EXPERIMENTAL INVESTIGATION AND PERFORMANCE ASSESSMENT OF SCROLL EXPANDERS IN SERIES CONFIGURATION OF A SMALL SCALE TWO-STAGE ORC UNIT

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ABSTRACT

The paper presents the results of performance assessment of scroll expanders integrated into a two-stage ORC unit supplied with heat from vacuum tubes solar collectors at a temperature around 130 ^{o}C. The system under investigation uses R245fa as working fluid and two scroll expanders (hermetic scroll compressors in reverse operation) connected in series. The system is designed so as to obtain optimal performance as that indicated by the variation of the heat source temperature, ranging between 95-130 ^{o}C, respecting to a pressure ratio in the order of 10 and given that each scroll expander pressure ratio is in the order of 3, similar to its built-in volume ratio. Effects of temperature variation are investigated to predict the performance of system driven by intermittent solar heat, where partial load operation prevails. In the two scrolls connected in series, the outlet of the first expander defines the inlet conditions of the second expander, thus strongly affecting its performance.

During laboratory tests under controlled conditions, the ORC system was supplied with a mixture of hot water and glycol from using an electric heater of 100 kWth capacity with variable heat flow and temperature, while the total (maximum) expansion work is ~10 kWel. Under this variation of the heat source temperature, the key operational parameters of the two expanders were calculated (i.e. pressure and volume ratio, filling factor) to reveal their interrelation and influence on the expanders' performance, with direct effect on the cycle performance as well. Expanders showed isentropic efficiency as higher as 60% for the first expander and 80% for the second.