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Selection of the heat transfer medium for heating various gases in a solar bubble receiver

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The relative potential of metal/metal oxides for use as the heat transfer medium in a solar bubble receiver for heating differnt gases is reported. Solar bubble receivers are a recently proposed form of indirectly irradiated receiver, in which the concentrated solar radiation into the solar cavity is absorbed by the cavity walls and is then transferred to the bubbles of gas within a molten bath (Jafarian, Abdollahi et al. 2017, Jafarian and Nathan 2017). The gas, in turn, is injected through submerged nozzles. The solar bubble receiver was shown to acheive a significantly high rate of heat transfer of more than 2000 $W/m^2.°C$ around the cavity surface (Jafarian and Nathan 2017). However, the opration of the system has been only assessed for heating N_2 and Ar, as gaseous working fluid, and Ga as the molten heat transfer medium. This is despite that to enable the use of potential benefits of gas-bubbleing regime in a solar receiver in practice, there is a need to identify approriate heat transfer media e.g. molten metal/metal oxides, alloys and molten salts, which are compatible with target gases e.g. N_2, Ar, He, CO_2 and air. In so doing, there is also a need to identify criteria with which to compare the applicability of different heat transfer media employed in the solar bubble receiver. Of primary importance is the non-reactivity of the heat trasnfer media with the target gas, while also considering vapour pressure, corrosiveness and melting point. These influence evaporation, material compatibility and need for the heat tracing. Based on these criteria, In and Sb were selected for heating N_2, Ga was selected to heat Ar and He, while nitrate salts were found to be appropriate for heating air. Furthermore, bismuth and antimony oxides are selected for heating CO_2. Material phase diagrams together with HSC Chemistry Software were used to identify potential materials.

References

Jafarian, M., M. Abdollahi, M. Arjomandi and G. J. Nathan (2017). Concentrated Solar Receiver And Reactor Systems Comprising Heat Transfer Fluid", International Patent Application No. PCT/AU2018/050034 from Australian Provisional Patent Application Nos. 2017900167 and 2017900564.

Jafarian, M. and G. J. Nathan (2017). A solar receiver with bubbling heat transfer for heating a pressurised gas. Asia-Pasific Solar Research Confenerence, Melbourne, Australia.