Sensing ethanol-blended gasoline with long-period fiber grating: a metrological perspective

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***Abstract*— This work shows a standard metrological characterization of an optical fiber sensor based on long period grating for assessing ethanol-blended gasoline. The sensor performance is evaluated according to the following metrological characteristics: response curve, calibration curve, sensitivity, resolution, repeatability, reproducibility, conformity, detection peak uncertainty, calibration system uncertainty, combined standard uncertainty and expanded uncertainty. The results showed that the sensor can determine ethanol concentrations in ethanol-gasoline blends as small as 0.14 % v/v, for a range between 0 and 40.0 % v/v (range *I*), and 0.30 % v/v, for a range between 40.0 and 100.0 % v/v (range *II*). However, the uncertainty analysis indicated that sensor response is mainly influenced by reproducibility and repeatability uncertainties. The result of measurement inherent to sensor can fluctuate up to ± 2.00 and ± 3.88 % v/v, for ranges *I* and *II*, respectively, for a confidence level of 95.45 %. Such complete performance characterization is fundamental to not overestimate the sensor capabilities.**

***Index Terms*—** Ethanol-blended gasoline, long period fiber grating, metrological characterization, optical fiber sensor

I. INTRODUCTION

Although fossil fuels have been historically considered the most important source of power for industrial process and machines, the use of biofuels has increased worldwide in last few years for reasons of energy security, diversity, and sustainability [1], [2]. Among the biofuels, ethanol has been widely employed in order to minimize the global dependency of non-renewable fossil fuels. Ethanol has also been used to mitigate the greenhouse effect and to support the sustainable development [1]-[3]. Additionally, ethanol is an octane booster with anti-knocking properties used as a substitute for both tetra-ethyl lead and methyl tertiary butyl ether (MTBE) in gasoline blends [4].

The ethanol-blended gasoline increases the engine torque, brake power, volumetric and brake thermal efficiencies and fuel consumption, while reduces the brake specific fuel consumption and equivalence air-fuel ratio. Besides, the ethanol can minimize the exhaustion emissions of carbon monoxide and hydrocarbons inherent to gasoline combustion [4], [5]. On the other hand, excessive ethanol concentrations in blends can induce structural problems, such as premature corrosion of the

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