Response to Reviewer 1 Comments

Point 1: 1. How the Radio frequency (RF) and microwave techniques are cost effective rather than to analyze liquid samples using high resolution gas chromatography/mass spectrometry (HRGC/MS)? Author should give a parallel comparison.

Response 1: The gasoline driveability index (DI) sensor is used at the start of a vehicle. It should be compact in size for mounting in vehicle and for fast measurements. In this regard, radio frequency and microwave technologies are efficient and cost effective because they help to make smaller and faster sensing sensors than mass spectrometry and gas chromatography.

-Previous paper: Line (36)
Radio frequency (RF) and microwave techniques are strong and cost-effective sensing approaches to identify and observe liquid samples [7], [8], [9].

-Revised paper: Line (38)
The gasoline driveability index (DI) sensor is used at the start of a vehicle. It should be small in size for mounting in vehicle and for fast measurements. In this regard, conventional analysis technology based on gas chromatography/mass spectrometry can analyze sample with high resolution. However, this analysis process is complicated, time consuming [7][8]. In comparison radio frequency and microwave technologies are fast and simple process. Therefore, radio frequency and microwave technologies are efficient and cost effective approaches for DI sensing. Recently, many researches are proposed that incorporates microwave based techniques to identify and observe different liquid samples [9], [10], [11].

Point 2: Author should justify that Cylindrical Cavity Sensor is applicable inside the Cylindrical where we found very high temperature.
Response 2: In this study, high driveability index gasoline samples are used, which are generally used in the cold areas. Therefore, measurements are taken at temperatures ranging from 0°C to -35°C. Reasons are also added to the revised version of manuscript.

- Previous paper: Line (196)
The minimum frequency separation of 31 MHz lies between Euro4 and Cold CO at 0◦C temperature.

-Revised paper: Line (214)
The designed temperature range for the fuel tanks are between −40°C and 85°C [29]. Moreover, HiDI gasoline samples are generally used in the cold areas. Therefore, the measurements are carried out for the temperature ranges of 0°C to -35°C.

Point 3: References [7] [8] [9] are not papers related to gasoline.
Point 4: Please explain why you think that the radio frequency (RF) and microwave technology is strong and cost-effective for this gasoline distinction experiment?

Response 3 & 4: The answers to the comment 3 & 4 have been combined. The gasoline driveability index (DI) sensor is used at the start of a vehicle. It should be small in size for mounting in vehicle and for fast measurements. In this regard, conventional analysis technology based on gas chromatography/mass spectrometry can analyze sample with high resolution. However, this analysis process is complicated and time consuming [7], [8]. In comparison, radio frequency and microwave technologies are fast and simple processes. Therefore, radio frequency and microwave technologies are efficient and cost effective approaches for DI sensing. Recently, many researches are proposed that incorporates microwave based techniques to identify and observe different liquid samples [9], [10], [11]. The purpose of mentioning these techniques was to highlight the incorporation of microwave-based techniques for analyzing any liquid samples and not just gasoline. This explanation is also included in the revised manuscript.

Revised paper: Line (38) Section 1. Introduction
The gasoline driveability index (DI) sensor is used at the start of a vehicle. It should be small in size for mounting in vehicle and for fast measurements. In this regard, conventional analysis technology based on gas chromatography/mass spectrometry can analyze sample with high resolution. However, this analysis process is complicated and time consuming [7], [8]. In comparison, radio frequency and microwave technologies are fast and simple processes. Therefore, radio frequency and microwave technologies are efficient and cost effective approaches for DI sensing. Recently, many researches are proposed that incorporates microwave based techniques to identify and observe different liquid samples [9], [10], [11]. The sensing occurs when the solution undergoes interaction with propagating or resonating modes of electromagnetic waves. Due to this interaction, the complex permittivity of the material changes and it manifests itself as a frequency change, attenuation, reflection of the signal or a phase shift. The sensing principle relies on the changes of the device response in terms of the transmitted power, resonant frequency, and 3-dB bandwidth. Among these techniques, spectroscopy is a commonly used technique to measure permittivity of liquid samples as a function of frequency that gives information about relative permittivity and loss tangent of sample [12]. It is being used to distinguish between materials but the sensitivity is not high and can sense the variation of permittivity values from 3 to 11 for resonant frequency change of 5.2 GHz to 4.1 GHz [13]. Since the gasoline sensor needs to be small, microwave technologies help to make sensor compact and more configurable than mass spectrometery and gas chromatography.

Point 5: In Section 3.1, how did you get the conclusion "those parameters were chosen that gave best results in frequency separations and reflection coefficients", in the absence of a control experiment?
Response 5: To incorporate this suggestion into the updated manuscript, we have included the design procedure of the proposed sensor with simulation results. The sensor is designed to attain high quality factor and low reflection coefficients for clearly frequency separations.

