For many years, Sulzer Pumps has been providing customers with innovative, technologically advanced and pioneering solutions for their pumping requirements. Over the years, Sulzer Pumps has developed the practice of working closely with clients, understanding their requirements, and designing solutions to match those needs. With an understanding of the customers’ processes and the future developments that will be shaping their industries, the engineers of Sulzer Pumps will continue to create new ideas and methods that will provide solutions to customer needs. Many of Sulzer’s clients in the energy markets are aware of the environmental impact and the finite nature of most fossil fuels. Every combustion process emits carbon dioxide (CO₂) into the atmosphere. The subsequent buildup of CO₂ in the atmosphere is a cause of global warming.

Second-generation biofuels are fuels based on lingo-cellulosic feedstocks and various organic waste materials. Their production uses non-food crops or waste and does not compete with the animal or human food chain.
Tailor-made solutions
Numerous companies in the energy markets currently work on new technologies to reduce the emission of CO₂. The use of carbon-neutral energy sources like solar power or biofuels is one approach. As long as fossil fuels have to be burned, another approach is to capture the CO₂ at the point of origin and to store it in locations where it has no impact on the earth’s atmosphere.

Such future-oriented concepts have significant potential to support the fight against global warming. These new technologies call for dedicated pumping solutions, which are tailor-made to meet their very specific and challenging requirements, such as managing high temperatures or handling solid-laden liquids.

Reduced greenhouse gases
Biofuels are fuels derived from biomass. Biomass is a term describing any source of organic carbon that is renewed rapidly as part of the carbon cycle. Because of this renewal, biofuels reduce greenhouse gas emissions. Biofuels provided 1.8% of the world’s transport fuel in 2008, and according to the International Energy Agency (IEA), biofuels have the potential to meet more than a quarter of world demand for transportation fuels by 2050.

First-generation biofuels are biofuels made from food crops, first-generation biofuels are often criticized. When taking emissions from production and transport into account, life-cycle assessment of the CO₂ balance of first-generation biofuels frequently approaches that of traditional fossil fuels.

Biofuel from non-food crop
Second-generation biofuels are fuels based on lingo-cellulosic feedstocks and various organic waste materials. Their production uses non-food crops or waste and does not compete with the animal or human food chain. The process technology to manufacture second-generation biofuels is more complex and demanding than that necessary to produce first-generation biofuel. The technology development for second-generation biorefining is well under way but many challenges remain. The first commercial plants have been started up and are in the optimization stage.

Also, many new projects have been announced and are already in design or construction. Public financing, government grants, and loan guarantees as well as venture capital have become more readily available, thus accelerating commercialization of second generation biorefineries.

The process technology is based on both thermo and biochemical conversion of various feedstocks. Major technical challenges are high pressures and temperatures as well as corrosion and wear. The pumping requirements have many similarities to those in the production of pulp and paper, as pumps for chips grassy and other solid containing suspensions are needed. Feedback from several customer visits regarding Sulzer technology and capabilities has been very positive. In collaboration with clients, Sulzer is working to find solutions for their process and technology challenges.

References in biofuel production
Sulzer Pumps and Sulzer Chemtech already have several references for operation in refineries for the production of second-generation biofuels. Each second-generation biorefinery will need many pumps, mixers, and agitators for various applications. With the main market activity anticipated between 2013 and 2025, it is expected that the need for made from food crops, first-generation biofuels are often criticized. When taking emissions from production and transport into account, life-cycle assessment of the CO₂ balance of first-generation biofuels frequently approaches that of traditional fossil fuels.

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Sulzer expertise and equipment will be high. Sulzer Pumps has very broad experience in managing different liquids, liquids with suspended solids and their applications, as well as in-depth knowledge of corrosion and wear-resistant materials. Combined with the know-how relating to large-volume agitation and in-line mixing of suspensions, the company will be able to deliver centrifugal pumping and mixing solutions with superior hydraulics and design to serve this market of the future.

Electricity from the sun

While biofuels use solar power indirectly via the detour of growing plants, there are several technologies available that exploit the energy of the sun more directly. Photovoltaic panels directly transform sunlight into electricity whereas concentrated solar power (CSP) systems concentrate sun rays to heat up a working fluid [2]. This heat is later used in a Rankine cycle to produce electricity. That means generation of steam and decompression over a steam turbine, which drives a generator. It is identical to the process used in a conventional thermal power plant. Nowadays, the most common CSP plant technology uses parabolic-trough collectors in the solar island. Sulzer provides pumps to circulate a primary fluid (heat transfer oil) through heat exchangers in the power island to generate steam and drive a steam turbine to produce electricity. Additionally, Sulzer supplies pumps for parabolic-trough CSP plants that have a secondary heat transfer fluid circuit used to store heat by means of molten salts during the daylight hours. This energy is released after the sundown to improve and extend the power plant utilization. Sulzer Pumps supports the power generation process in the conventional island (supplying boiler feed pumps, condensate extraction pumps, and cooling-water pumps) as much as in the solar island (supplying heat transfer oil pumps, molten-salt circulation pumps).

Sulzer Pumps also has experience in CSP plant using other technologies like central tower or Fresnel reflector having direct steam generation (DSG) in conventional steam cycles. The technical challenges for the pumps are the high temperatures of the fluids combined with thermal transients, as the sun does not always shine. The warming-up phase can lead to thermal stresses and is also a challenge for the seal technology.

