Batch Reactor Energy Balance Example

Propylene glycol is produced by the hydrolysis of propylene oxide

$$CH_2(O)CHCH_3 + H_2O \xrightarrow{H_2SO_4} CH_2(OH)CH(OH)CH_3$$

Under the reaction conditions this reaction is first order in propylene oxide, $r = kc_{\text{propyleneoxide}}$. The rate constant is $k = 16.96 \times 10^{12} \exp(-32,400/RT)$ hr^{-1}, where T is in Rankine and E is in Btu/lbmole.

The reaction is to be conducted in an adiabatic batch reactor. The reactor is charged with 0.122 lbmole of propylene oxide, 0.204 lbmole of methanol (a solvent for propylene oxide) and 2.28 lbmole of water. The initial temperature is 58 F. How long will it take for the conversion to reach a value of 51.5 % and what is the reactor temperature after this conversion is reached?

You may assume the heat of reaction and the component heat capacities are independent of temperature.

Compound	C_p (Btu/lbmole-F)	H_f (Btu/lbmole) at 58 F
propylene oxide	35	-66,600
water	18	-123,000
propylene glycol	46	-226,000
methanol	19.5	-