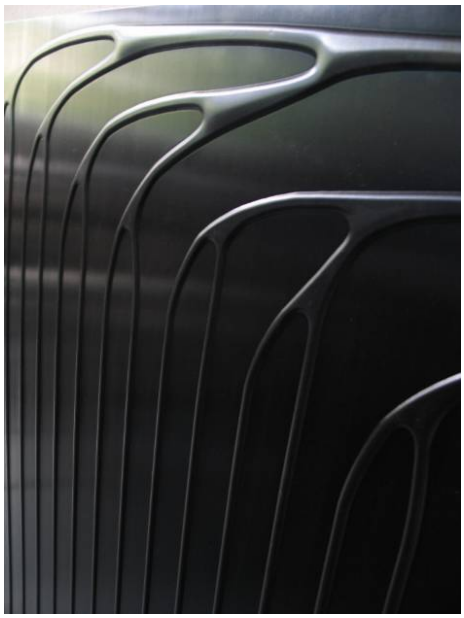
BIONICOL - DEVELOPMENT OF A BIONIC SOLAR COLLECTOR WITH ALUMINIUM ROLL-BOND ABSORBER

Project status after second year

Project aim



The aim of the project is to develop solar collectors with absorbers which feature bionic channel structures ("FracTherm®" structures), which are multiply branched in a fractal way in order to obtain a uniform flow distribution, a low pressure drop as well as a high thermal efficiency. The absorbers will be built of aluminium using the so-called roll-bond process. Small solar absorbers have already successfully been built in a previous research work. It is now necessary to develop collectors with typical dimensions needed for the market up to a prototype stage and demonstrate their efficiency and functionality as a basis for a following series production. It is expected that high-efficiency collectors at low costs can be obtained as a result of the project. The collectors are to be investigated for a wide temperature range in order to cover various applications. To reach the mentioned aims, the FracTherm® algorithm is to be developed further and the obtained designs have to be produced, evaluated and optimized. Moreover, the possibilities and constraints of the roll-bond production process have to be investigated in order to find out the best possibilities to produce a solar absorber with maximum efficiency and minimum costs. One of the very important tasks of the project will be the coating of the absorber after its channels are produced. Finally, the absorber has to be mounted into a collector casing and thus also has to fulfill a number of requirements. The target of a prototype and small-series production is to demonstrate the possibilities of manufacturing FracTherm® solar collectors with variations of the absorber. In order to prevent corrosion, it is necessary to work on appropriate heat transfer fluids. It is intended to build demonstration systems in various sites in Europe which are operated for more than one year within the project. The final objective is to evaluate the competitiveness of the developed solar collectors with state-of-the-art products.

Work done so far

During the first two years of the BIONICOL project the consortium carried out basic investigations concerning possibilities and restrictions with respect to both manufacturing and operation of roll-bond absorbers with special focus on multiply branched FracTherm® channel designs. After the specifications needed for a competitive solar collector had been defined, tests with different bifurcation and header designs were done. Concerning the header construction it turned out that a flat roll-bond header would lead to too high pressure drops. Therefore either a tube solution or an alternative header construction with appropriate cross sectional area has to be used. Due to cost reasons a tube solution will be followed in the first step. After the principal investigations different roll-bond channel designs were made and produced by CGA (Figure 1).

