MINISTERUL EDUCAȚIEI ȘI CERCETĂRII
UNIVERSITATEA PETROL-GAZE DIN PLOIEȘTI
B-dul. București nr. 39, 100680, Ploiești, România, www.upg-ploiesti.ro
Telefon +40 244 573 171 Fax +40 244 575 847

Abstract Habilitation Thesis

Candidate: Assoc. Prof. Dr. Eng. Suditu Costel-Silvian

The habilitation thesis, entitled "*Research on educational and technological processes in the oil and gas industry in the context of climate change*" summarizes the scientific, teaching and research activities that the candidate has carried out in the 25 years of teaching and research activity at the Petroleum - Gas University of Ploiești, scientific research disseminated through numerous scientific publications, more intensively after the defense of the doctoral thesis.

The doctoral thesis entitled "*Contributions to the optimal use of gas distribution pipelines*" was carried out under the supervision of Prof. Dr. Eng. Stan Alecsandru and publicly defended in 2008 at the Petroleum - Gas University of Ploiești, within the Faculty of Petroleum and Gas Engineering.

The habilitation thesis written by Assoc. Prof. Dr. Eng. Suditu Costel – Silvian has 199 pages, and is structured in three parts:

- Synthesis of didactic and scientific achievements.
- Description of scientific contributions.
- Proposal for the development of the academic career.

Also, the thesis contains 63 figures, 34 tables, 29 mathematical formulas, each of the scientific contributions is concluded with a list of bibliographical references.

In the process of developing the habilitation thesis, I identified and included the most representative contributions from the research activity, considered relevant in terms of originality and scientific value of the results obtained. At the same time, I have carried out and continue to carry out scientific research activities, materialized in papers developed in the following directions of academic interest:

- CO2 emission from fossil fuel combustion;
- Energy efficiency in the oil and gas industry;
- Carbon dioxide capture and storage for its sequestration in underground geological formations;
- Carbon dioxide transport, treatment and storage for its storage in geological repositories and/or saline horizons;
- Carbon dioxide chemistry evaluation on collector or transfer rocks to the storage area;

- Carbon dioxide utilization analysis for the purpose of increasing the recovery factor of petroleum fluids;

- Current issues regarding education with a specific focus on engineering sciences.

The first part of the habilitation thesis reviews the results obtained in scientific research and teaching activity and synthesizes the candidate's notable achievements, as follows:

Analysis of environmental factors that favor losses of petroleum products and technological consumption in the storage of petroleum products

The study aims to identify/determine the sources and causes generating technological losses of petroleum liquids, analyze the influence of environmental factors on fugitive emissions that occur in the storage, transit and loading-unloading activity of petroleum liquids handled in the facilities of OIL TERMINAL S.A., establish a minimum package of measures to reduce fugitive emissions. The analysis of the effects of environmental factors on fugitive emissions was carried out for the storage and handling of typical petroleum products (crude oil, gasoline, diesel, fuel oil) and atypical (toluene, benzene, n-hexane, white spirit, solvents, methanol, ETBE, MTBE, orthoxylene, biodiesel, bioethanol, reactor petroleum, octanol). Evaluation of the influence of geographical and meteorological factors on heat transfer in the case of aboveground tanks for crude oil storage

This study, also published in the Revista de Chimie, started from the realization of a series of contracts with S.C. Conpet S.A. which aimed to analyze the main factors that influence heat transfer in the case of crude oil storage. A model was developed based on calculation relationships taken from specific publications. The case studies were carried out based on experimental research on several oil storage tanks, located in an oil transit station in Romania, and the proposed calculation model, based on relationships from the literature, allowed the detection of the factors on which heat transfer depends in the case of storing the hot product in an aboveground cylindrical tank.

