Numerical investigation of a hybrid (Cu-Alumina) nanofluid cooled double pipe gas cooler for a trans-critical CO_2 refrigeration system

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Abstract: Performance of a hybrid (Cu-Alumina) nanofluid cooled double pipe gas cooler [1] for trans-critical CO_2 refrigeration cycle is numerically explored [2] and compared with a water cooled gas cooler. Besides conventional equal Reynolds number comparison, equal pumping power comparison basis is also adopted. Nanofluid is loaded with 0.1 %, 0.33 %, 0.75 %, 1 % and 2 % of particle volume fraction under turbulent flow conditions [3]. The numerical model is validated using experimental data available in literature and the maximum deviation in simulated and experimental results is found to be 7.89%. It is observed that the overall heat transfer coefficient of nanofluid cooled gas cooler improves by maximum of 16.29 % under equal Reynolds number comparison basis. On the contrary, on equal pumping power basis, the overall heat transfer coefficient of water cooled gas cooler is found higher by 6.58 %.

Keywords: Nano fluid; CO_2 refrigeration; Gas cooler; Double pipe heat exchanger; Comparison criteria; Hybrid.

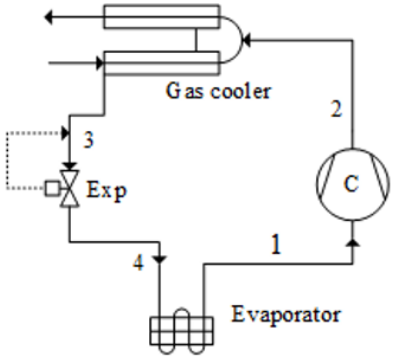

Fig. 1 Trans-critical CO_2 refrigeration cycle.

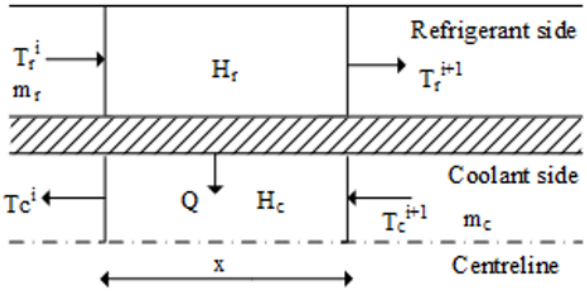

Fig. 2 Discretization scheme of gas cooler.

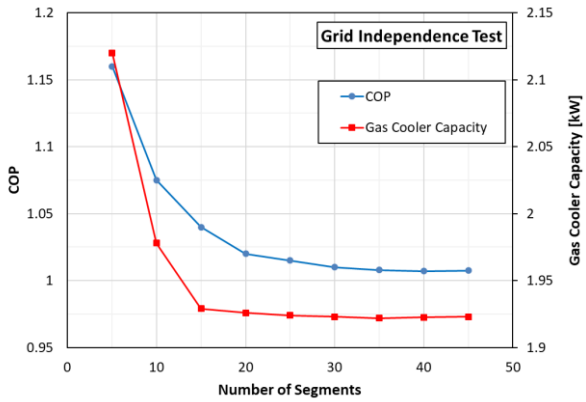

Fig. 3. Grid Independence Test.

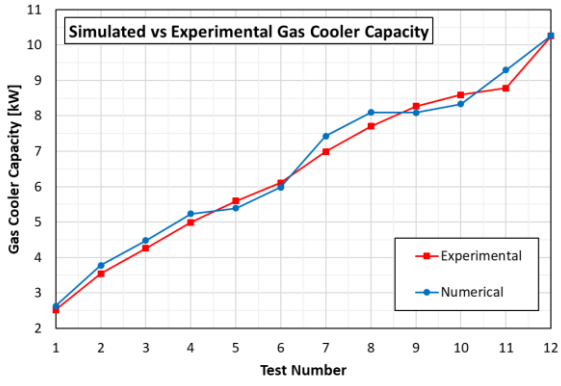

Fig. 4 Simulated vs Experimental Gas Cooler Capacity [kW].

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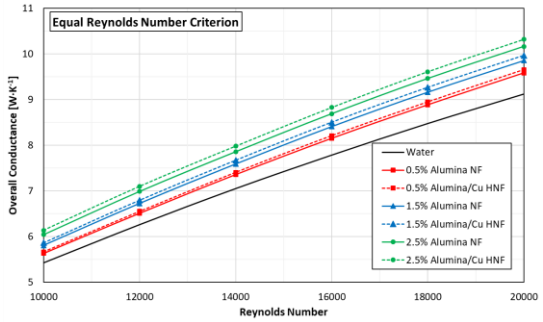

Fig. 5 Overall conductance [W·K^{-1}] vs Re of water, Alumina NF and Alumina/Cu HNF under equal Re criterion.

