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Characterization and quantification of polycyclic aromatic hydrocarbons (PAHS) in used and fresh engine oil by chromatography and spectroscopy techniques

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ABSTRACT

Polycyclic Aromatic Hydrocarbons (PAHs), which arise from incomplete combustion during engine operation, escape the combustion chamber, leading to lubricant contamination. PAHs have been declared highly detrimental to living organisms, and thus, PAH regulation in the environment is crucial because used engine oil accumulates PAHs in high levels. Engine oil samples were collected at different car maintenance workshops around Johannesburg, where the analysis of 5 target PAHs was carried out in both fresh and used engine oil samples (different oil bands), and then subjected to Gas Chromatography- Mass Spectrometry (GC/MS) and High Performance Liquid Chromatography (HPLC). In contrast to preliminary studies reporting higher PAH values of 300+ in used engine oil, the PAH value has decreased significantly, with PAH content being 70 and 7 times more in used engine oil by HPLC and GCMS respectively due to the different capabilities of the two instruments. Fourier Transform Infrared (FTIR) revealed evidence showing the formation of PAHs, which was corroborated by the presence of a band at 1600 cm^{-1}, which is associated with a C-C stretch in a ring. In comparison to fresh oil, used oil quantitative proton Nuclear Magnetic Resonance (NMR) revealed a new intense peak at the aromatic region between 7-7.5 ppm, which may have arisen due to PAH formation. It was also observed that the PAH content was considerably lower compared to other constituents found in the oil sample. This drastic reduction in PAH concentration, may be due to the significant improvements made in lubricating (engine) oil formulations, refining processes, and engine designs.