

Development and Validation of a Carbon Dioxide TDLAS Sensor for Studies on Fermented Dairy Products

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Abstract : An instrument for the detection and evaluation of gaseous carbon dioxide in the headspace of closed containers has been developed in the context of Packsensor Italian-Serbian joint project. The device is based on Tunable Diode Laser Absorption Spectroscopy (TDLAS) with a Wavelength Modulation Spectroscopy (WMS) technique in order to accomplish a non-invasive measurement inside closed containers of fermented dairy products (yogurts and fermented cheese in cups and bottles). The purpose of this instrument is the continuous monitoring of carbon dioxide concentration during incubation and storage of products over a time span of the whole shelf life of the product, in the presence of different microorganisms. The instrument's optical front end has been designed to be integrated in a thermally stabilized incubator. An embedded computer provides processing of spectral artifacts and storage of an arbitrary set of calibration data allowing a properly calibrated measurement on many samples (cups and bottles) of different shapes and sizes commonly found in the retail distribution. A calibration protocol has been developed in order to be able to calibrate the instrument on the field also on containers which are notoriously difficult to seal properly. This calibration protocol is described and evaluated against reference measurements obtained through an industry standard (sampling) carbon dioxide metering technique. Some sets of validation test measurements on different containers are reported. Two test recordings of carbon dioxide concentration evolution are shown as an example of instrument operation. The first demonstrates the ability to monitor a rapid yeast growth in a contaminated sample through the increase of headspace carbon dioxide. Another experiment shows the dissolution transient with a non-saturated liquid medium in presence of a carbon dioxide rich headspace atmosphere.

Keywords : TDLAS, carbon dioxide, cups, headspace, measurement

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