-Revised paper: 3.1. Structural Parameters of the Proposed Sensor, Line (133)

The proposed sensor is designed to attain high quilty factor and low reflection coefficients for clearly frequency separations. The design steps of proposed cavity sensor are as follows:

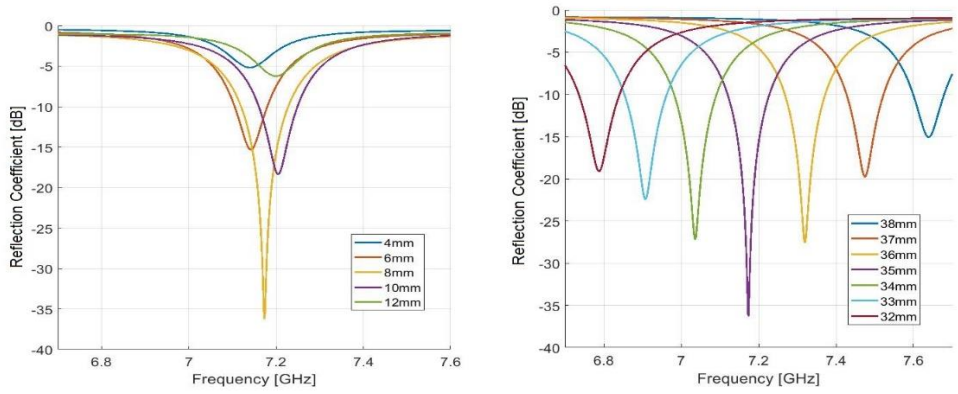
1. Selection of permittivity (ε): First, we selected the permittivity of gasoline for simulating the sensor model. The gasoline samples used in our experiments are high driveablity index (HiDI) samples with average permittivity value of 2.16 and the permittivity of normal gasoline used in the design of this sensor is 2.15, which is similar to the average permittivity of HiDI gasoline.

2. Selection of cylindrical cavity mode: The basic modes for cylindrical cavity resonators are transverse magnetic TM_{01} and Transverse electric TE_{01} and TE_{11} [20]. In microwave theory, the higher-order mode decays rapidly, hence TM_{01}, the first higher mode of the circular waveguide, was selected. This selection was made since it is easier to manufacture as compared to the TE mode in actual application environment.

3. Selection of monopole height (h): We have chosen the height of the monopole cavity through simulations by sweeping the radius of the cylindrical resonator for the frequency range of 6.7-7.7 GHz. Figure 3a shows the optimization process of selecting monopole height. The height of monopole is chosen to be 8mm as it gives the minimum reflection coefficient for the given frequency range.

4. Selection of cylindrical cavity height (d): To find the best height for the design, we have observed that the height of 35 mm of cavity gives good response in terms of lower reflection coefficient as shown in Figure 3b.

Similarly, all those optimized parameters were chosen that gave best results in frequency separations and reflection coefficients.



(a) **(b)**

Figure 1. (a) **Simulation results for the optimization of monopole height (h), (b) Simulation results for the optimization of cylindrical cavity height (*d*)**

Point 6: There are some typographical and grammatical errors in manuscript, please go through them during the re-submission. There are some grammatical errors, please correct

Response 6: Thank you for the thorough review. We have checked the submitted paper to correct grammatical mistakes. The errors have been corrected.

Point 7: The labels in Figure3.(a) and (b) are too small to be seen after being printed. Please adjust.

Response 6: The Figures 2 & 3 present in the revised manuscript as Figure 4a & 4b are updated and resized in the revised version of the manuscript.

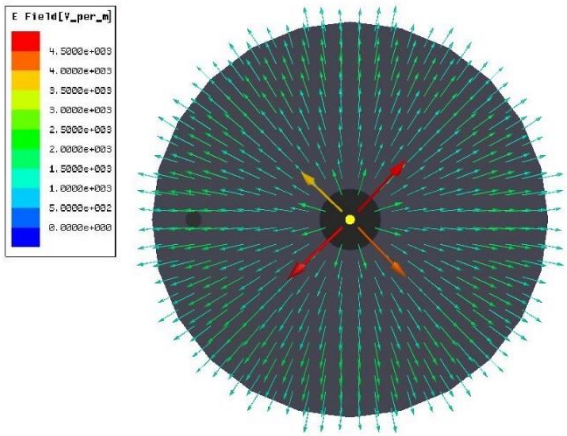


Figure 2. Electric field top view of cylindrical resonator

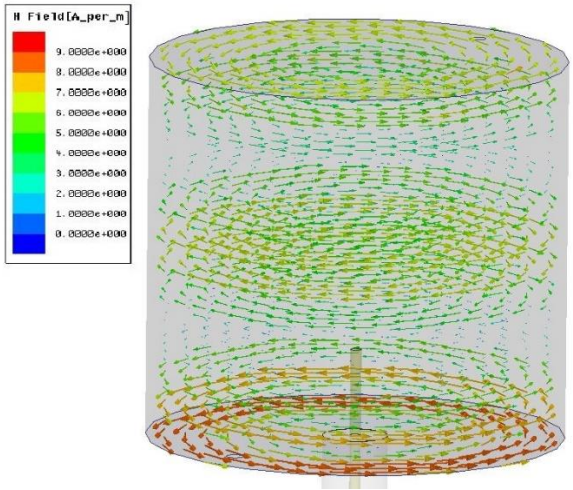


Figure 3. Magnetic field side view of cylindrical resonator