הטכניון מכון טכנולוגי לישראל TECHNION Israel Institute of Technology

Faculty of Mechanical Engineering הפקולטה להנדסת מכונות

MECHANICAL ENGINEERING MSc SEMINAR (30 min.)

Thursday, March 19, 2026, at 13:30-14:00, D. Dan and Betty Kahn Building, Room 250

BUBBLY MEDIA BASED NEAR-ISOTHERMAL COMPRESSION FOR HEAT PUMP APPLICATIONS

Feintuch Nir

Adviser: Assoc. Prof. Carmel Rotschild

Reducing greenhouse-gas emissions requires both the deployment of low-carbon energy sources and substantial improvements in the efficiency of energy-intensive processes. Gas compression is widely used across industry and is the dominant power consumer in vapor-compression heat pumps, whose performance strongly influences global electricity demand for heating and cooling. While conventional compressors operate near-adiabatically and have been optimized for decades, near-isothermal compression remains an attractive pathway for efficiency gains as it minimizes the temperature rise and associated compression work. Achieving near-isothermal behavior at practical power densities is challenging due to the need for very high heat-transfer rates during compression.

A new thermodynamic heat-pump cycle is proposed in which the working fluid is compressed as bubbles suspended in a heat-transfer liquid. Immersion of the gas in a high-thermal-mass liquid enables effective heat exchange and near-constant gas temperature throughout the compression, offering a route toward near-Carnot performance at MW-class scales.

This work investigates Near-isothermal compression using Liquid-Gas Jet Pumps (LGJPs), in which a high-speed liquid jet entrains and then compresses a gaseous working fluid as dispersed bubbles. LGJP are widely treated in the literature as effectively isothermal, but practical efficiency is limited by viscous losses and irreversibilities associated with two-phase mixing. LGJP were designed and assessed using computational fluid dynamics and validated experimentally. The results quantify the key loss mechanisms and demonstrate an inherent coupling between achievable temperature lift and required flow velocity, which constrains efficiency in practical LGJP-based compression.

Motivated by findings on LGJP experiments, a different approach based on subsonic bubble-flow compression in a rotating apparatus is introduced as ongoing work, and preliminary results are presented to outline its potential to overcome the limitations observed in jet-pump-based compression.

Note: the seminar will be given in English

Seminars Coordinator: Assoc. Prof. Sefi Givli