American Nuclear Society

use of borosilicate-glass raschig rings as a neutron absorber in solutions of fissile material

an American National Standard

published by the
American Nuclear Society
555 North Kensington Avenue
La Grange Park, Illinois 60525 USA

ANSI/ANS-8.5-1986

ANSI/ANS-8.5-1986
Revision of
ANSI/ANS-8.5-1979

American National Standard
Use of Borosilicate-Glass Raschig Rings as a Neutron Absorber in Solutions of Fissile Material

Secretariat
American Nuclear Society

Prepared by the
American Nuclear Society
Standards Committee
Working Group ANS-8.5

Published by the
American Nuclear Society
555 North Kensington Avenue
La Grange Park, Illinois 60525 USA

Approved January 3, 1986
by the
American National Standards Institute, Inc.

American National Standard

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Published by

American Nuclear Society
555 North Kensington Avenue, La Grange Park, Illinois 60525 USA

Printed in the United States of America

Foreword

(This Foreword is not a part of American National Standard Use of Borosilicate-Glass Raschig Rings as a Neutron Absorber in Solutions of Fissile Material, ANSI/ANS-8.5-1986.)

This standard, which provides guidance for the use of borosilicate-glass raschig rings as a neutron absorber for criticality control in plants processing fissile materials, was first approved as N16.4-1971, revised as ANSI/ANS-8.5-1979, and this revision results from the prescribed five-year review. It recommends maximum concentrations of homogeneous solutions of uranium and plutonium in vessels of unlimited size when packed with rings. Although the general use of neutron absorbers, including raschig rings, for this purpose dates back to 1958, some applications were recorded as early as the mid-1940s.

In this standard the concentration of solutions is expressed as the mass of plutonium or of uranium per unit volume. Limitations on the relative abundance of the various isotopes of plutonium are imposed in the specifications applicable to plutonium solutions. The limits on total uranium concentration, which are based on 100% ^{235}U, apply to uranium of any ^{235}U content. The ^{233}U content of solutions in which ^{235}U is the principal uranium isotope is limited.

The experimental data forming the bases for the specifications and a review of experience with raschig rings were reported by Nichols et al.[1] at the time of initial preparation of this standard. Additional data that provides bases for this revision have also been published.[2, 3]

This document was approved as an American National Standard in 1971. The present revision, which provides clarification of several items requested by users of the standard and more clearly identifies supporting documentation, was coordinated by N. Ketzlach of the U.S. Nuclear Regulatory Commission assisted by B. Ernst of American Nuclear Insurers, J. D. McCarthy of Rockwell International, Rocky Flats Plant, P. B. Adams of Corning Glass Company, and Martyn C. Evans of British Nuclear Fuels, plc.

The development of the standard and its maintenance were performed under Subcommittee 8 of the Standards Committee of the American Nuclear Society. At the time of this approval of the revision, Subcommittee 8, Fissionable Materials Outside Reactors, had the following membership:

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[1]J. P. Nichols, C. L. Schuske, and D. W. Magnuson, "Use of Borosilicate-Glass Raschig Rings as a Neutron Absorber in Solutions of Fissile Material," Y-CDC-8, Oak Ridge Y-12 Plant, Oak Ridge, Tennessee (1971).

[2]P. B. Adams, Chapter 14 in *Ultrapurity*, M. Zief and R. Speights Editors, Marcel Dekker, Inc., New York (1972).

[3]N. Ketzlach, *Nucl. Tech., 42*, 65 (1979).

The American National Standards Committee N16, Nuclear Criticality Safety, which reviewed and approved this standard in 1985, had the following membership:

D. Callihan, Chairman
E. B. Johnson, Secretary

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Use of Borosilicate-Glass Raschig Rings as a Neutron Absorber in Solutions of Fissile Material

1. Scope

This standard applies to the use of borosilicate-glass raschig rings as a neutron absorber for primary and for secondary criticality control in packed vessels containing solutions of ^{235}U, ^{239}Pu, or ^{233}U. The chemical and physical environment, properties of the rings and packed vessels, maintenance inspection procedures, and criticality operating limits are specified.

2. Definitions

2.1 Limitations. The definitions given below are of a restricted nature for the purposes of this standard. Other specialized terms are defined in American National Standard Glossary of Terms in Nuclear Science and Technology, N1.1-1976/ANS-9 [1].[1]

2.2 Shall, Should, and May. The word "shall" is used to denote a requirement, the word "should" to denote a recommendation and the word "may" to denote permission, neither a requirement nor a recommendation. In order to conform with this standard all operations shall be performed in accordance with its requirements.

2.3 Glossary of Terms

control raschig rings (control rings). Rings that are nondestructively tested for physical properties and remain in the solution except for short test periods.

primary criticality control. A method of control upon which principal or sole dependence is placed for maintaining subcriticality.

raschig ring (ring). A small, hollow, borosilicate-glass cylinder having approximately equal length and diameter.

secondary criticality control. A method of criticality control that supplements a primary criticality control and provides backup for the unlikely case where the primary control fails.

3. General Specifications and Criteria

The borosilicate glass shall be of the low-expansion, corrosion-resistant type that is conventionally used for chemical laboratory glassware as specified in Standard Specification for Glasses in Laboratory Apparatus, ASTM E 438-83 [2]. The glass shall be compatible with the chemical and physical environment in which it is to be used.

3.1 Chemical Environment

3.1.1 Acidic and Neutral Environment. When used as either a primary or secondary criticality control, in an acidic or neutral solution, the following restrictions shall apply:

(1) pH less than or equal to 7.0,

(2) temperature no greater than 120°C,

(3) hydrogen fluoride concentration[2] no greater than 0.0001 molar unless compatibility is established according to 4.2.3 and 6.5.3, and

(4) phosphate ion concentration no greater than 1 molar.

Subject to these restrictions, acceptable chemical environments may include solutions of salts of organic or inorganic acids, hydrocarbons, or solutions of complexing or chelating agents in hydrocarbons.

The results of corrosion resistance tests performed on borosilicate-glass raschig rings have been summarized in a report, "Use of Borosilicate Glass Raschig Rings as a Neutron Absorber in Solutions of Fissile Material," Y-CDC-8, dated July 1971 [3].

3.1.2 Basic Environment. When utilized in a basic solution the rings shall not be used as a primary criticality control. The basic solutions to which the rings are exposed shall have either:

(1) sodium, potassium, or ammonium hydroxide concentration no greater than 0.5 normal at a temperature less than 38°C or

[1] Numbers in brackets refer to corresponding numbers in Section 8, References.

[2] Greater fluoride concentrations may be permitted for certain complexes of fluorides and other acids.