Chapter 1
Recent Trends in Optimizing Hydrogen Supply Networks

Devanshi Srivastava
Department of Chemical Engineering, Harcourt Butler Technical University, Kanpur, India

Adarsh Kumar Arya
https://orcid.org/0000-0002-2378-3832
Department of Chemical Engineering, Harcourt Butler Technical University, Kanpur, India

Toufik Mzili
https://orcid.org/0000-0002-5733-3119
Chouaib Doukkali University, Morocco

Murali Pujari
Department of Chemical Engineering, University of Petroleum & Energy Studies, Bidholi, India

ABSTRACT

The extensive reliance on conventional fossil fuels escalates greenhouse gas emissions and exacerbates environmental pollution, necessitating an urgent energy shift. Consequently, the advancement and use of renewable energy are of paramount significance. Hydrogen is expected to progress in the following years as a replacement for fossil fuels among various renewable sources. However, the high cost of the hydrogen supply network (HSN) has provoked the researchers to use optimization techniques to optimize the (HSN). The present study analyzes modern optimization methods for (HSN) and thoroughly examines the 'Green hydrogen sup-

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ply chain'(GHSC), including transportation, production, storage and consumption, emphasizing metaheuristic optimization (MO) applications. The difficulties inherent in each phase are highlighted, and the capacity of MO techniques to mitigate these difficulties is examined. The study also examines multi-objective methodologies for optimizing issues within this area.

1. INTRODUCTION

In light of the official initiation of the Paris Climate Change Agreement, which took place on November 4, 2016, there has been a notable increase in the expectations surrounding hydrogen fuel, as it is being recognized as an essential element in the broader strategy for achieving environmental sustainability. The ambitious 2°C global warming scenario is designed to create a carbon release trajectory that effectively limits the accumulation of greenhouse gases within our atmosphere, thereby compelling various governments and advocates for climate action, especially in developing nations, to diligently pursue the critical goal of significantly reducing emissions while simultaneously ensuring that economic growth remains unhindered and robust. Hydrogen is increasingly viewed as a vital component that enhances the sustainability and resilience of our power systems and plays a crucial role in providing the necessary flexibility that modern energy infrastructures require to adapt to fluctuating demands and supply conditions(Arya et al., 2022). Consequently, the ongoing exploration and investment in hydrogen fuel technologies present a promising avenue for addressing the dual challenges of climate change and economic development in an era that increasingly prioritizes environmental stewardship alongside economic viability. The International Energy Agency (IEA), in its publication titled "Hydrogen and Fuel Cells," released in the year 2015, made a noteworthy observation that the utilization of hydrogen has the potential to seamlessly integrate a multitude of energy sectors alongside the intricate logistics and distribution (T&D) networks, thereby significantly enhancing the operational flexibility and adaptability of the low-carbon energy systems that are anticipated to emerge shortly. The current energy system predominantly relies on fossil fuels; besides co-generation, there are few interconnections among the various transmission and distribution systems. In a forthcoming system, Hydrogen may play a crucial role in connecting different tiers of infrastructures within a low-carbon energy framework. Hydrogen products and technology have advanced considerably over several decades and are now being integrated into the market. The infrastructure's inadequacy is a significant obstacle to reaching the hydrogen economy. Consequently, extensive infrastructure investment initiatives grounded in formulating novel techniques should be implemented. Furthermore, the business