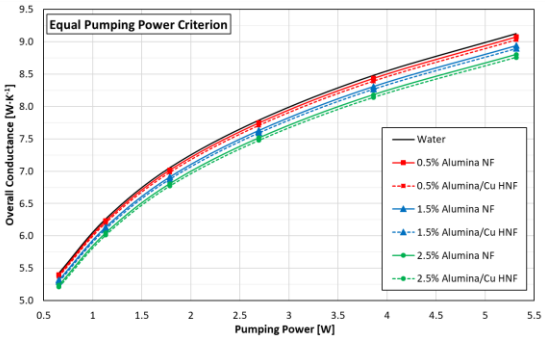

Fig. 6 Overall conductance [W·K^{-1}] vs pumping power of water, Alumina NF and Alumina/Cu HNF under equal pumping power criterion.

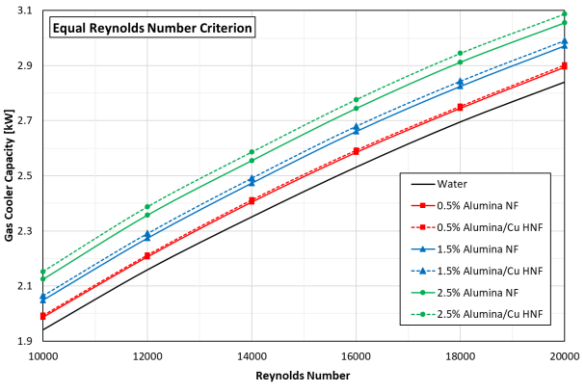

Fig. 7 Gas Cooler Capacity [kW] vs Re of water, Alumina NF and Alumina/Cu HNF under equal Re criterion.

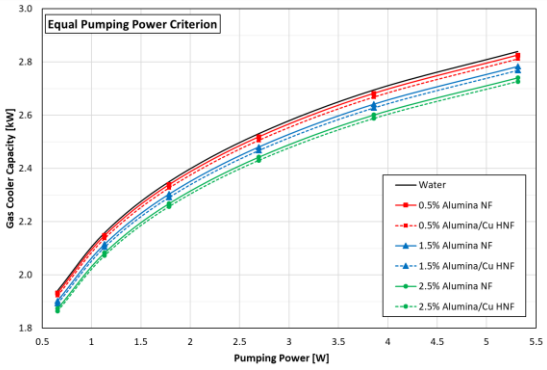

Fig. 8 Gas Cooler Capacity [kW] vs pumping power of water, Alumina NF and Alumina/Cu HNF under equal pumping power criterion.

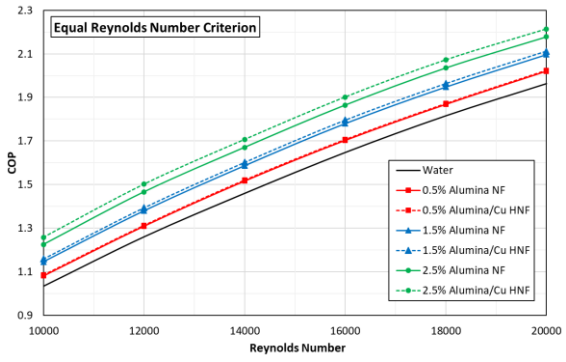

Fig. 9 COP vs Re of water, Alumina NF and Alumina/Cu HNF under equal Re criterion.

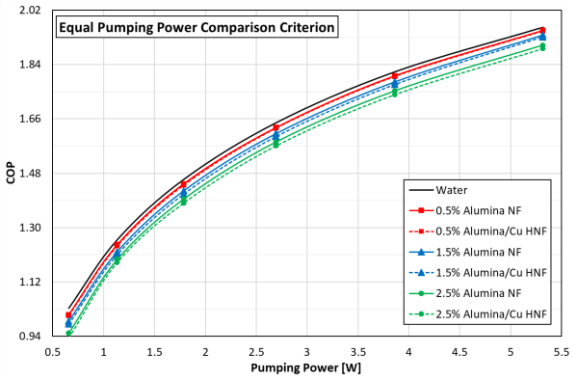

Fig. 10 COP vs pumping power of water, Alumina NF and Alumina/Cu HNF under equal pumping power criterion.

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Biography: Dr. M. S. Dasgupta is full Professor at Mechanical Engineering Department of BITS Pilani and presently the HOD. He has twenty-six years of teaching and research experience at BITS Pilani. He is coordinator of IQAC and served as the chief of Placement Unit for 12 years. Dr. Dasgupta is recipient of several awards including Young Scientist Award from Department of Science & Technology. Dr. Dasgupta has research interest is Environment friendly technologies, CO_2 Transcritical systems, E-waste management, Fuzzy logic and Neural network based control. He has published many papers and has delivered Key note addresses at Conferences within India and abroad.

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