UNIVERSITI TEKNOLOGI MARA

PHYSICAL, STRUCTURAL AND PERFORMANCE ANALYSES FOR CONFORMITY OF POLYMERIC PAINTS AND OTHER PRODUCTS

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ABSTRACT

Several improvements on the experimental procedures, data processing and results interpretation were done for various types of paints in different storage times and storage conditions for the practicality of the FTIR conformity analysis of the polymeric paint. The reproducibility and reliability of the results from FTIR conformity analysis were then supported with statistical test, physical test and performance test. In this study, four protective coating systems with several industry grade of raw materials and its polymeric paints, which are commonly used in oil and gas industry were collected from five reputable paint manufacturers. The first section of the study describes the process in determining the suitable method to be implemented as an additional QA/QC practice for protective paints. Based on the data analysis from several scientific analyses (*i.e.* TGA, DSC, Raman, Far-IR), ATR-FTIR is still more practical and cost effective to be used for monitoring the paint quality, either in the testing laboratory as well as on-site verification. It shows the incorporation of spectra matching and/or degree of similarity (r values) of FTIR spectra obtained from ATR-FTIR technique for the FTIR conformity analysis are reliable and reproducible ($r \geq 0.900 \pm 0.002$) compared to assignment band table and curve-fitting. The curve fitting able to differentiate two mixtures/compounds with different compositions, however, the inconsistency of replicate values implies the need for skillful analyst. The second section describes the refinement of the experimental procedure, data processing and results interpretation for the FTIR conformity analysis. This section deduces the applicability of (1) three significant figures of r values and (2) universal FTIR fingerprint region, 2000-900 cm^{-1} for FTIR conformity analysis as the statistical analysis criteria is fulfilled (t-statistic < t-critical and p-value > 0.05). The former standardizes the data presentation for accuracy while the latter replace the predecessor approach on using various selective or specific fingerprint regions that depends on the type of functional groups in the paint. Besides, it also demonstrates that the handheld FTIR is only opted as a screening tool whereas the benchtop FTIR is to be used for verification purposes in order to avoid approximately 20 % false rejection rate due to sensitivity of the spectrophotometer. The third section highlights the preventive measures to minimize the error of the FTIR conformity analysis which related to (1) sampling drying as the lid open and close multiple times, (2) generation of Reference spectrum without background scanning and pre-screening FTIR spectra, and (3) location of storage device of FTIR spectra that influence the generated r-values. The fourth section discusses on the reproducibility and reliability of the FTIR conformity analysis for different types of paints in variation of storage times and storage conditions. The incorporation of pre-installed Reference spectrum (generated from fresh paint spectra) into the FTIR software shows that the properly stored retained paints passed both the acceptance criterion of FTIR conformity test ($r > 0.900$) and statistical test, unlike improperly stored retained paints where $r << 0.900$ are always observed. Moreover, the similar procedure of FTIR conformity analysis using mid-IR for raw materials of the paints is also comparatively practical. The last section describes the adoption and usefulness part of the procedures for commercial polymeric and organic-based products in authentication analysis to differentiate product replicas (purchased from unauthorized retailer) from real products (purchased from authorized retailer) as the $r < 0.500$ are generated.

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