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Sustainability Analysis of Converting Grain Dryers to Agricultural By-product Firing as a Natural Gas Alternative

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Abstract

The starting point of the research was the recognition that transitioning from natural gas to biomass combustion offers significant advantages for the biogeochemical carbon cycle. While natural gas combustion releases fossil carbon stocks that have been stored inertly for millennia, the carbon released into the atmosphere during biomass utilization is equivalent to the amount previously sequestered by the plants; thus, the process can be considered nearly carbon-neutral. In addition to reducing the carbon footprint, a further advantage of the development is the reduction of the European Union’s energy import dependency. The research, conducted within a consortium between Anthera ltd. and the Hungarian University of Agriculture and Life Sciences, led to the development of an innovative technology that enables the efficient energetic utilization of agricultural by-products and other biomass-based fuels. The investigations extended to the transport and mixing of flue gases from fuels mixed in various proportions, as well as the creation of auxiliary equipment suitable for spark arresting. The implemented solution demonstrated significantly higher energy efficiency than the drying technologies currently available. Within the framework of industrial research, the fundamentals of combustion technology were examined in a broader context, and the technical development of the components related to the application was also realized. During the process, physical models and experimental units were established. Based on the measurement data obtained from these units, the firebox, the chimney, and the complex flow-technical system were designed. As a result of the research, a new, environmentally friendly energy transformation technology was created, which can replace a significant amount of fossil energy sources while modernizing and intensifying crop processing procedures. One of the main objectives of the research was the precise determination of the reduction in environmental impact, which was demonstrated using a carbon balance calculation model based on our own measurement data. As the technological transition carried the risk of combustion products and

particulate matter entering the drying space, the research paid prioritized attention to the analysis of health risks. To identify these risks, the concentrations of carbon monoxide and nitrogen oxides generated during the combustion of various raw fuels were examined, along with various fractions of particulate matter. In the case of the latter, the presence of organic and inorganic pollutants adsorbed onto the surface of the particles—such as toxic metals and polycyclic aromatic hydrocarbons (PAHs)—was also analyzed, thereby ensuring the safe applicability of the technology.

Keywords: grain drying, agricultural by-products, biomass combustion, alternative energy, sustainability assessment

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