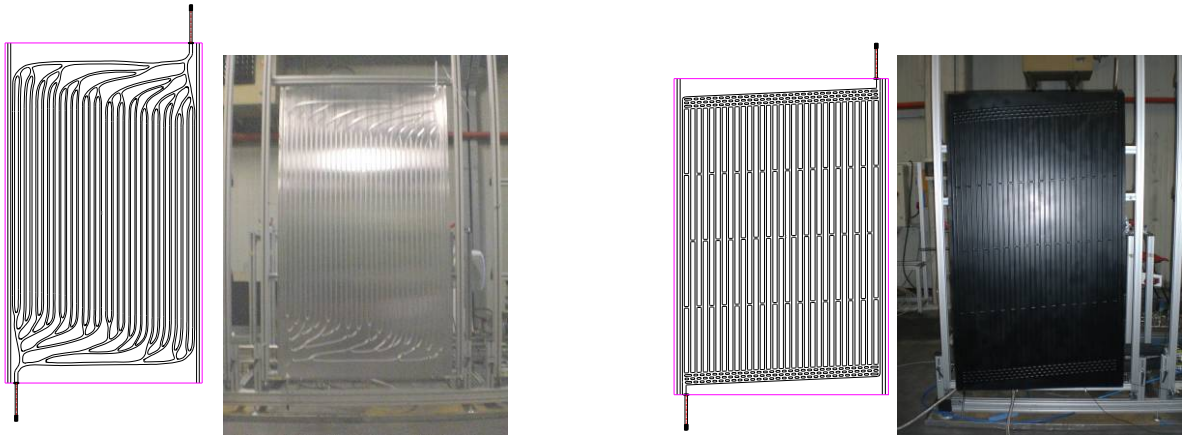


Figure 1: Roll-bond panels with FracTherm® (left) and CGA design (right)

In order to better understand flow phenomena occurring in FracTherm® bifurcations, Computational Fluid Dynamics (CFD) simulations were carried out (Figure 2). In the simulations no sudden pressure drops at bifurcations – as would be expected in conventional T- or Y-pieces – could be observed. A newly developed fluid dynamics test facility will allow for measurements and visualizations of fluid flow in real absorbers as well as in scaled models. The pressure drop of the FracTherm® absorber was very low compared to other designs within roll-bond technology (CGA design (Figure 3) and another, optimized design mentioned in the literature). Its fluid flow distribution – evaluated using thermography (Figure 4) – was more uniform, but not yet perfect.

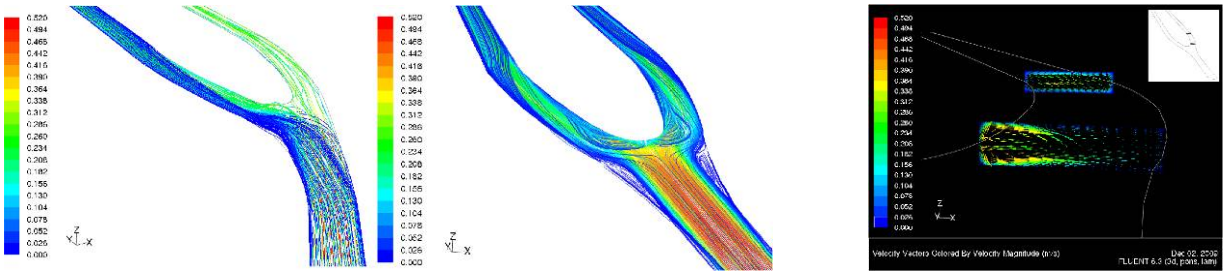


Figure 2: Streamlines of different bifurcations (left), DEAN vortices after bifurcation (right)

