World Academy of Science, Engineering and Technology
International Journal of Aerospace and Mechanical Engineering
Vol:17, No:10, 2023

Non-Invasive Viscosity Determination of Liquid Organic Hydrogen Carriers by Alteration of Temperature and Flow Velocity Using Cavity Based Permittivity Measurement

Authors : I. Wiemann, N. Weiß, E. Schlücker, M. Wensing, A. Kölpin

Abstract : Chemical storage of hydrogen by liquid organic hydrogen carriers (LOHC) is a very promising alternative to compression or cryogenics. These carriers have high energy density and allow at the same time efficient and safe storage of hydrogen under ambient conditions and without leakage losses. Another benefit of LOHC is the possibility to transport it using already available infrastructure for transport of fossil fuels. Efficient use of LOHC is related to a precise process control, which requires a number of sensors in order to measure all relevant process parameters, for example, to measure the level of hydrogen loading of the carrier. The degree of loading is relevant for the energy content of the storage carrier and represents simultaneously the modification in chemical structure of the carrier molecules. This variation can be detected in different physical properties like viscosity, permittivity or density. Thereby, each degree of loading corresponds to different viscosity values. Conventional measurements currently use invasive viscosity measurements or near-line measurements to obtain quantitative information. Avoiding invasive measurements has several severe advantages. Efforts are currently taken to provide a precise, non-invasive measurement method with equal or higher precision of the obtained results. This study investigates a method for determination of the viscosity of LOHC. Since the viscosity can retroactively derived from the degree of loading, permittivity is a target parameter as it is a suitable for determining the hydrogenation degree. This research analyses the influence of common physical properties on permittivity. The permittivity measurement system is based on a cavity resonator, an electromagnetic resonant structure, whose resonation frequency depends on its dimensions as well as the permittivity of the medium inside. For known resonator dimensions, the resonation frequency directly characterizes the permittivity. In order to determine the dependency of the permittivity on temperature and flow velocity, an experimental setup with heating device and flow test bench was designed. By varying temperature in the range of 293,15 K -393,15 K and flow velocity up to 140 mm/s, corresponding changes in the resonation frequency were measured in the hundredths of the GHz range.

Keywords : liquid organic hydrogen carriers, measurement, permittivity, viscosity., temperature, flow process
Conference Title : ICFMFA 2023 : International Conference on Fluid Mechanics and Flow Analysis
Conference Location : Athens, Greece
Conference Dates : October 16-17, 2023