



PhD in CHIMICA INDUSTRIALE E INGEGNERIA

CHIMICA / INDUSTRIAL CHEMISTRY AND CHEMICAL ENGINEERING - 39th cycle

PNRR 117 Research Field: DEVELOPMENT OF TECHNOLOGIES FOR THE CAPTURE AND THE USE OF CARBON DIOXIDE FROM INDUSTRIAL EMISSION SOURCES, SUCH AS WASTE-TO-ENERGY PLANTS AND POWER PLANTS

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 focuses on the study of a process for treating a flue gas stream from WtE in an Italian context (the first one in Italy) to remove CO₂ of non-biogenic origin that is, then, planned to be utilized. Decarbonization and reduction of emissions are relevant topics of the considered thematic area ("Rivoluzione verde e transizione ecologica") and, in general, of PNRR. In particular, the aim of the research is the study of a CO₂ removal process based on absorption for the innovative application to the WtE plant, with the aim of employing a low impact technology in incinerating wastes for producing electric and heating power. Municipal Solid Waste (MSW) contains materials of biogenic and non-biogenic origin. The incineration of biogenic component produces CO₂ that does not lead to an increase in atmospheric CO₂ levels, so Carbon Capture Utilization and Storage (CCUS) can provide a path to negative CO₂ emissions by producing energy and managing locally the produced waste in particular for WtE plants operating on MSW with a significant biogenic component. For reducing the CO₂ content in flue gas streams before their emission in the atmosphere, chemical absorption is the most suitable technology, with MonoEthanolAmine (MEA) aqueous solution being the traditional solvent used for this aim in fossil fueled power plants. Aqueous amine solutions are



	<p>also employed for acid gas removal to treat gaseous streams for accomplishing product specifications. According to what is reported in the literature, there is a very limited number of WtE plants in the world coupled with a CO₂ capture unit that could accomplish the implementation of CCUS. The plants for which more information is available are located in Norway, Japan, the Netherlands and Denmark and applications of CCUS in other four WtE plants outside Italy started to be considered. Few scientific studies on this topic have been performed until now and there is a lack of experimental data and information in the literature regarding this type of application, still not active in Italy. Therefore, the main objectives of the research activity are:- selection of the amine solvent(s) to be used;- operation of a pilot plant to be set-up in a WtE plant located in the Northern Italy and collection of experimental data;- design of the process of absorption and regeneration for the full scale plant;- analysis of possible alternative configurations for energy-saving.</p>
<p>Methods and techniques that will be developed and used to carry out the research</p>	<p>The research activity will involve:</p> <ul style="list-style-type: none"> •an experimental activity aimed at filling the gap regarding the application of CO₂ capture in WtE plants;- an analysis activity on the experimental data for evaluating the efficiency of CO₂ removal; •a simulation activity aimed at representing the system, for CO₂ capture from the WtE flue gas stream, composed of an absorption section and a solvent regeneration section;- a process design activity aimed at determining the characteristics of the units for the full scale CO₂ capture section in the WtE facility; •an evaluation activity for determining the performances of alternative configuration(s) for energy-saving. <p>The experimental activity will be carried out at a WtE plant (a2a S.p.A.) located in Northern Italy and will involve the use of a pilot plant with one absorption section and one regeneration section, fed with the industrial flue gas obtained from the incineration of the MSW treated in the</p>



	<p>considered WtE plant. During this activity, the experimental plan (test duration, parameters to be varied, etc.) and the most suitable measurement procedures for the collection of experimental data will be defined. The analysis activity will be carried out in the experimental facility of a2a S.p.A. to check the heat and material balances, to evaluate the CO₂ capture efficiency and the solvent degradation and to create the report of the experiments. The activities of simulation, process design and study of alternative scheme(s) will be carried out at Politecnico di Milano, in collaboration with a2a S.p.A. The simulation activity will take into account the thermodynamics of the system and the mass transfer with reaction characteristic of the specific system to be considered, that include the formation of ions due to chemical reactions. The simulation activity will consider a comparison of the estimated performances of the pilot plant with the ones obtained experimentally and then will focus on the representation of the CO₂ capture process for the application to the full scale plant. The process design activity will include the definition of the Process Flow Diagram, the heat and material balances, the layout and the economic evaluation. For the activity related to the evaluation of the performances of the process considering alternative configurations, a sensitivity analysis on the main process parameters will be performed to determine the best process scheme, with minimization of the energy requirements.</p>
Educational objectives	<p>The planned research activity is expected to improve the capabilities of the PhD candidate in providing cutting-edge and sustainable solutions. By using the acquired knowledge, in particular related to chemical engineering topics, the PhD graduate will be able to design processes able to meet the needs of society.</p>
Job opportunities	<p>The PhD graduate will have the expertise for starting a professional career in national and multinational companies related to process engineering (i.e., in multi-utility companies, in the Oil&Gas field), with recognition of the experience gained during the PhD.</p>



Composition of the research group	1 Full Professors 1 Associated Professors 2 Assistant Professors 3 PhD Students
Name of the research directors	Prof.ssa L Pellegrini, Ing. A. Carrara

Contacts
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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

National Operational Program for Research and Innovation	
Company where the candidate will attend the stage (name and brief description)	a2a S.p.A. Via Mezzana 81 – 25038 Rovato (BS) https://www.gruppoa2a.it/it/home
By number of months at the company	6
Institution or company where the candidate will spend the period abroad (name and brief description)	to be defined
By number of months abroad	6

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information
<p>Confidentiality (Agreement with company): 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 company. Upon acceptance of the scholarship, the beneficiary must sign a specific commitment.</p> <p>Individual budget for research (5.700 euro): 1st year: 1.900 euro; 2nd year: 1.900 euro; 3rd year: 1.900 euro</p> <p>Teaching assistantship (availability of funding in recognition of supporting teaching activities by the PhD student): there are various forms of financial for activities of support to the teaching practice. The PhD student is encouraged to take part in these activities within the limits allowed by the regulation.</p>



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