Harnessing Stranded and Flared Natural Gas: The Role of Heat Transfer in Micro-Channel Reactors/Heat Exchangers

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Background/Rationale

•About US$100boe (~= 4.5 trillion MJ energy~=265 million tons CO_2) wasted through flared gas in 2011 (BP Energy Review, World Bank, 2012) .

•The subject of Stranded and Shale Gas is gaining more attention around the world (up to 7000tscf remained untapped globally as at 2011)

•The Fischer Tropsch Synthesis (FTS) has been adapted to be carried out in auto-thermal, micro-channel reactors/heat exchangers in order to harness gas- accelerating the traditional process by between 10 and 1000 times!

•Operational issues like flow mal-distribution, feedstock quality, temperature hot spots, etc, could constitute reactor control issues. Isothermicity within the reactor is ideal to achieve maximum conversion, avoid thermal fatigue and improve system reliability.

Proposed Solutions

•Concept of **Hybrid Heat Transfer** from micro-electronics- synergistic combination of jet impingement and micro-channel schemes. Looking to overcome the drawbacks of either technique (large pressure drops, uneven temperature distributed temperature gradients, reduction in local heat transfer), etc.

•Use of **Phase Change Material (PCM)**, placed within the reactor. The melting-solidification cycles occurring, **with enthalpy of fusion at constant temperature**, cause the PCM to act as an energy storage buffer/ thermal flywheel, mitigating temperature excursions

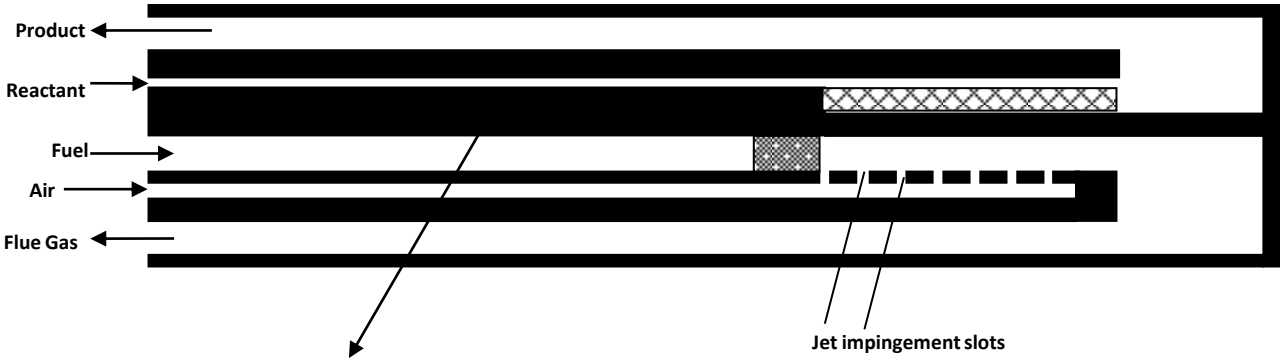

Plate separating endothermic (Methane steam reforming) reaction and exothermic (Natural Gas Combustion) reaction

Hybrid Cooling Scheme

Phase Change Material (PCM) Scheme

Future Work

- Construction of experimental rig

- Experimental work on hybrid scheme, including exploring the effects of pressure drop and jet diameters on achieving near-isothermal conditions within the reactor

- Comparison with Analytical Models

- Optimisation including choice and thickness of PCM