ID-466

ANALYSIS AND MODELING OF ENVIRONMENTALLY FRIENDLY HEAT PUMP SYSTEM

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BACKGROUND

- The world's attention to environmental damage continues to increase.
- Ozone layer damage, global warming and air pollution become the main concern nowadays.
- Indonesia contributes to 11% of the total CO_2 emissions in Asia (IEA, 2017).
- Researchers also pay attention to the energy consumption on buildings, especially the Heating Ventilating Air Conditioning (HVAC) system.
- One of the challenges in HVAC systems is finding alternative refrigerants with high system performance but have low environmental effects.

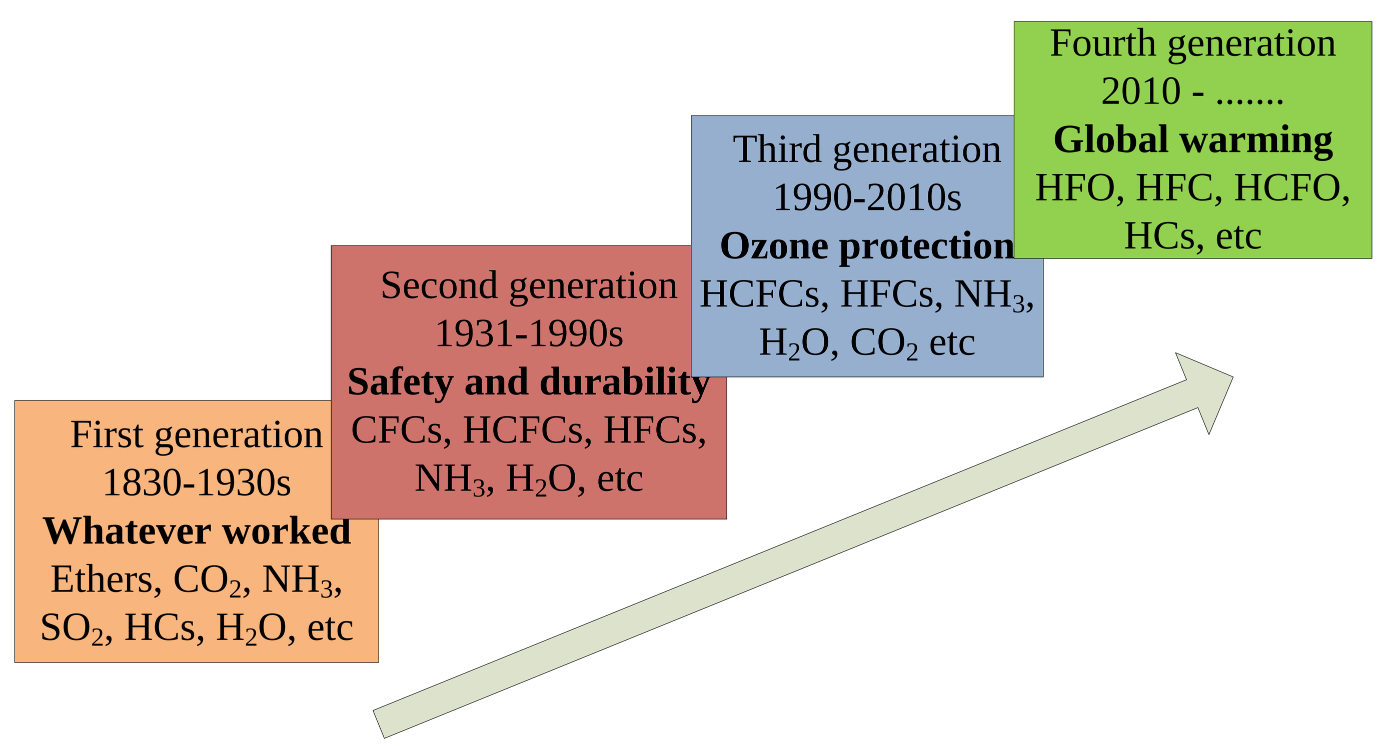

Fig 1. Efforts to find alternative refrigerants

OBJECTIVE

Evaluation of some alternative refrigerants in terms of phisycal properties, safety aspects, performance and environmental impacts for heat pump system applications with high system performance but have low environmental effects.

