ATTACHMENT B

Methodology for Estimating ECP in Dresden-2 RWCU Piping

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(Methodology generated by General Electric)

METHODOLOGY FOR ESTIMATING ECP IN DRESDEN - 2 RWCU PIPING

The following is the methodology to be used to estimate the ECP at points of interest in the RWCU piping at Dresden-2. It should be noted that the RWCU flow comes only from the recirculation water; the bottom head drain is not used.

1. Obtain the ECP values measured in the recirculation flange at various feedwater hydrogen injection rates.

2. Determine the location of the ECP flange relative to the recirculation piping inlet.

3. Determine the location of the RWCU piping inlet relative to the recirculation piping inlet.

4. Determine the location of the point of interest for ECP estimation in the RWCU piping relative to the RWCU piping inlet.

5. Utilize the information on the locations (Steps 2-4), line lengths, recirculation and RWCU pipe sizes, flow rates and temperatures to calculate the hydrogen peroxide concentrations at the point of interest on the RWCU piping relative to the concentrations at the electrode locations at several feedwater hydrogen concentrations which will be determined.

   5a. The BWR water radiolysis model indicates that the predominant oxidizing species is hydrogen peroxide at feedwater hydrogen concentrations where the IGSCC protection point is approached in the recirculation system.

   5b. Laboratory data obtained previously [1] and being obtained currently [2] on the variation of the ECP with increasing hydrogen peroxide concentrations indicates a substantially more positive ECP than obtained at corresponding oxygen concentrations, especially at lower concentrations.

6. Calculate the extent of hydrogen peroxide decomposition at the point of interest on the RWCU piping relative to that at the recirculation pipe location utilizing a formula which takes into account the effects of flow rate, surface-to-volume ratio, temperature and mass transfer. The formula includes Sherwood, Reynolds and Schmidt numbers.

6a. This information is described in a journal article [3]. Relevant calculations are summarized as follows:

$C = C_O \exp(-k_{obs}t)$

$k_{obs} = k_{act}k_{dif}/k_{act} + k_{dif}$

k_{act} is calculated from laboratory data shown in Figure A-1 of [3], attached.

k_{dif} is calculated from the following equations:

$$k_{dif} = KS/V$$

$$Sh = Kd/D$$

$$Re = dU/v$$

$$Sc = v/D$$

$$K = 0.023Re^{0.8}Sc^{0.33}D/d$$

where:
C = H_20_2 concentration at time t
C_o = Initial H_2C_2 concentration at time t = 0
t = reaction time
k_{obs} = observed hydrogen peroxide decomposition rate constant
k_{act} = rate constant from chemical activation
k_{dif} = rate constant from diffusion
Sh = Sherwood number
Re = Reynolds number
Sc = Schmidt number
d = piping inner diameter
D = diffusivity of H_2O_2
U = water flow velocity
v = kinematic viscosity
(S/V) = surface to volume ratio

6b. The basic values for the decomposition rate constants were obtained in laboratory studies [1], [2]. Data from [2] is shown graphically in Figure 1, attached.

7. For the previously determined feedwater hydrogen concentrations, compare the hydrogen peroxide concentrations at the point of interest on the RWCU piping relative to the electrode location. Using the information in 6b estimate the ECP at the point of interest on the RWCU piping compared with the electrode location.

References

1. C. C. Lin, et al, "Electrochemical Potential Measurements Under Simulated BWR Water Chemistry Conditions," Corrosion, Vol. 48, No. 1, January 1992

2. Y. Kim, et al, Effect of Water Flow Velocity on Electrochemical Corrosion Potential of Stainless Steel in 288°C Water, " National Association of Corrosion Engineers, to be published in 1993.

3. C. C. Lin, et. al., "Decomposition of Hydrogen Peroxide in Aqueous Solutions at Elevated Temperatures", Int. Journal of Chem. Kinetics, Vol. 23, 971-978 (1991).

