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On freezing mixtures made with solid carbonic acid

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of the pressure. I have been prevented by circumstances from completing this investigation. Very special care was devoted to the dryness of the air. For this purpose it passed through potash and sulphuric acid into a large glass receiver, the bottom of which was covered with anhydrous phosphoric acid; the air-thermometer was not filled with this until it had been stored for several days. The agreement between the coefficients with the various fillings was nevertheless insufficient; it varied for atmospheric pressure between 3667 and 3676.

I imagined now that the air of the town might contain variable quantities of hydrocarbons; in order to eliminate this factor I passed the air through a hard-glass tube containing platinum wire, which was kept heated by a lamp placed underneath it. The air passed afterwards through caustic potash and sulphuric acid into the reservoir. When air was taken from this twenty-four hours afterwards the coefficient of tension was found to be 3731; air taken from the same reservoir six days afterwards, 3669. I then made several such determinations, of which I will mention one: the reservoir was filled after using the platinum wire; air removed twelve hours afterwards gave 3767, after three days 3673, and after six days 3670.

It appears thus that air which has passed over heated platinum has apparently a very high coefficient of tension, but after long standing it loses this property. This is explained by the fact that particles are detached from the platinum which are so small that they float for a long time in the air. They become coated by absorption with condensed layers of gas, which by heating in the air-thermometer are partially liberated. The value of the coefficient of tension thereby rises too high. But if the gas is at rest for some time, these particles settle down and the air is again pure.

If this explanation is correct, it must be possible by filtering the air to get at once the normal coefficient of tension. Hence, after passing the gas over the heated platinum through potash and sulphuric acid, I passed it through a layer of wool freed from fat, 15 centim. in length, which was so closely pressed that an excess of 20 centim. was necessary to drive the air through. After twelve hours the value 3670 was obtained, by which the explanation is confirmed.—Wiedemann's *Annalen*, No. 7, 1888.

ON FREEZING MIXTURES MADE WITH SOLID CARBONIC ACID. BY MM. CAILLETET AND E. COLARDEAU.

In a recent Note (*Journal de Physik*, vol. vii. p. 286) we gave the results of the comparison of various thermometric apparatus, and showed that they held to a temperature below $-100°$.

The agreement in the indications of these instruments has led us to use the most sensitive of our thermoelectrical pincettes, graduated by direct comparison with the hydrogen-thermometer, to investigate the temperature of solid carbonic acid, either alone or mixed with various liquids.

In using carbonic acid snow to obtain intense cold it is usually mixed with ether, as directed by Faraday and Thilorier. In these conditions the ether is generally considered as intended to produce a much more intimate contact with the body to be cooled than is obtained with the snow alone.

It is, however, a question whether ether has not a special action other than that.

We commenced by measuring the temperature obtained with carbonic acid snow alone. A thermoelectric pincette, by which a fraction of a degree could be estimated, was placed in the centre of a large mass of this substance. In some cases the snow was strongly compressed, and in others left to its ordinary porosity. The results obtained varied very slightly, and the temperature of the snow at the ordinary pressure is about $-60°$.

To try what effect a vacuum has on the temperature, we used a Bianchi's rotatory air-pump and the absorbing action of potash; we were thus able to produce for some time together an almost complete vacuum; but although the experiment was frequently repeated, the conditions being varied as much as possible, the temperature did not sink below $-76°$.

The same thermoelectric pincette gave us in the pasty mixture of solid carbonic acid and ether a temperature of $-77°$ at the ordinary pressure, and in a vacuum of about $-103°$.

The following experiment shows very neatly the special part which ether plays. It is known that when a tube containing liquid carbonic acid is immersed in the mixture, the contents of the tube solidifies very rapidly. If the temperature of the mixture were not below that of the congelation of carbonic acid, this congelation would not take place.

In order to ascertain the part played by the liquid in the mixture we gradually added carbonic acid to ether. The first portions of snow rapidly disappear in contact with the liquid. This disappearance is not solely due to a volatilization resulting from the difference of temperature, but to a solution of solid matter. For the ether, which has kept its transparency and limpidity, disengages carbonic acid steadily for a long time. By continuing the addition of the carbonic acid snow, a point is reached at which it ceases to dissolve, and the mixture then gradually becomes more and more pasty. By following the changes of temperature with the thermoelectric pincette, it will be observed that it sinks at each addition of snow until the liquid, losing its transparency, indicates that it is saturated.

It appears then natural to admit that the cold produced by solution of solid carbonic acid in ether is the cause of the difference of temperature observed between simple snow and the mixture. The greatest cold is attained just at the point of saturation.

It will be understood from this that if we vary the proportions of the mixture the differences of temperature should be almost null, provided there is an excess of solid snow which keeps up the saturation. We have found in fact that, by varying the proportions from a syrupy consistence almost to the state of solid, this difference is scarcely 1°.

In order to confirm the part which we have ascribed to the ether we have made experiments with the following solvents. We have obtained the following results:—

	Temperature observed.
Chloride of methyle	−82°
Sulphurous acid............	−82
Acetate of amyle	−78
Terchloride of phosphorus ..	−76
Bisulphide of carbon........	−74
Absolute alcohol	−72
Chloride of ethylene	−60

With the last three liquids, and especially with chloride of ethylene, the solubility of carbonic snow is manifestly less than the others. These also are the liquids which produce least cooling.

By producing a vacuum over these liquids we can, as Faraday has shown, materially reduce the temperature, even below −100°. With chloride of methyle and sulphurous acid it happens that this temperature in a vacuum is sufficiently low to solidify the solvent. All the mass then becomes solid, and from this point the temperature remains almost stationary.

The lowest temperature we have obtained under these conditions is with chloride of methyle. Solidification only takes place at about −106°.

With chloroform, whose freezing-point is below that of carbonic acid, the action of the vacuum is not needed to produce this effect. Carbonic snow gradually added to the liquid dissolves at first with disengagement of carbonic acid. When the temperature has sunk to −77° this ebullition ceases suddenly, and the whole mass solidifies. There is thus a freezing mixture which congeals under the influence of its own cooling.—*Journal de Physique*, September 1888.

A SIMPLE PENDULUM EXPERIMENT TO EXPLAIN RESONANCE AND ABSORPTION. BY W. HOLTZ.

A caoutchouc tube is stretched between two door-posts by means of packthread attached to the ends, and nails. If two string pendulums are hung over this by means of hooks equidistant from the ends at about $\frac{1}{6}$ of the width of the door, and if an impulse be given to one, the other is set in oscillations which increase as the others slacken. When the original one has come to rest the phenomenon is inverted. If the pendulums are unequal the second begins to vibrate indeed, but the vibrations do not continuously increase.—*Beiblätter der Physik*, No. 7, 1888.