National Institute of Technology Rourkela

Departmental Seminar

Seminar Title	: Enhancing Atmospheric Sustainability with Vapour Ad/Ab-Sorption Systems
Speaker	: Prof Bukke Kiran Naik
Supervisor	: Prof. Saurav Datta (2524), PIC Departmental Seminar
Venue	: ME Seminar Hall (ME-001)
Date and Time	: 21 Jul 2025 (11:00 AM)
Abstract	: Vapour adsorption and absorption systems are crucial for sustainable atmospheric management, enabling efficient moisture regulation, air purification, and waste heat recovery while facilitating freshwater extraction from the atmosphere. This study conducts a thermodynamic and exergetic analysis of desiccant-coated energy exchangers, liquid desiccant dehumidification systems, and thermochemical energy storage technologies, focusing on their role in atmospheric moisture harvesting and climate control. Adsorption/desorption kinetics of circular fin tube heat exchangers and hollow fiber membrane-based dehumidifiers are evaluated, considering moisture diffusivity, heat transfer coefficients, and structured packing effects for enhanced water capture efficiency. Computational modeling using Eulerian-Lagrangian multiphase simulations and discrete phase methods is applied to analyze moisture transport, condensation dynamics, and phase change behaviors in adsorption-driven water harvesting systems. AI-driven predictive optimization, integrating physics-informed neural networks, ANFIS, and KNN algorithms, enhances real-time control, optimizing energy efficiency and water yield. PCM-assisted thermochemical storage is examined for its effectiveness in sustaining continuous water extraction cycles. Comparative studies of liquid desiccant air conditioning, Ranque-Hilsch vortex tube cooling, and mobile thermochemical storage highlight their potential in atmospheric water harvesting, waste heat utilization, and decentralized cooling applications. The findings suggest that AI-enhanced optimization, coupled with advanced heat exchanger architectures and adaptive control, significantly improves the energy efficiency, scalability, and feasibility of vapour ad/ab-sorption systems for sustainable atmospheric applications, including clean water generation from ambient air.