

## NEW COMPRESSOR WITH MAGNETIC BEARINGS TARGETS THE SOLAR INDUSTRY

With the increasing use of solar cells, the demand for polysilicon has risen dramatically in recent years. To satisfy demand, a new production process has been introduced. FIMA Maschinenbau GmbH has designed a new compressor with magnetic bearings for this process. Although shafts mounted on magnetic bearings are not new, compressor working conditions – hydrogen atmosphere, heavy impellers, no impurities – are. The compressor is suitable for all gas applications.

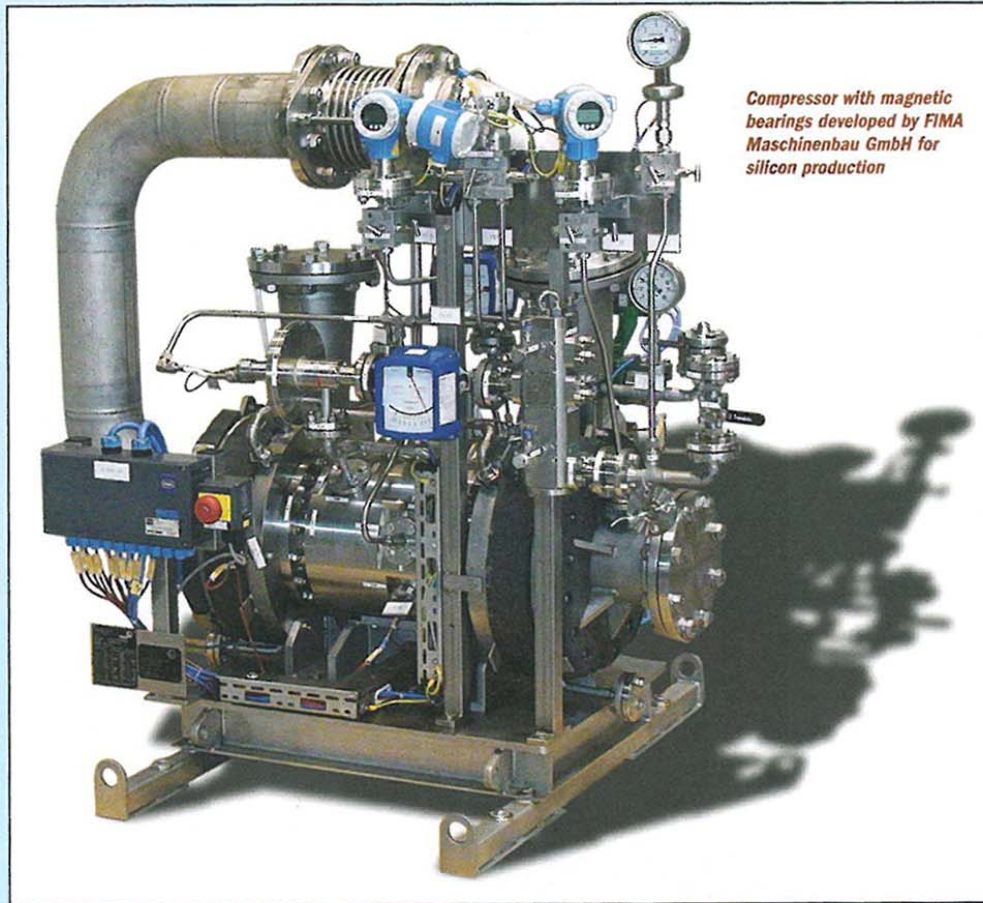
In the conventional production process, impurities are extracted from the raw silicon in time-consuming distillation steps via an intermediary step involving trichlorosilane. In the new process – called monosilane pyrolysis – monosilane decomposes at high temperature into pure silicon and hydrogen. Polycrystalline silicon settles on previously inserted seed rods and can be “harvested” every five to six days. As the process is cyclic and high-purity silicon is obtained, special compressors are called for that do not generate any particles or allow the penetration of alien molecules. Furthermore, an explosive atmosphere must not be allowed to develop within the hydrogen cycle.

The conventional compressor, with seals, driven by gears and motor, cannot be used in the process, as seals touching one another would release miniscule particles into the hydrogen gas system. For this reason the compressor has to be hermetically sealed; with the entire drive unit being located in the hydrogen process chamber. All dynamic seals are thus dispensed with; only static seals and cable lead-ins are featured which do not generate any particles.

Once the drive unit is located in the hydrogen process chamber, conventional bearing mountings cannot be used, as they would allow contamination by lubricants. In the new solution, a shaft is held by the magnetic bearing in the hydrogen gas both when at a standstill and at high speeds in a state of suspension. The required low leakage rate of  $10^{-6}$  mbar l/s made it necessary to mount flanges with special O-ring sealing for exceptionally high tightness levels for small gas molecules. Besides helium, hydrogen molecules are the smallest in size. For this reason, special materials had to be used to prevent the hydrogen molecules from penetrating the materials. A state-of-the-art

cable bushing had to be developed for the four control and sensor cables of the drive and magnetic bearings, to ensure the necessary tightness between the individual cable wires.

In order to achieve high drive efficiency and, at the same



*Compressor with magnetic bearings developed by FIMA Maschinenbau GmbH for silicon production*

time, low gas heating between the rotor-stator gap, a synchronous drive is used. High-performance magnets are embedded in the shaft and bring the latter up to a speed of 21,000 rpm. The coils of the magnetic bearing and motor are moulded in plastic to prevent the emission of particles caused by electrical oscillations in the coils. The compressor can be controlled across a wide speed range. In the event of extended periods of non-use, the shaft can be deposited in a holder bearing with ceramic beads.

Despite the high circumferential speed of 400 m/s at 21,000 rpm of the impellers weighing 11 Kgs, the compressor features a sub-critical rotor. All speeds remain at least 20% lower than the critical bending speed so that the hydrogen process can be reliably controlled across a wide speed range.