toughTrough: From renewable to invincible

Posted by Rikki Stancich [1] on May 18, 2012

German OEM toughTrough has delivered a highly efficient, low-cost, virtually indestructible concentrated solar power collector. CSP Today speaks to toughTrough CEO Carsten Holze to learn more.

By Rikki Stancich in Paris

As with most brilliant ideas, the toughTrough [2] concept is simple. Borrowing heavily from the aeronautics and automotive sectors, toughTrough has neatly sidestepped the need to 'reinvent the wheel' on composite materials and manufacturing. The end result is a virtually indestructible, lightweight parabolic trough collector that is 25% cheaper than existing models, designed for industrial-scale manufacturing.

Founded in 2011, toughTrough is a joint venture between German aeronautics engineering R&D firm machtTechnik [3]AG and the shareholder of automotive manufacturing firm Brüggen [4]GmbH. And therein the secret to their success lies.

The geometric dimensions of the toughTrough collector shell share significant symmetry to those of an aircraft fuselage. This has enabled the equipment manufacturer to use the same composite materials, material facilities and handling tools that are used by the aeronautics industry, while incorporating manufacturing processes from the automotives sector.

Perhaps most importantly, according to toughTrough CEO Carsten Holze, the mirror shell can be manufactured in one integrated single step. The use of composite materials accommodates a fast, high-precision manufacturing process, which results in the production and integration of 3 to 4 collectors per hour by a single assembly line – an in-house record that toughTrough says it will soon beat.

The stiffness and strength of the shell means that only few supports or cantilevers are required to hold the curved mirrors in place. With reduced wind loading due to shape and component optimization and lower collector weight, the environmental impacts as wind loading and potential earth quake loading is different, which means that the other components such as pylons and foundations also look different, explains Mr Holze. With each collector weighing approx. 1 ton – half the weight of a EuroTrough design - the end result is a lighter-weight, simplified design structure.

So where exactly do the cost reductions play in? According to Mr Holze, the company has achieved more than a 25% cost reduction on foundations, more than 25% cost reduction on the mirror shell and collector frame as well as in the pylons. In parallel the higher collector stiffness and corresponding optical accuracy as well as highest mirror reflectivity due to the use of thin glass mirrors lead to a considerable performance increase.

Survival of the fittest

The technology has already been subjected to rigorous mechanical and optical testing at qualification and test facilities across Europe. toughTrough started out testing small-scale samples, which yielded "excellent" deflectometry measurements of below 1 millirad. Milliradiation, (milliards), measures how far off focus the system can be and still collect energy efficiently.

Last October, larger samples were manufactured and implemented at the worst possible operational angles (60 degrees and 120 degrees, or 10:00am and 14:00pm, assuming the zenith orientation at noon). Wind loading was applied, and the samples yielded an accuracy of below 2 millirads – an extremely good result.

Finally, in April this year, the collector was subjected to fatigue and earthquake resistance tests. To emulate an 8 Richter magnitude earthquake, “the most powerful earthquake imaginable”, the company swung a 600kg demolition ball into the side of the collector.

“Perhaps we are sometimes overly-scientific,” laughs Mr Holze. “I don’t know of any other competitors that have carried out this level of testing”, he adds.

The collector passed the ‘earthquake’ test with flying colours: the glass mirror collector remained intact; the collector held its shape; and the shock absorbing foundations (similar to those used on railway lines) were left intact. Miraculous? Unlikely. Well engineered? Undoubtedly.

For Mr Holze and his team, the wrecking ball put the company’s design philosophy to the ultimate test. “Our approach is to start with a theoretical model, and then to subject every component to rigorous numerical analysis, mechanical testing and calibration”, he explains.

Mr Holze says the design process started out with complex analysis in wind tunnels in order to arrive at the design loads and torque moments on the mirrors. Based on this analysis, the mirror shell was fabricated in a precision mold designed to take the torque moment (the torque tube, he says, is pre-manufactured and easy to install).

The product’s quality is built into the production process, says Mr Holze. The mirror’s optical precision is ensured by the panel’s high degree of stiffness and the precision mold. In other words, there is no need for post-assembly optical tuning.

“It’s a different philosophy of manufacturing,” he says, explaining, “We have a central torque tube into which we integrate four ribs using a single precision bolt for each rib, to ensure geometrical and associated mirror accuracy. The four mirror shells are then integrated with eight precision bolts”.

The collector is a sandwich structure comprising a polyurethane core (roughly 25-50mm thick) sandwiched between a thin glass mirror layer, and a steel backing, the thickness of which can vary according to the needs of the customer.

Why didn’t toughTrough opt for lighter-weight, harder-wearing aluminum? According to Mr Holze, the thickness-to-cost ratio was too expensive, compared to the “incredibly inexpensive” 35 tons of back-and-front coated steel coil the company ultimately opted for.

toughTrough’s mobile manufacturing process is designed for on-site for the fabrication of thousands of square meters of mirrors, for plant sizes ranging from 20MW – 200MW. The highly automated production process requires 3 – 4 personnel for a single assembly line.

Once a job is complete, the mobile production unit can either be moved to the next CSP solar field construction site; or can be put to use manufacturing a variety of other CSP and non-CSP-related components and products. “Not only is [the toughTrough’s] concept and design perfect, it is also perfect from a manufacturing perspective”, surmises Mr Holze.

Beyond parabolic troughs

The company is working on several pilot plants in a range below 5MW in America, Middle East and the MENA region. However, Mr Holze takes pains to point out that the production concept is not limited to parabolic troughs.

“Parabolic troughs were our initial focus, however, we have since developed production systems for heliostats and dishes”. The company has already manufactured heliostat as well as mirrors for dishes with diameters of up to 10m.

To gain a manufacturer’s insight into future market trends, it is worth asking where demand is likely to be greatest, in terms of product type (heliostats, troughs or dishes) and technology type (CSP or CPV). Mr Holze’s response is even-handed: “There is a lot of potential for a range of solar and non-solar applications, so we are not driven by discussions of CSP technology types, or whether it

will be PV or CSP in the future”.

To respond to this article, please write to the Editor:

Rikki Stancich: rstancich@csptoday.com [5]

Links:
[1] http://social.csptoday.com/users/rikki-stancich-0
[2] http://www.toughtrough.com/
[3] http://www.machttechnik.de/
[4] http://www.brueggen-gmbh.de/brueggen2/
[5] mailto:rstancich@csptoday.com