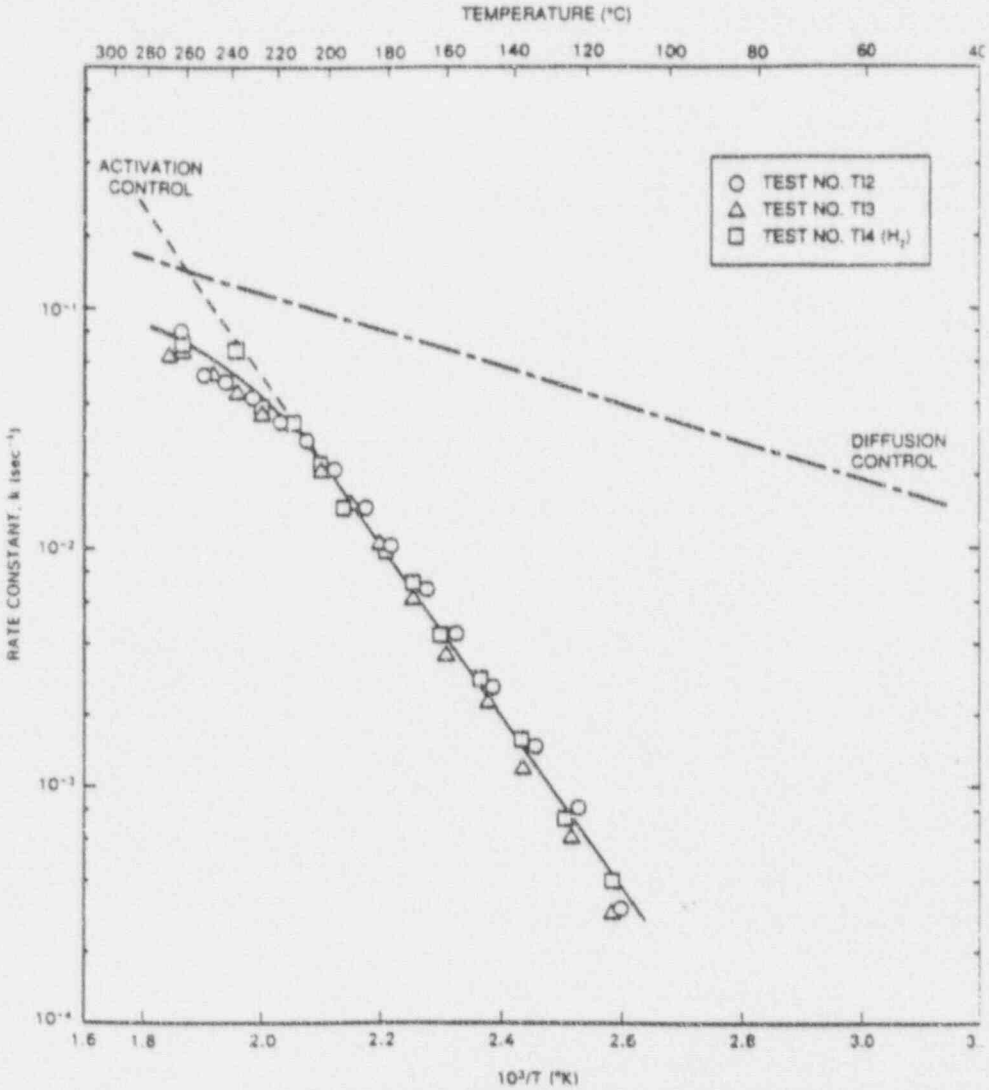

Figure A-1. Comparison of activation-controlled and diffusion-controlled decomposition rate constants as function of temperature.