METHODOLOGY

Modeling

In this study, an evaluation of some alternative refrigerants was conducted by comparing some alternative refrigerants in terms of safety, environmental impact, and performance. The model of the system was built in Matlab 2017a software and used REFPROP ver 10 database. The selection of refrigerant candidates is illustrated in Fig 2.

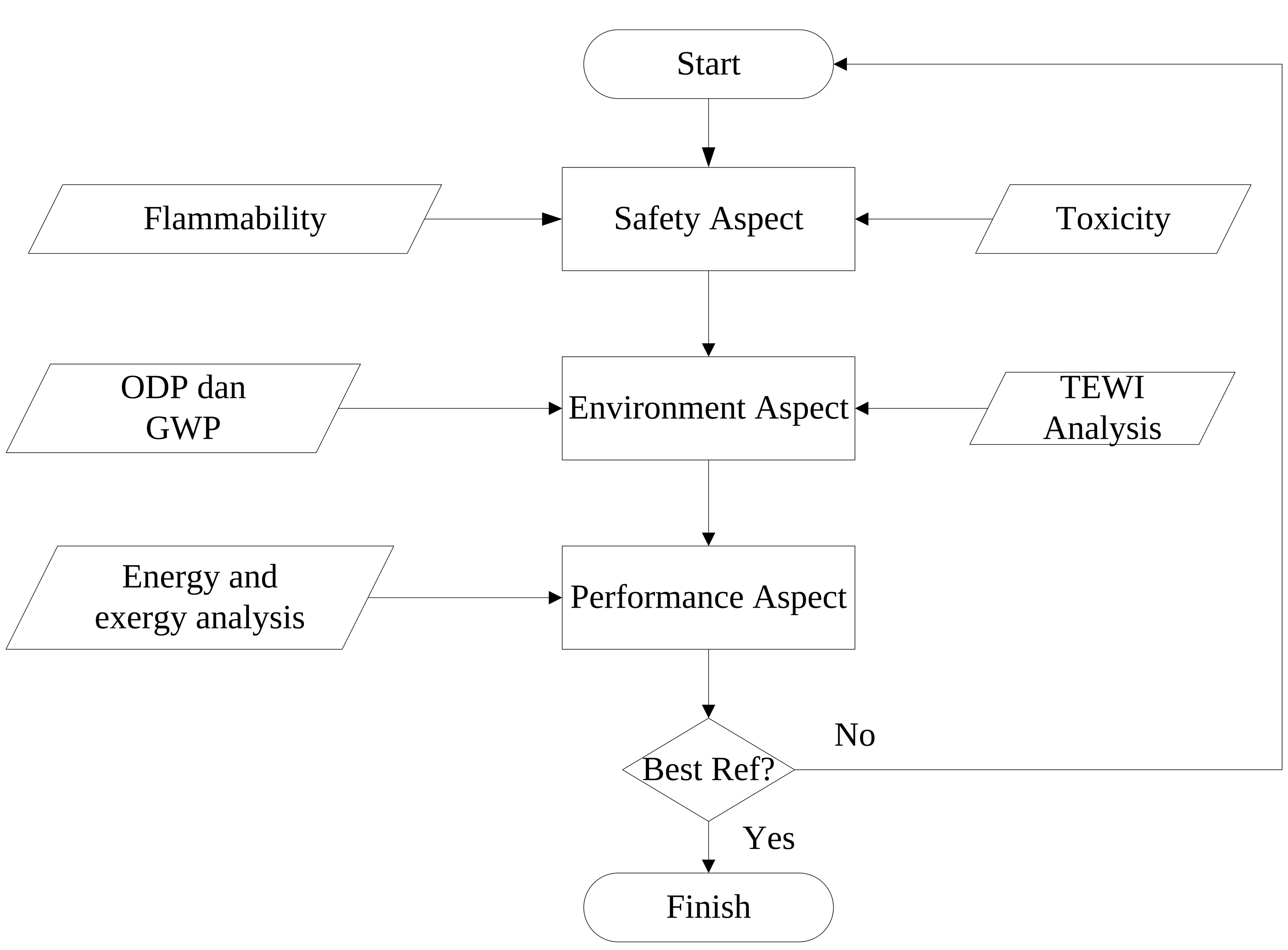

Fig 2. Refrigerant Evaluation Flowchart

Environmental Analysis

The analysis of the environmental aspects of the heat pump system in this study was as follows (Mastrullo, 2016):

TEWI = direct emissions + indirect emissions

= (GWP x L x N) + (Ea β n)

RESULT AND DISCUSSION

Evaluation of Refrigerant Selection

Fig 3 and 4 present the evaluation results of studied refrigerants with regard to physical properties and environmental aspects.

Fig 3 shows that R1224yd covers the area in the form of a perfect rectangle that indicates as the best refrigerant in terms of physical properties, safety aspect, and ODP and GWP values.

