Investigating the Relationship between Salinity and Specific Heat Capacity

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The specific heat capacity of different concerntrations of salt solutions were investigate in order to find the relashionship between salinity and specific heat capacity.

Research Question:

How does the concentration of salt dissolved in water affect the specific heat capacity?

Background:

Different materials have varying specific heat capacities. Or rather, different amounts of energy is needed to heat different materials. Water has a specific heat capacity of 4.18 kJ/kgK while salt (NaCl) has a specific heat capacity of 0.88 kJ/kgK. When salt is dissolved in water, it changes several properties, one of which is the specific heat capacity.
Specific heat capacity can be calculated through the formula $Q=mc\Delta T$, with Q representing the heat energy, m representing the mass, c being the specific heat capacity and ΔT being the change in temperature.

Methodology:

1. Measure 500ml of water and pour into a kettle
2. Boil water while measuring the temperature rise using temperature probe until temperature rises to 80°C
3. Weigh 25g of NaCl and mix until fully dissolved with 500ml of water then pour into a kettle
4. Repeat step 2
5. Repeat steps 3 and 4 with 50, 75, and 100g of salt
6. Find the gradient of the graph of time against temperature from 40-70°C. The gradient is the temperature rise in one second
7. Use $Q=mc\Delta T$ with Q being the power of the kettle and T being the gradient of the graph to calculate the specific heat capacity
8. Graph the specific heat capacity of each concentration of salt to find trend

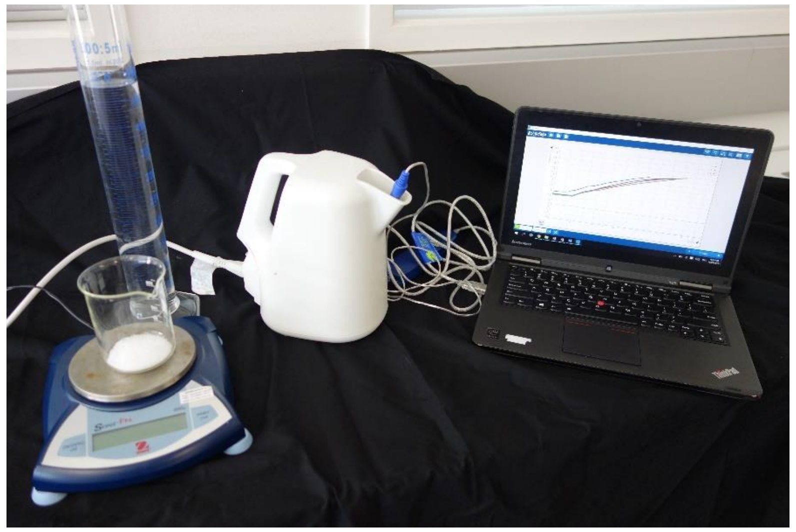

Figure 1. Apparatus setup

Data:

Concentration of salt (g/dm^3)	ΔT/second	Mass of salt + water (g)
0	4.80	500
50	3.02	550
100	2.87	600
150	2.48	650

Analysis:

The power of the kettle was 2300W, which meant that it produced 2300J/s. When the change in temperature was graphed against time, the resulting gradient would be equal to the ΔT/s. As both the power and temperatures are measured over the same amount of time, it can be assumed that the power is 2300J and the ΔT is equal to the gradient. Therefore, by using $Q=mc\Delta T$, the specific heat capacity can be found. From this, the specific heat capacity at each concentration was found.

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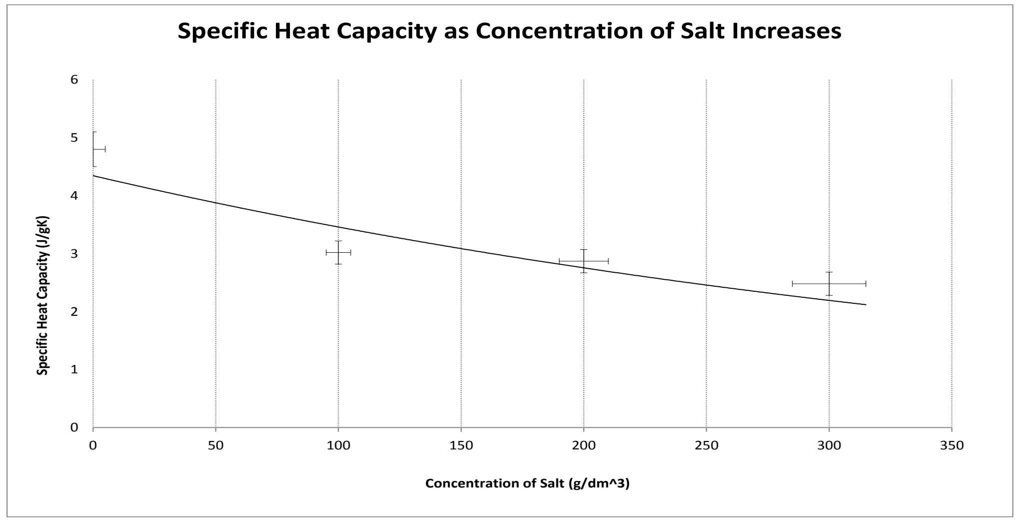

Evaluation:

To verify the viability of using the method of finding the specific heat capacity, the experimental value of the specific heat capacity of water can be compared to the theoretical. The experimental value was 4.80J/gK while the theoretical value was 4.18J/gK. This leads to a percentage error of 15%. This could have been because of many factors such as the water not being uniformly heated and heat being lost.
The trend in the graph shows that there is an inverse relationship between the concentration of salt and the specific heat capacity. It appears to be decreasing at a constant rate. As the specific heat capacity of NaCl is 0.86J/gK, it would make sense that the specific heat capacity of an aqueous solution containing NaCl should decrease.

Conclusion:

The experiment showed that as the concentration of salt increased, the specific capacity of the solution decreased.

Applications:

Oceans cover over 70% of the Earth's surface and salinity in the ocean varies by 5-10%. The high specific heat capacity of water helps to control the rate of change of air and affects our climate. As sea water contains salt, the concentration of salt and its specific heat capacity will also impact on our climate.
Additionally, the specific heat capacity is one of the factors affecting distillation system performance in desalination systems and is considered when modelling and analysing desalination processes.