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Short Research Article

Gamma-ray application for an in-service diagnosis of a packed bed reactor in a petrochemical process†

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Introduction

Radioisotope technologies are widely used to diagnose the cause of a specific inefficiency of process operations in a plant. Gamma scanning by using a sealed radioisotope is an efficient technique to carry out an internal inspection of the process equipment, without interrupting its production. A collimated beam of penetrating gamma rays is allowed to pass through the shell of a vessel, which is then modified by the vessel internals and emitted out of the other side. By measuring the intensity of the transmitted radiation, valuable information can be obtained about the densities of the materials present inside the vessel.[1]

Styrene monomer plant is a facility in which a styrene monomer is manufactured by alkylating benzene with ethylene to form ethylbenzene, and then dehydrogenating it to styrene. A long-term operation of this process can cause the distributors to become clogged and structural abnormalities to occur in the packed beds. The objective of this study is to investigate the stability of the packed beds and the distributors of the styrene monomer plant during an operation, respectively, by using ^{60}Co as a gamma-ray source.

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Results and discussion

The experimental facility is composed of six structured packed beds and six distributors. Gamma radiation counts were measured by a detector (BGO) positioned diametrically outside the pipe-wall, opposite to the gamma source, with a regular space as the detector and the source were concurrently lowered.[2] The result of a gamma scanning on the packed bed reactor is shown below in Figure 1. A total of six distributors within the experiment region were in a stable condition and no structural abnormalities were discovered on them. But some regions showing a remarkable distinction when compared with the results of the neighboring section were discovered at both the lower and the upper parts of packed bed no. 5 (region ① and ②). These suggest the existence of an inhomogeneous distribution area of the internal media. In the region ③ (bed no. 1), the area was found to be relatively low in its mass distribution when compared with the neighboring area. This suggests that the inner areas of the packed bed are not completely filled with packed materials, or the fluids such as ethylene and ethylbenzene which flow among the packed beds are not distributed homogeneously. However, when considering that structural failures in beds cause a substantial decrease in the detected radiation counts, the deviation at the region no.3 can be considered to be from the fact of the latter. When more detailed and comprehensive information about the system of interest is needed, it is recommended to use the radiotracer application in addition to the sealed gamma-ray absorption measurement technique.

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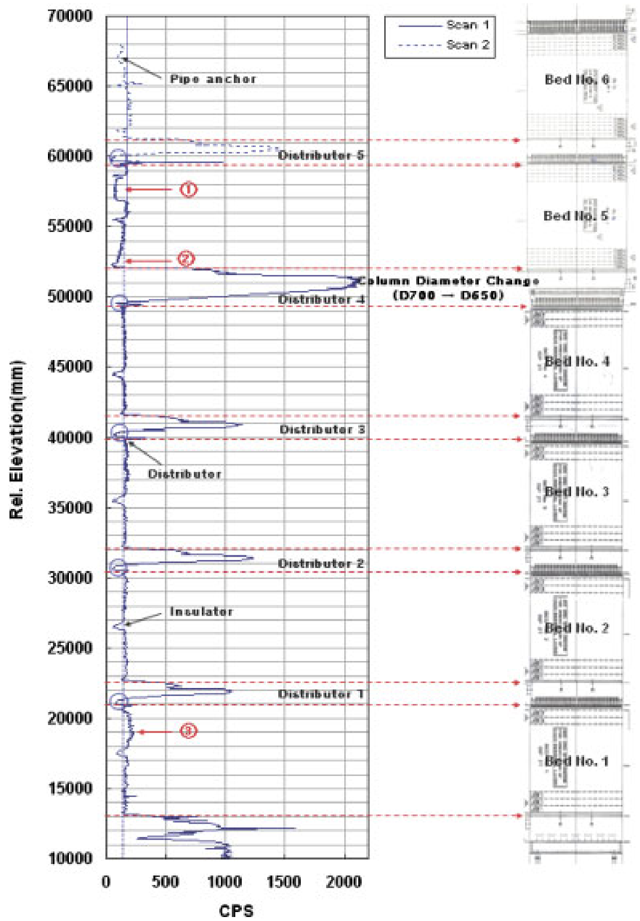

Figure 1 Internal density profile of packed bed reactor measured by 60Co and BGO detector. Figure available in colour online at www.interscience.wiley.com

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