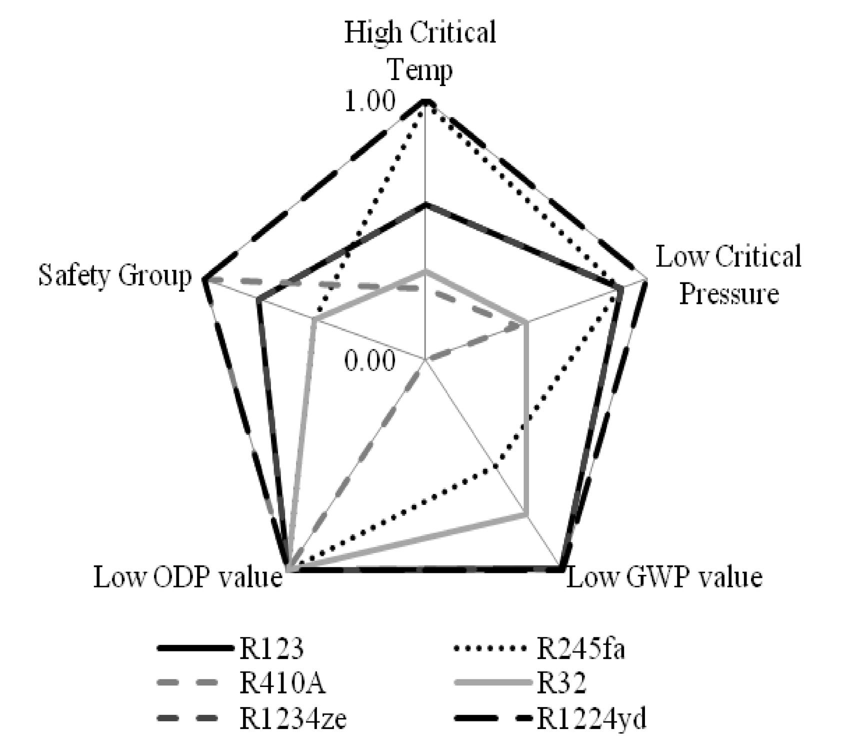

Fig 3. Evaluation of Studied Refrigerants

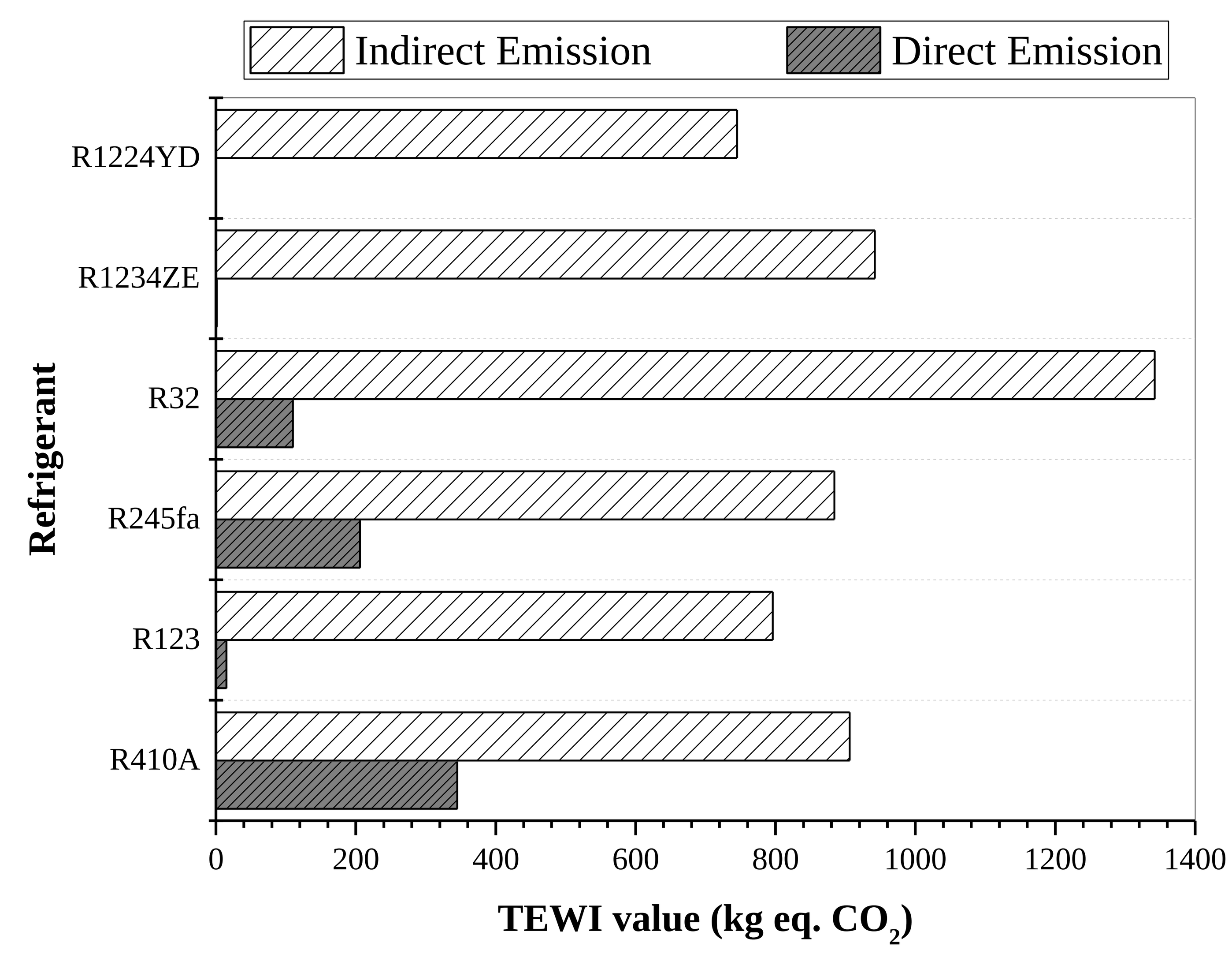

Fig 4. TEWI Analysis of Studied Refrigerants

System Performance Evaluation

The performance of vapor compression system for air conditioning using selected R1224yd as the refrigerant was evaluated by observing the effect of evaporation and condensation temperature, and refrigerant mass flow rate on the system performance; compressor work, heating load, and COP.

