HYPERSONİC FLOW CHARACTERİZATİON BY USİNG TUNABLE DİODE LASER ABSORPTİON SPECTROSCOPY

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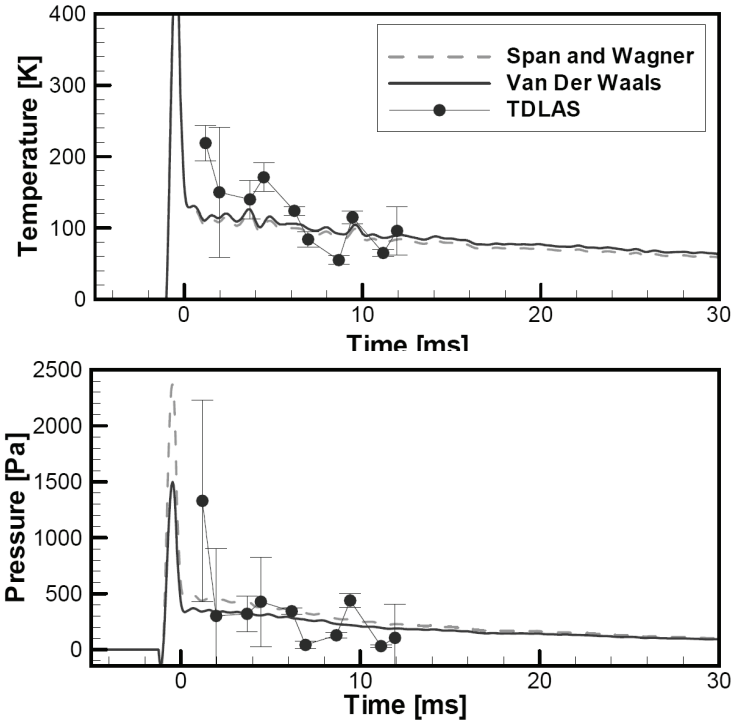
Determining the free stream enthalpy, temperature, density, pressure etc. is one of the major issues in hypersonic facilities like VKI Longshot due to the high uncertainties of classical rebuilding methods. Tunable Diode Laser Absorption Spectroscopy, being a non-intrusive technique, is promising for free stream measurements even during very limited test durations. The laser beam when passing through the medium interacts with the existing molecules. This interaction is in form of absorption of the photon energy that occurs at specific wavelengths depending on the species. The well known Beer-Lambert law relates the absorption of the light to the physical properties such as temperature, density, pressure, etc. of the medium. On the other hand, the Doppler shift of the absorption peaks corresponds to velocity information. The velocity information can usually be found with low errors since it is only related to the shift of the peaks. Nevertheless, the temperature, density and pressure measurements have always been challenging due to the high sensitivity of the width determination.

Measurements on the optical bench, which is a model of the real experimental setup in Longshot facilities, are conducted prior to the implementation in Longshot in order to observe the issues and gain experience in the inner workings of the system. Furthermore, the optics are set in Longshot facilities where two different double pass configurations are considered. The first one is when the beam is passed twice through the test section and the optics are placed outside in front of the Schlieren windows. A mirror is placed on the other side of the test section. The angle between the two beams is so small that velocity measurements are not possible. In the second configuration, the beam is navigated inside the test section with mirrors mounted on the nozzle frame. This configuration allows velocity measurements due to the sufficiently large angle between the beams. However the mirrors were not resistant to the big vibrations of the facility, thus the inside configuration is not feasible. Therefore, the double pass - outside configuration is used for thermodynamic data extraction.



The TDLAS data are compared with the rebuilt data of Longshot. It should be noted that this is only a comparison and not a validation since the reduction methods already contain high amounts of uncertainties. Although a good agreement is eventually achieved, there is still a large uncertainty margin that cannot be neglected. The major error source was the noise due to the damaged optical instruments.