OAK RIDGE NATIONAL LABORATORY

Operated by
UNION CARBIDE NUCLEAR COMPANY
Division of Union Carbide Corporation

Post Office Box X
Oak Ridge, Tennessee

MASTER

ORNL
CENTRAL FILES NUMBER

59-2-25

External Transmittal Authorized
COPY NO. 114

DATE: February 6, 1959
SUBJECT: Critical Concentrations for HRT-Type Reactors
Subjected to Various Conditions
TO: Distribution
FROM: Roger Chalkley

ABSTRACT

Critical concentration calculations were made for several D_2O - H_2O moderated HRT-type reactors with 30- and 28-in. core diameters and pressure vessel diameters of 60 and 54 in. A core temperature of $300^\circ C$ was assumed for all cases while the blanket temperatures assumed the values 250, 280, and $300^\circ C$. The assumed moderator compositions were 80, 90, 100% D_2O .

NOTICE

This document contains information of a preliminary nature and was prepared primarily for internal use at the Oak Ridge National Laboratory. It is subject to revision or correction and therefore does not represent a final report. The information is not to be abstracted, reprinted or otherwise given public dissemination without the approval of the ORNL patent branch, Legal and Information Control Department.

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency Thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

CRITICAL CONCENTRATIONS FOR HRT-TYPE REACTORS
SUBJECTED TO VARIOUS CONDITIONS

Roger Chalkley

Discussion

Critical concentrations were estimated for a two-region spherical reactor in which the core contains the fuel material (taken as pure U^{235}) while the reflector region contains only moderator (a mixture of D_2O and H_2O). The effect of poison and the influence of a core tank were neglected.

Since the harmonics method criticality condition requires that the slowing down properties in all regions be the same, the harmonics method cannot be used directly to treat cases where the moderator is at different temperatures in different regions. The percentage change in critical concentration due to a different reflector temperature was first calculated by the two-group procedure and applied as a correction to the harmonics result for a uniform reactor temperature at $300^\circ C$. The results of these calculations are presented in Table 1.

It is evident that lowering the blanket temperature causes the critical concentration to be decreased. In fact, the critical concentrations with the core at $300^\circ C$ and the blanket at $250^\circ C$ appear to be less than the corresponding critical concentrations when both the core and blanket are at $280^\circ C$.*

The presence of some light water lowers the critical concentration in all cases. The reduction increases percentagewise as the reflector temperature increases. At a uniform temperature of $300^\circ C$, the effect of an H_2O addition upon these reactors appears substantially greater than for the corresponding $280^\circ C$ cases.* Increased reflector thickness likewise produces a noticeable concentration reduction.

* See ORNL CF-58-12-36.

Table 1. Critical Concentration as a Function of Moderator Composition and of Reflector Thickness and Temperature for Two-Core Diameters. Core Temperature 300°C in all Cases. No Fuel in Reflector.

Core Diameter (in.)	Reflector Thickness (in.)	% D ₂ O	Blanket Temperature		
			300°C	280°C g U/liter	250°C
30	15	100	14.80	12.12	9.84
		90	10.58	9.40	8.38
		80	10.32	9.65	8.98
30	12	100	21.16	16.90	13.38
		90	11.89	10.42	9.15
		80	10.82	10.00	9.25
28	16	100	18.69	15.14	12.18
		90	12.70	11.22	9.92
		80	12.08	11.20	10.32
28	13	100	26.92	21.25	16.70
		90	14.19	12.38	10.78
		80	12.58	11.53	10.62

DISTRIBUTION

1. HRP Director's Office
Rm. 259, Bldg. 9204-1
2. G. M. Adamson
3. S. E. Beall
4. A. M. Billings
5. E. G. Bohlmann
6. S. E. Bolt
7. E. S. Bomar
8. J. R. Brown
9. W. D. Burch
- 10-14. R. Chalkley
15. R. H. Chapman
16. R. D. Cheverton
17. H. C. Claiborne
18. E. L. Compere
19. R. S. Crouse
20. J. S. Culver
21. D. G. Davis
22. R. J. Davis
23. J. L. English
24. D. E. Ferguson
25. T. B. Fowler
26. C. H. Gabbard
27. W. R. Gall
28. R. S. Greeley
29. J. C. Griess
30. W. R. Grimes
31. P. A. Haas
32. P. H. Harley
33. P. N. Haubenreich
34. J. W. Hill
35. E. C. Hise
36. C. J. Hochanadel
37. S. Jaye
38. G. H. Jenks
39. D. T. Jones
40. P. R. Kasten
41. F. Kertesz
42. L. J. King
43. R. B. Korsmeyer
44. N. A. Krohn
45. C. G. Lawson
46. R. E. Leuze
47. W. H. Lewis
48. M. P. Lietzke
49. R. A. Lorenz
50. M. I. Lundin
51. R. N. Lyon
52. W. L. Marshall
53. T. H. Mauney
54. J. P. McBride
55. H. F. McDuffie
56. H. A. McLain
57. R. A. McNees
58. J. R. McWherter
59. R. L. Moore
60. C. S. Morgan
61. C. W. Nestor
62. L. F. Parsly, Jr.
63. R. L. Pearson
64. F. N. Peebles
65. M. L. Picklesimer
66. B. E. Prince
67. S. A. Reed
68. D. M. Richardson
69. R. C. Robertson
70. M. W. Rosenthal
71. H. C. Savage
72. C. H. Secoy
73. C. L. Segaser
74. E. M. Shank
75. M. D. Silverman
76. M. J. Skinner
77. I. Spiewak
78. R. W. Stoughton
79. J. A. Swartout
80. E. H. Taylor
81. D. G. Thomas
82. M. Tobias
83. D. S. Toomb
84. W. E. Unger
85. R. Van Winkle
86. A. M. Weinberg
87. K. W. West
88. J. C. Wilson
89. C. E. Winters
90. F. C. Zapp
- 91-92. REED Library
- 93-94. Central Research Lib.
- 95-96. Document Ref. Lib.
- 97-111. Laboratory Records
112. ORNL-RC
- EXTERNAL
113. D. H. Groelsema, AEC,
Washington
- 114-128. TISE-AEC