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Subject: Porosity of Uncoated
Unfueled Elements

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Some concern has been shown about the effect of element permeability on core interstitial flow rates. Interelement flow will be measured as part of the EML-60 core effective gap test. In order to estimate the magnitude of this effect, a permeability check was made on three fuel elements. The leakage flow due to element permeability appears to be small, in comparison with expected interelement flow rates. A more extensive check on a representative number of element samples will be performed prior to the actual test.

The procedure used is represented schematically below:

The open end of a capped element was placed in a chamber pressurized with helium gas. A pressurized rubber bladder prevented any leakage around the edge of the element. The gas leakage due to element porosity can be determined from the pressure change in the chamber using the relationship $\omega = \frac{PV}{RT}$, so the gas weight loss becomes $(\omega_2 - \omega_1) = \frac{V\Delta P}{RT}$.

INFORMATION CATEGORY

UNCLASSIFIED

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$$\text{Chamber Volume } V = 2250 \text{ cm}^3 = 0.078 \text{ ft.}^3$$

$$R_{\text{Helium}} = 1544/M = 386$$

$$T = 530^\circ\text{R}$$

19 Hole Element

$$\text{Initial Pressure } P_0 = 25 \text{ psig}$$

$$\text{Final Pressure} = 20.3 \text{ psig} \quad \text{Time} = 150 \text{ sec.}$$

Single Element

$$\begin{aligned} \text{Leakage} &= (0.078) \left(\frac{1}{\Delta V} \right) = \frac{(0.078) \left(\Delta P \frac{\text{lb}}{\text{ft}^2} \right)}{RT} = \frac{(0.078)(676)}{(386)(530)} = 0.00025 \text{ lb/150 sec.} \\ &\approx 1.67 \times 10^{-6} \text{ lb/sec} \end{aligned}$$

13 Hole Element

$$\text{Initial Pressure} = 25 \text{ psig}$$

$$\text{Final Pressure} = 22.7 \text{ psig} \quad \text{Time} = 150 \text{ sec.}$$

Single Element

$$\text{Leakage} = \frac{(0.078)(330)}{(386)(530)} = 0.00013 \text{ lb/150 sec.} \approx 0.87 \times 10^{-6} \text{ lb/sec.}$$

No detectable leakage was found in an element containing one large central hole.

For a 25 psi total pressure drop across the core in the EML-60 "Core Effective Gap Test", the total interstitial flow is expected to be of the order of 3×10^{-2} lb/sec of helium. The above porosity results would indicate a maximum flow due to porosity of

$$\begin{aligned} \text{Max. porosity flow} &= (\text{number of elements})(\text{leakage of 19 hole element}) \\ &= (2000)(1.67 \times 10^{-6}) = 3.34 \times 10^{-3} \text{ lb/sec.} \end{aligned}$$

This is only 10% of the total expected interstitial flow. The calculated is very conservative since it assumes a uniform interstitial pressure along the full element length where in reality it will vary axially.

At higher pressures both the interelement and leakage flow due to porosity should increase proportionally.

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