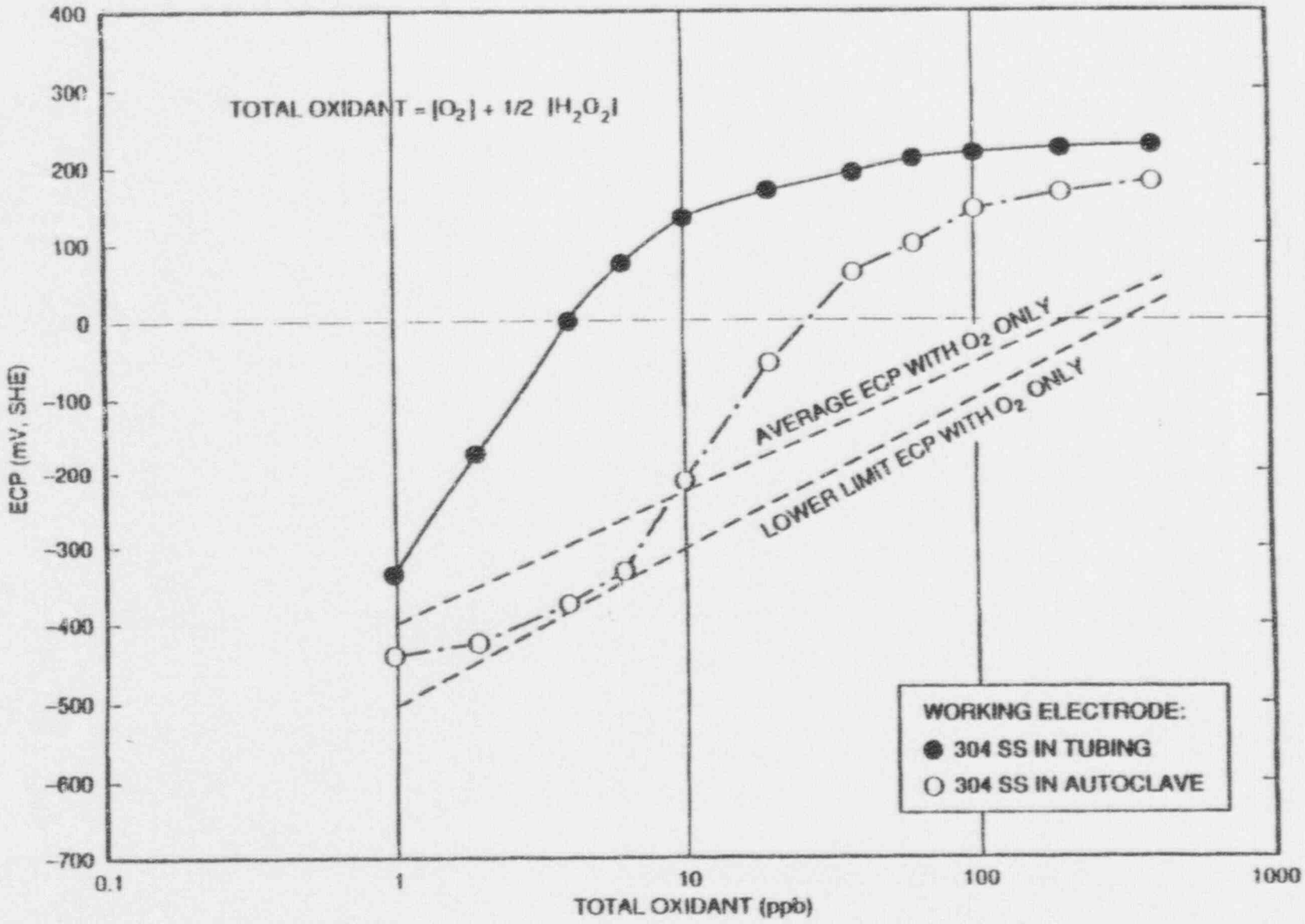

FIGURE 1

Effects of H_2O_2 on the ECP of 304 SS in High Purity Water at 270 C.
Average of Several Measurements Using Ag/AgCl, Cu/Cu_2O and Pt Reference Electrodes.

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