Solar thermal pre treatment of manganese ore

Temperature range:
- *600 … 800 °C*

Typical size of a Mn-ore submerged arc furnace:
- *10-45 MW*

Industry field:
- *manganese industry*

Countries with high potential:
- *South Africa, Australia, China*

Character of process:
- *continuous*

What is the Mn-ore process?

The production of Manganese requires in a first step the reduction of MnO_2 to MnO. In the second step the MnO is further reduced to Mn by use of carbon. The process is driven by electric energy and requires approx. 12 200 GWh electric energy and emits about 14 million tons of CO_2 a year (figures of 2013). The first reduction process contributes to a large extend to this consumption. While the traditional process is operated in a single furnace in the liquid phase, the process can be split up into a preheating/first reduction and a final reduction. The preheating can be accomplished in the solid phase at temperature of up to 600 °C.

Where is this process used?

The overall process is part of the Manganese production world-wide. Usually, there is no separate pre treatment with Manganese. For other ores, pre treatment processes are used. Manganese ores a found in many countries.

What makes it suitable for solar integration?

Many production sites of Mn-alloy industry are located in regions with typical high DNI, such as South Africa, Australia or China, providing the possibility to support the industrial production process with sustainable energy sources. Especially solar integrated high temperature heat seems promising. Particle based solar tower systems would be capable to provide particle temperatures of more than 900 °C. The inherent particle storage capability helps to compensate fluctuations in solar energy thus guaranteeing an constant supply of thermal energy to the pre treatment process. Replacing significant parts of the electricity demand by renewable thermal power helps to reduce CO_2 emissions. The fact that hot air is needed in the process simplifies its integration with particle based solar plants.

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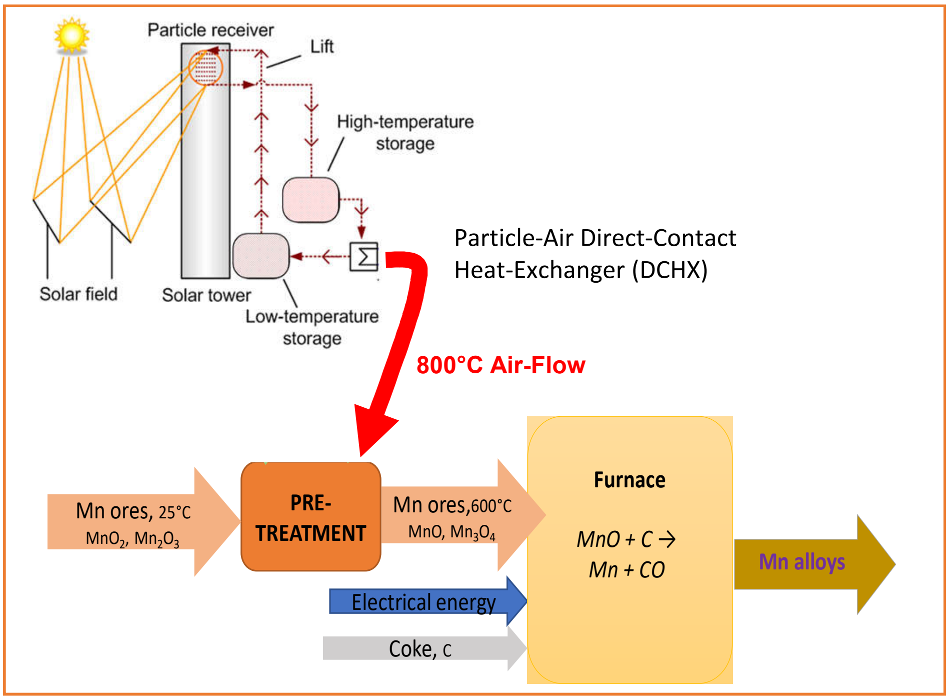

Summary of requirements for solar systems providing heat for this process

User side heat transfer fluid:

- *Air*

Final temperature:

- *800 °C*

Return temperature:

- *600 °C*

Power level required:

- *low MW*

Required continuity of heat supply:

- *high continuity needed*

Available backup heat supplies:

- *to be defined*

Heat storage options:

- *Beneficial and in principle possible*

Solar integration options

Integration of the solar process with the production process is done via an particle-gas heat exchanger. The heat exchanger use the hot particle stream from the storage tank to continuously heat up the air flow up to 800 °C. The heat exchanger can be based on the principles of trickle flow reactors, commonly used in gas-fluid systems. Such heat exchangers are expected to have high efficiencies and power densities and low operation costs.

Status quo in solar integration

A demonstration of solar particle heating up to 965 °C has been done in the CentRec® particle receiver at 2.5 MW scale in solar tower Jülich in 2017.

Currently, engineering for testing facilities is conducted to investigate the particle hydrodynamics of particles trickling through packing structures with countercurrent air flow, to reduce particle sink velocity and hence increase total particle surface in the TFHX. Afterwards, heat exchanger characterization and testing up to particle temperatures of 900 °C are planed.

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