BURNERS, COMBUSTION AND HEAT TRANSFER

(570) - 3D-PRINTED BURNER FOR EFFICIENT HEAT RECUPERATION

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The success of the energy transition depends on several factors. Long- and mid-term approaches to decarbonize energy intensive sectors such as thermal process industry intend to use regenerative energy sources like green electricity and hydrogen. But to achieve the current climate targets, there is also a need for short term and directly available solutions to ensure a highly efficient usage of current and future energy resources.
A common solution in the thermal process industry to enhance the energy efficiency is preheating combustion air with waste heat of hot flue gases. Widely spread technologies to transfer heat from the flue gas to the air are regenerative and recuperative burners as well as central regenerators and recuperators. Each of these technologies provide different advantages and drawbacks in major characteristics like maximum heat transfer, construction volume and the mode of operation.
State-of-the-art recuperative burners manufactured by conventional technologies do not yet operate at their full potential due to the choice of materials and manufacturing processes. To further enhance the heat transfer capabilities and the resulting energy saving in applicable processes, the research project 'AdReku' aims to develop and investigate a 3D-printed, recuperative burner. Key elements of the design of the heat exchanger unit are complex geometrical structures as well as a choice of optimized materials, which deliver high heat transfer and temperature resistance capabilities.
The result of this development process is the design of a so called TPMS heat exchanger (short for 'triply periodic minimal surface'), which comprises three elements of different materials, each optimized for different temperature levels. By using first prototypes of the recuperative burner operating with the new heat exchanger, reproducible air preheating values of more than 90 % (relative to the hot flue gas temperature) could be achieved in experimental investigations. These investigations were done in conditions similar to the potential use case of the burner with flue gas temperatures at about 900 °C to 1,000 °C. The relative air preheating corresponds to a value, which is considered above the industrial standard of recuperative burners. Due to these high values of air preheating and the potential energy saving, industrial combustion processes can be designed more efficiently by using this technology.
Further goals of the project are to develop a burner unit to reduce nitrogen oxide emissions and to ensure the highly preheated combustion process to operate below legislative requirements. The burner unit is still in development and will be further investigated and optimized by numerical and experimental approaches within the scope of this project.
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Palavras-chave : efficiency, recuperator, 3d print, additive manufacturing, preheating