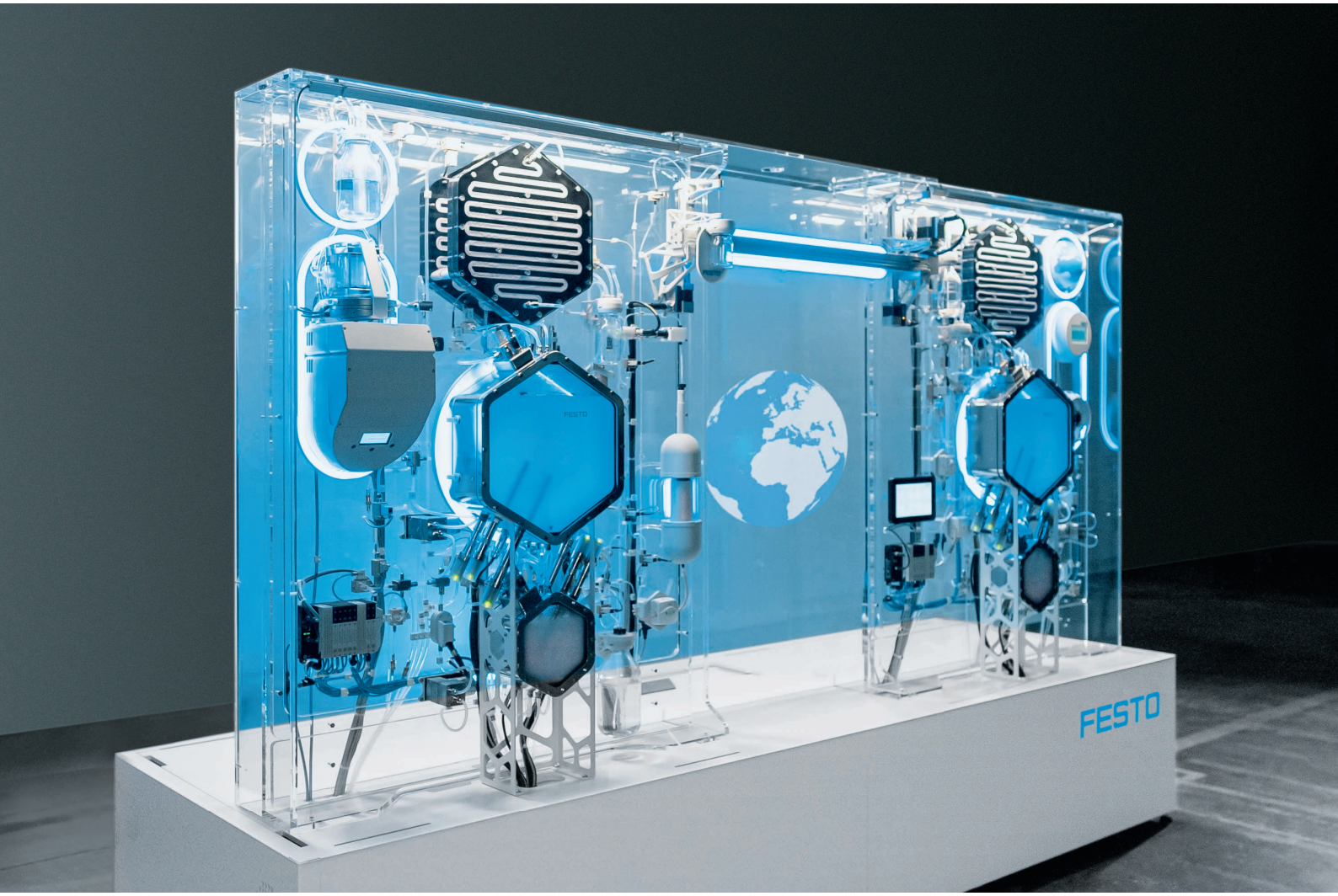
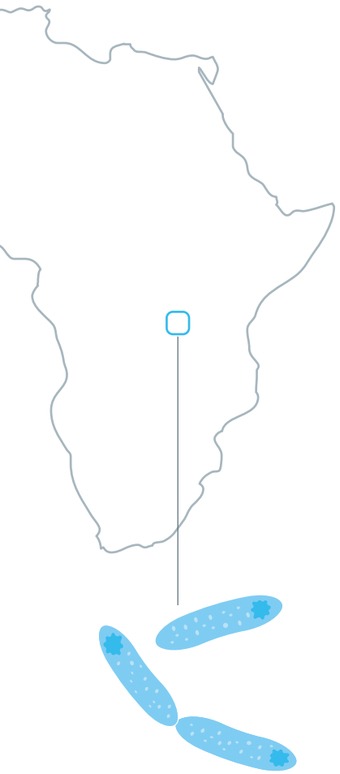
FESTO



BionicHydrogenBattery

Storage and Transport of Hydrogen with the Help of Bacteria



T. kivui
(Thermoanaerobacter kivui)
The bacterium lives in Central Africa, deep in the mud of Lake Kivu, far away from light and oxygen. It naturally has a special enzyme that enables it to convert hydrogen (H_2) and carbon dioxide (CO_2) into formic acid (CH_2O_2) and vice versa.

