World Academy of Science, Engineering and Technology
International Journal of Mathematical and Computational Sciences
Vol:14, No:12, 2020

Evaluation of an Integrated Supersonic System for Inertial Extraction of CO_2 in Post-Combustion Streams of Fossil Fuel Operating Power Plants

Authors : Zarina Chokparova, Ighor Uzhinsky

Abstract : Carbon dioxide emissions resulting from burning of the fossil fuels on large scales, such as oil industry or power plants, leads to a plenty of severe implications including global temperature raise, air pollution and other adverse impacts on the environment. Besides some precarious and costly ways for the alleviation of CO_2 emissions detriment in industrial scales (such as liquefaction of CO_2 and its deep-water treatment, application of adsorbents and membranes, which require careful consideration of drawback effects and their mitigation), one physically and commercially available technology for its capture and disposal is supersonic system for inertial extraction of CO_2 in after-combustion streams. Due to the flue gas with a carbon dioxide concentration of 10-15 volume percent being emitted from the combustion system, the waste stream represents a rather diluted condition at low pressure. The supersonic system induces a flue gas mixture stream to expand using a converge-and-diverge operating nozzle; the flow velocity increases to the supersonic ranges resulting in rapid drop of temperature and pressure. Thus, conversion of potential energy into the kinetic power causes a desublimation of CO_2. Solidified carbon dioxide can be sent to the separate vessel for further disposal. The major advantages of the current solution are its economic efficiency, physical stability, and compactness of the system, as well as needlessness of addition any chemical media. However, there are several challenges yet to be regarded to optimize the system: the way for increasing the size of separated CO_2 particles (as they are represented on a micrometers scale of effective diameter), reduction of the concomitant gas separated together with carbon dioxide and provision of CO_2 downstream flow purity. Moreover, determination of thermodynamic conditions of the vapor-solid mixture including specification of the valid and accurate equation of state remains to be an essential goal. Due to high speeds and temperatures reached during the process, the influence of the emitted heat should be considered, and the applicable solution model for the compressible flow need to be determined. In this report, a brief overview of the current technology status will be presented and a program for further evaluation of this approach is going to be proposed.

Keywords : CO_2 sequestration, converging diverging nozzle, fossil fuel power plant emissions, inertial CO_2 extraction, supersonic post-combustion carbon dioxide capture
Conference Title : ICSRD 2020 : International Conference on Scientific Research and Development
Conference Location : Chicago, United States
Conference Dates : December 12-13, 2020