High temperature, high efficiency

Sulzer Pumps has recently undertaken two product development projects with the goal of better serving the market for heat transfer oil and molten-salt circulation pumps in the solar island of the CSP plants.

We have developed a complete range of double-suction-between-bearings pumps specifically designed for heat transfer oil circulation applications in parabolic-trough CSP plants. This range combines the robustness with the optimum efficiency and fine hydraulics of our PG booster pumps with increased design pressures at a temperature of 400°C. In the context of the product development project, Sulzer has paid special attention to the allowance of thermal transients and the optimization of the sealing systems to prevent any leakage of this hazardous heat transfer oil.

The design innovations added to the vertical molten-salt circulation pumps for parabolic-trough CSP plants include the elimination of the suction inducer and the incorporation of an umbrella to reduce both the distance from the suction bell to the tank bottom and the pump submergence to the absolute minimum. The design and the materials used are also optimized for the thermal transients and pump elongation. These pumps are already available for suitable projects.

The central-tower CSP process is evolving to use molten salt as primary heat transfer fluid. This technology allows heat storage during the daylight hours. It is a very innovative concept to generate solar power, with the first prototype plant being currently commissioned in Spain. The central-tower CSP technology needs less space than parabolic-trough CSP plants; furthermore, the working temperature of the primary fluid in such a system will be in the range of 500–600°C. Such high temperatures will allow the generation of supercritical steam and thus the optimization of the efficiency of the thermal cycle. Considering that the molten salts will have to be circulated to the top of the solar tower where the central receiver is located, Sulzer Pumps is developing a vertical pump for the high pressure (60 to 80 bar) and high power concentration needed in the molten-salt circulation pumps for the central-tower CSP application.

Sulzer Pumps has been supplying pumps to CSP plants since the early 1980s, when the first big parabolic-trough plants, SEGs I and II, were built in the Mojave Desert in California (USA). So far, the company has already supplied more than 250 pumps for CSP applications, and it will continue to serve this market with dedicated products [3, 4]. The company has delivered pumps to many different sites in the USA, Spain, and North Africa.

Storing Carbon

Although biofuel and solar technologies aim to avoid the production of CO₂, it is forecasted that fossil fuel power generation will remain an important energy
supplied in the next 20–30 years. Nevertheless, CO₂ emissions must be reduced significantly in order to reduce global warming. In its World Energy Outlook 2010, the International Energy Agency (IEA) identified carbon capture and storage (CCS) as one of the technologies crucial to reducing CO₂ emission to the atmosphere. According to the agency, CCS has the potential to contribute about one-fifth to the emissions reduction necessary to limit the mean global temperature rise to 2°C by 2050.

The basic idea of CCS is to capture the CO₂ emitted from a fossil-fueled power plant or from an industry plant with large carbon emission (e.g., refineries, cement industry). The captured CO₂ has to be compressed for transportation and storage. Suitable storage sites can either be depleted oil and gas fields or saline aquifers. The CO₂ can also be used for enhanced oil or coal-bed methane recovery.

Sulzer Pumps is a full line supplier and can deliver pumps for all process steps of CCS, i.e., solvent circulation pumps for CO₂ capture (pre- and post-combustion) and pumps for supercritical or liquid CO₂ as well as all auxiliary pump duties.

25 years of experience

The pump requirements for the capture, compression, and injection of CO₂ are very close to the existing portfolio of Sulzer Pumps. The company has over 25 years of experience in pumping low-lubricity fluids (CO₂, ethylene) in the USA and Europe and long-standing experience in amine solvent pumping for CO₂ scrubbing at high pressure in gas-processing plants.

In order to be prepared for this new application, Sulzer Pumps developed guidelines and tools for pump selection and operation. In the CO₂ capture process, possible pump performance impairment due to free gas and the risk of impeller damages due to the resolving of the free gas has to be checked when pumping amine solvents. The calculation tool developed is based on our experiments on the test bed to check these risks, and the guidelines give recommendations concerning an additional booster pump needed or the location of the pump in the process to achieve the NPSH required. Pumping supercritical CO₂ requires the calculation of the temperature and the density in each pump stage and the careful selection of the mechanical seal. Our calculation tool considers the thermodynamics of supercritical CO₂ and fractions of typical impurities. These results are the basis for the hydraulic design.

The guidelines give information on the selection of the mechanical seal (typically, we recommend dry gas seals in tandem arrangement), the material selection, and the operation—especially the commissioning of the pump with supercritical CO₂ (how to make sure that the pump is completely dry and how to fill the pump with supercritical CO₂). In the last two years, Sulzer Pumps has won several important projects related to CCS. For example, for CO₂ pipeline transport in the US, the division delivered six pumps, and for a pre-combustion pilot plant, it delivered specialized pumps for the solvent circulation and the auxiliary services.

Continuing innovation

The three technologies presented are still in the development or demonstration stages of the innovation cycle. It is expected that regulative support and public funding will speed up commercialization. Experts and politicians around the world emphasize the importance of technologies to reduce CO₂ emission into the atmosphere, and most of them predict fast-growing markets for biofuels, solar energy, and carbon capture and storage.

However, the estimates of the time needed until these technologies will be fully commercial vary significantly. Sulzer Pumps will continue to support the players in these new markets with technical knowledge and innovative solutions. In such partnerships, the company will contribute to shaping an environmentally and economically sustainable future.

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