This property was extensively researched by the team headed by Prof. Dr. Volker Müller, Head of the Department of Molecular Microbiology and Bioenergetics at Goethe University Frankfurt, with whom Festo is working closely on the project.

BionicHydrogenBattery

Storage and Transport of Hydrogen with the Help of Bacteria

With the biotechnological system BionicHydrogenBattery, Festo is presenting a completely new, fully automated solution for energy-efficient storage and low-risk transport of one of the energy sources of the future: hydrogen. It is converted into formic acid with the help of bacteria – at mild temperatures and low pressure compared to previous processes.

Efficient Storage
The storage and transport of hydrogen remains a challenge to this day. Common methods compress hydrogen under high pressure, liquefy it at extremely low temperatures, or chemically convert it. All of these processes are energy intensive and complicated.

With the help of the T. kivui bacteria, hydrogen is converted into formic acid at temperatures of around 65 °C and a low pressure of 1.5 bar, so it can be stored and transported with relatively little effort.

Although it is a biological process, this reaction happens quickly because it is not linked to the growth of the cells. Instead, the bacteria are used as catalysts: they are not used up and the process can be repeated as desired with sufficient regeneration phases – in the sense of a circulation.

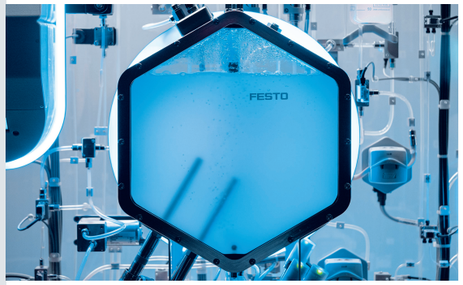
Automation of Complex Processes
What was previously only possible in the laboratory can now be achieved on an industrial scale with the BionicHydrogenBattery. Many products from the Festo portfolio are used to automate the highly complex biotechnological processes.

Secure Processes
The T. kivui bacteria are anaerobic, which means they only thrive in the absence of oxygen. In the event of a leakage of the system, the bacteria die immediately and therefore do not pose any risk to humans.

At the same time, the absence of oxygen makes it impossible for the hydrogen to form a flammable mixture. In addition, the system only contains tiny amounts of it at any given time.

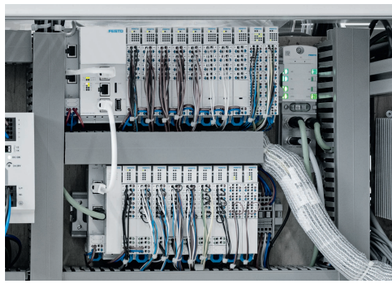
Sustainable Solutions
Biologization means: we no longer only learn from nature, but also work with it. In this way, we enable ecological innovations and climate-friendly solutions for the world of tomorrow and contribute to improving the quality of life of current and future generations.

The energy-efficient and low-risk storage of hydrogen with the help of bacteria offers great potential in this regard. It allows us to produce and store hydrogen when there is enough sustainably generated energy – for example, in summer or in sunny and windy countries – and to recover it when it is needed to generate energy.

