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Development of a 3D Cone Beam Tomography System: A Tool for Reverse Engineering

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Abstract

3D Visualization of the interior of an object has been one of the important goals of NDT and it has many industrial and strategic applications. It can be used for reverse engineering and for examination of defects and cracks in their full three dimensional perspective. Till recently, development of only two dimensional x-ray tomography system has been reported within the country and only way 3D images could be obtained from such a 2D setup is by repeating the experiment for different slices and stacking these slices. This approach besides being time consuming has the inherent disadvantage that images are magnified only in one plane resulting in reconstructed images with asymmetric resolution. The main problem in developing full 3D tomography has been complex mathematical formulation leading to difficult reconstruction algorithm development and sophisticated instrumentation. We have developed a 3D Cone beam tomography system based on Feldkamp algorithm and high dynamic range cooled CCD. To our knowledge this is the first such operational system within the country. The technique can be used for micro-tomography using micro-focus x-ray source or three dimensional tomography of large objects in a short span of time. Entire hardware and software for the system has been developed indigenously. At present, the system has been designed using 160 KV -4mA constant potential X-ray generator which is being upgraded to 320 KV in next phase. Initial results obtained are highly encouraging and show minute details and sectional view of the object not seen by any other method. Fig.1(a) shows photograph of a sample used for 3D reconstruction. The sample is made up of aluminum and used as end-cap of nuclear fuel bundle. Fig. 1(b-e) shows 3D reconstructed image including those sliced at arbitrary angle using 200 projections.

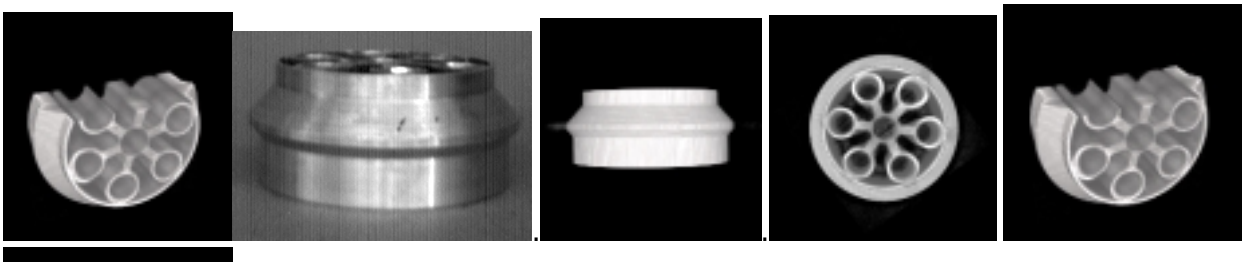

Fig. 1(a) Photograph of a sample used in the experiments and (b-e) 3D reconstructed image shown at various angles and cutaway view.

We have used it for volume visualization of zircaloy welds used in end caps of MOX fuel (Fig. 2(a) and (b) & (c)) and for the examination of the interior of objects containing materials with very small density difference which is otherwise very difficult to examine with conventional radiography.

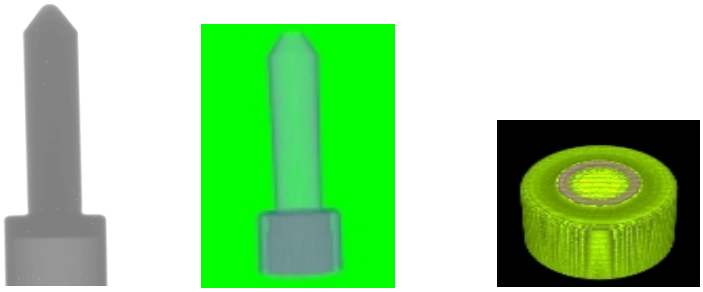

Fig. 2(a) Radiograph of MOX fuel end cap -Zircaloy (b) 3D reconstructed image (c) Cutway view of the weld