Particle Modeling of Hand Warmers

The reusable hand warmers we’re considering contain a supersaturated aqueous solution of the ionic compound sodium acetate (CH₃COONa). The main species present in this solution can be represented as shown below:

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\begin{align*}
\text{H}_2\text{O} & \quad \text{Na}^+ \\
\text{CH}_3\text{COO}^- & \\
\end{align*}
\]

1. Draw a particulate representation of the supersaturated solution of sodium acetate that is present before the hand warmer is activated. Describe in writing what your image seeks to represent.

2. Activate the hand warmer by bending the metal disk inside the plastic packet several times. Observe and feel any changes that may occur. Describe in writing all changes that you observed.

3. Draw a particulate representation of the contents of the hand warmer after bending the metal disk. Describe in writing what your image seeks to represent.
4. Using the two particulate representations before and after the activation, build an explanation for any changes in temperature that you perceived in the system. Your explanation should be based on the properties and behaviors of the molecules and ions that comprise the system.

5. Describe how the kinetic energy and potential energy of the molecules and ions in the system change when the hand warmer is activated.

6. Using bar graphs similar to those used in Parts 1 and 2 qualitatively represent the kinetic energy and the potential energy of the particles before and after the activation.

7. How do you think the particles in the hand warmer behaved similar to the melting ice we considered previously? How do you think the two situations are different?

8. The models you’ve built suggest a different form of potential energy, commonly known as chemical potential energy. How could this form of energy be defined? Build a detailed explanation of how chemical potential energy in the supersaturated solution of sodium acetate is transformed into kinetic (thermal) energy as a result of the activation.

9. The packaging provides the following directions for reuse: “Fully immerse the hand warmer in a pot of boiling water for 20 minutes until all of the crystals in the pack have disappeared.” Does your model predict this phenomenon? Explain.