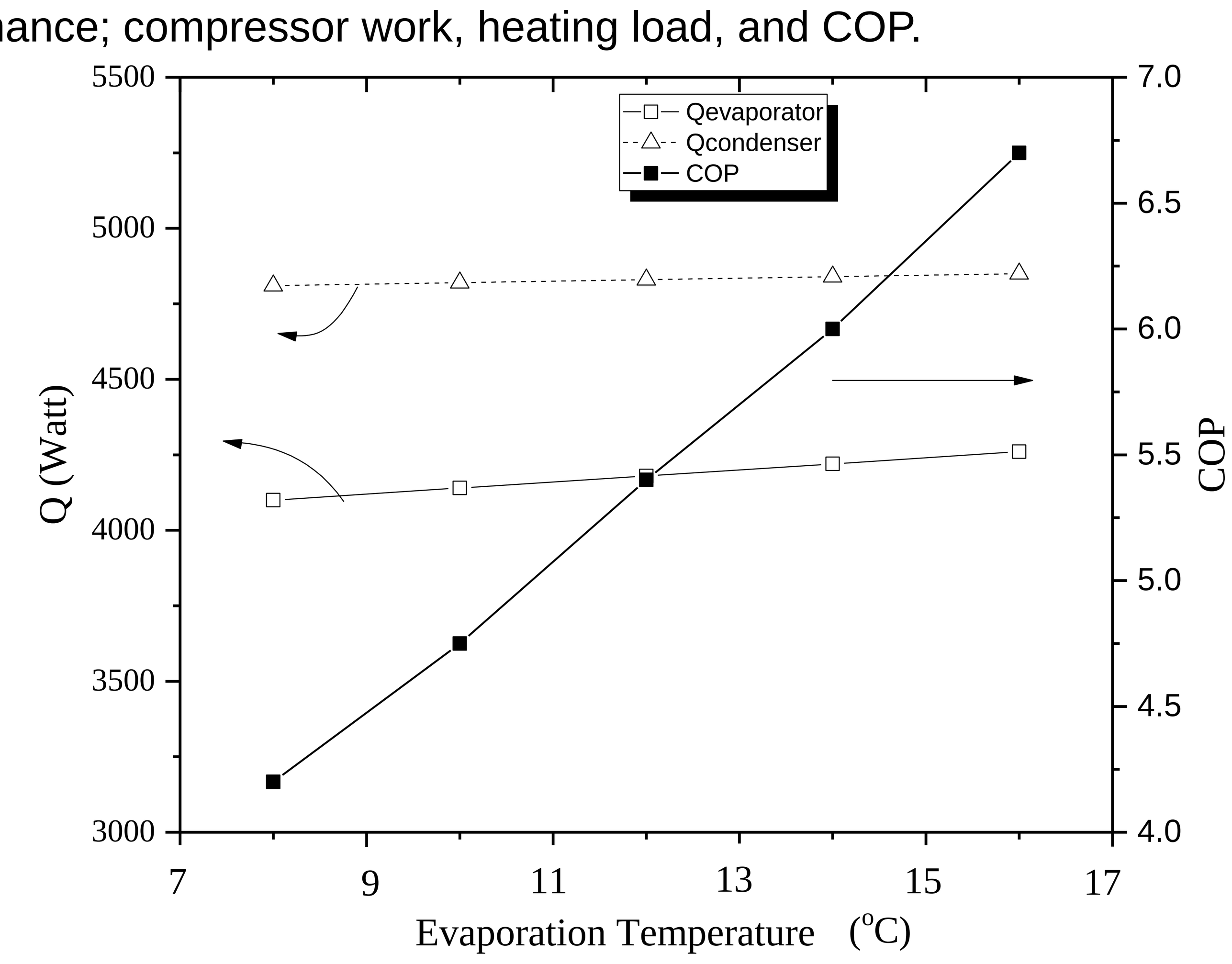

Fig 5. Effects of evaporation temperature on Q and COP

CONCLUSIONS

- Based on the evaluation, R1224yd is the best refrigerant from aspects of safety, environmental impact, and physical properties when compared to other studied alternative refrigerants such as R1234ze, R32, R123, and R245fa.
- R1224yd has the lowest indirect impact on the environment at 780 kg of CO_2 and a direct impact of about 0.2 kg of CO_2.
- The simulated heat pump system using R1224yd has COP ranging from 4.6 to 6.5 and exergy efficiency ranging from 22% to 29.8% at an evaporation temperature of 8–16 °C.

International Conference on Renewable Energy and Power Quality (ICREPQ), 2-4 September 2020