Contribution ID : **28** Type : **Oral**

Recent Advances in Neutron Imaging using a High-Flux Accelerator-Based Neutron Generator

Monday, 3 September 2018 13:50 (20)

Neutron imaging systems have been designed and constructed by Phoenix LLC to investigate low density material attributes of composites and other materials where other Non-destructive evaluation, (NDE), methods do not suffice. The first-generation electronic neutron generator was commissioned in 2013 at a United States Army research facility to inspect munitions and other critical defense and aerospace components. A second-generation neutron imaging system has undergone extensive testing at the Phoenix laboratory with an increased total neutron output from an upgraded gaseous deuterium target of 3x10^11 deuterium-deuterium (DD) neutrons/second. This system generates a higher neutron flux at the imaging plane, approximately 1x10^4 n/cm^2-sec, which reduces interrogation time, while maintaining high contrast and low geometric unsharpness. A further optimized system is currently under construction and promises yet even higher neutron output with increased image quality regarding signal to noise, contrast, and resolution. This system is expected to be installed at a production plant in 2018 and will be the first of its kind installed and used in a commercial setting. Phoenix's technology offers high throughput and image quality for neutron radiographs, like images currently acquired at nuclear reactors, but with greater accessibility, an eased regulatory environment, at a much-reduced cost, and without great environmental or biological hazards. As neutron radiography becomes more accessible due to the increased neutron yield of accelerator-based systems, a wider range of inspection techniques will be possible including digital radiography and computed tomography, with shorter image acquisition times. A description of the Phoenix neutron generator and imaging system, including the beamline, target, moderator and collimator, various detector platforms, and post processing techniques including neutron interaction localization and computed tomography, are demonstrated in this presentation. Neutron radiographs captured with a Phoenix neutron radiography system will be presented for both analog and digital based formats.

Keywords:

Neutron, radiography, munitions, artillery, aerospace, imaging, direct radiography, computed radiography, computed tomography

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Session Classification : Speaker Sessions and Seminars

Track Classification : Methods