Fraunhofer Institut
Solare Energiesysteme

FracTherm®

Fractal Hydraulic Structures for Solar Absorbers and Other Heat Exchangers

Fraunhofer Institute for Solar Energy Systems ISE
Heidenhofstraße 2
79110 Freiburg
Germany
Tel.: +49 (0) 7 61/45 88-0
Fax: +49 (0) 7 61/45 88-9 000
www.ise.fraunhofer.de

Give us a phone call!
We are happy to provide competent advice, without obligation and specific to your application.

Dr. Michael Hermann
Tel.: +49 (0) 7 61/45 88-54 09
Fax: +49 (0) 7 61/45 88-94 09
E-Mail: Michael.Hermann@ise.fraunhofer.de

Naturally better!

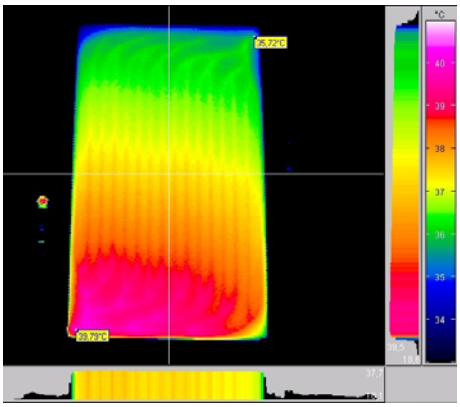
Heat exchangers are important components of technical systems, both those using fossil fuels and those based on renewable energy sources. The solar absorber, the core of a solar collector, is a heat exchanger in which the solar radiation is absorbed and transferred to the heat transfer medium. The total energy efficiency of such a heat exchanger strongly depends on how uniformly the heat transfer fluid flows through the channels and on the pressure drop of this component, which influences the energy demand for the pump.

Conventional heat exchangers normally feature channel structures arranged in series or in parallel – in solar technology known as absorbers with serpentine or parallel flow, respectively. However, these absorbers are often connected with drawbacks, e. g. a large pressure drop or a non-uniform flow distribution.

In nature, one can find networks of flow channels that provide energy-efficient heat and/or mass transfer such as systems of blood vessels or veins of leaves. However, these natural constructions are neither serial nor parallel, but mostly multiply branched structures. These self-similar structures can be described mathematically as "fractals".

An algorithm developed at Fraunhofer ISE and patented since 2005 aims at transferring such natural structures to technology (bionic approach). By means of this *FracTherm*® algorithm, a given area can be provided with a suitable fractal hydraulic structure after determining the inlet and outlet points.

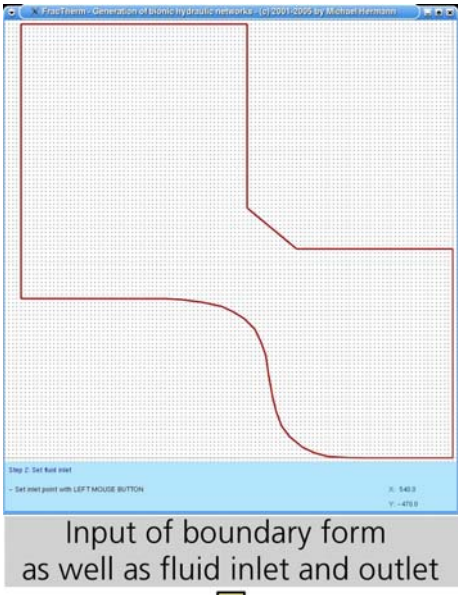
FracTherm® solar absorber in collector casing (here without glazing)



Thermograph of a *FracTherm* solar absorber after entrance of warm water

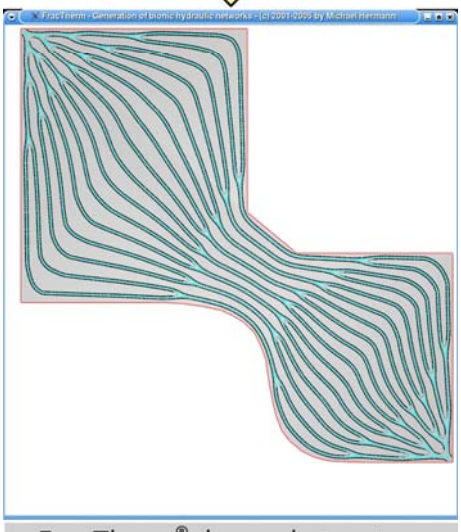
March 2007

Fractal Hydraulic
Structures for
Solar Absorbers and
Other Heat Exchangers



Input of boundary form
as well as fluid inlet and outlet

FracTherm®



FracTherm® channel structure

FracTherm® fits...

The *FracTherm*® algorithm is extremely flexible with regard to the boundary form input, describing the area where the channels are to be applied. The generated hydraulic structure fits the input geometry very well, e. g. also narrowing within the area is considered when the bifurcation points are distributed.

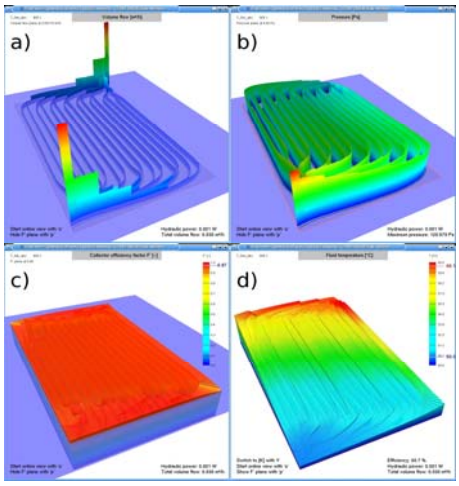
The appearance of the structures is determined by several network parameters, so that an abundance of possible variants can be implemented. However, the ultimate aim of the algorithm is to uniformly distribute the channels over the area with small flow deflections in order to obtain a high total efficiency.

The *FracTherm*® algorithm is implemented in a computer program with the same name to evaluate individual variants using hydraulic and thermal simulations. The generated structures can be exported as DXF files and thus be used with CAD and CAM programs. Thus, prototypes and series products can be produced by milling, casting, stamping, roll-bonding or similar processes.

In experiments, a solar absorber produced by roll-bonding showed a high thermal efficiency and a significantly reduced pressure drop for high mass flows compared with state-of-the-art channel configurations.

...your profile also!

With *FracTherm*® individual proposals for heat exchanger structures can be prepared according to customer specifications. We would be happy to make you an appropriate offer. We are also always interested in working with industry on joint projects.



Hydraulic and thermal simulations with *FracTherm*®
a) Volume flow
b) Pressure
c) Collector efficiency factor F'
d) Fluid temperature

Design of a *FracTherm*® heat exchanger for cooling of a concentrator solar cell

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