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TITLE

EXPOSURE, POWER, AND TEMPERATURE EFFECTS ON RUPTURE RATES OF SOLID FUEL ELEMENTS

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J. L. Jaech

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1. R. R. Bloomstrand
- 2. J. L. Jaech

April 9, 1959

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R. R. Bloomstrand
Process Analysis Operation
1704-D BUILDING, 100-D AREA

EXPOSURE, POWER, AND TEMPERATURE EFFECTS ON RUPTURE
RATES OF SOLID FUEL ELEMENTS

Reference: "Effects of Exposure, Power, and Temperature on Rupture Rates,"
HW-55219 RD, 3/4/58, J. L. Jaech

Introduction

In the reference document, rupture data observed between the Spring of 1956 and December, 1957, were used to obtain an equation relating side rupture rates to reactor variables. The 1958 rupture data for solid fuel elements have recently been summarized. In this report, the equation expressing tube-wise rupture rate as a function of exposure, power, and temperature has been adjusted to include these 1958 data.

Summary

Inclusion of the 1958 data does not significantly change the rupture equation in current use.

Discussion

Thirty-six ruptures were included for the old reactors in the original study. An additional 32 ruptures occurring in solid fuel elements were included in the 1958 data. Most of these latter ruptures (25 of them) occurred at tube powers in excess of 750 KW and at temperatures exceeding 95° C.

An analysis similar to that reported in detail in the reference document was performed on the over-all data. The existence of more tubes operating at the higher temperatures essentially spread out the range of data which adds confidence to further extrapolations.

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In the previous analysis, it was assumed that the exponent for the exposure term was 5, this assumption being based on past experience. Sufficient data were available using the combined data to permit an estimation of this exponent. The over-all average was estimated to be 4.4 with a standard deviation of 0.7. Since this was insufficient evidence to alter the value of 5 in current use, the exponent was still assumed to be 5. This exponent is the a_1 parameter in the model:

$$RR = 1 - \exp(-a_0 E^{a_1} P^{a_2} T^{a_3})$$

$$+ a_0 E^{a_1} P^{a_2} T^{a_3}$$

Estimates for a_2 and a_3 given in the reference document are summarized below for comparison purposes together with estimates based on the combined data.

	$\hat{a}_2$	σ	$\hat{a}_3$	σ
1956-57 data...old reactors	2.54	1.40	6.71	2.22
'56-'57 data...C reactor	3.49	1.02	10.15	1.85
Combined '56-'57	3.3	0.83	8.7	1.42
'56-'58 data...old reactor	2.30	1.21	8.12	2.05
Combined with C	3.1	0.78	9.2	1.37

It is clear from the above table that inclusion of the 1958 data does not appreciably change the estimates of the parameters. If one were to use these revised estimates, the over-all expression for side rupture rate at the old reactors becomes

$$RR = 5.0 E^5 P^{3.1} T^{9.2} \times 10^{-44}, \text{ as compared with}$$

$$RR = 2.1 E^5 P^{3.3} T^{8.7} \times 10^{-43} \text{ given in the}$$

reference. The difference is not great from a practical viewpoint.

J. L. Jauch
J. L. Jauch
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