MEMS-based Handy Fuel Adulteration Detection Device

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Abstract

Adulteration of automobile fuels, especially petrol and diesel is a rampant malpractice in India. The most commonly found forms are—mixing kerosene in diesel and diesel in petrol. With the rising prices of fuel and the subsidy on kerosene, getting away with even 10-15% adulteration is immensely profitable. While less than 10% adulteration is financially unattractive, more than 30% is easily detectable by the end user. Several players involved in this malpractice mix cheaply available kerosene, naptha or other such adulterants with fuel which not only causes pollution but also engine troubles and proves to be a costly affair for the consumers. To check adulteration effectively, it is necessary to monitor the fuel quality at the distribution point itself. The equipment for this purpose should be handy and the measurement method should be quick, capable of providing test result within a very short time. It should also be preferably economic (as a large number of such units would need to be simultaneously deployed) and easy to use.

This paper discusses the use of a microacoustic sensor, with integrated temperature control, to be used as a combined density and viscosity sensor incorporated in the device for detecting adulteration. The microacoustic sensor chosen is the MEMS Quartz Resonator, which can be used in several different modes, depending on the application intended. Using COMSOL Multiphysics®, a quartz resonator model was made and a sensitivity analysis of the different possible quartz crystal cuts and modes was performed. The frequency responses generated suggest that a TSM or LFE mode AT-cut quartz crystal is the best choice for fuel adulteration detection sensor. The frequency and change in impedance values generated were used to develop a signal conditioning circuit for the device. With CATIA®, a model of the basic device assembly (sample holder with attachment) has also been made.

With this idea in mind, the main aim of this paper is to propose a design for an economical, hand-held device for easy detection of adulteration in fuel beyond permissible limits.

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Figures used in the abstract

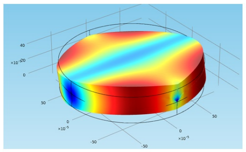

Figure 1: Eigenfrequency response of at cut quartz crystal upon loading

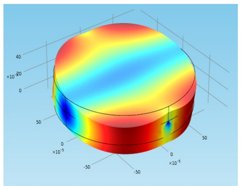

Figure 2: Eigenfrequency response of sc cut quartz crystal upon loading