Solar Pumps

# Plastic AODD Pumps for Manufacture of Solar Cells

The manufacture of solar cells is a very harsh process. Since the discovery of Photovoltaic (PV) effect in 1839, solar or photovoltaic energy have grown to become major components in the success of a number of industries today. The Plastic Air-Operated Double-Diaphragm (AODD) pumps offer the best of all worlds in the manufacture of solar or photovoltaic cells.

When considering the discovery and development of solar or photovoltaic energy, it should come as no surprise that the genius of such scientific luminaries as Albert Einstein and Nikola Tesla played a prominent role in the harnessing of this energy source. In fact, Einstein, who offered the first theoretical explanation of the phenomenon of photovoltaic effect in 1905, was awarded the Nobel Prize for Physics in 1921 for his efforts in this area.

With the aid of Einstein and Tesla, along with the initial work of French physicist, Alexandre Edmond Becquerel, who is credited with actually discovering the photovoltaic effect in 1839, solar or photovoltaic energy have grown to become major components in the success of a number of industries. Today, such products as solar batteries and solar heating panels are commonplace, while the future hints at such exciting, paradigm-changing developments as solar-powered cars. The basic building block of all solar- or photovoltaic-powered mechanisms are solar or photovoltaic cells, which are defined as "devices that convert solar energy into electrical energy."

## Manufacture of Solar Cells

The first primitive solar cells were built in 1877 by William G Adams, a British professor of Natural History. More than 130 years later, in 2008, scientists at the US Department of Energy's National Renewable Energy Laboratory developed a photovoltaic device that converts 40.8 per cent of the solar light that hits it into electricity.

As of 2006, Germany accounted for 55 per cent of the world's production of photovoltaic energy with Japan, the second-largest producer, at 17 per cent. The United States produced 8 per cent of the photovoltaic energy, which was a 33 per cent increase from the previous year. The foundation of all of this advancement in photovoltaic production is the solar or photovoltaic cell. Solar cell manufacture is a precise, exacting process that can tolerate no inefficiencies or errors in production.

While precise, the manufacture of solar cells is also a very harsh process. After the raw silicon is cut into wafers, they must be cleaned and polished, resulting in pulverised waste pieces of silicon particles that are hard and sharp and must be disposed of. Some of the liquids used to polish the solar wafers are quite abrasive and have to be supplied to, circulated within and drained away during the manufacturing process. After the draining process, these abrasives are usually cleaned of any impurities, filtered and reused.

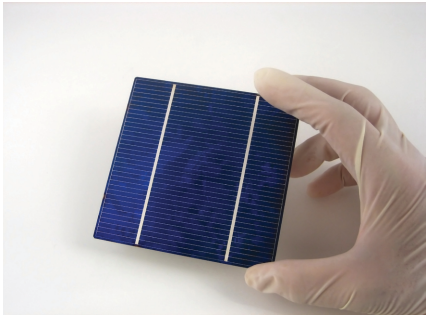
Doing most of the heavy lifting during the various stages of this production process are industrial pumps. Pumps that have a high capacity to resist abrasion, can only complete these tasks.

Fortunately, for those involved in the production of solar or photovoltaic cells, there is a pumping technology available that offers the design, materials of construction, energy consciousness and operational efficiencies that needed for this critical application.

## Plastic AODD Pumps

They are called Plastic Air-Operated Double-Diaphragm (AODD) Pumps. These are positive-displacement pumps that make use of a unique construction that features two pump chambers. There is a diaphragm in each of the pump chambers that are connected by a shaft. When the compression stroke takes place in one chamber, the suction stroke takes place simultaneously in the other chamber.

Other critical parts of the pump's construction are the pump housing, valves and air valve. The pump housing can be made from many types of material, depending on the pump's application. Some popular plastic materials of construction are Teflon®, polypropylene, polyethylene and acetal. Stainless steel, aluminium and cast iron can also be used, but they are not always compatible with the chemicals and abrasives used in solar cell construction. The pump's valves are of a ball-type that fit snugly with the valve seat to ensure that the pump chambers are completely sealed. The air valve, which is sealed off from the pump chambers by the diaphragms, handle the variable displacement of air behind the diaphragms.



*A solar or photovoltaic cell is a device that converts solar energy into electrical energy*

The characteristics of this design offer many benefits for the end-user, among them the absence of an axle seal or other lubricated parts allows the pumps to run dry; no seals means the pumps are guaranteed 100 per cent leak-free; the pump's capacity can be adjusted by increasing or decreasing the air pressure or air volume; and the pump will shut down automatically if the discharge pressure exceeds the air pressure.

When speaking specifically of plastic AODD pumps for use in solar-cell manufacture, Almatec®, Kamp-Linfort, Germany, offers the E-Series line of pumps, which have been designed to meet every challenge. E-Series pumps feature solid-block construction (as shown in Figure 1), which increases their strength and life cycle, while eliminating many maintenance concerns.

