Use of a Salt Hydrate for Thermochemical Energy Storage

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Background

- Waste heat is produced by the Carty Power Plant in Boardman, Oregon
- This heat is normally dissipated and lost to the environment
- One way to store this heat for later use is through Thermochemical Energy Storage
- This method uses reversible chemical reactions to store thermal energy indefinitely
- Waste heat is used to drive an endothermic reaction which can be then reversed at a later time, releasing the stored energy

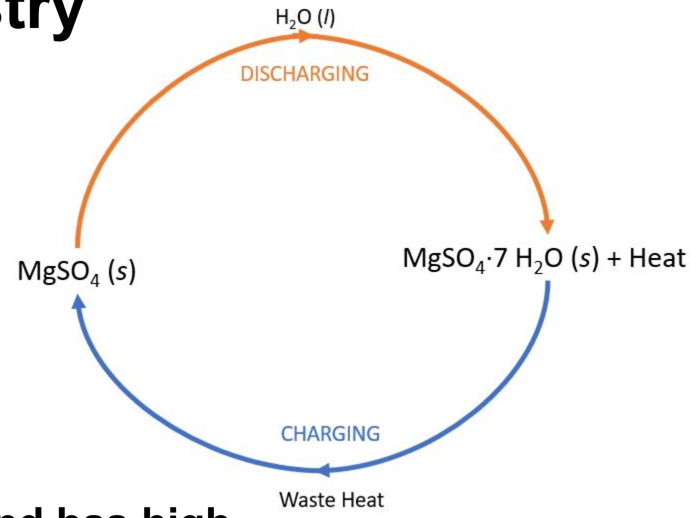
$$A + B \overset{yields}{\Longleftrightarrow} C + Heat$$

Current Methods

- Our design uses Magnesium Sulfate ($MgSO_4$), also known as Epsom Salts as the chemical basis
- To discharge our reactor, a water stream is ran through the anhydrous $MgSO_4$, which causes it to transition to its heptahydrate form, releasing heat that can be then used for space heating
- To charge the reactor, the waste heat from the plant is used to heat the $MgSO_4 \cdot 7H_2O$ to 150℃, for 9 days causing it to dehydrate.

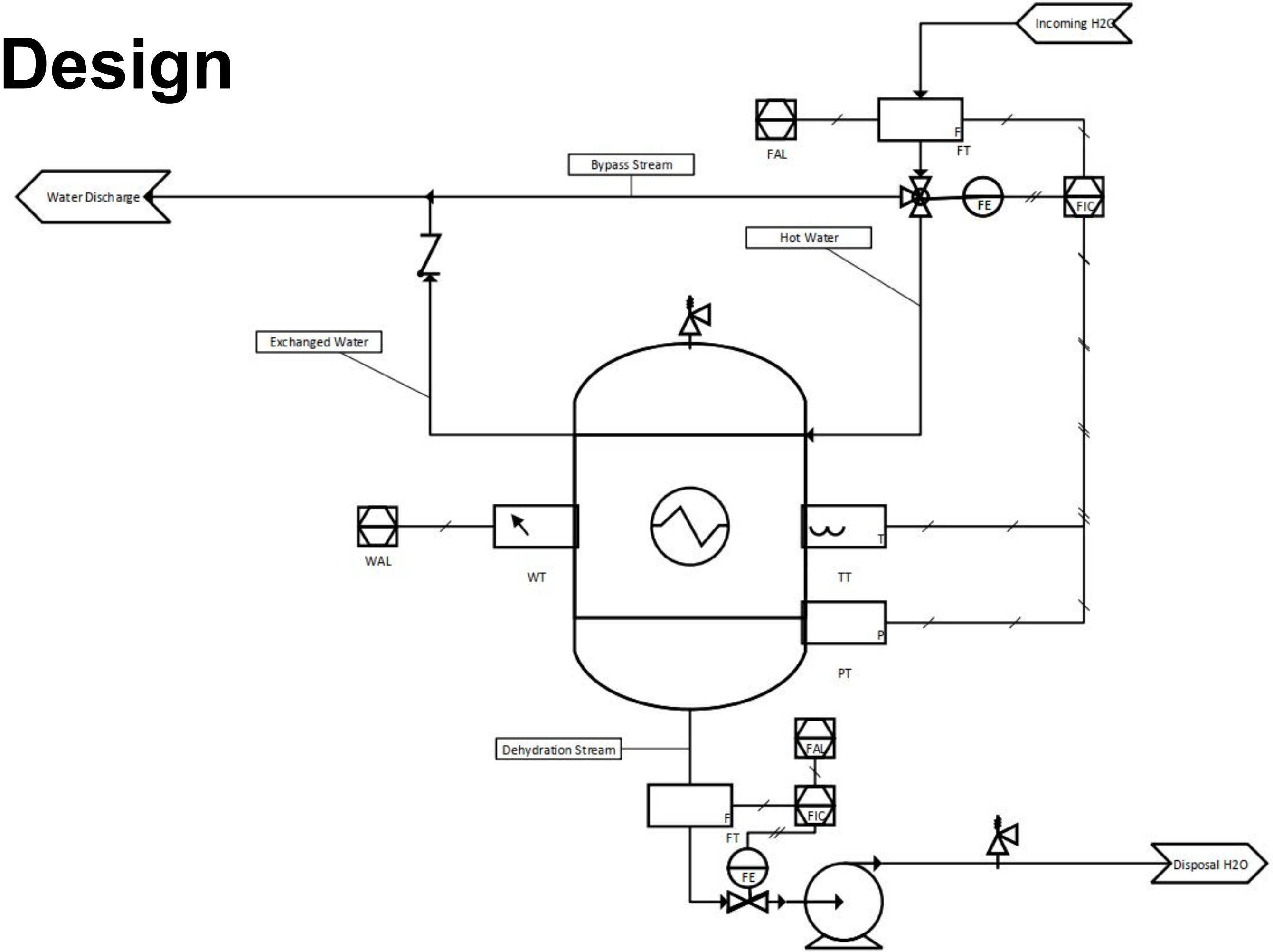
TCES Reaction Chemistry

$$MgSO_4 + 7H_2O \rightleftharpoons MgSO_4 * 7H_2O$$



- **Salt hydrate reaction**
- **$MgSO_4$ is safe, readily available, cost effective and has high energy storage density**
- **Charging involves dehydration reaction, discharging involves hydration reaction**

Reactor Design



Operating Procedure

- Once the reactor bed has been packed and loaded the hot waste water can be diverted to the reactor
- It takes 52 minutes for the reactor to reach reaction temperature from room temperature
- For the next 9.2 days the $MgSO_4 \bullet 7H_2O$ slowly absorbs heat from the waste water stream until the $MgSO_4$ is dehydrated
- Once dehydrated the $MgSO_4$ can be stored in a dry environment.
- Reactor is then cleaned and reset for next batch

Results

- Over the course of 9 days we are able to process $4m^3$ of $MgSO_4 \bullet 7H_2O$
- This corresponds to 4 Gigajoules of stored energy
- Since energy generated in the 5 operational summer months is stored a total of 65.1 Gigajoules can be stored for heating in winter
- A total of 143.2 Gigajoules can be produced yearly using this reactor.

Improvements

- At current design we can only source 7% of heating requirements
- To improve the efficiency of the design it would be easiest to provide a different heat exchange fluid.
- Reactor geometry can be further improved to squeeze out additional heat transfer.
- At hotter temperatures a different more efficient chemistry base can be used.