Project Title: Applied Processes to Achieve Optimal Methods of Manufacturing Value Added Products from Power Plant Flue Gas

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Project Necessity:

The development of industries and the rapid growth of population due to the increase in consumables and consequently the growth of industrial waste are some of the issues that have recently caused major crises in human societies. The intensity of environmental pollutants from industrial wastes in industrial assembly centers is such that it has attracted the attention of the world's scientific and executive sources for the principle recycling of these materials. Many industries are responsible for releasing new contaminants and in some cases for releasing pollutants such as carcinogens and toxins into the environment. Therefore, effective control and implementation of a proper industrial waste recycling policy for environmental health and resource management is of particular importance. Over the past few decades, society has faced one of the most important consequences of industrial development, the recycling of waste gas, which makes up a large share of the total environmental pollution and its devastating effects in causing environmental crises. Many countries have tried to adopt appropriate technologies and scientific methods for the recycling of their waste. However, waste recycling technologies are still being developed and developed. Most industries currently lack a proper recovery and utilization system to recycle waste, and this will pose serious environmental problems for the future.

It is important to note that although a number of relatively relevant projects have been implemented in the Niroo Research Institute, none have resulted in the development of a comprehensive and well-defined document and roadmap to advance and guide research on the path to implementation. Therefore, in order to target research and to prevent wasting of material and spiritual resources, it is necessary to conduct future research in this field before research is carried out on laboratory and semi-industrial scale. In the proposed project the conventional and efficient methods of conversion of flue gases will be studied and compared and finally the technical and economic studies of the selected methods will be carried out.

Project Goals:

1)]Review of existing articles and industrial reports on methods of recovery and use of flue gas in power plants to categorize the types of processes and products available

2) Explaining the dimensions, identifying technological areas and feasibility of using recovery processes and using flue gas in power plants
3) Investigating the feasibility of methods and products that can be produced technically and economically to achieve the most appropriate option in Iran
4) Evaluate and compare the results of each of the recovery and utilization options to introduce the most suitable product that can be produced and the best production method.

Abstract:

Today, energy, as one of the important inputs of production, has a special place in achieving economic growth. On the other hand, due to the limited energy resources in the world, the need for optimal use of energy resources in the process of economic development is raised. Therefore, improving the methods of exploitation, consumption and energy efficiency are at the top of the concepts of economic development. In addition, the use of fossil fuels in production and transportation, which became popular after the Industrial Revolution, has led to increased emissions of greenhouse gases such as carbon dioxide (CO2) into the atmosphere. For this reason, over the past few decades, much research has been done in this regard, and significant advances in CO2 capture and utilization technologies have been made to produce value-added products from power plant flue CO2, including chemical CO2 adsorption from production. Ammonia and natural gas processing, use of CO2 in the production of fertilizer (urea) and transfer and injection of CO2 through a remote pipeline .

The present project is a continuation of previous projects carried out in the research institute and in line with the technical and economic study of existing projects for the recovery and use of CO2 greenhouse gases. In previous projects such as " The prospects for recycling CO2 from power plants and its use in value added products" qualitative studies have been conducted on the methods for CO2 recovery and use, and finally qualitatively appropriate methods according to the location of the country's power plants and the amount of CO2 produced per year have been selected. Finally, it was found that the production of chemicals is the most appropriate method. In the current project, in the continuation of the process and direction of this research, the technical-economic calculations of the production processes of value-added materials from the CO2 chimneys of power plants are discussed.

In this report, chemical, mineralization and biological conversion technologies of CO2 into several proposed products such as methanol, methane, formic acid, dimethyl carbonate, polycarbonate, urea and dimethyl ether, etc. were evaluated. Technical and economic evaluations of urea, which are the most important and most produced CO2 products in the world, and DME were done. DME production is preferred because it is more economical than urea production and can also be a substitute for natural gas for distributed electricity generation, especially in small-scale power plants that are not supplied by the natural gas distribution network. But while cost-effective, process intensification is necessary to achieve a favorable conversion in DME production and to compete with fossil fuel production routes. As a result, due to the growing demand for cheap chemicals and alternative fuels, the industry is trying to use existing power plants (optimized and upgraded) or new power plants based on process intensification technologies to provide DME with lower production costs.

Steps and Methodologies:

1. Study phase and data collection (Review of existing articles and industrial reports on methods of recovery and use of flue gas in power plants to categorize the types of processes and products available)

2. Collecting flue gas information (A comprehensive study on the flue gas composition of power plants in the country and creating a division in terms of gas volume, available compounds and etc.)

3. Technical and economic study (Investigating the feasibility of methods and products that can be produced technically and economically to achieve the most appropriate option in Iran)

4. Prioritization and selection (Evaluate and compare the results of each of the recovery and utilization options to introduce the most suitable product that can be produced and the best production method)

Main Results (technical outputs, patents, papers, books, reports, etc.):

1. PPCPN30\E: Applied Processes to Achieve Optimal Methods of Manufacturing Value Added Products from Power Plant Flue Gas, April 2021.
2. Perspectives on fossil fuel emission control methods, Green Chemistry and Sustainable Technologies, No. 3, Spring-Summer, pp: 3-16.
3. Book chapter: Whole Energy Systems - Bridging the Gap via Vector-Coupling Technologies: Chapter 3. Polygeneration Systems in fossil fuel power plants: The role of Power-to-X in CO2 mitigation. Springer, Accepted.