Best way to heat sand

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Storing energy can be done in many ways, with the chemical storage method of a battery being one of the most common. Another option is a thermal battery, which basically means making something hot, and later extracting that heat again. In this video by [Robert Murray-Smith] the basic concept of a thermal battery that uses sand is demonstrated.

By running a current through a resistive wire that’s been buried inside a container with sand, the sand is heated up to about 200 ?C. As [Robert] points out, the maximum temperature of the sand can be a 1000 ?C or more. Because sand doesn’t boil like water, the total amount of energy stored in sand is correspondingly higher.

Extracting the thermal energy can be done rather inefficiently using the demonstrated Peltier element. A Stirling engine, or steam generator and turbine, would get a lot more energy out. Either way, the thermal battery itself is made using just plain sand, which makes it an attractive DIY target to tinker with.

Coming in at ~ 0.8 J/(g*K), one needs a 5x temperature increase to store the same amount of energy as in water (gram per gram), but this also means that most of the total stored energy can be extracted as higher grade heat (with more favorable Carnot efficiency).

A small spherical `boiler&#8217; with water trapped permanently inside could be heated above the critical temperature of water to have super-heated steam inside (the wall would have to be strong enough to withstand that pressure). This `heat nugget’ would store heat both from the specific heat as well as the latent heat of water. A collection of such elements could be used like pebbles, to replace the sand with great storage capacity.

I was considering a 200L barrel filled with sand, aluminium ventilation pipes and the 60L barrel with its element inside that, both inside a rockwool-lined box with temperature probe to turn the solar off if it exceeds 550C

Water can be heated way past 100?C if it’s contained in a pressure vessel, that’s how steam engines work. They can only extract energy in the vapor phase, which effectively becomes the difference in temperature between when the steam enters the engine and when it is exhausted, ideally juuust above it’s condensation point.

A Stirling engine could probably work with hot water, but since they were never widely adopted, I’m assuming there was some kind of inefficiency in using them that I’m not familiar with

The main problem Stirling engines have is that when they’re competing with steam engines, gas

turbines, internal combustion, and electric motors, one of those four usually has a decisive advantage. Stirling engines (and the related Ericsson cycle engines) still have an edge when you need to extract work from a tiny temperature difference though and would make sense here. Plus, you can use the engine as a heat pump to warm up the sand.

That’s an important contribution. IIRC, creating heat through resistance takes roughly three times the energy compared to just moving the equivalent amount of heat from one location to another. If a Sterling engine can run as a pump to heat the sand at better efficiency than resistive heat, that’s a win.

Some steam engines are or at least were low pressure steam, so the water temperature for them isn’t all that high if actually over boiling at all. Not that I’d advise anybody to actually try to build one of those now…