SELECTIVE SPECTROPHOTOMETRIC DETERMINATION OF TNT USING A DICYCLOHEXYLAMINE-BASED COLORIMETRIC SENSOR

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Because of the extremely heterogeneous distribution of explosives in contaminated soils of abandoned and to be remediated military sites, on-site colorimetric methods are a valuable, cost-effective tool to assess the nature and extent of contamination. Because costs per sample are lower, more samples can be analyzed per unit of time. Thus, redesign of sampling or remediation scheme while in the field can be accomplished. On-site screening also facilitates more effective use of off-site laboratories [1] using more sophisticated but costly instrumental techniques. Another advantage of on-site screening is fast decision making of police criminology laboratories after terrorist attacks. For example, colorimetric screening tests for detecting tri- and di-nitrotoluenes in post-blast debris with the alcoholic KOH reagent has found application to a large number (exceeding 2000) of samples in the mobile laboratory unit of Australian Federal Police (AFP) following the 2002 Bali bombings [2]; the presence of TNT could only be later confirmed in the laboratory by IMS and GC-TEA techniques. The most important lesson learned during the investigation of the Bali bombings was the combination of portable instruments like IMS, FT-IR with classical colorimetric techniques using spot-tests for most rapid and efficient identification of the explosives actually used on the site. To meet the need for rapid and low-cost chemical sensing of explosive traces or residues in soil and post-blast debris, a colorimetric absorption-based sensor for trinitrotoluene (TNT) determination has been developed. The charge-transfer reagent (DCHA) is entrapped in a polyvinylchloride (PVC) polymer matrix plasticised with dioctylphtalate (DOP), and moulded into a transparent sensor membrane sliced into test-strips capable of sensing TNT showing an absorption maximum at 530 nm when placed in a 1-mm spectrophotometer cell. The absorbances of the charge-transfer complexes developed on the sensor (against the blank sensor) for TNT solutions containing 5-50 mg L\(^{-1}\) TNT in 30 % acetonated aqueous solution were recorded against concentration to yield a calibration line with the equation: 
\[ A_{530nm} = 1.24 \times 10^{2} C_{\text{TNT}} \text{ (mg/L)} + 1.16 \times 10^{1} \] (correlation coefficient: \( r = 0.9948 \)) with a limit of detection (LOD) of 3.0 mg L\(^{-1}\) and a limit of quantification (LOQ) of 10.0 mg L\(^{-1}\). The sensor is only affected by tetryl, but not by RDX, PETN, DNT, and picric acid. The proposed method was statistically validated for TNT assay against HPLC using a standard sample of Comp B. The developed sensor was relatively resistant to air and water, was of low-cost and high specificity, gave a rapid and reproducible response, and was suitable for field use of TNT determination in both dry and humid soil and groundwater.

References
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