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Sensor-Based Innovations in Petrol Adulteration Detection: A Comprehensive Review

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Abstract: *Fuel adulteration is a persistent problem that has serious repercussions for engine performance, economic stability, and environmental sustainability. Maintaining fuel quality and guaranteeing adherence to legal requirements depend on the ability to detect adulteration in petrol. Sensorbased detection systems provide a sophisticated, effective, and real-time substitute for conventional detection techniques like chemical analysis and physical inspection, which are frequently laborious, non-portable, and resource-intensive. The utilization of sensor technologies in gasoline adulteration detection is the main topic of this review, with a focus on load cell and dielectric constant sensors in particular. Dielectric constant sensors, which have a high sensitivity and dependability, use variations in the electrical characteristics of fuel mixes to identify the presence of adulterants. By measuring weight and density changes, load cell sensors, on the other hand, make it possible to identify density differences brought on by adulteration. When combined, these sensors offer a strong foundation for precise and effective adulteration detection. The principles of functioning of these sensors, their incorporation into detecting systems, and the performance metrics—such as sensitivity, accuracy, portability, and cost-efficiency—that characterize their efficacy are all examined in this study. Recent developments in sensor technologies that have enhanced real-time monitoring and decreased system complexity are also highlighted. In addition, the research highlights important issues that need to be resolved to improve the realistic implementation of these systems, including scalability, environmental adaptation, and integration with IoT frameworks*

Keywords: Petrol Adulteration, Fuel Quality Analysis, Detection Techniques, Adulteration Impact, Common types of adulterants , Sensor Methods, Real-time Detection Systems