
Synopsis Seminar

Seminar Title	: Design and Development of Sustainable Freshwater Extraction System from Wastewater/Seawater Employing Low-Grade Energy Sources across India
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Venue	: ME Seminar Hall
Date and Time	: 04 Aug 2025 (05:00 PM)
Abstract	: This research develops and evaluates sustainable freshwater recovery systems based on humidification&ndashdehumidification (HDH) using renewable energy. Three approaches were explored: (a) a geothermal wastewater recovery system, (b) a solar-powered seawater/wastewater desalination system with evacuated tube heat pipe/U-tube collectors, and (c) a U-tube collector-based humidification-condensation system. The geothermal system, validated against literature with $\pm 8\%$ error, showed hot spring temperature as the key performance factor. Feasibility mapping identified composite climates as most suitable, achieving up to 0.78 L/h water recovery. The solar desalination system, validated experimentally ($\pm 12\%$ error), revealed that collector exit temperature strongly affects energy exchanges (0.91 kW/m^2 in humidifier, 0.21 kW/m^2 in condenser) and freshwater rate ($0.154 \text{ L/h}\cdot\text{m}^2$). Optimization of condenser effectiveness and flow ratios further enhanced output. The U-tube collector-based system, modeled using finite difference ($R^2 > 0.98$), achieved up to $1.445 \text{ L/h}\cdot\text{m}^2$ water extraction and 1.37 kW/m^2 condenser energy exchange, with air inlet temperature and humidity ratio as critical parameters. Experimental HDH studies with SS304 mesh and Celdek 7090 packing showed higher water yield (0.825 kg/h), energy efficiency (35.6%), and GOR (0.65) using structured packing, though with higher pressure drop. Exergy analysis revealed humidifier irreversibility ($>85\%$). Response Surface Methodology ($R^2 > 0.99$) validated optimization. Overall, geothermal and solar-driven HDH systems prove to be viable, eco-friendly solutions for decentralized freshwater production, offering key insights into design, optimization, and implementation across diverse climates.