LITHUANIAN ENERGY INSTITUTE

ADMISSION TO PHD STUDIES FOR THE YEAR 2025

DOCTORAL RESEARCH TOPIC:

Optimization of methane pirolysis process for hydrogen production using innovative nanocatalyts produced by environmentally friendly synthesis technologies

RESEARCH FIELD:

Energetics and Power Engineering (T 006)

BRIEF DESCRIPTION OF RESEARCH TOPIC:

The global energy sector is moving towards low- and zero-emission fuels to reduce greenhouse gas (GHG) emissions and combat climate change, with hydrogen emerging as one of the main solutions to help achieve this crucial goal. Despite the growing amount of electrolysers production, there are still huge gap to cover foreseen H2 demand. Here, pyrolysis can play an important role as a clean H2 production method. During the pyrolysis reaction, the methane molecule CH4 is decomposed into hydrogen and solid carbon representing CO2-free hydrogen technology. However, due to high reaction temperature the methane pyrolysis faced significant issues. Therefore, various technological combinations are used to solve these problems including different catalysts, synthesis techniques, supports, etc. Today's research works showed that oxide-based compounds (e.g. SiO2, TiO2) might be suitable solutions as a supports for methane pyrolysis catalysts. Meantime, Fe or Ni are suitable materials as the main catalysts. Still, both of them faced some challenges and incorporation of other metal additives (e.g. Cu, Co) might improve their characteristics. While it is known that metal-based catalysts are one of the most effective, these catalysts are mostly prepared by chemical methods demanding a significant amount of time, are contingent on temperature, and are intricate, encompassing multiple stages. Meantime magnetron sputtering is green, one-step fabrication method showing the possibility to control the amount and composition of metal-based catalysts during their synthesis on various substrates. Still this catalyst formation method is lacking of knowledge for methane pyrolysis application.

Therefore, the main aim of the work is the optimization of methane pyrolysis process using innovative nanocatalyst synthesised by environmentally friendly technique. In order to reach this goal, the student will have to overcome these objectives: i) to perform literature analysis by crystallising the most promising additives for Fe or Ni; ii) to synthesise catalysts using selected metal-additive-support combination by magnetron sputtering technique; iii) to create the small-scale methane pyrolysis reactor; iv) to perform methane pyrolysis experiments at different temperatures and pressures by analysing produced gas and solid-carbon product; v) to model energetic balance, H2 yield and reaction efficiency.

The expected outcome is to increase the student knowledge in hydrogen energy, methane pyrolysis and catalysts topics to the expert level at the end of the study time by creating the effective catalyst for methane pyrolysis process.

During this work the student will have to combine energetics, hydroengineering, material science and other knowledge while tackling the main aim and objectives of the proposed work.

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