



PhD in CHIMICA INDUSTRIALE E INGEGNERIA

CHIMICA / INDUSTRIAL CHEMISTRY AND CHEMICAL ENGINEERING - 40th cycle

THEMATIC Research Field: ADVANCED CCU TECHNOLOGIES FOR THE DECARBONIZATION OF CEMENT MAKING PROCESSES

Monthly net income of PhDscholarship (max 36 months)

€ 1400.0

In case of a change of the welfare rates during the three-year period, the amount could be modified.

Context of the research activity

Motivation and objectives of the research in this field

The research project will have the main aims to develop and evaluate the performances of advanced processes and techniques for the reduction of carbon footprint along the entire cement and concrete value chain. One of the goals is to use captured CO₂-rich streams in a zeolite-based CO₂ mineralization plant integrated with a cement plant for the production of CO₂-trapped natural and/or synthetic zeolites. CO₂-enriched materials will then be used as Supplementary cementitious materials (SCMs) for casting concrete with lower cement content and lower carbon footprint. According to this technology, during cement hydration, part of the CO₂ entrapped in zeolites will be released enabling the precipitation of nanocrystalline seed of CaCO₃, promoting the cement hydration and storing part of the CO₂ for the whole lifecycle of the building material. This activity will be performed in cooperation with other international partners of the Horizon Europe HERCCULES Project (<https://www.herccules.eu/>). The advancement of these technologies therefore requires fundamental research activities, aimed at improving the understanding of the physical and chemical phenomena linked to the interaction between gaseous streams and solid adsorbent (e.g. increase in loading capacity, high selectivity, etc.), to be combined however with applied research activities, the ultimate aim of which consists in the development and



	<p>engineering of technology for future full-scale use (performance analysis of the entire process, definition of geometry and features of the equipment to minimize load losses, etc.).</p> <p>This approach will promote a dual advancement of knowledge: selection and/or development of adsorbent materials with particular attention to physical/chemical properties and performances in the CO₂ adsorption, without neglecting crucial aspects such as costs production; study of the optimal layout of the equipment in which to insert the adsorbent material and the structure of the related process cycle. Once the performance of the material on a laboratory scale will be characterized, mathematical models will be developed aimed at studying the sizing of the components of a pilot plant, aimed at advancing the maturity of the technology through performance analysis or experimental demonstration in a relevant environment (TRL 6-7) at a later stage of the research.</p>
Methods and techniques that will be developed and used to carry out the research	<p>The research activity will involve, in particular, lab. facilities of the CMIC department and the experimental facilities of other partners of the Horizon Europe HERCCULES Project. Both experimental techniques and modeling approaches will be required to design and optimize the main processes to be studied:</p> <ul style="list-style-type: none"> - synthesis and characterization of cheap adsorbents particularly suitable for capturing CO₂ from exhausts; - configuration of novel equipment and processes for the CO₂ utilization in the cement field, in which the new materials can be used, including integration in a future context with high penetration of renewable sources; - design of experiments and pilot plant testing of the selected technologies to fully demonstrate the technical properties of the concrete containing the CO₂-loaded adsorbents.
Educational objectives	<p>Objectives include the training of young researchers in the field of chemical and materials engineering oriented to Carbon Capture and Utilization processes, as well as in the reuse of spent materials and/or wastes in the cement</p>



	manufacturing process (https://www.herccules.eu/).
Job opportunities	Opportunities in the field of chemical processes, manufacturing processes and in the environmental safety field.
Composition of the research group	4 Full Professors 6 Associated Professors 2 Assistant Professors 15 PhD Students
Name of the research directors	Prof. Marco Derudi

Contacts
Telephone: 02-2399-3109 Email: marco.derudi@polimi.it

Additional support - Financial aid per PhD student per year (gross amount)	
Housing - Foreign Students	--
Housing - Out-of-town residents (more than 80Km out of Milano)	--

Scholarship Increase for a period abroad	
Amount monthly	700.0 €
By number of months	6

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information
<p>Confidentiality Since this is a thematic scholarship, the management of Confidential Information, Results and their publication is subordinate to the restrictions agreed upon with the funding body/company. Upon acceptance of the scholarship, it could be asked to the beneficiary to sign a specific commitment.</p> <p>Educational activities (funding for participation in courses, summer schools, workshops and conferences) - financial aid per PhD student per year: - 1st year: around 1.900 euros per student - 2nd year: around 1.900 euros per student - 3rd year: around 1.900 euros per student</p> <p>Teaching assistantship: availability of funding in recognition of supporting teaching activities by the PhD student: There are various forms of financial of for activities of support to the teaching practice. The PhD</p>



student is encouraged to take part in these activities within the limits allowed by the regulation.