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A SHORT REPORT ON: ACTION OF NACL ON FREEZING TEMPERATURE OF TAP WATER

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ABSTRACT

Paper discusses about effect of NaCl proportion on freezing temperature of tap water. Tap water is purposely selected as the same has certain conductivity for the dissolution of hardness causing salts and the minerals present in it. Considering the freezing voltage of the tap water as such, equating to the temperature below 4^0C the experiment is performed. The purpose of this study is to generate data for the K-Type thermocouple for ready reference to the researchers.

Keywords: *NaCl, Tap water, K-Type thermocouple, Freezing point.*

I. INTRODUCTION

Salt and ice are basic kitchen ingredients that react chemically together. Salt is commonly used to melt ice on winter sidewalks and streets. The resulting brine is actually colder than ice alone. This quality of ice and salt makes them useful when we are freezing milk and sugar to make ice cream.

Salt Reduces Freezing Temperature of Water.
Salt works by lowering the freezing temperature of water. Salt water needs to reach a colder temperature than pure water to freeze. This is why salted ice on roads that are near the freezing temperature of pure water (32 degrees Fahrenheit) will melt and not refreeze immediately. The ice forms very salty water that will not freeze unless temperatures drop significantly.

When you add salt to an ice cube, you end up with an ice cube whose temperature is above its melting point.
This ice cube will do what any ice cube above its melting point will do: it will melt. As it melts, it cools down, since energy is being used to break bonds in the solid state.

An ice cube melting will take up energy, while an ice cube freezing will give off energy. I like to think of it in terms of Le Chatelier's principle: if you need to lower the temperature to freeze an ice cube, this means that the water gives off heat as it freezes.

We know that melting or freezing is an equilibrium process. The energy that is required to melt an ice cube will not contribute in elevating its temperature until all the solid water is molten.

If we take two ice cubes and add salt to one of them, then put each of them at room temperature, both of the ice cubes will absorb energy from the surroundings, and this energy as we said will contribute in breaking down the bonds between water molecules.

The cube that salt has not been added to, has a melting point 0 ∘C and so if we measure its temperature during melting it will remain zero until all ice is molten. That ice cube to which we have added salt, the salt that is added lowers the melting and freezing points of water because it lowers the vapor pressure of water. This ice cube will absorb energy from the environment to help break bonds between water molecules. We know that the salt added will dissolve in the melted portion of the ice. This formed solution of salt will have a lowered freezing point, so the equilibrium between the solid phase and the aqueous phase will be shifted towards the liquid phase since such a solution will freeze at say −2 ∘C. Since both phases are close together, the ice will absorb energy from the salt solution and will reduce its temperature to the −2 ∘C to maintain the equilibrium. When all ice is molten we end up

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with a salt solution that has got a temperature of say −1.5 ∘C. This is due to the solution being diluted now. After that, it will start absorbing heat from the room and reach zero and above. So, in conclusion that is how salt melts ice.

The cooling you get, therefore, comes from the fact that some of the bonds in the ice are broken to form water, taking energy with them. The loss of energy from the ice cube is what causes it to cool.
So it is necessary to study the melting properties of ice at different concentrations of salts present in it. Also hardness of the water should be considered. As it affects the concentration of the salt.

Experimental:

Table – 1: Properties of Tap Water

Sr No.	Content		WHO Standard	Reading as $CaCO_3$ equivalent
1	Hardness (ppm)	Total	150 - 260	170
		Temporary		90
		Permenant		80
2	Alkalinity (ppm)	OH^-	150 – 200	0
		HCO_3^-		155
		CO_3^{--}		0
3	pH		6.5 – 9.5	7.3
4	TDS		< 500	62

Procedure:
Seven samples are considered for observation. Firstly 20 ml of water is taken in all samples and in each sample 2gm, 4gm, 6gm, 8gm, 10gm, 12gm and 14gm NaCl is added. Stir all the samples till salt gets completely dissolved in it. Each sample labeled by their weight of salt present in it. Then all samples are putted in freezer for 5hrs. K-type thermocouple is selected for ranging (-235 to 200) it for different temperatures. Voltmeter is set on milli-Volt range. Firstly reading is taken for room temperature to remove error in thermocouple. Care is taken in case of thermocouple that enough portions is dipped into samples. Now all the samples are maintained at room temperature (26^0c) and there rate of melting is taken into considered.

Precaution: Melting Ice
Salt is routinely used to make icy roads and sidewalks safe in the winter. As soon as the salt comes in contact with the ice, the surface of the ice starts to melt. This only works, however, if the temperature outside is at or near freezing. If it is too cold outside, the ice itself becomes very dry and salt is not as effective in melting it.

