Cold Pack Temperature

A cold pack consists of $NaNO_3$. When the pack breaks open the salt is released into water and causes cooling because of the endothermic reaction.

Given the enthalpy and entropy data below, what is the minimum temperature at which $NaNO_3$ will dissolve in water?

$$\Delta_{solv}H^o(NaNO_3) = +42.5\ kJ/mol$$

$$\Delta_{solv}S^o(NaNO_3) = +165\ J/molK$$

Cold Pack Temperature

The cross over temperature at which the process

$$NaNO_3(s) \rightarrow NaNO_3(aq)$$

is no longer spontaneous occurs when

$$\Delta_{solv}G^o(NaNO_3) = 0.$$

This temperature is:

$$T = \frac{\Delta_{solv}H^o(NaNO_3)}{\Delta_{solv}S^o(NaNO_3)}$$

$$T = \frac{42{,}500\ J/mol}{165\ J/molK} = 257.6\ K$$