Review of: "Refrigerant Selection in Air Conditioning Systems Considering Thermodynamic, Environmental, and Economic Performance Using the BHARAT-II Multi-Attribute Decision-Making Method"

Aman Srivastava[1]

1 Indian Institute of Technology Kharagpur

Potential competing interests: No potential competing interests to declare.

This manuscript introduces the BHARAT-II multi-attribute decision-making method, which aims to select the most suitable refrigerant for air conditioning systems by considering thermodynamic, environmental, and economic factors[1]. The proposed methodology is applied in two case studies: one for residential split air conditioners and another for automobile air conditioning systems. In evaluating the identified best choices, I have focused on their Ozone Depletion Potential (ODP) and Global Warming Potential (GWP) to assess their climate resilience, environmental friendliness, and sustainable viability. Through this analysis, I aim to highlight potential limitations of the identified best choices in the context of climate change[2], emphasizing the need for careful consideration of their long-term environmental impacts.

The evaluation of the refrigerants based on ODP and GWP shows that R1234yf is the most climate-resilient, environmentally friendly, and sustainably viable option. With an ODP of 0 and a GWP of less than 1, R1234yf stands out as an excellent choice for minimizing environmental impact while maintaining effective cooling performance. It should be prioritized in applications where its use is feasible, offering a significant reduction in the potential contribution to global warming and ozone depletion compared to other refrigerants. This prioritization aligns with global efforts to combat climate change and reduce greenhouse gas emissions, particularly under the Kigali Amendment[3][4] to the Montreal Protocol, which aims to phase out high-GWP refrigerants.

R32, with an ODP of 0 and a GWP of around 675, offers a moderate level of sustainability. Although not as low in GWP as R1234yf, R32 presents a viable interim solution that balances performance with a reduced environmental impact relative to high-GWP refrigerants. Its moderate GWP makes it a better choice than R410A, R134a, and especially R22, which has a GWP of around 1760. While R32's moderate sustainability indicates it could serve as a transitional refrigerant, further improvements and the development of lower-GWP alternatives are necessary for long-term climate resilience[5][6].

Refrigerants like R410A, R134a, and R22 pose significant challenges to sustainability due to their high GWPs. R410A, with a GWP of approximately 2088, and R134a, with a GWP of around 1300, are likely to face increasing regulatory pressures aimed at reducing greenhouse gas emissions. R22, with a high GWP and an ODP, is particularly problematic and is already being phased out in many regions. These refrigerants contribute significantly to global warming and ozone depletion, making them less favorable choices for sustainable cooling solutions[7][8]. The potential phase-out of these high-GWP refrigerants under international agreements such as the Kigali Amendment to the Montreal Protocol[3][4] further emphasizes the need for alternative solutions.

To overcome the challenges associated with high-GWP refrigerants, future research and development should focus on promoting the use of low-GWP refrigerants like R1234yf and exploring new alternatives that offer better environmental performance without compromising thermodynamic efficiency. It is also essential to consider the broader context of climate resilience, which includes the potential impacts of extreme climatic events, evolving climate policies, and the importance of international collaboration, as can be seen in allied/related works[9][10][11][12][13][14][15][16][17][18][19]. Effective implementation of low-GWP refrigerants requires coordinated efforts across different sectors and regions to ensure that climate policies are robust and adaptable. International collaboration and knowledge sharing will be crucial in accelerating the phase-out of high-GWP refrigerants and achieving sustainable development goals. By addressing these broader issues, we can enhance the climate resilience and sustainability of refrigeration and air conditioning systems worldwide.

