TEAM 01 9

Boiler Enhancer

Salah Faisal Alanazi, Omar Samman, Munif Alwafi, Abduljawad Naji Alahmadi
Coach: Dr. Ali Elkhazraji

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Introduction/Background

- Refineries and chemical plants face high energy costs and slow boiling. Our aluminum-enhanced boiler cuts both by boosting heat transfer with low-cost chips, requiring no major modifications.
- Constraints: Required liquid temperature (40–100 °C), energy consumption (0.1–10 kW/h), typical lifespan (5–15 years), unit capacity (3–50 L), and liquid flow rate (0.5–20 L/hour).
- Specifications: The system must safely operate under 10 bar with relief valves (200–300 kPa), staying ≥20°C below the chip's toxin release temperature. It must maintain liquid temperatures between 40–110°C, achieve energy savings of 0.1–5 kWh/day, handle flows under Re 2300 (0.5–20 L/h), fit within 3–50 L volume, use chips with ≥220 W/m·K conductivity occupying <40% of volume, heat 1–10°C faster with ±5°C uniformity, reduce heat loss by 1–50%, last 5–15 years (extendable by 1–5 years), and cost $50–1000 to install.

Prototype Design

- The prototype features a vertical brass boiler with inlet/outlet ports and aluminum alloy chips positioned inside the heated zone. The chips absorb and redistribute heat, lower energy loss and improve thermal efficiency.

- Main Components:
  - Inlet / Outlet: Enables continuous fluid flow.
  - Alloy Chips: High conductivity (≈ 237 W/m·K) for better heat transfer.
  - Heated Plate: Responsible for heating and promoting bubbling which result in uniform heat distribution

Testing / Validation

- A series of comparative boiling trials were conducted, testing a standard boiler both with and without the aluminum chips. The experimental results demonstrate conclusively that the chip-enhanced system meets all performance specifications.

Conclusion

- The system with the mechanism was 18% faster at boiling, achieved 64% faster heat recovery, and showed 27% faster overall heating compared to a normal boiler. It also reduced surface heat loss by 15%.