Mechanical Properties of Impurities in Ice

Introduction

The topic I chose was 'The effect on the mechanical properties of ice through the addition of sawdust'. I chose this topic because I thought it sounded interesting and would be fun to investigate. I had to however narrow my aim down as 'mechanical properties' encompasses a lot and with the equipment available some such properties would have been very difficult to measure accurately such as tensile strength. A property that I knew I could measure relatively accurately was melting speed. I used this to devise the aim; To investigate the changes in melting speeds of blocks with different concentrations of sawdust relative to water.

Methodology

- First I measured out the following ratios of water and saw dust out of a total of 50g.

100% water, 0% saw dust

92% water, 8% saw dust

86% water 14% saw dust

80% water, 20% saw dust

- Using a scale accurate to one gram.
- The mixtures of the required concentrations were in plastic cups and placed in the freezer to freeze.
- The plastic cups were all identical and kept upright so as to ensure all the blocks would be of the same shape and have relatively the same surface to volume ratios.
- After several hours the blocks had frozen solid.
- The blocks were removed independently of each other, so as to ensure all the blocks were equally frozen when their recordings were taken.
- The blocks once removed from the freezer were placed on two skewers overhanging a bowl of known weight.
- Every five minutes the skewers and consequently the cube was lifted and the bowl and melted water was measured.
- Through the subtraction of the bowls mass and the multiplication of the melted waters mass by the total waters percentage out of 100, the percentage of melted water relative to the total water could be deduced.

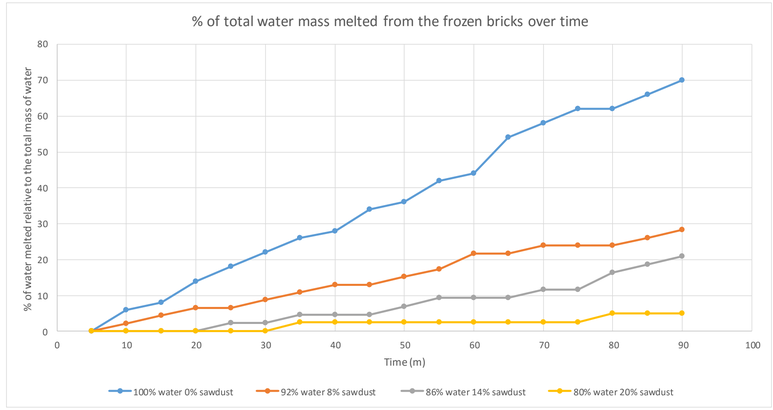
The independent variable was the proportion of water and sawdust

The dependent variable was the percentage of water melted relative to the total mass of water Constant variables included; temperature, surface are to volume ratios of the bricks, mass of the bricks and the scales used.

RESULTS

The total weight includes the weight of the bowl which was 0.543kg for 100% water and 86% water and 0.556kg for 92% and 80% water. To find the % melted of total mass I first subtracted the weight of the bowl form the total weight, multiplied it by 2000 and then multiplied it by the percentage of water composition out of 100.

Time (m)	100% water, total weight (Kg)	% melted of total mass	92% water, total weight (Kg)	% melted of total mass	86% water, total weight (Kg)	% melted of total mass	80% water, total weights (Kg)	% melted of total mass
5	0.543	0	0.556	0	0.543	0	0.556	0
10	0.546	6	0.557	2.174	0.543	0	0.556	0
15	0.547	8	0.558	4.348	0.543	0	0.556	0
20	0.55	14	0.559	6.522	0.543	0	0.556	0
25	0.552	18	0.559	6.522	0.544	2.326	0.556	0
30	0.554	22	0.56	8.696	0.544	2.326	0.556	0
35	0.556	26	0.561	10.870	0.545	4.651	0.557	2.5
40	0.557	28	0.562	13.043	0.545	4.651	0.557	2.5
45	0.56	34	0.562	13.043	0.545	4.651	0.557	2.5
50	0.561	36	0.563	15.217	0.546	6.977	0.557	2.5
55	0.564	42	0.564	17.391	0.547	9.302	0.557	2.5
60	0.565	44	0.566	21.739	0.547	9.302	0.557	2.5
65	0.57	54	0.566	21.739	0.547	9.302	0.557	2.5
70	0.572	58	0.567	23.913	0.548	11.628	0.557	2.5
75	0.574	62	0.567	23.913	0.548	11.628	0.557	2.5
80	0.574	62	0.567	23.913	0.55	16.279	0.558	5
85	0.576	66	0.568	26.087	0.551	18.605	0.558	5
90	0.578	70	0.569	28.261	0.552	20.930	0.558	5



Discussion

By comparing gradients on the graph above a clear correlation between % composition of saw dust and melting speed can be established. As % saw dust increases the rate at which a percentage of the total water melted decreases. This is clear when observing that; The 100% water brick melted the fastest and the greatest after the 90 minutes and the 80% water brick (with the greatest composition of sawdust) melted the slowest and the least amount after the 90 minutes. It should also be noted that the 100% water showed a much greater total amount of water than the second fastest. This difference indicates that the addition of sawdust in small amounts markedly decreases the melting speed and subsequent additions, although retarding the process, are less effective than the difference in the initial addition. There were many limitations in the experiment that could have potentially lead to inaccuracies in the results;

- The scales were only accurate up until a thousandth of a kilogram or one gram and occasionally drifted from the original zero point.
- The temperature was kept relatively stable throughout, to the best of my abilities but would have fluctuated leading to slight inaccuracies.
- I also had to handle the bricks when they came out of the freezer which would have, if only slightly, effected the results.
- On a broader scale, the equipment available prevented me from evaluating other mechanical properties of the bricks like tensile strength.
- The saw dust I used may have also had impurities in it. This may have affected the results.
- Due to the time each individual trial took I was limited in the number of trials I could perform to achieve a more averaged set of results.
- I also did not account for any water that may have evaporated from the bowls whilst the melting was taking place. Additionally, some of the water melted in pools on top of the cube without dripping down into the bowl.
- The wooden skewers used may have also absorbed some of the water but would not have had much effect on the overall correlation of results as they were kept constant throughout the experiment.

CONCLUSION

Through my experiments I established that adding sawdust to water in a frozen block decreased its melting speed. Some suggestions for improvements include; Repeating the experiment many more times to obtain more averaged results, using a more accurate scale, making sure the humidity and temperature of the atmosphere remained more constant. Further aspects of the experiment that I would like to investigate include; Using a wider range of concentrations for each brick, using substances other than saw dust mixed with water, conducting the experiment at different temperatures to see if this in any way influences the correlation in the results.

I believe I achieved my results for the following reasons;

Wood is a poor conductor of heat meaning that heat passes through it slowly, it is an insulator of heat.

The saw dust in the blocks decreased the melting speed of the blocks due to its decreasing of the conductivity of heat by the block.

The specific heat capacity of ice is 2100 J/kg/K whereas it is 900 J/kg/K for saw dust. If we use this information in the following equation Q= mcT, knowing that mass and time are constant, we can clearly see that the greater the specific heat capacity (c) the greater the 'Q' (heat transferred in joules). A greater transfer of heat accounts for why the 100% water block melted more rapidly than the blocks with part saw dust.