Contribution ID: **7**

Type: **Oral Presentation**

Multi-Stage Waste-Heat Recovery and Furnace Optimization in Seamless Pipe Production: A Case Study at Atieh Partak Pipe Industries

Wednesday 13 May 2026 12:40 (20 minutes)

Enhancing thermal efficiency and reducing operating costs are critical objectives in seamless pipe production, particularly in processes where billet preheating constitutes a major portion of total energy demand. In rotary hearth furnaces operating at billet temperatures near 1280 ℃, a significant fraction of the fuel input is released as high-enthalpy flue gases, representing a valuable but underutilized source of recoverable energy. This study investigates the technical and economic feasibility of converting this waste heat into electrical power through an integrated Heat Recovery Steam Generator (HRSG) and Organic Rankine Cycle (ORC), while also examining furnace-level process optimization strategies. At Atieh Partak Pipe Industries, a strategic reduction in annual production capacity—from 400,000 to 150,000 t/year—prompted a preliminary engineering assessment to evaluate the elimination of the billet preheating furnace and the exclusive operation of the rotary hearth furnace as the primary heating unit. A comprehensive case study was subsequently conducted to quantify the recoverable thermal energy in the furnace exhaust and to assess its potential for power generation.
The methodology incorporates field measurements and energy–exergy analyses to characterize the exhaust temperature profile, mass flow rate, and gas composition. Three waste-heat recovery configurations were modeled: a high-temperature HRSG coupled with a small steam turbine, a dual-stage HRSG–ORC system, and a ceramic recuperator integrated with a low-temperature ORC. Results indicate that, depending on operating conditions, several hundred kilowatts of electrical power can be generated. Overall, the proposed configurations are shown to be technically feasible and economically advantageous for the plant.

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Session Classification: Energy Efficiency and Consumption Reduction

Track Classification: EMECR: EMECR 7. Energy savings and energy efficiency optimization