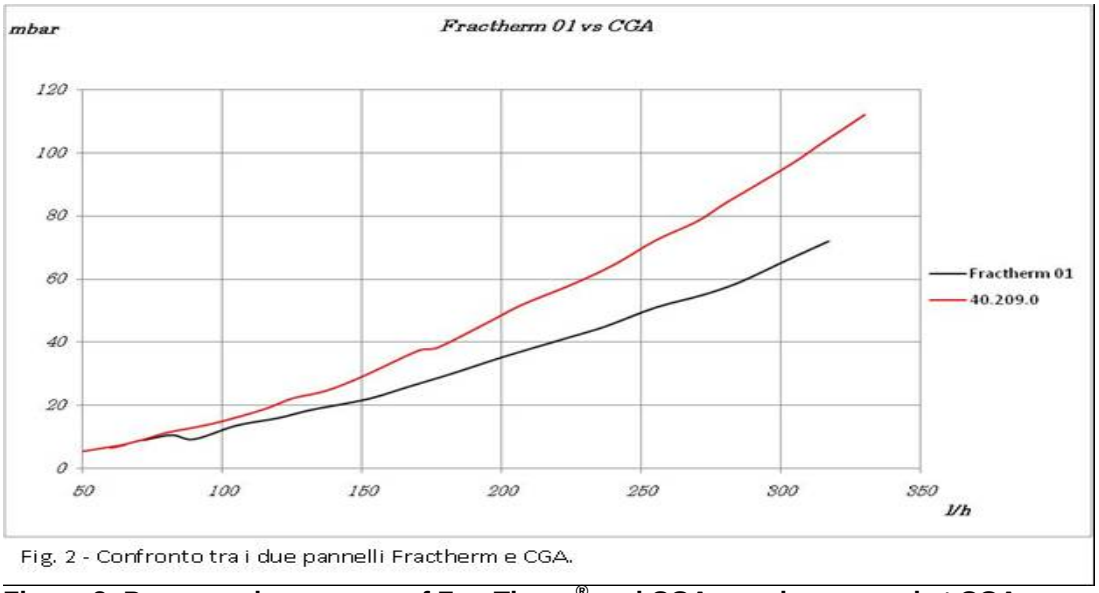


Figure 3: Pressure drop curves of FracTherm® and CGA panel measured at CGA

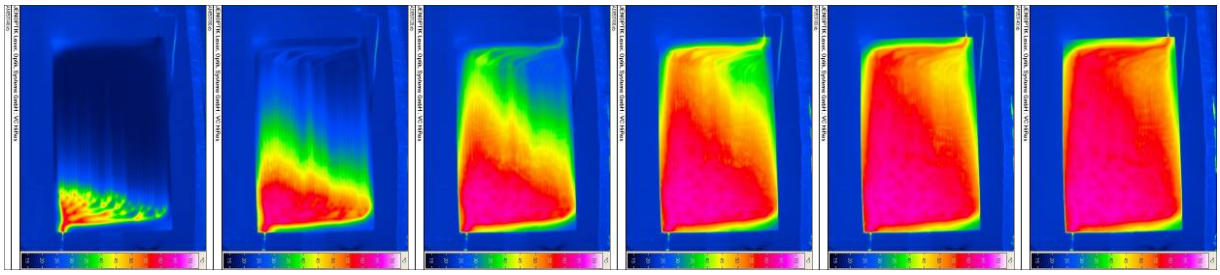


Figure 4: Thermography sequence of absorber with FracTherm® channel design

In order to be able to apply a selective coating on roll-bond absorbers, an appropriate pre-treatment consisting of brushing/polishing and cleaning is necessary. With this pre-treatment it was possible to coat the absorber samples using the coating plant of FRAUNHOFER ISE. For commercial use the adaptation of an existing coating plant of INTERPANE would be possible, but not within the project due to high investment costs. The physical properties of the absorber coatings were close to state-of-the-art values.

Corrosion prevention is one of the main issues with respect to roll-bond technology. After standard ASTM D 1384 corrosion tests had been carried out successfully with different TYFOROP fluids during the first project year, the focus in the second year was on more realistic tests in a solar collector loop. The tests were done at TISUN under repeated stagnation conditions (evaporation and condensation) up to 200 °C. During the tests fluid samples were continuously taken and analyzed by TYFOROP. Even after 195 days and several stagnation situations the commercially available heat transfer fluid TYFOCOR® L proved to be suitable with respect to corrosion protection and did not show any critical change in properties (Figure 5). Therefore this fluid is intended to be used for the demonstration plants to be built during the third year.

Figure 5: Appearance of selected fluid samples taken during corrosion test under stagnation conditions

Prototype solar collectors with selectively coated absorber (Figure 6) were assembled by TISUN and sent to FRAUNHOFER ISE for performance tests (Figure 7). These tests were carried out successfully at the beginning of the third reporting period.

Due to a delay of the project the field test installations could not yet be started. The main task to be done is the development of the second generation of prototypes, which again mainly depends on an appropriate header solution. As soon as the production of these second generation prototypes can start and a time schedule is more clear, the field test installations can be done. The necessary preparation, e. g. selection of components for the data acquisition system, has already been done. The production of the heat transfer fluid is not crucial, since the commercially available fluid TYFOCOR® L will be used.

