UCRL-ID-125503

# Porosity Gain from Increase in Core Radius and Fuel Mass in Tory II-C

W. E. Kane
A. G. Cole

RECEIVED
JAN 2 1 1997
OSTI





February 14, 1963

Lawrence Livermore National Laboratory


Work performed under the auspices of the U.S. Department of Energy by the Lawrence Livermore National Laboratory under Contract W-7405-ENG-48.

## DISCLAIMER

DISCLAIMER

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

[redacted]

NAVAL APPLICATIONS MEMORANDUM NO. 19 - February 14, 1963 [redacted]

TO: Distribution

FROM: W. E. Kane and A. G. Cole

SUBJ: Porosity Gain from Increase in Core Radius and Fuel Mass in Tory II-C

---



## I. Introduction

A set of machine calculations has been done to determine the amount by which the volume of solid material in a Tory II-C core can be reduced with respect to the total core volume. The work was undertaken at the request of Jerauld Moyer.

Three separate problems were studied. In each case some change was made which by itself would increase the $K_{eff}$ of the reactor. Then, in order to keep $K_{eff}$ unchanged, a certain amount of core material was removed. The calculations were done by means of the one-dimensional neutronic diffusion code ZOOM. The base problem ZR 1008 on which the variations were made is a cross section of Tory II-C as represented in two dimensions by ANGIE problem RZ 501. The cross section is taken at a distance of 0.3 of the length of the reactor from the front surface, and the Z dimension is adjusted in ZR 1008 so that $K_{eff}$ is the same as for RZ 501.

## 2. Expanded Core with Total Fuel Mass Unchanged

The simplest problem was that in which the radius of the core-reflector interface was increased by 3.03815 inches ($T = 1550^{o}K$) with the total amount of fuel in the core left unchanged. The thickness of the reflector was not changed, but all radial dimensions within the core were increased in proportion to the increase in core radius. The core material was distributed radially throughout all regions of the expanded core in the same manner as in the base problem. The mass of fuel per unit volume was reduced uniformly by the ratio of the original volume to the expanded volume in order to preserve the total fuel mass. The mass density of the other materials in the core was left unchanged, resulting in an increase of total mass.

Having made the foregoing alterations in the input of the problem, one can reduce uniformly the concentration of BeO in the active core to obtain the same $K_{eff}$ as in the base problem. The resulting core is such that within a unit volume the [redacted] by solid material has been reduced.

[redacted]

S-9 [redacted] T [redacted]

[redacted] This document consists of [redacted] pages.
[redacted] copies,
[redacted] Series [redacted]

GROUP 1 — Excluded from automatic downgrading and declassification

NAVAL APPLICATIONS MEMORANDUM NO. 19 - February 14, 196[redacted]

TO: Distribution

FROM: W. E. Kane and A. G. Cole

SUBJ: Porosity Gain from Increase in Core Radius and Fuel Mass in Tory II-C

---

DECLASSIFICATION STAMP ON REVERSE

## 1. Introduction

A set of machine calculations has been done to determine the amount by which the volume of solid material in a Tory II-C core can be reduced with respect to the total core volume. The work was undertaken at the request of Jerauld Moyer.

Three separate problems were studied. In each case some change was made which by itself would increase the $K_{eff}$ of the reactor. Then in order to keep $K_{eff}$ unchanged, a certain amount of core material was removed. The calculations were done by means of the one-dimensional neutronic diffusion code ZOOM. The base problem ZR 1008 on which the variations were made is a cross section of Tory II-C as represented in two dimensions by ANGIE problem RZ 501. The cross section is taken at a distance of 0.3 of the length of the reactor from the front surface, and the Z dimension is adjusted in ZR 1008 so that $K_{eff}$ is the same as for RZ 501.

Classification (...) changed to UNCLASSIFIED by authority of (...) by (...) verified by (...)

## 2. Expanded Core with Total Fuel Mass Unchanged

The simplest problem was that in which the radius of the core-reflector interface was increased by 3.03815 inches ($T = 1550^{o}K$) with the total amount of fuel in the core left unchanged. The thickness of the reflector was not changed, but all radial dimensions within the core were increased in proportion to the increase in core radius. The core material was distributed radially throughout all regions of the expanded core in the same manner as in the base problem. The mass of fuel per unit volume was reduced uniformly by the ratio of the original volume to the expanded volume in order to preserve the total fuel mass. The mass density of the other materials in the core was left unchanged, resulting in an increase of total mass.

Having made the foregoing alterations in the input of the problem, one can reduce uniformly the concentration of BeO in the active core to obtain the same $K_{eff}$ as in the base problem. The resulting core is such that within a unit volume the amount of space actually occupied by solid material has been reduced.

DOWNGRADE TO SECRET, CONFIDENTIAL, OR UNCLASSIFIED
SIGNATURE OF ORIGINATOR OR CLASSIFYING AUTH.

S E C R E T

Let V represent the amount of space occupied by solid material in a fuel tube element where $V_o$ represents the same quantity in the unaltered Tory II-C. By doing a series of problems in which V was effectively varied, it was found that for $V/V_o = 0.9671$ the expanded core would have the same $K_{eff}$ as ZR 1008 with the same total fuel mass.

## 3. Expanded Core with Increased Fuel Mass

Using the same geometry as described in Section 2, the fuel mass was increased so that more BeO moderator could be removed and a further reduction made in V. The relative fuel distribution of RZ 501 was preserved while the fuel mass was increased to correspond to a maximum loading of 10% by weight of $OyO_2$. This maximum in RZ 501 is slightly greater than 8%.

In order to make the appropriate alterations in the problem input, it was necessary to compute the mass density of fuel element material such that the $OyO_2$ comprised 10% of the mass. This was done by reference to the work of A. Rothman in Tory II-C Memo. No. 329 which gives the density formula as well as the relative weight percentages of the horseradish constituents.

By a series of problems in which V was varied with the maximum weight percent of $OyO_2$ held constant at 10%, the same $K_{eff}$ as for ZR 1008 was found for $V/V_o = 0.8996$.

## 4. Increased Fuel Mass with Unaltered Tory II-C Geometry

With the weight percent of fuel increased to correspond to a maximum of 10% as in the problem just described, but with the Tory II-C geometry unaltered, the appropriate value of $V/V_o$ was found to be 0.9658.

[redacted]



[redacted]

[redacted]

WEK/AGC:jas

Distribution:

1. A. Lorenz
2. J. Hadley
3. H. Reynolds
4. E. Goldberg
5. T. Stubbs
6. J. Moyer
7. M. Mintz
8. A. Cole
9. E. Sheridan
10. V. Hampel
11. C. Barnett
12. J. Thomas
13. M. Jester

14-19. H. Reynolds/File

20. W. B. Myers
21. W. Miller
22. W. Wells
23. E. Platt
24. C. Walter
25. J. Hodges
26. J. Kane
27. A. Rothman
28. B. Rubin
29. H. McDonald
30. A. Kirschbaum
31. T. Merkle
32. P. Neal
33. J. G. Wenzel, Lockheed
34. J. Radcliffe, AEC-SAN
35. I. Hoffman, AEC-Washington
36. Harold Jaffe, AGN
37. W. Kane

SERIES B: 8/13/63

1. File
2. File
3. File
4. File
5. File
6. File

[redacted]