References

1. ^*Ravipudi Venkata Rao, Ravipudi Jaya Lakshmi. (2024). Refrigerant Selection in Air Conditioning Systems Considering Thermodynamic, Environmental, and Economic Performance Using the BHARAT-II Multi-Attribute Decision-Making Method. Qeios. doi:10.32388/94AKJ7.*
2. ^*Aman Srivastava, Rajib Maity, Venkappayya R. Desai. (2022). Assessing Global-Scale Synergy Between Adaptation, Mitigation, and Sustainable Development for Projected Climate Change. doi:10.1007/978-3-031-15501-7_2.*
3. a, b*Eric A. Heath. (2017). Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer (Kigali Amendment). Int. leg. mater., vol. 56 (1), 193-205. doi:10.1017/ilm.2016.2.*
4. a, b*Tina Birmpili. (2018). Montreal Protocol at 30: The governance structure, the evolution, and the Kigali Amendment. doi:10.1016/j.crte.2018.09.002.*
5. ^*Kutub Uddin, Bidyut Baran Saha, Kyaw Thu, Shigeru Koyama. (2018). Low GWP Refrigerants for Energy Conservation and Environmental Sustainability. doi:10.1007/978-981-13-3302-6_15.*
6. ^*Zhao Yang, Biao Feng, Haiyun Ma, Lei Zhang, et al. (2021). Analysis of lower GWP and flammable alternative refrigerants. International Journal of Refrigeration, vol. 126 , 12-22. doi:10.1016/j.ijrefrig.2021.01.022.*
7. ^*Animesh Pal, Kutub Uddin, Kyaw Thu, Bidyut Baran Saha. (2018). Environmental Assessment and Characteristics of Next Generation Refrigerants. doi:10.5109/1936218.*
8. ^*D.C. Savitha, P.K. Ranjith, Basavaraja Talawar, N. Rana Pratap Reddy. (2021). Refrigerants for sustainable environment – a literature review. International Journal of Sustainable Energy, vol. 41 (3), 235-256. doi:10.1080/14786451.2021.1928129.*
9. ^*Changru Yang, Sangwon Seo, Nobuo Takata, Kyaw Thu, et al. (2021). The life cycle climate performance evaluation of low-GWP refrigerants for domestic heat pumps. International Journal of Refrigeration, vol. 121 , 33-42. doi:10.1016/j.ijrefrig.2020.09.020.*

10. ^Aman Srivastava, Pennan Chinnasamy. (2021). Developing Village-Level Water Management Plans Against Extreme Climatic Events in Maharashtra (India)—A Case Study Approach. doi:10.1007/978-3-030-76008-3_27.
11. ^Pavel Makhnatch, Rahmatollah Khodabandeh. (2014). The Role of Environmental Metrics (GWP, TEWI, LCCP) in the Selection Of Low GWP Refrigerant. Energy Procedia, vol. 61 , 2460-2463. doi:10.1016/j.egypro.2014.12.023.
12. ^Mark O. McLinden, J. Steven Brown, Riccardo Brignoli, Andrei F. Kazakov, et al. (2017).Limited options for low-global-warming-potential refrigerants. Nat Commun, vol. 8 (1). doi:10.1038/ncomms14476.
13. ^Aman Srivastava, Pennan Chinnasamy. (2023). Watershed development interventions for rural water safety, security, and sustainability in semi-arid region of Western-India. Environ Dev Sustain. doi:10.1007/s10668-023-03387-7.
14. ^Atilla Gencer Devecioğlu, Vedat Oruç. (2015). Characteristics of Some New Generation Refrigerants with Low GWP. Energy Procedia, vol. 75 , 1452-1457. doi:10.1016/j.egypro.2015.07.258.
15. ^Aman Srivastava, Rajib Maity. (2023). Assessing the Potential of AI–ML in Urban Climate Change Adaptation and Sustainable Development. Sustainability, vol. 15 (23), 16461. doi:10.3390/su152316461.
16. ^Di Wu, Bin Hu, R.Z. Wang. (2021).Vapor compression heat pumps with pure Low-GWP refrigerants. Renewable and Sustainable Energy Reviews, vol. 138 , 110571. doi:10.1016/j.rser.2020.110571.
17. ^Aditya Dhanuka, Aman Srivastava, Leena Khadke, Nand Lal Kushwaha. (2023).Smart Geometric Design of Highways Using HTML Programming for Sustainable and Climate Resilient Cities. doi:10.1007/978-3-031-24767-5_39.
18. ^Sergio Bobbo, Giovanni Di Nicola, Claudio Zilio, J. Steven Brown, et al. (2018).Low GWP halocarbon refrigerants: A review of thermophysical properties. International Journal of Refrigeration, vol. 90 , 181-201. doi:10.1016/j.ijrefrig.2018.03.027.
19. ^Aman Srivastava, Shubham Jain, Rajib Maity, Venkappayya R. Desai. (2022).Demystifying artificial intelligence amidst sustainable agricultural water management. doi:10.1016/b978-0-323-91910-4.00002-9.