silicon products
RESEARCH ENGINEERING PRODUCTION

Background information on the converter technology

Innovation regarding the hydrogenation process with the new development of the second generation hydrogenation reactors (converters)

The Siemens process for the production of high-purity silicon is a chemical-thermal process at temperatures between -45 and 1400 degrees centigrade. It is made up of the following stages:

- tank farm
- production facility for silicon slim rods for mounting in Siemens reactors
- hydrogenation of silicon tetrachloride using hydrogenation reactors (converters)
- process gas treatment and purification
- multi-stage distillation facility
- silicon deposition in deposition reactors – so-called Siemens reactors – for the production of our high-purity silicon
- facilities for the generation of compressed air, exhaust gas and waste water treatment

Despite the longstanding and worldwide production experience with the Siemens process and the developments that have been made the individual process stages still offer considerable potential for cost reductions.

In addition to the deposition of silicon in so-called deposition reactors (Siemens reactors) the thermal hydrogenation of chlorosilanes is the central stage in which considerable energy and cost savings – regarding production as well as investment – will still be possible in the future. This reaction takes place in converters.

The thermal conversion is the transformation of silicon tetrachloride ($SiCl_4$) into trichlorosilane ($HSiCl_3$) at high temperatures, medium pressures and in a hydrogen atmosphere based on the following molecular formula:
(Thermal conversion of silicon tetrachloride with hydrogen (H_2))

$$\mathbf{SiCl_4 + H_2 \leftrightarrow HSiCl_3 + HCl}$$

This reaction is an equilibrium reaction which crucially determines the course of the reaction and correspondingly the geometry of the reactors.

Based on the longstanding production experience of Silicon Products and the recognized potential for improvement developments were pushed ahead and successfully implemented in the second generation of converters in 2013.
At the restart of the production facility this new type of converter was successfully tested. The significant increase of the conversion factor by more than 30% - from 12.5% by mass to 16.5% by mass - results in considerable economic advantages in the operation of the existing production facility (energy savings of 12%) and for new investments.

Market development

The overall photovoltaic market will continue to increase strongly in volume in the next few years and in all stages of the value-added chain cost reductions and efficiency improvements will be required so as to

further increase the economic efficiency and competitiveness of solar power compared to fossil energy sources.

Market research shows that the worldwide demand for high-purity and competitive solar-grade silicon for photovoltaic applications is going to increase annually into double-figures. In this regard improved technological solutions for product optimization and the resulting cost reductions are of the utmost importance.

In 2012 the worldwide production capacity of silicon stood at approximately 250,000 MT and various forecasts show a possible increase in demand to over 800,000 MT in 2025.