NPRE 470. HW #2 Answer.

1a.

Sulfur - iodine process.

① $SO_2 + I_2 + 2H_2O \rightarrow H_2SO_4 + 2HI$ $\Delta H_1 = -216$ kJ/mol

② $2HI \rightarrow I_2 + H_2$ $\Delta H_2 = 12$ kJ/mol

③ $H_2SO_4 \rightarrow SO_2 + H_2O + \frac{1}{2}O_2$ $\Delta H_3 = 371$ kJ/mol

(data P.M. Mathias) Aspen Tech.

Note the sum of ① ② ③ $\Rightarrow$ $H_2O \rightarrow \frac{1}{2}O_2 + H_2$

$\Delta H = 167$ kJ/mol. ~ roughly between 1/2 mol and 1 mol of H_2O enthalpy at high temperature and pressure. due to vaporization and work done at 125°C

The efficieny is given by (w/o considering heat exchanger)

$$\eta = \frac{\Delta H}{~~383~~ (\Delta H_2 + \Delta H_3)} = \frac{\text{gain in watersplit enthalpy.}}{\text{total heat input}}$$

$$= \frac{167}{383} = 43.6\%$$

1b. sulfur - iodine bromide:

① $SO_2 + IBr + 2H_2O \rightarrow H_2SO_4 + HI + HBr$ at ≈40°C

-320.5 40.8 -285.8×2 -814.0 26.5 -36.3 $\Delta H_1' = 275$ kJ/mol

~~Solvation heat of HI ~ 80 kJ/mol~~

Ideally. consider HBr is inert in the cycle. ~~$\Delta H_1 = -52.5$ kJ/mol~~ $\Delta H_1 + \Delta H_2 + \Delta H_3 \doteq 400$ kJ/mol

The S-IBr efficieny is given by $\eta = \frac{\Delta H}{\Delta H_2 + \Delta H_3} = \frac{285}{400}$

$= 70\%$

2. Probeems: ① phase isolation ② HBr is wasted ③ HBr has "dead" weight.