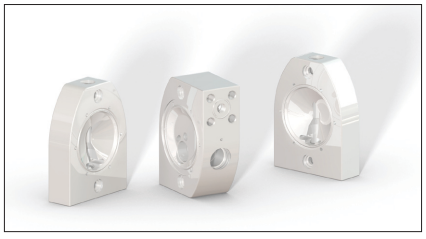


*Figure 1 - Almatec® E-Series Pumps*

Almatec® E-Series pumps have the capability to handle demanding applications found in the manufacture of solar cells because they feature solid-block construction that increases their strength and life-cycle while eliminating many maintenance concerns.

The housing of the Almatec E-Series pumps are constructed in polyethylene (PE) and Polytetrafluoroethylene (PTFE).

**A simplified look at the steps in a typical solar cell manufacturing process shows why**

- Poly-crystalline silicon wafers are made by wire-sawing block-cast silicon ingots into very thin slices, or wafers
- A surface diffusion of n-type dopants is placed on the frontside of the wafer to make a solar cell from the wafer
- Anti-reflection coatings, which increase the amount of light that can be coupled into the solar cell, are then applied
- Silicon nitride or titanium dioxide are applied
- The front surfaces of the solar cells are textured to increase the amount of light that can be coupled into the cell
- The wafer is metallised using silver paste or aluminium paste
- Metal electrodes are attached to the silicon wafer, creating Ohmic contact
- The new solar cells are interconnected in a series by flat wires or metal ribbons and assembled into modules or "solar panels"
- The solar panels have a sheet of tempered glass placed on the front with a polymer encapsulation placed on the back

Both materials are ideal for solar cell production. PE pumps are used for the abrasive silicon carbide slurry. PE has a very high abrasion resistance, which is, for example, seven times higher than polypropylene (PP). The E-Series pumps made of PTFE, which has an excellent chemical resistance, are used for the chemical supply (acids, caustics) within the solar-cell manufacturing. Thinking of these high-purity applications, it is very important that the exterior of the E-Series pumps are free of metal.

The diaphragms are available in Ethylene Propylene Diene Monomer (EPDM) or PTFE/EPDM. Components like ball valves are available in EPDM or PTFE, with the cylinder valves constructed of PTFE. The E-Series pumps are available in seven sizes with maximum delivery volumes up to 48 $m^3/h$ (800 lpm/210 gpm).

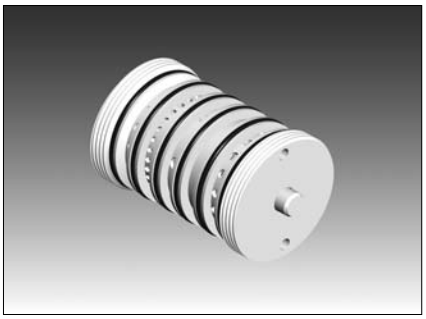


*Figure 2 - PERSWING P® Air-Control System*

The E-Series also features a patented maintenance-free air-control system, called PERSWING P®, which allows for greater flexibility in solar cell applications (Shown in Figures 2 and 3). The

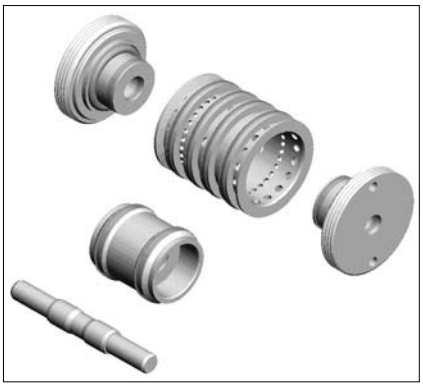


*Figure 3 - PERSWING P® - Dismantled*

E-Series pumps are self-priming and provide gentle displacement of fluids. The compact, solid design makes E-Series pumps easy to install and provide unattended operation with long service life. The pumps are easy to start-up and also include an integrated muffler. Options such as a screw-on pulsation damper, back-flushing system, barrier-chamber system, diaphragm monitor, stroke counting and flange connection are also available.

**Almatec E-Series pumps have the capability to handle demanding applications found in the manufacture of solar cells because they feature solid-block construction that increases their strength and life-cycle while eliminating many maintenance concerns**

### The Almatec Advantages to Solar Cell Manufacturers

- Increased pump safety due to an innovative ring-tightening structure
- Increased product capacity and decreased air consumption
- Reduced noise level
- Optimised flow pattern
- A screwed-on or fanged pulsation dampener
- The pump's structure allows all housing bolts to be tightened against a diaphragm-sized ring on each side of the liquid housing. This creates a greater and more even compression at the sealing surfaces, which results in increased safety.
- The E-Series also features a patented maintenance-free air-control system, called PERSWING P®, which allows for greater flexibility in solar cell applications.
- The E-series pumps are easy to start-up and include an integrated muffler.

## Conclusion

When considering solar or photovoltaic cell manufacture, there is really only one choice for your pumping needs – plastic air-operated double-diaphragm pumps. Due to their broad range of applications based on the different types of liquids that need to be handled, plastic AODD pumps can be used successfully in any circumstance where aggressive and/or dangerous liquids must be pumped with absolutely no risk of leakage. ■

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