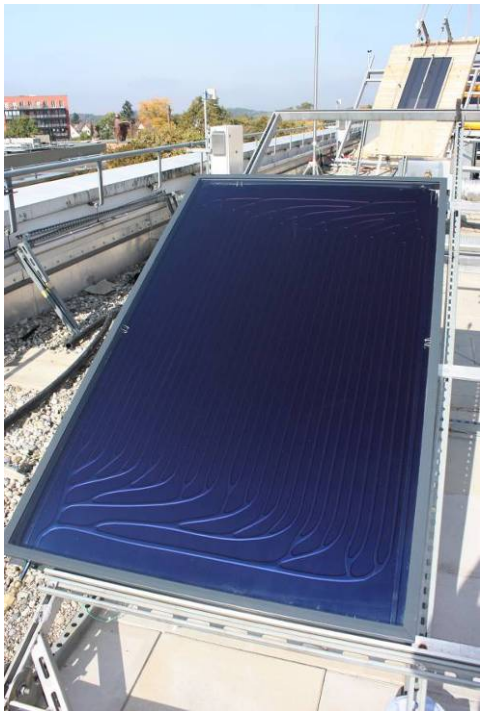


Figure 6: First generation prototype of BIONICOL collector

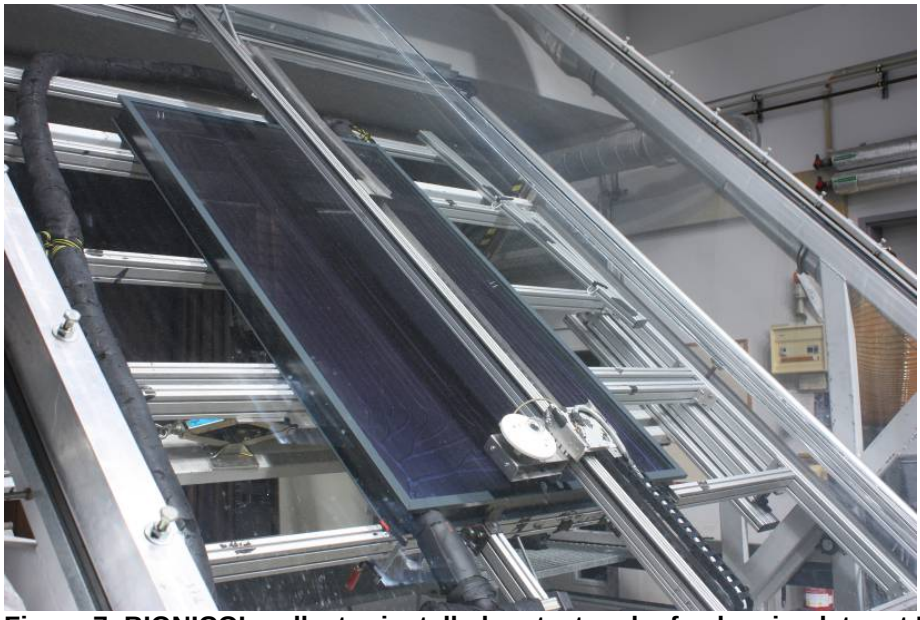


Figure 7: BIONICOL collector installed on test rack of solar simulator at FRAUNHOFER ISE

Project data

Project duration: 1.9.2008-31.8.2011

Project consortium:

Fraunhofer Institute for Solar Energy Systems, Germany **(coordinator)**

TiSUN GmbH, Austria

CGA Technologies S.p.A., Italy

INTERPANE Entwicklungs- und Beratungsgesellschaft mbH & Co KG, Germany

Tyforop Chemie GmbH, Germany

Website: www.bionicol.eu

Contact

Dr.-Ing. Michael Hermann
Fraunhofer Institute for Solar Energy Systems ISE
Heidenhofstraße 2
79110 Freiburg
Germany

Phone: +49 (0) 7 61/ 45 88-54 09
michael.hermann@ise.fraunhofer.de