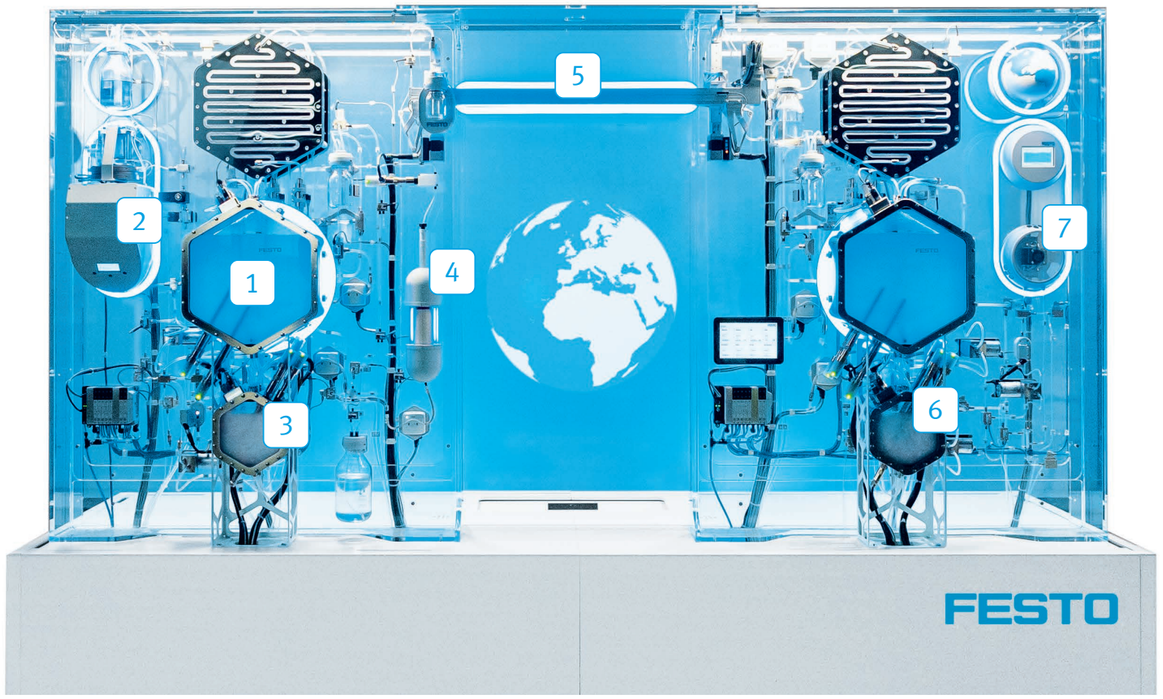


Cultivation reactor: optimized bacterial growth thanks to automation technology

Production reactor: conversion of hydrogen and CO_2 into formic acid



Automation technology in the base: control of complex processes



From Hydrogen to Formic Acid – and Back

Over millions of years of evolution, bacteria have optimized their metabolic processes. We can harness their capabilities by combining them with technology. With the BionicHydrogenBattery, we reproduce the biological process on a small scale, which we could now scale to any size thanks to our automation technology.

1 Multiplication of T. kivui bacteria under optimized conditions in a bioreactor.
2 Hydrogen is produced from water via electrolysis.
3 Bacteria convert CO_2 and hydrogen into formic acid.
4 The acid is extracted and placed in a container.
5 Safe transport of formic acid to the place of recovery.
6 In an identical reactor, the same bacteria break down the formic acid back into its components hydrogen and CO_2.
7 Hydrogen is converted back into electricity in a fuel cell.

Project Participants

Project Initiator: Dr. Wilfried Stoll, Managing Partner, Festo Holding GmbH

Project Team: Dr. Adrian Eilingsfeld, Michael Jakob, Nicolai Knauer, Dr. Elias Knubben, Isabel Lamich, Laura Neuscheler, Cornelius Pflumm, Micha Purucker, Anuj Sambhare, Sebastian Schrof, Dr. Michael Sinsbeck, Emily Stafira, Philipp Steck, Xiaojia Yao, Festo SE & Co. KG

Cooperation Partner: Prof. Dr. Volker Müller, Yvonne Burger, Goethe University Frankfurt

Technical Data

A total of 117 different product types (equivalent to 1,089 parts) from the Festo portfolio are installed in the exhibit.

Components for Liquid Handling:
- Media separated solenoid valves VYKB and VYKC
- Media separated pneumatic valves VZDB
- Pinch valves VZQA
- Mounting plates VABS
- Peristaltic pumps with servo motor EMMT and servo drive CMMT-ST

Components for Gas Handling:
- Proportional pressure regulator VEAB
- Proportional flow control valve VEMD
- Service unit MS4
- Filter unit MS6-LFM with micro filter MS6-LFM-AI
- Fitting NPCK

Components for Control:
- Automation systems CPX-E and CPX-AP-I
- Reliable power supply with power supply unit CACN
- Operator unit CDPX
- Modular valve terminal VTUX
- Color sensor SOEC

Components for Transport:
- Toothed belt axis unit ELGS
- Mini slide unit EGSS

Festo SE & Co. KG
Ruiter Strasse 82
73734 Esslingen
Germany
Phone +49 711 347-0
cc@festo.com
→ **www.festo.com/bionics**

en 4/2024