1. Justification for undertaking the topic

The main goal of the European Green Deal is to achieve zero net greenhouse gas emissions by the year 2050. In combustion processes, zero emissions can be achieved if this does not require the extraction and processing of fossil fuels. However, the current state of the art in combustion processes is adapted to conventional fuels, i.e. fuels with fairly well-defined physical parameters (e.g. hard coal). Therefore, there is a need to evolve combustion processes and adapt them to the processing of more heterogeneous materials which differ in density, e.g. waste biomass. In combustion processes, it is also possible to generate both thermal and electrical energy. Processing of waste fuels and independence from imported fuels while ensuring the growing demand for energy is of great importance in today's world problems.

2. Aim of the project

The aim of the project is to obtain a new, innovative solution for the organization of alternative fuel combustion. This will be achieved by using a fluidized bed with a specially obtained density distribution that varies with height. The combustion processes of waste fuels have so far been carried out mainly in grate furnaces and less frequently in fluidized bed boilers. Significant limitations of fluidized bed thermal processing technology result from the use of sand for the formation of the fluidized bed. The density of sand is about 2.6 g/cm^3, while that of waste fuels is 0.7 - 1.2 g/cm^3 which causes the material to float on the surface of the fluidized bed and not sink into the fluidized bed volume. In such an organized process, all the positive features of the fluidized bed, such as low-temperature gradients, excellent mixing of the bed particles, and relatively large interfacial contact area are not utilized. Because of the above-mentioned difficulties, **it is proposed to create a binary, i.e. two-layer fluidized bed with a variable vertical density profile.** The applied density ratio of so prepared fluidized bed material will allow waste biomass to sink freely inside the bed, but they will not reach the bottom of the fluidized bed reactor. This is due to the significant difference in density of the two materials forming the binary bed. Due to the proper positioning of biomass particles in the bed, combustion efficiency will be improved and flue gases will contain less harmful compounds. As a result of using waste fuels, the combustion processes will be able to be reconciled with the concept of a low-carbon economy.

3. Research description and main expected results

The planned research includes two stages, the first concerns the creation of a binary fluidized bed with a variable density profile and the second stage concerns the execution of combustion processes in the obtained binary beds. In the first part of the experimental work, it is planned to perform fluidization tests on materials characterized by high chemical, mechanical and thermal resistance. Fluidization tests will be performed at different velocities of the fluidizing medium with simultaneous measurement of pressure drop at different heights of the bed. Then, using hydrodynamic correlations, the pressure drop will be converted into fluidized bed density under varying process conditions, i.e. at different fluidizing medium flow rates and different fluidization column heights. In this way, it will be possible to select suitable binary beds (characterized by a variable density profile) for combustion processes. The second stage of the research involves carrying out combustion of biomass in binary fluidized beds. It is expected that the materials tested will freely sink into the upper layer of the binary bed, but will not sink into the lower part of the bed. This will be achieved by creating the upper layer of the bed with a material density lower than that of the fuels, while the lower layer will be created of material with a density higher than the density of fuels. In this way, conditions will be ensured for effective use of the fluidized bed and all of its advantages, as thermal degradation will occur throughout the entire fluidized bed volume. Another advantage will be the fact that the lower layer of the fluidized bed with relatively high density will protect the fluidized bed reactor against possible falling of fuel particles to the bottom of the apparatus and process problems that may result from this fact.