Research on carbon dioxide emissions from the combustion of fossil fuels

At the national level, policies and action plans for the reduction of greenhouse gas (GHG) emissions represent a key element in limiting the effects of climate change on the environment, economy and society. They are in line with European requirements in this area. In this regard, the Romanian National Strategy on Climate Change 2013-2020 adopted in July 2013 and the National Strategy on Climate Change and Low-Carbon Economic Growth were published, which identify the main sectors for priority actions to reduce GHG emissions, such as energy, transport, industrial processes, agriculture and rural development, urban development, waste management, water and forestry. A large number of fuel samples from all three states of aggregation, gaseous, liquid and solid, were analyzed. After investigations carried out on the chromatographic analysis reports of some gas mixtures, five samples considered to be representative were selected. From a qualitative point of view, the evaluation of the carbon dioxide emission coefficient provides a hierarchy of the main fuels used. From a quantitative point of view, depending on the consumption by fuel category, the amount of carbon dioxide that reaches the atmosphere can be estimated. Depending on the amount of carbon dioxide emitted following combustion, a strategy for the category/type of fuel used can be created. Using the carbon dioxide emission coefficient as an additional criterion for decisions regarding the choice of fuel and energy strategy.

Factors influencing the increase in energy efficiency in the oil and gas industry

Energy has been, is and will be a priority subject for a society. The measures necessary to develop public policies in the field of energy efficiency are applied throughout the chain: primary resources, production, distribution, supply, transport and final consumption. The effects of recovering secondary energy resources in an oil production framework are technical, economic and ecological in nature. From a technical point of view, the design and inclusion of recovery facilities directly in the technological flow contributes to the modernization of oil transport, storage and treatment schemes and allows the adoption of energy-efficient technologies. Technologically oriented recovery solutions lead to the optimization of oil transport, storage and treatment processes. The main energy indicator that highlights the efficiency of recovery solutions is the economy of classic fuel. Cogeneration is one of the most economical technologies for reducing greenhouse gas emissions (GHG), along with the use of renewable energies. Cogeneration and trigeneration are opportune solutions that satisfy the demand for electricity, heat, and cooling, respectively, and lead to reduced fuel consumption, which, as in any such situation, also satisfies environmental protection requirements.

Study of carbon dioxide capture and storage for its sequestration in underground geological formations

In my research I presented the simulation of the capture and injection of these greenhouse gases through injection wells into neighboring depleted natural gas reservoirs using commercial numerical simulators for the Iernut (CH) natural gas combustion plant (one of the most important gas-fired plants in Romania). Within this simulation study, the amount of total CO2 that can be stored through the proposed carbon capture and sequestration study and the proportion of each of the three CO2 were determined and the storage mechanisms involved in the process (physical capture, hydrodynamic capture and geochemical capture) were presented.

The CO2 storage/sequestration potential has been assessed on several oil and gas fields in southern Romania belonging to the Getic Basin (Bradu-Albota, Silistea, Babeni, Bălteni, Bibești, Bulbuceni), the Moesian Platform (Brădești, Sâmnic-Ghercești, Plopu, Oprisenesti, Bordei Verde Est, Liscoteanca, Jugureanu-Odaieni, etc.) or towards the Pannonian Basin (Turnu, Satchinez, Calacea). However, for the gas fields mentioned in the paper (Iernut, Lechința, Cucerdea Sud, or Laslau Mare) the CO2 storage/sequestration potential has not been assessed. Therefore, from this point of view, our paper is a step forward in this direction. The Laslau Mare gas field was chosen to simulate the CCS process because the geological-physical model of the gas fields has a high degree of knowledge, so that geological research and exploration works are no longer necessary.

According to our findings, the total amount of CO2 that will be stored through this proposed study of carbon capture and sequestration in the depleted gas fields around Iernut is approximately 26.46 MtCO2. This amount can be divided into 15.50 MtCO2 (59%) sequestered by physical capture (stratigraphic and structural), 9.46 MtCO2 (36%) sequestered by hydrodynamic capture and approximately 1.50 MtCO2 (5%) sequestered by geochemical capture.

Underground Carbon Capture and Storage Study for a Natural Gas-Fired Power Plant in Oltenia, Romania

Results of dynamic simulations of CO2 storage in one of these geological structures, Brădești, which contains depleted hydrocarbon deposits, using a numerical simulator are successfully presented for the nearby Isalnita Power Plant.

According to our findings, the total amount of CO2 that will be stored through this proposed carbon capture and sequestration study in the depleted hydrocarbon deposit of Isalnita around Brădești is approximately 20,603 MtCO2 over a time frame of 31 years for the probable scenario and 23 years for the maximum injection scenario.

