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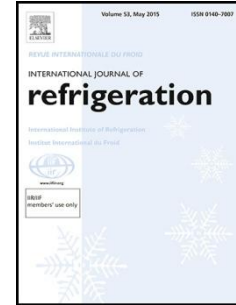
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## Stepped pressure cycle – A new approach to Lorenz cycle

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### Highlights:

- Stepped pressure cycle is proposed for vapor-compression refrigeration systems.
- Stepped pressure cycle can help refrigerants approach the Lorenz cycle.
- A pilot system with dual-step and triple-step pressures was made and tested.
- Dual-step, triple-step pressure cycle can improve COP by 12.3%, 18.7%, respectively.

### ABSTRACT

Refrigerant vapor-compression cycle usually works with variable temperature heat sources in reality, which causes remarkable irreversible losses in heat exchange process. This paper proposed the stepped pressure cycle to modify the vapor-compression cycle using refrigerant, particularly pure refrigerant. Refrigerant is designed to flow through a series of heat transfer units with stepped pressures so that the irreversible losses can be reduced. Theoretical proof confirmed the stepped pressure cycle with pure refrigerant can approach the Lorenz cycle, the most efficient cycle under variable temperature heat sources. Numerical analysis on cycle performance demonstrated that a dual-step suction and discharge pressure cycle using R32 can achieve 11.5 % cooling COP improvement for residential air conditioner, while a dual-step discharge pressure cycle using R134a can bring 9.8% heating COP increase for heat pump water heater. A pilot system was made and preliminarily tested. Compared to the single cycle system, 12.3% and 18.7% COP increase were achieved in the pilot system by applying dual and triple subcycles, respectively.

**Keywords:** Refrigerant; Refrigeration cycle; Stepped pressure cycle; Lorenz cycle; Cycle analysis; Experiment

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