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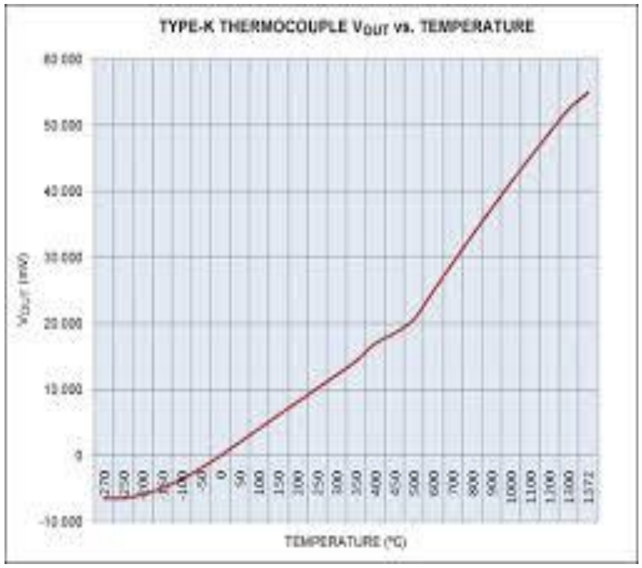


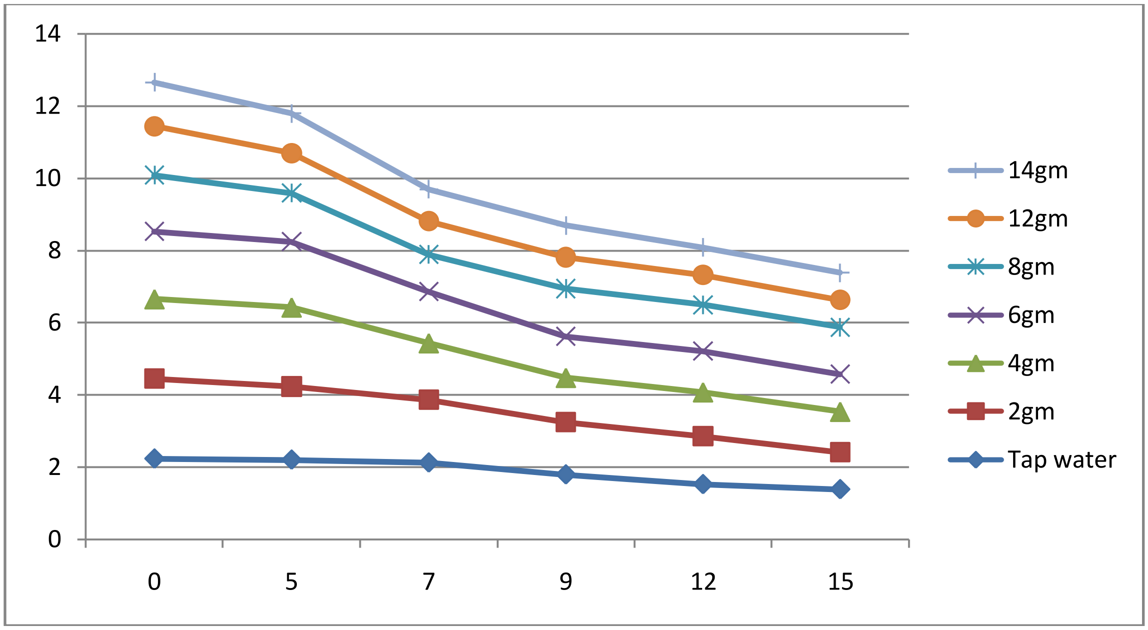
Figure – 1: Voltage Vs Temperature Standard Graph for K-Type Thermocouple

Figure – 2: Photograph of experimental set up

Table – 2: Change in freezing temperature of different mixtures of NaCl and Tap Water

Time (Min)	Tap Water	2gm Salt Milli-Volts	4gm salt Milli-Volts	6gm salt Milli-Volts	8gm salt Milli-Volts	10gm salt Milli-Volts	12gm salt Milli-Volts	14gm salt Milli-Volts
0	2.23	2.22	2.20	1.87	1.56	1.43	1.36	1.21
5	2.20	2.03	2.19	1.82	1.35	1.22	1.11	1.09
7	2.12	1.75	1.56	1.42	1.03	0.97	0.93	0.88
9	1.79	1.45	1.23	1.15	1.32	0.76	0.87	0.88
12	1.52	1.33	1.22	1.13	1.29	0.69	0.83	0.76
15	1.38	1.03	1.12	1.04	1.30	0.67	0.76	0.75

All readings are taken in 20 ml volume of water.



On X-Axis: Time (Min)
On Y-Axis: NaCl in gm
Figure – 3:Newton Law of cooling graph for Weight of NaCl in solution as a function of Time

II. HOW IT WORKS?

Freezing Ice Cream
Mixing salt and ice cubes in an old-fashioned ice-cream maker works because the salt melts the ice and reduces its temperature, forming a freezing cold brine around the container holding the ice-cream ingredients. The brine absorbs heat from the ingredients and the friction of the churning motion required to make the ice cream, so more ice and salt must be added during the process.

III. CONCLUSION

whenever a substance undergoes a phase change it's temperature does not rise and usually stays relatively constant, if you looked at a graph of most substances when undergoing different phase changes (i.e. solid to liquid to gas) you will observe regions that are 'flat' or horizontal this is because the energy is no longer causing a rise in temperature but a change in state. Since you have dissolved salt in the ice it will lower the freezing point (note that freezing and melting point of any substance is the same they can be seen as mirrors for one another) this means that water can now exist at lower temperatures and not turn into ice or in other words it will begin to melt at lower temperatures this could attribute as to why the temperature would LOWER as it no longer needs to reach as high a temperature to begin to melt.

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