ENERGETICS

PNRR - Innovative processes and materials for long-term thermal energy storage

Funded By	MINISTERO DELL'UNIVERSITA' E DELLA RICERCA [P.iva/CF:97429780584] Politecnico di TORINO [P.iva/CF:00518460019]
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Context of the research activity	This research grant aims to investigate low-cost solutions for long-term thermal energy storage using suitable composite adsorbent materials. The grantee will focus on synthesizing, characterizing, and testing adsorbent materials, including cement-based and mesoporous materials. The research will involve becoming familiar with the relevant experimental techniques as well as the conduction of systematic material and process screening. Progetto finanziato nell'ambito del PNRR - PNRR M4C2, Investimento 1.3 - Avviso n. 341 del 15/03/2022 - PE0000021 Network 4 Energy Sustainable Transition (NEST) - CUP E13C22001890001
	The activities planned in this PhD research program encompass a comprehensive investigation into thermal energy storage, specifically focusing on low-temperature, long-term (seasonal) applications. The primary objective of the research is to develop cost-effective and robust solutions through the synthesis, characterization, and testing of suitable adsorbent materials, with a particular emphasis on composite adsorbents. To begin with, the grantee will have to familiarize with various techniques for synthesizing those adsorbent materials. To this end, water adsorbent materials will be primarily investigated, although the foreseen studies will not necessarily be limited in this respect. This will involve understanding the principles and methodologies involved in creating cement-based adsorbents or other mesoporous materials, although the exploration is not limited to these examples. The synthesis process will be carefully designed to ensure the resulting adsorbents possess the desired properties for efficient thermal energy storage. Once the materials are synthesized, the successful candidate will embark on developing strategies for both thermal and energetic characterization of the newly created adsorbents. On one hand, thermal characterization involves

Objectives	analyzing the materials' heat capacity, thermal conductivity, and thermal stability, among other relevant properties. On the other hand, energetic characterization shall focuse on evaluating the adsorbents' sorption capacity, kinetics, and energy storage performance. The optimization of materials and thermal energy storage processes will be pursued through systematic experimentation, involving a thorough screening of various solutions. By exploring the parameter space comprehensively and effectively, the goal is to identify the most promising combinations of materials and storage conditions that offer optimal thermal energy storage capabilities. This iterative screening process will involve testing different composite adsorbents, varying synthesis conditions, composition, and other relevant factors. In the pursuit of efficient exploration of the parameter space, modern computational approaches will also be employed. If needed, active learning algorithms - along with other computational tools – will possibly aid in accelerating the screening process. These algorithms can intelligently guide the selection of new experiments based on the knowledge gained from previous experiments, optimizing the use of resources and facilitating the discovery of high-performance materials and energy storage configurations. Overall, the PhD activities on thermal energy storage will encompass the synthesis, characterization, and testing of suitable adsorbent materials, with a focus on composite materials, for low-temperature, long-term applications. Through a combination of experimental and computational approaches, the research aims to develop cost-effective and efficient solutions for thermal energy storage, thereby contributing to the advancement of sustainable energy technologies.

Skills and competencies for the development of the activity	Basic notions on: i) thermodynamics; ii) heat and mass transfer; iii) material science.