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Techno-Economic Analysis for the Deployment of Electric Thermal Energy Storage Systems Using Binary Chloride Salts in Edmonton, Alberta

Abdul Saboor[1], Muhammad Taha Naveed[1], Thasanka Kandage[1], Muhammad Taha Manzoor[1]
[1]Department of Mechanical Engineering, University of Alberta, Edmonton, Canada

ABSTRACT

Unlike traditional electrically heated molten salt thermal energy storage E TES systems using nitrate salts limited to 570°C, E TES technology utilizing binary chloride salts (50 wt% NaCl: 50 wt% KCl) achieves thermal stability up to 1100°C, enabling decarbonization of high grade heat for metal processing, cement production, and petrochemical refining. Although chloride salts are abundantly available and cost effective, they are highly corrosive to metal structures. Previous studies demonstrated low cost materials like engineered concrete can store chloride salts, reducing the need for expensive stainless steel such as Inconel 600, but lacked techno economic feasibility analysis for commercial deployment. This study evaluates the techno economic feasibility of chloride salt based E TES systems in Alberta's industrial sector to provide low cost, high temperature heat (670°C to 1000°C) for space constrained locations. Alberta is selected as Canada's heavy industrial hub with the highest total energy demand, where 75% is used for industrial heat. Alberta also boasts Canada's best solar energy resources, making it ideal for renewable energy driven E TES deployment. The study assumes a single tank, concrete based E TES system using binary chloride salts, minimizing complexity by eliminating additional piping and pumps required in traditional two tank systems. The tank is charged via an electric heater powered by a photovoltaic farm, creating a sustainable energy solution. A preliminary model was developed for steel tempering requiring 700°C steam output. The analysis evaluated critical economic indicators including Levelized Cost of Heat, Return on Investment, and payback period based on Alberta's energy prices and operating costs. Round Trip Efficiency was calculated by modeling three stages: electric heating of salts, heat transfer from salt to air, and air to water heat exchange for steam generation, plus considering tank heat losses. Preliminary results show the system can achieve a Levelized Cost of Heat of approximately $20/MWht and Round Trip Efficiency of 80%, while achieving 700°C output temperature using renewable electricity. These results indicate the system provides economically viable, high efficiency energy storage for regions with abundant renewable resources. Additional details will be discussed at the upcoming conference.