Docket #: S22-039

Inductive heating with a conductive metal mesh for chemical reactor systems

Stanford researchers have designed a new type of reactor that uses magnetic induction instead of fossil fuel combustion to enable even distribution of high-grade heat for thermochemical processing.

Uniform heating of volumetric media to high temperatures is the foundation of many physical and chemical reaction systems that involve elevated processing temperatures or endothermic heat requirements. The predominant source of heating for most high temperature reactor systems is chemical fuel combustion, which produces significant carbon emissions. Inductive heating is an established method for clean, efficient heating. However, an underlying challenge to date is understanding how inductive heating can be adapted to heat volumetric media efficiently and uniformly, which requires unique specification of the susceptor and power electronics.

Researchers at Stanford University have incorporated a metamaterial mesh susceptor and high-efficiency electronics to create a sustainable thermochemical reactor that can produce a customized volumetric heating profile. Their invention electrifies the heating process by using magnetic induction to produce high frequency currents. The mesh susceptor in the core of the reactor can be tailored to support electrically conductive properties that enable high efficiency and uniform inductive heating within the entire reactor volume. This invention can assist in decarbonizing many heavy industrial processes.

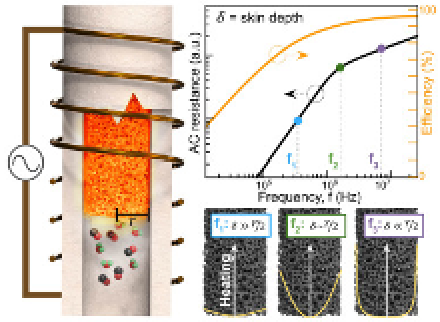

Figure 1. Reactor design and efficiency by frequency.

Stage of Development
Proof of concept

Applications

- Carbon dioxide capture
- Oil and gas production
- Steam cracking
- Limestone decomposition
- Cement and ceramic manufacturing
- Materials processing through pyrolysis
- Hydrogen sulfur capture and utilization

Advantages

- Decarbonization
- Uniform heating at high temperatures
- Efficient
- High reaction rates
- Smaller
- Cheaper
- Scalable

Publications

- Lin, C. H., Wan, C., Ru, Z., Cremers, C., Mohapatra, P., Mantle, D. L., Tamakuwala, K., Höfelmann, A. B., Kanan, M. W., Rivas-Davila, J., & Fan, J. A. (2024). Electrified thermochemical reaction systems with high-frequency metamaterial reactors. *Joule, 8*(10), 2938–2949.

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