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AI-Based Optimization of Compressed Air Networks in Hard-to-Abate Industrial Sectors

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Compressed air systems represent a critical utility in energy-intensive industries, particularly in hard-to-abate sectors such as steel, cement, and chemicals, where efficiency improvements can significantly reduce energy consumption and carbon emissions. This study presents an artificial intelligence (AI)-based methodology for the optimization of compressed air networks in industrial plants, leveraging advanced machine learning algorithms and data-driven models. The proposed solution employs AI algorithms for predictive maintenance, anomaly detection, and dynamic pressure control, enabling the system to autonomously adapt to varying production needs.

By analyzing historical operational data and real-time sensor information, the AI models identify inefficiencies, forecast demand patterns, and suggest optimal operating parameters. This intelligent decision-making process not only enhances overall system performance but also minimizes energy losses, reduces unplanned downtime, and extends equipment lifespan. The integration of AI-based control systems empowers end users with actionable insights and autonomous optimization capabilities, translating into tangible cost savings and operational resilience.

Case studies from the steel, cement and chemical industries demonstrate the effectiveness of the proposed approach, achieving up to 15% energy savings and a significant reduction in CO_2 emissions. The results highlight the transformative potential of AI as a key enabler for decarbonizing hard-to-abate sectors. This work underscores the strategic benefits of AI applications in compressed air systems and provides a scalable framework for future industrial implementations, supporting the broader goal of energy efficiency and sustainable industrial transformation.

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