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Short Research Article

Gamma ray CT application for a process diagnosis†

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Introduction

Although X-ray CT is a well-established technique for medical and industrial purposes, it has limitations when used for large-scale process units which are composed of a steel clad and a high-density material.[1] Because the relatively higher-energy gamma rays enable an imaging of processes hidden behind thick process vessel walls, we can say that a gamma ray CT by using a high energy is suitable for a large-scale process unit. To evaluate the effects on image contrast by the energy of radiation source, ^{137}Cs and ^{60}Co were used as gamma ray sources for each case. A phantom with an air void was designed on the basis of an example case established at the Chemical Reaction Engineering Laboratory, Washington University ST (Figure 1).[2] Normally the outer shield of an actual industrial process unit is an iron plate. For a situation similar to an actual shield, the phantom used in this study was shielded with lead plate whose thickness was 3 mm. We used a first generation type CT (Figure 1, left) for generating the sinogram (Figure 2) and the Expectation Maximization (EM) algorithm for a image reconstruction.

Results and discussion

The reconstructed phantom image by MAP-EM is shown in Figure 3. The image obtained from using ^{60}Co shows a fuzzy result when compared to the result from using ^{137}Cs as the gamma ray source. We used a lead collimator whose depth and aperture were 5 and 4 mm for an inch NaI(Tl) detector. A scattered radiation was detected more for ^{60}Co because the collimation shield was not perfect.[3] It can be inferred that we can obtain a sharper image by using a

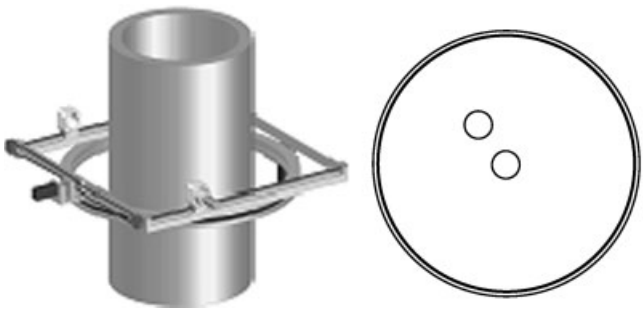

Figure 1 The experimental set-up (left) and the phantom (right).

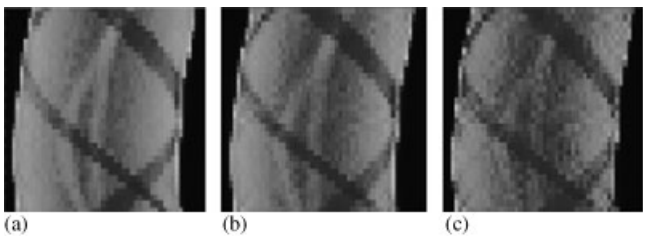

Figure 2 The reconstructed sinograms: (a) original; (b) by using ^{60}Co; and (c) by using ^{137}Cs.

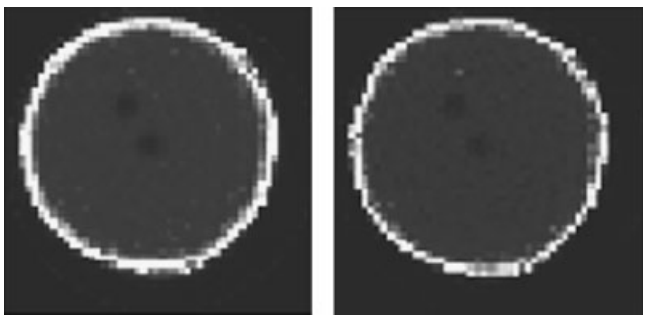

Figure 3 Image reconstruction results of the phantom with a metal shield by using (left ^{137}Cs) and (right ^{60}Co).

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lower gamma energy source when a detector collimation is not perfect. When a process unit is large enough for a detector size as in an industrial application, even a low-resolution image can provide a plant engineer with valuable information.[4,5] So our future work will be focused on how to take advantage of high-energy gamma ray sources for a large-scale industrial CT.

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