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Structural Inspection and Troubleshooting Analysis of a Lab-Scale Distillation Column Using Gamma Scanning Technique in Comparison with Monte Carlo Simulations

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Abstract

In the present study, structural inspection and troubleshooting analysis of a lab-scale distillation column has been performed using Gamma scanning technique and Monte Carlo simulations. MCNP4C Monte Carlo code has been used for simulations of the column and calculation of the computational density profile. The tested column is a one-pass tray type with 51 cm diameter. A Cs-137 sealed source and a 1×1 inch NaI (Tl) detector has been used for this gamma scanning process. According to the results, both experimental and simulation results showed the specification of trays and another section of the column accurately. Also, in addition to the flooding and damaged tray in the column, defects such as foaming with the density of 0.17 g/cm^3 can be distinguished using this technique. Based on the results, using photopeak count approach the differences in the material attenuations can be better distinguished. The effectiveness of this approach in determination of malfunctions increases with the density of the material between the source and the detector. Analyzing the experimental and simulation results are indicative of the fact that the procedures and methods used in this work are quite suitable for improving the accuracy of the troubleshooting analysis based on gamma scanning technique.

Key words: Gamma scanning technique, Monte Carlo simulations, Density profile, Troubleshooting, Distillation Columns

1. Introduction

Nucleonic measurement methods are frequently used in modern industrial measurement systems. Ionizing radiation responds to the fundamental physical properties of materials such as density and the interaction of ionizing radiation can be used for measurement of physical properties with high sensitivity. Also these methods are non-contacting and mostly performed while the unit is operating [1].

A cost-effective and completely nondestructive application of nucleonic measurements is troubleshooting of distillation columns by gamma rays. Gamma scans are used to evaluate trayed and packed columns, fixed bed reactors and the other process vessels that are one of the main

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