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Performance Analysis of Three Absorption Heat Pump Cycles, Full and Partial Loads Operations

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Abstract : The environmental concerns related to global warming and ozone layer depletion along with the growing worldwide demand for heating and cooling have brought an increasing attention toward ecological and efficient Heating, Ventilation, and Air Conditioning (HVAC) systems. Furthermore, since space heating accounts for a considerable part of the European primary/final energy use, it has been identified as one of the sectors with the most challenging targets in energy use reduction. Heat pumps are commonly considered as a technology able to contribute to the achievement of the targets. Current research focuses on the full load operation and seasonal performance assessment of three gas-driven absorption heat pump cycles. To do this, investigations of the gas-driven air-source ammonia-water absorption heat pump systems for small-scale space heating applications are presented. For each of the presented cycles, both full-load under various temperature conditions and seasonal performances are predicted by means of numerical simulations. It has been considered that small capacity appliances are usually equipped with fixed geometry restrictors, meaning that the solution mass flow rate is driven by the pressure difference across the associated restrictor valve. Results show that gas utilization efficiency (GUE) of the cycles varies between 1.2 and 1.7 for both full and partial loads and vapor exchange (VX) cycle is found to achieve the highest efficiency. It is noticed that, for typical space heating applications, heat pumps operate over a wide range of capacities and thermal lifts. Thus, partially, the novelty introduced in the paper is the investigation based on a seasonal performance approach, following the method prescribed in a recent European standard (EN 12309). The overall result is a modest variation in the seasonal performance for analyzed cycles, from 1.427 (single-effect) to 1.493 (vapor-exchange).

Keywords : absorption cycles, gas utilization efficiency, heat pump, seasonal performance, vapor exchange cycle
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