HEAT TRANSFER AND MULTIPHASE FLOW APPLICATION

PHD DAY 2023 - DIEF UNIFI - THERMOGROUP

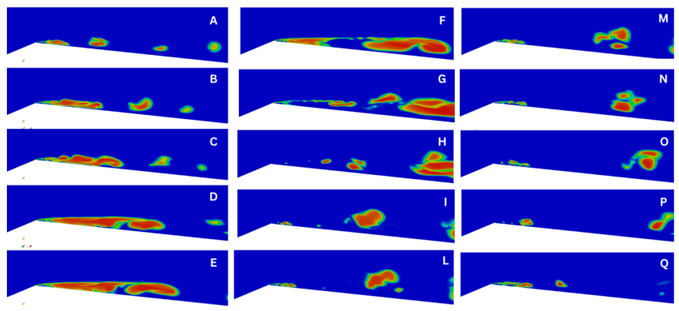
CAVITATION IN CRYOGENIC FLUIDS

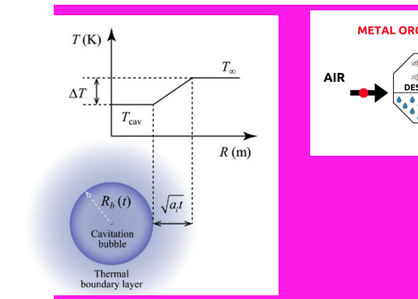
CAVITATION, THE PHASE CHANGE FROM LIQUID TO VAPOR DUE TO A SUDDEN PRESSURE DROP, EXHIBITS UNIQUE CHARACTERISTICS IN CRYOGENIC FLUIDS. THE WORKING CONDITIONS IN CRYOGENIC APPLICATIONS ARE OFTEN NEAR THE CRITICAL POINT OF THE FLUID, RESULTING IN INCREASED SATURATION VAPOR DENSITY AND ENHANCED MASS VAPORIZATION REQUIREMENTS TO SUSTAIN A CAVITY. THIS LEADS TO EVAPORATION-INDUCED COOLING, CAUSING A SIGNIFICANT TEMPERATURE DROP WITHIN THE CAVITY. EFFECTIVE MANAGEMENT OF THERMODYNAMIC EFFECTS CAN ENHANCE THE PERFORMANCE, EFFICIENCY, AND RELIABILITY OF CRYOGENIC PUMP SYSTEMS.

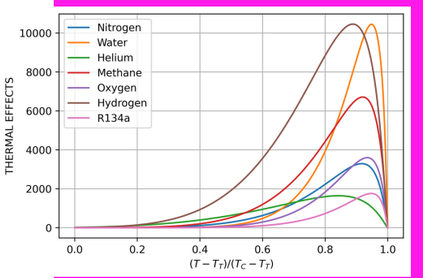
KEY POINTS FOR CFD **VOF-MULTIPHASE** MODEL DEVELOPMENT:

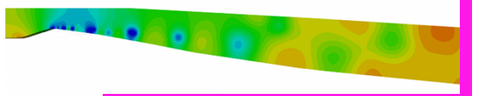
- **THERMOPHYSICAL PROPERTIES**: ACCURATE REPRESENTATION OF THE THERMOPHYSICAL PROPERTIES OF CRYOGENIC FLUIDS IS CRUCIAL IN CFD SIMULATIONS.
- **CAVITATION MODEL :** MOST CURRENT MODELS FOR CAVITATION ASSUME ISOTHERMAL CONDITIONS. DEVELOP A MATHEMATICAL MODEL THAT INCLUDES THERMAL EFFECTS, AN EXTENSION OF THE RAYLEIGH-PLESSET EQUATIONS IS NECESSARY.
- **CAVITATION BEHAVIOUR:** IT IS NECESSARY TO DEVELOP A TURBULENT MODEL THAT CAN CAPTURE THE NON-STATIONARY MECHANISMS OF : **RE ENTRANT JET-SHOCK FRONT-SHEET CAVITATION**
- **INTERFACE CAPTURING METHOD:** INTEGRATION OF VOF MODELS WITH LEVEL-SET METHODS IS ESSENTIAL

