The rapid progress in the development of many industrial processes is undeniably very beneficial for the economy and the quality of human life. Nonetheless, industrialization results in the increased demand for the energy, drawn mainly from fossil fuels. As everyone knows, the combustion processes are inextricably linked to the emission of hazardous pollutants that affect the natural environment. One of the most common and harmful are nitrogen oxides, so-called "NO_x". Excessive emission of these gases results in the formation of acid rain, photochemical smog or destruction of the Earth-protecting ozone layer. Fortunately, among recent years the social awareness of the environmental issues has reached very high level. Thus, many new political regulations were implemented to suppress the amount of adverse contaminations in the atmosphere. The new restrictions of the NO_x emission from industry, valid from July 2021 will be decreased to 100 mg/Nm^3. The objective can be achieved only when the old-fashioned measures of emission control will be renovated or replaced by modern installations. Since the former solution is much easier and economical to implement, the groundbreaking modifications of the existing technologies are in great demand. At present, the prevalent method of NO_x abatement is selective catalytic reduction with ammonia (NH_3-SCR). It is based on the chemical reaction between nitrogen oxide and ammonia, to form harmless nitrogen and water vapour. The most important role in the process is played by the catalyst which provides the active surface for the reaction to proceed. Nonetheless, the material used commonly on the industrial scale has some significant limitations related to its toxicity and operating problems. The drawbacks of the prevalent catalytic system and more strict regulations set by the governments are the motivation for the search to the state-of-the-art, environmental friendly and effective materials to reduce the emission of nitrogen oxides.

In line with this, the goal of the project is to prepare and compare two groups of materials as the potential precursors of substitutive catalysts for NH_3-SCR. The research will involve the synthesis, modification, physicochemical characterization and catalytic tests of the natural clays and zeolites and novel synthetic layered zeolites. The materials of natural origin are residuals of low price and their re-utilization could meet the objectives of the circular economy. The application of the new synthetic layered zeolites will allow to obtain catalysts with repetitive structure and chemical properties. Besides, the research over their implementation in NH_3-SCR is limited and still needs deeper focus. Both groups of the proposed precursors exhibit excellent structural properties, beneficial for the high catalytic activity. The next aim of the project is to elucidate which kind of preparation procedure will result in the best catalytic performance. For that reason, the precursors will be modified using not only usual but also new methods, not commonly recognised for the preparation of NH_3-SCR catalysts. Another target of the work is to test the stability of the obtained materials in the presence of SO_2 and H_2O that are always present in the industrial exhausts.

The first part of the laboratory work includes preparation of the catalysts supports. The structure of the natural precursors will be modified in order to facilitate the access of NO and NH_3 molecules to the active surface of the reaction. The synthetic layered zeolites will be prepared in the collaboration with Instituto de Tecnologia Quimica (ITQ) in Valencia that specializes in the synthesis of porous materials. The influence of the preparation steps will be monitored by using advanced techniques that will enable to obtain materials of repetitive physicochemical properties. The second part of the work is focused on the deposition of various transition metals and so-called "promoters" that provide great capability to remove NO_x from the flue gas. For that purpose, many methods will be tested to obtain the most preferable form of active species. The new idea that will be investigated is to deposit alternative layered structures or to perform combustion of metal salts solutions to form mixed metal oxides directly on the supports in a very short time. The properties of the synthesized samples will be compared to the reference, self-madeV_2O_5-WO_3-TiO_2, that stands for the commercial catalyst. Third part of the project will cover detailed physicochemical characterization in order to link the properties of the materials with the results of catalytic tests. The stability of the catalyst will be tested in different concentrations of SO_2 and H_2O, at diversified temperature ramps. Additionally, the influence of different concentrations of oxygen in the feed will be tested.

It is predicted that most of the analyzed materials will exhibit very good activity in NH_3-SCR. Possibly, the synthetic layered zeolites will be more active. Besides, their implementation would be more preferable for industry due to the repetitive properties and composition. Natural materials are likely to escalate the conversion of NO_x by the content of the wide range of metal oxides, perhaps active in NH_3-SCR. The preparation procedure is prognosticated to have a great influence on the final properties of the materials and we predict that the new proposed methods will provide innovative idea to prepare novel, effective catalyst for NO_x abatement.