecting elements and connectors are not required
- Extra long life

### THERMAL RESISTANCE

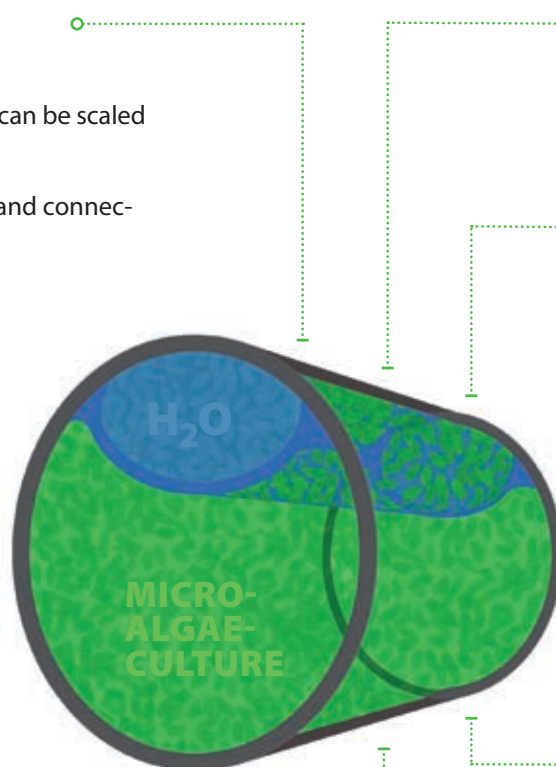
- Stable up to 150 °C
- Steam sterilization possible

### CHEMICAL RESISTANCE

- Use of salt water for cultivation and temperature control

### ENVIRONMENTAL SUSTAINABILITY

- Flame retardant and easily recyclable



### TRANSPARENCY

- Optimal at 400 – 760 nm

### RADIATION RESISTANCE

- Silicone does not lead to discoloration and has a lifetime of up to ten years
- Material can be exposed to electromagnetic radiation in high doses

### FOOD CONTACT SUITABILITY

- Physiological compatibility with regard to use in the food and feed sectors

### CLEANING / MAINTENANCE

- Simple mechanical cleaning technology
- Cleaning possible during the production process (no downtime)
- Silicone material is repairable

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