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SUBJECT: OPERATIONAL REQUIREMENTS
FOR THE TEAPOT RECOMBINER

TO: R. N. Lyon

FROM: C. G. Lawson

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To: R. N. Lyon

November 1, 1952

From: C. G. Lawson

Subject: Operational Requirements for
the Teapot Recombiner

This memorandum contains information which may be of use to the design group in detailing the catalytic recombining for the teapot.

The maximum rate of steam and $H_2 + 1/2 O_2$ production at various temperature and pressure throughout the operating range of the teapot are listed as follows:

P Psia	Core T °F	KW	Steam Ft ³ /Hr	H ₂ O Dissociate #/Hr	H ₂ + 1/2 O ₂ at P and T Ft ³ /Hr
14.7	212	54	5,080	1.19	48.5
150	358	210	2,510	4.62	27.4
300	417	340	2,240	7.5	19.5
450	456	405	1,860	8.91	16.2
600	486	500	1,782	11.0	15.5

If a partial condenser is used then about 90% of the steam can be returned directly to the core and 10% of the steam may be passed through the recombining with the $H_2 + 1/2 O_2$. The volume flow rate entering the recombining will then be:

Psia	Steam Ft ³ /Hr	H ₂ + 1/2 O ₂ at P and T Ft ³ /Hr	Total	Adiabatic Temp. Increase °F
14.7	508	48.5	556.5	744
150	251	22.4	273.4	650
300	224	19.5	243.5	612
450	181	16.2	197.2	597
600	178	15.5	193.5	586

Calculations have been made to predict the pressure drop to be expected through the recombiner. The results are as follows:

U Ft/Hr		$\frac{\Delta P}{L}$	$\frac{\#}{Ft^2}$ Pressure Drop Ft Depth of Bed		
	14.7	150	500	600	← Psia
360	.224	.34	.655	2.2	
720	.458	.953	2.06	3.71	
1080	.145	1.7	4.09	7.55	
1440	.934	2.5	6.52	12.9	
1800	1.12	3.71	9.83	17.8	
2160	1.4	4.9	13.42	26.9	
2520	1.652	6.2	17.5	31.8	
2880	1.87	7.74	23.5	44.4	
3,600	2.46	10.9	34.0	50.4

Some thought has been given to the possibility of running a thermo-cycle recombiner in the teapot. The height of the hot leg required to maintain a given flow rate through a catalytic bed 4" thick at several core pressures has been computed to be

U ft/Hr ↓	<u>ΔH for a 4" thick bed</u>			
	14.7	150	<u>Psia</u> 500	600
360	2.77	.667	.666	1.66
720	5.73	1.87	2.1	2.84
1080	8.07	3.34	4.16	5.70
1440	11.6	4.9	6.87	9.7
1800	14.0	7.26	10.00	13.45
2160	17.5	9.6	13.70	19.7
2520	20.7	12.2	17.80	24.7
2880	23.4	15.6	23.9	31.3
3600	30.8	21.5	33.4	46.6

This is based on a temperature of 400°C for the gases leaving the recombiner.

If one arbitrarily decided that a 10 foot thermal leg would be the maximum tolerable for the teapot, the minimum velocity would be at atmospheric pressure with a value of 1260 ft/hr or 0.35 ft/sec. The volume flow would be (with a partial condenser) 508 + 48.5 = 556.5 ft³/hr.

The cross section of the bed would be

$$\frac{556.5 \text{ Ft}^3/\text{Hr}}{1,260 \text{ Ft}/\text{Hr}} = 0.441 \text{ ft}^2$$

The volume flow rate through the 4" bed is

$$= \frac{1260}{0.333} \frac{\text{Ft/Hr}}{\text{ft of Bed}} = 3,780/\text{Hr}$$

This would lead to a conservatively designed recombiner since the maximum volume flow rate recommended for design by ORNL-1209 is 30,000 Hr⁻¹.

The recombiner should be able to withstand a temperature of 600°C under full pressure.

Note: Pressure drop calculations were made on the basis of Brown et al, Unit Operations, pp. 210 ff, John Wiley and Sons, New York (1950)

The power levels - pressure variation was obtained from the work of R. V. Bailey which will be released in an ORNL Report. The calculations assume 60 liters of uranyl sulfate solution in the teapot.

Hydrogen and oxygen production is based on a G value of 1.5 H₂O molecules dissociated/100 ev of energy absorbed by the core solution.

Cyril A. Lawson
C. G. Lawson

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