A neutron radiographic facility on a research reactor and some results obtained in NDT

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ABSTRACT

A neutron radiographic facility on a research reactor and its characteristics are briefly described. A collimator of the facility is placed in a horizontal thermal column channel of 150mm in diameter. The converters of Gd or Dy metal foils, or painted Gd$_2$O$_2$S paper plate combined respectively with x-film are used as image detector and indicator. Some performances of the system, such as resolution and sensitivity, have experimentally been tested. Some practical applications of the facility and better results obtained in NDT for the quality inspecting and controlling of several industrial products are illustrated.

INTRODUCTION

In China the study of neutron radiographic technology began in the late 1970s. Research reactors are used as the neutron source for all neutron radiographic facilities. The research reactor mentioned in this paper is a pool type reactor (PTR). It has been operated in our institute since June 1979. The neutron radiography is only one aspect of nuclear technical applications at the reactor, and has been developed for NDT of some industrial products, such as several assemblies.
including explosive, nuclear fuel elements and its components, etc. In recent years because of improving device and adjusting parameters several times, and making inspect for testing specimens or product parts of different materials, some better results were obtained. This technology has already become an important means for testing and controlling quality of some products that can not be examined by x or γ-ray radiography.

THE FACILITY AND ITS PROPERTY

1. Source and Beam Energy

PTR is a thermal neutron research reactor with a power of 3MW. It utilizes light water as coolant and neutron moderator, beryllium and graphite as neutron reflector. The highest thermal neutron flux in the core is $6.5 \times 10^3$ n/cm$^2$.s. The neutron beam for the radiography is derived from a horizontal thermal column channel with 150mm-diameter by 2200mm-long. A 1100mm-long collimator is inserted into latter half of the channel, as shown in Fig.1. Several different long graphite plugs can be also inserted into front part of the channel to moderate neutrons, and thereby to change the beam energy (expressed in cadmium rate 'Rcd'). As the plug lengths are accumulated from 0 to 1000mm the values of Rcd (for gold foil) are also changed from 4 to 150, but the highest thermal neutron flux at radiographed objects is contrarily decreased from $4.2 \times 10^7$ to $2.5 \times 10^5$ n/cm$^2$.s.

2. Collimator and Collimation Ratio

The collimator of the facility is a similar conical-like structure.[1] On the beam passageway a few annuli are placed, the hole diameters of which are enlarged step by step along the beam direction. A minimum hole size (D) for introducing beam into the collimator is 50mm in diameter. Both the annuli and the inner wall of the collimator are made of gadolinium foils, boron-carbide plastic and lead plates. This kind of structure can largely decrease the effect to radiography from scattered neutrons and γ-ray emitted by inner surface of the collimator.

In order to adjust the collimation ratio (L/D) the L values can be changed by means of moving a handcart with a support of the cassette and the objects to be radiographed. In this way the ratio L/D can continuously chosen in the range of 50-110.

3. The Ratio of Neutrons to γ-Ray

For raising ratio of neutrons to γ-ray (n/γ), in