Previous local studies have analyzed the use of carbon capture and storage in underground reservoirs, either in saline aquifers or in depleted hydrocarbon deposits located in Romania; however, none of these evaluated the use of depleted oil and gas deposits in the vicinity of the Isalnița Power Plant, i.e. the Brădești structure located in the Moesian Platform.

Software for CO2 storage in natural gas reservoirs

The developed work represented a software developed for CO2 storage in a reservoir, which takes into account the geometry of the reservoir, the properties of the rocks and in which the gas movements can be described. The presented software allows for the rapid finding of solutions for a complete CO2 storage cycle in a short time, so that it can be successfully used in the operating process. The simulation was done on a depleted reservoir where the exploitation-research wells crossed sedimentary deposits belonging to the Pliocene, Sarmatian, Buglovian and Badenian ages, within a maximum depth of 3200 m. The developed software can be used for the verification and validation of depleted reservoirs that are suitable for being transformed into CO2 storage deposits.

Modeling CO2 injection in an oil field

The mathematical models presented show us the possibility of determining the evolution of the water, carbon dioxide and crude oil front. We presented new methods for determining the minimum miscibility pressure P.M.M, so that CO2 injection is one of the best methods for storing this greenhouse gas. We also presented the chemical and physical effects of CO2 on crude oil and reservoir rocks.

As this study shows, CO2 storage in depleted reservoirs is also a technique for extracting residual crude oil.

Interactive strategies in learning engineering sciences for the oil and gas field: a follow-up study

The study presented - in the context of ongoing concerns for increasing teaching quality to achieve professional performance of students and their integration at the level of labor market requirements - a software designed and applied/used by future engineering students in the oil and gas field during class and laboratory hours. The analytical and descriptive perspective of the study was doubled by the follow-up evaluation on the impact of using these software programs in general, as interactive strategies for learning, designed to make learning more efficient and increase the ability to understand, contextualize and apply/simulate highly/deeply abstract theoretical elements by students.

Educational software for calculating thermodynamic quantities of gases in the training of engineering students in Romania

This study analyzes the challenges and opportunities associated with the design and implementation of modern teaching-learning strategies in the training of future engineers in the field of oil and gas engineering. The main objective of the investigative approach is to develop a teaching tool that combines efficiency, technical-scientific complexity and pedagogical

accessibility. In this context, the educational software Gaze Reale is presented, designed for the calculation of thermodynamic properties of real gases and gas mixtures, including hydrocarbons. The program uses advanced calculation algorithms and a comprehensive local database, being configured through a menu system that facilitates user interaction. The applicability of the software is analyzed in terms of teaching efficiency.

The scientific research activity is notable for publishing 11 books/course materials/scientific specialty, writing 54 articles that appeared in various specialized journals published in the country and abroad, of which 23 ISI articles, and carrying out 38 grants/projects won through competition/research/consultancy projects (of which he was director of 5).

The objectives of the development of the scientific research activity are: analyzing the impact of the development of the oil and gas industry on the environment, reducing the impact on the environment by capturing, using and storing carbon dioxide, studying energy efficiency applied to the oil and gas industry.

In the third part of the paper, Proposal for the development of the academic career, the candidate eloquently presents his objectives and targets. The career plan outlined capitalizes on a professional trajectory of over two decades, characterized by constant commitment, scientific rigor and substantial contributions in the field of applied research and university teaching. The academic evolution, fully completed from the level of assistant to associate professor, is doubled by a prolific research activity and dissemination of scientific results.

The research plan targets strategic objectives such as: strengthening the presence in ISI and BDI indexed publications; expanding collaborations with the industrial environment, especially in the energy sector; attracting funds and implementing national and international projects focused on energy efficiency, hybrid technologies and renewable sources; training and coordinating research teams with an international outlook; integrating students, master's and doctoral students in scientific research activities, in order to train an emerging generation of specialists.

On the didactic level, the development directions aim at: refining the educational methodology in accordance with the principles of student-centered education; revitalizing laboratory activities by using modern teaching resources and updated technologies; developing university courses and specialized guides adapted to the current requirements of the industry; developing the educational infrastructure through institutional projects, with a direct impact on the quality of the learning process.

This integrated approach therefore aims to optimize the synergy between research, teaching and socio-economic partnership, in order to strengthen the personal academic profile and the sustainable contribution to the university mission.

Assoc. Prof. Dr. Eng. Suditu Costel-Silvian