

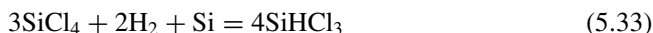
silica is about 60 000 MT measured in terms of silicon unit. This presently corresponds to three times the output of polysilicon in 2000. Moreover, a significant portion of fumed silica is also produced by burning derivated by-products from the silicones industry. In the early stages of the polysilicon industry, the fumed silica business could absorb the excess of silicon tetrachloride generated by the Siemens process. This explains the arrangements between polysilicon and fumed silica producers all around the world. With polysilicon production growing much faster than silicones and fumed silica, the question was whether to eliminate or recycle the tetrachlorosilane. This became an environmental and economical necessity. The concept of recycling on site the by-product back to the valuable starting material to form a closed-loop production process is generally an ideal preferred solution today. There are two basic chemical processes applicable to reconvert SiCl_4 to SiHCl_3 :

1. The high temperature reduction of silicon tetrachloride with hydrogen.



At about 1000°C , a 1:1 molar mixture of SiCl_4 and H_2 produces approximately 20 to 25% molar SiHCl_3 in the gaseous mixture. This process requires a fair amount of electrical energy but has a distinct advantage that the trichlorosilane produced is of very high quality because both reactants, silicon tetrachloride and hydrogen, are basically electronic grade when produced by equations (5.28) and (5.31).

2. The hydrogenation of silicon tetrachloride in a mass bed of metallurgical silicon.



This hydrogenation reaction produces approximately 20% trichlorosilane at 500°C , 35 atm with a 1:1 ratio of SiCl_4 to H_2 in one pass through a mass bed of metallurgical grade silicon in a fluidised bed reactor.

In spite of its widespread and dominant position in the industry, the Siemens process as described above suffers from the following disadvantages:

- High energy consumption, over 90% of the input power is lost to the cold walls of the reactor.
- Two power supplies and preheating of the seed rods are normally required because the high-resistivity ($\sim 230\,000$ ohm cm) seed rods require very high power supplies and high initial power rates to heat the rods. Therefore, a separate power supply for quartz lamps or graphite rod induction heating is used to preheat seed rods to about 400°C (~ 0.1 ohm cm). Lower power electrical supplies can then be used to provide continued heating and control.
- Electrical contacts to seed rods are made of graphite, which is a source of contamination.
- Power failure (especially when starting the process) causes run abortion.
- Hot spot formation and filament burn out may occur.
- Problems arise owing to gas inclusions and to non-uniform deposition at the joints.
- Gas flows and electrical power have to be adjusted during the process to obtain optimal deposition rate.