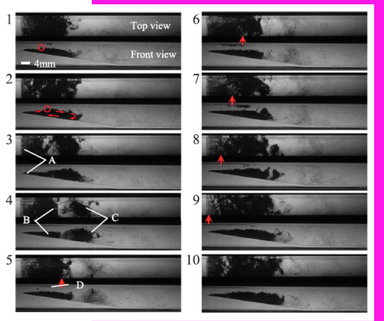
OpenFOAM®

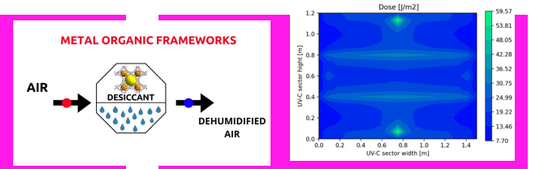


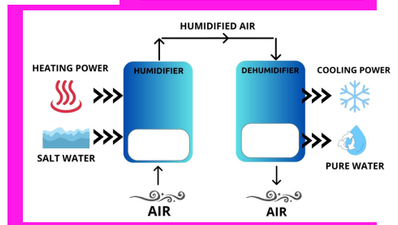


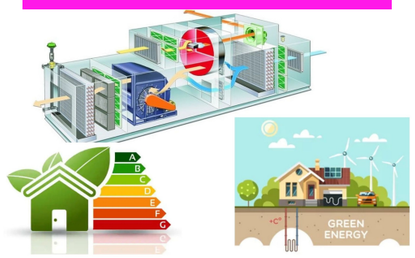


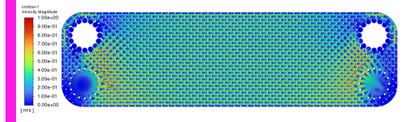


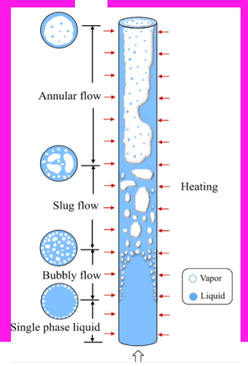


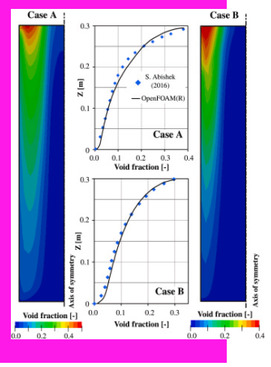












HVAC-NZEB-AIR QUALITY HDH DESALINATION

HVAC (HEATING, VENTILATION, AIR-CONDITIONING) SYSTEMS ALLOW TO OBTAIN, INSIDE A BUILDING, A CAREFUL REGULATION OF THERMO-HYGROMETRIC PARAMETERS AND TO ENSURE HIGH STANDARDS OF INDOOR AIR QUALITY. THE ENERGY EFFICIENCY OF THESE SYSTEMS AND THE BUILDINGS SERVED BY THEM IS ESSENTIAL TO REACH AN EFFECTIVE **DECARBONISATION OF THE HEATING AND COOLING SECTOR**.

SPECIFIC FOCUSES OF THE RESEARCH ACTIVITY ARE:

- STUDY AND OPTIMISATION OF HVAC SYSTEMS BASED ON THE USE OF **BIOMIMETIC TECHNOLOGIES** (EVAPORATIVE COOLING) AND INNOVATIVE **DESICCANT MATERIALS** (METAL ORGANIC FRAMEWORKS).
- ANALYSIS OF THE EFFECT OF **AIR FLOWS DISINFECTION TECHNOLOGIES** (UV-C LAMPS) AND OPTIMISATION OF THE DISTRIBUTION OF AIR FLOWS IN INDOOR ENVIRONMENTS.
- STUDY AND OPTIMISATION OF **DATA CENTRE COOLING SYSTEMS.**
- ANALYSIS OF NEAR ZERO ENERGY BUILDINGS (**NZEB**).

MOREOVER, IN THE CONTEXT OF PSYCHROMETRIC TECHNOLOGIES APPLICATIONS, THE GROUP IS INVOLVED IN THE OPTIMISATION OF **HDH** (HUMIDIFICATION-DEHUMIDIFICATION) **DESALINATION** SYSTEMS

MULTIPHASE BOILING MODELS

THE DEVELOPMENT OF ACCURATE COMPUTATIONAL FLUID DYNAMICS (CFD) MODELS FOR **MIXTURE REFRIGERANTS** IS ESSENTIAL FOR THE DESIGN AND OPTIMIZATION OF REFRIGERATION SYSTEMS. IN PARTICULAR MIXTURE REFRIGERANTS, COMMONLY USED IN VARIOUS COOLING APPLICATIONS, **EXHIBIT THE GLIDE EFFECT,** WHERE THEIR COMPOSITION CHANGES DURING EVAPORATION OR CONDENSATION. THIS EFFECT NECESSITATING THE CONSIDERATION OF NON-IDEAL THERMODYNAMIC AND TRANSPORT PROPERTIES.

- **MULTISPECIES MULTIPHASE MODEL :** INCORPORATES A SET OF CONSERVATION EQUATIONS FOR SPECIES FOR EACH COMPONENT IN THE MIXTURE TO TAKE INTO ACCOUNT GLIDE EFFECT
- **INNOVATIVE MICRO-PLATE HEAT EXCHANGERS :** DEVELOPMENT OF INNOVATIVE PLATE DESIGN OPTIMISES HEAT TRANSFER IN CONDENSER OR EVAPORATOR WITH HIGH RELIABILITY TO ACHIEVE INCREASED EFFICIENCY WITH A REDUCED REFRIGERANT CHARGE.

UNIVERSITÀ DEGLI STUDI FIRENZE
DIEF DIPARTIMENTO DI INGEGNERIA INDUSTRIALE

PhD DAY 23may23

NICOLA.ANDREINI@UNIFI.IT
LORENZO.GIUNTI@UNIFI.IT
LUCA.SOCCI@UNIFI.IT
GUGLIELMO.VACCARO@UNIFI.IT

VOTE HERE