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Thermochemical energy storage concept based on a fluidized bed reactor cascade with different storage materials and an internal chemical condensator for waste heat recovery

BACKGROUND

Thermochemical energy storage is a novel thermal energy storage technology that offers high energy density per volume and nearly loss-free storage at ambient temperature. The concept is based on the utilization of reversible reactions to store and release heat. Many of the materials that qualify for such an application are available as solids. The reactions are expressible as:

$$A_{(s)}+B_{(g)} \leftrightarrow C_{(s)}+heat$$

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Fluidized bed reactors are promising for this application because they offer high heat transfer coefficients and isothermal operating conditions. Although isothermal operation is advantageous for the reaction, it is also desired to cool the waste heat source, which cannot be achieved if the reaction occurs at a high temperature level. On the other hand if a reaction at low temperature level is chosen, the exergy losses of the process would rise significantly. A cascaded storage concept consisting of 2 or more reactions leads to an efficient energy storage process with low exergy loses (see Fig.1).

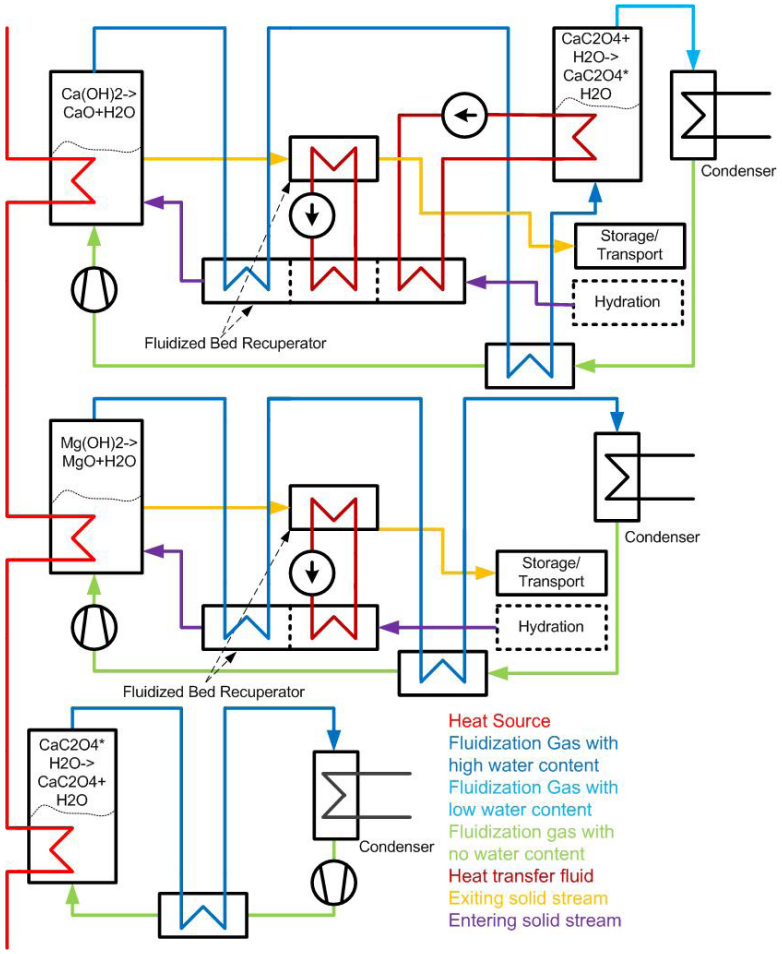

Fig. 1: Illustriation of a heat storage concept utilizing three fluidized bed reactors with different thermochemical materials

REFERENCE:
M062/2016

APPLICATIONS:
- Heat Recovery
- Energy Storage

KEYWORDS:
- Waste Heat Recovery
- Thermochemical Energy Storage
- Magnesium Oxide
- Calcium Oxide
- Calcium Oxalate
- Fluidized Bed Reactors

DEVELOPMENT STATUS:
Fundamental Research

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The implementation of an additional reactor in the first stage in which a portion of the produced calcium oxalate (CaC2O4) from the last stage is hydrated has apart of the supplemental heat provided to the system, the effect of absorbing a portion of the water in the fluidization gas. The water that has to be removed from the gas stream amounts to a significant portion of the process losses, therefore this configuration leads to a more efficient utilization of the heat source.

BENEFITS

- Efficient waste heat recovery
- Cascaded arrangement leads to high energy and exergy recovery
- Water absorbtion at high temperature levels

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