IJDACR
ISSN: 2319-4863

IJDACR
International Journal Of Digital Application & Contemporary Research

International Journal of Digital Application & Contemporary Research
Website: www.ijdacr.com (Volume 13, Issue 07, February 2025)

A Theoretical Review on Enhancing Waste Heat Recovery Through Thermoelectric Energy Conversion

Yashwardhan Singh Chandrawat
singhchandrawat84@gmail.com

Khemraj Beragi
khemrajberagi@gmail.com

Abstract – **The growing demand for energy, coupled with the need for sustainable practices, has increased focus on efficient energy utilization, especially in waste heat recovery (WHR) systems. Waste heat, generated as a byproduct of industrial processes, remains an underutilized resource despite its potential to contribute significantly to energy savings and environmental sustainability. Thermoelectric energy conversion, through the Seebeck effect, presents a promising solution for converting low- and medium-grade waste heat into electricity. This review explores the theoretical principles behind thermoelectric materials and their application in waste heat recovery systems, focusing on advancements in material science, system design, and emerging technologies. Challenges such as material costs, limited efficiency at low-grade heat, and scalability for industrial applications remain. Furthermore, machine learning techniques are being integrated into thermoelectric systems to optimize material properties, enhance system performance, and enable predictive maintenance. Ongoing research into cost-effective, high-performance thermoelectrics and smart technologies promises to significantly improve waste heat recovery, contributing to more sustainable and efficient energy systems in various industries.**

Keywords – **Additive Manufacturing, Alloying, Doping, Efficiency, Machine Learning, Predictive Maintenance, Seebeck Effect, Thermoelectric Materials, Waste Heat Recovery.**