SkyFuel White Paper

Molten Salt as Heat Transfer Fluid

All of the 1200 MW of parabolic trough solar plants in commercial operation today use synthetic oil as the heat transfer fluid (HTF). These plants typically operate between 300 and 400 degrees Celsius – the upper limit at which the synthetic oil is stable. Molten salt can operate at temperatures exceeding 550 Celsius, and can be used with the SkyTrough®, with simple modifications to transition piping and receivers.

Higher Temperature Reduces Cost

Use of molten salt allows the solar field to heat the HTF to a higher temperature. Higher temperature operation of the solar field reduces the cost of thermal storage because the volume of storage material and the size of the storage vessels are reduced. The following familiar equation

$$E = \rho V C_p \Delta T$$

shows the relationship between energy stored and storage volume.

To reduce storage volume for a given quantity of stored energy, it is necessary to increase the temperature difference between the inlet and the outlet of the stored fluid ("delta T"):

$$Volume = \frac{Energy\ Stored}{Density \cdot Heat\ Capacity \cdot (T_{in} - T_{out})}$$

In addition to having a larger delta T, the heat capacity per unit volume of salt is significantly greater than that of synthetic oil. With a delta T of 200° Celsius, twice that of most utility scale parabolic trough plants, the combined effect is to cut the storage volume by more than half.

Thermal Storage Increases Value

Parabolic trough solar power plants possess inherent thermal inertia in the circulating HTF that provides a 30-45 minute buffer against the transient effect of clouds on electricity production. Wind generators and photovoltaic systems have no such buffer and so produce power at levels that vary widely as the weather changes; parabolic trough systems have much more uniform output and this attribute is highly valued by electric utilities. This attribute can be amplified greatly by the addition of thermal storage. Electricity production can be shifted by several hours to meet the demand profile of loads served, thus increasing the value of the power to the market. Lifecycle Cost of Electricity (LCOE) is reduced because electricity production (hence utilization of power block) occurs for more hours of the day.

Direct Operation Eliminates Heat Exchanger

An additional advantage of using molten salt as the heat transfer fluid is that it eliminates the use of separate fluids in the solar field and storage system, and thus eliminates the need for a heat exchanger between the solar field and the thermal storage system.

Solar Concentrator Products in Development

SkyFuel is engaged in a US Department of Energy funded research and development (R&D) program with the National Renewable Energy Lab (NREL) on a larger aperture parabolic trough concentrating solar collector that features similar architecture but greater sun concentration than the SkyTrough®. The new collector will operate at even higher temperatures and can use molten salt as the heat transfer medium.

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SkyFuel White Paper – Molten Salt as Heat Transfer Fluid 2011.06
Printed with low-VOC toner on 30% post-consumer fiber
produced with 100% wind energy.