Longer life for receivers

Schott Solar claims that it is the technology and market leader in solar thermal power plant receivers. New projects have filled the company’s order books, and product innovations are in the starting blocks.

It has been rough going in the market for solar thermal power plants lately. But Christoph Fark, Managing Director of Schott Solar CSP in Germany, has a positive view of the current market, “We believe that we are far superior to the competition and we have a good view of the market moving forward.”

Fark admits that the company is not immune to competitive pressure, the generally weak financial market situation and macroeconomic weaknesses, such as the effects of the budget deficit on the Spanish market. “But we see new markets that are opening up to CSP.” India, North and South Africa, as well as China are among those new markets. Schott has seen a flurry of activity in China, for instance, which may well boost revenues.

Production lines fully utilised

The three production facilities where Schott Solar produces its standard PTR 70 receivers and the 400 employees who work at them are operating at full capacity and are capable of producing a gigawatt year, according to Fark. The company has one 200 MW production line in Mitterteich (Germany), as well as two 400 MW lines – one located near Seville, in Spain, and another in Albuquerque, New Mexico (USA). “We re-started the second line in the USA after we saw a spike in demand,” says Fark.

He said that currently business was good in the USA, Spain and India. “We’re supplying large-scale projects in the USA and we have a market share in Spain that is well over 70 %,” Fark says. Of the 2.5 GW listed in the Spanish government register of projects slated to receive feed-in tariffs, 1.1 to 1.2 GW has already been connected to the grid, and the rest is either under construction or will be installed by the end of next year.

Refining the standard receiver

Schott Solar essentially only has one competitor on the global market, Siemens. Furthermore, there is only one other consortium that manufactures receivers, and Siemens is a stakeholder in it. Schott stands behind its standard receivers which it has manufactured independently since 2005. The company’s experience with receivers goes back to the 1980s, when it supplied glass tubes for the first solar thermal power plants in the California desert. Schott has refined its PTR 70 receivers several times over the past few years and has managed to increase the performance of solar fields by 3.9 %. “Essentially, we did that by optimising the absorption layer of the receiver tubes and by minimising thermal losses through the enveloping glass tube,” says Fark.

Noble gas capsules improve performance

Schott presented a new innovation at the SolarPACES conference in Spain last September, a capsule filled with noble gas which will be added to receivers in the...
future. The capsule will significantly limit the effects of aging on these core components of solar thermal power plants. When power plant operators allow the thermal oil, which circulates through the receiver tubes currently in use, to overheat too often it releases hydrogen which diffuses through the steel receiver tubes into the ring joint between the steel tube and the outer glass tube. This phenomenon occurs with all of the receivers currently on the market. The hydrogen is such a good thermal conductor that the insulation effect of the vacuum is lost and the receiver has to be replaced.

In future, receiver tubes can be delivered from the factory, fitted with a sealed noble gas capsule at the ring joint. The capsule can be opened with a laser as soon as the effect occurs. The gas is released, equalising the pressure between the hydrogen and the noble gas. “This is a huge benefit for power plant operators because it ensures long-term power generation,” says Fark. The noble gas significantly reduces thermal losses and the receiver has almost the exact same properties as it did when it rolled off the line. Under normal conditions, the capsule can be opened with a laser as soon as the effect occurs. The gas is released, equalising the pressure between the hydrogen and the noble gas. “This is a huge benefit for power plant operators because it ensures long-term power generation,” says Fark. The noble gas significantly reduces thermal losses and the receiver has almost the exact same properties as it did when it rolled off the line. Under normal conditions, the capsule can be opened after about 25 years. Schott Solar CSP wants to begin delivering its first noble gas receivers this fall.

Developing larger receivers

In addition to refining existing receivers, manufacturing larger receivers also promises improved performance in the solar thermal power plants of the future, “We have seen a tendency with just about every project developer to take the larger-receiver approach.” For these customers, Schott Solar has developed the PTR 90. The PTR 90 has a steel absorber tube with a 90 mm diameter instead of the traditional 70 mm. This increases the aperture area, boosting thermal yield by 50 %.

But the receiver’s insides are not the only thing that has taken on larger dimensions. The glass enveloping tube has a 30 % larger diameter, and the absorber is 20 % longer. The overall design for the foundations, mountings, and reflectors has to be completely re-worked to accommodate the larger receivers. Of course, such a system also has a larger area subject to wind forces and it has to be engineered to withstand the added strain. Collector designers are currently working on this issue.

Products for high temperature thermal medium

Solar thermal power plants can be made even more competitive through increasing the efficiency of the plant’s turbine by substituting thermal oil, which is limited to 400 °C, with molten salt or steam as the heat transfer medium coursing through the absorber tubes. Both salt and steam can handle temperatures up to 550 °C. Salt can be stored directly in thermal storage tanks and steam can flow straight to the turbine without the need for a heat exchanger. In addition, both salt and steam are cheaper than the thermal oil typically used.

Both methods present new challenges, however. The salt hardens at a relatively low freezing point. If a few days pass without any sunshine, the collector field can get plugged up. Designers are looking for salts with lower freezing points or ways of heating the receivers. “We’re working on the latter option very intensively,” Fark says. Receivers designed to work with steam must be able to withstand pressures exceeding 100 bar, rather than the 40 bar requirement for receivers that use thermal oil. “To meet that requirement one of the things we have to do is increase the wall thickness of the steel tubes,” the Schott expert says.

The greatest challenge, according to Fark, was designing an absorber coating that would be stable enough over the long term to withstand continuous operating temperatures exceeding 500 °C. Despite these particularly demanding requirements, Schott Solar’s technology has apparently come a long way, “We supply products for both technologies,” says Fark, “some of which have been installed in the first commercial systems.”

Cost-cutting, the corporate mantra

The foremost goal of research and development at Schott Solar is making solar power plants more competitive. Rapidly falling prices for photovoltaics have left CSP companies scrambling to catch up. CSP does have one major advantage over PV already, however, dispatchability. The on-demand dispatchability of CSP power means that it can contribute to the stability of the grid.

But, says Fark, “The goal is to be competitive with conventional middle-load power plants.” The cost development is encouraging. Currently, with favourable financing, CSP power plants can generate electricity for just 0.16-0.18 US$/kWh; in India the cost is around 0.17 €. Fark speaks of the next goal, “In the medium term, the CSP industry is aiming for power generation costs of 0.10 €/kWh.”

Engineer Christoph Fark has been the Managing Director of Schott Solar CSP GmbH, Germany, since 2008. He has worked at the Schott group since 2003, initially working at the Schott-Rohrglas GmbH and Schott Solarthermie GmbH subsidiaries.

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Graphic: Schott