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The Ice Bomb

During the Chemistry Roadshow, we perform several demonstrations that are not what you would call classic chemistry, and do not involve a chemical reaction of any kind. The “Ice Bomb” experiment is one of those. The experiment relies on the physical properties of substances, mainly their phase change temperatures, and their density at certain temperatures, and in each phase. This can be considered part of either Chemistry, or Physics as it falls into the realms of both.

The relevant science that makes the experiment work are the freezing points of water, (and to some extent the freezing point of nitrogen gas) and the density of liquid water, and the density of frozen water, or ice. At room temperature, liquid water has a density of almost exactly 1 kg per 1 liter (at 4 degrees centigrade, this is exact, but the density varies slightly at other temperatures.) but ice at its freezing point has a density of 0.917 kg per 1 liter. This means, that if 1 kg of water was frozen, it would have 109% of the volume it had before freezing.

In this demo, a specially (Bought from Cenco Physics) made small iron flask is filled to the brim with distilled water and then screwed shut. Care is taken to ensure no air remains trapped inside the flask as this can ruin the demonstration. After it is tightly shut, the bomb is submerged into liquid nitrogen. The use of liquid nitrogen is not required, only a source of cold sufficient to freeze the ice, but liquid nitrogen is a quick and efficient method to provide this during a road show. The ice then begins to freeze, and expand. This increase in the size of the materials on the inside creates vast amounts of pressure, which is eventually enough to cause the iron casing to explode. The small explosion this creates launches liquid nitrogen into the air, which mostly becomes a gas because of the heat of the air, thus causing most of the visuals of the small explosion.

The phenomenon of ice expanding is not one that has very many technological applications. Actually, we spend a lot of time trying to avoid damage to things such as water pipes which can

happen during the winter, due to the expansion of water when it freezes. However, the process does play a part in nature. The expansion of ice also makes it less dense, since you have the same amount of material over a larger area (which is why ice cubes float), so during the winter in lakes and slowly flowing water, water that freezes always accumulates at the top, which traps water and heat down below, allowing many species of fish to survive during the winter.

More information can be found about the expansion of water from librarians, or teachers, however, for some quick online resources, here are some places you can look.

The "Ice Bomb" we use can be found here -

<http://www.cencophysics.com/flask-form-ice-bomb/p/IG0039251/>

The basic elemental properties such as phase changes and densities of water or other materials can be found on the NIST Chemistry Webbook

The Site - <http://webbook.nist.gov/chemistry/>

The Direct Link for water - <http://webbook.nist.gov/cgi/inchi/InChI%3D1S/H2O/h1H2>

Or a link specifically about density - <http://hypertextbook.com/facts/2007/AllenMa.shtml>

For information about the effect of pipes freezing -

<http://www.stevespanglerscience.com/experiment/bursting-water-pipe>

Or about water freezing in lakes -

<http://www.usatoday.com/weather/tq/wicetop/wicetop.htm>