PHYSICS

Water, Seemingly Formless, Has Definite Structure

Honeycomb Pattern Demonstrated in Very Cold Water; Weakens, But Persists, as Temperature Increases

SCIENTISTS are disclosing by direct evidence the structural nature of that most familiar of all chemical compounds —common water. School boys and many trained chemists alike speak glibly of water as H_2O, and then virtually dismiss it from further consideration.

The reason for this superficiality, said Dr. James H. Hibben of the Geophysical Laboratory of the Carnegie Institution of Washington before the meeting of the American Association for the Advancement of Science, is that the simple formula H_2O is about all that anyone has known directly about water until fairly recently.

By experiment, Dr. Hibben added, scientists had been able to make surmises about the nature of water and on these surmises superimposed further speculation. Out of it all came some very intelligent guesses on the nature of water but the result was, after all, pretty much hypothesis. The arrangement of the two hydrogen atoms and one oxygen atom in the molecule, their distances apart and the binding energies between the atoms were all vital matters on which science relied on deduction for its conclusions.

The technique of Raman spectra, in which liquids scatter intense light in peculiar fashion for analysis in spectroscopes, is the tool which is yielding first direct evidence of the structure of water, said Dr. Hibben. The lines on the spectrogram plates tell directly information about the configurations of the atoms in molecules and the interatomic forces which bind molecules together.

Framework for Migrations

Splashy, fluid water may seem the most spineless of all things, declared Dr. Hibben, but in reality measurements show it has a structure. In the frozen state of ice, of course, this structure is very evident. But as one passes to the liquid state the structure persists. Very cold water has a quite definite structure which can be likened to a sort of honeycomb through which the molecules of water move in and out of the framework. As the experimenter studies the structure at higher and higher temperatures the water structure grows weaker but continues to persist. It does not disappear completely, said Dr. Hibben, until the critical temperature of water is reached at 371 degrees Centigrade. These measurements were carried out under pressure, he added, because water normally would boil at 100 degrees Centigrade.

The powerful tool of Raman spectra studies has also disclosed new findings which may affect chemical industry. In particular the making of sulfuric acid and the manufacture of explosives where sulfuric and nitric acid are both used have potential benefits to be derived from Dr. Hibben's studies.

"For many decades," declared Dr. Hibben, "it has been customary to write the formula for sulfuric acid as H_2SO_4. As a result of Raman spectra investigations it can be demonstrated that at no time is this formula correct."

Fuming sulfuric acid has been shown to have the formula $H_2S_2O_7$. Sulfuric acid, itself, appears to be essentially a solution of sulfur dioxide (SO_2) in water.

Improved Explosives

Similar studies on the nature of nitric acid, concluded Dr. Hibben, show that the commonly accepted formula of HNO_3 is equally incorrect.

When sulfuric and nitric acids are combined, as in the manufacture of gunpowder and other explosives, the combinations occurring have not been well recognized. Mostly the art of making explosives has grown up empirically, through the years, without an exact knowledge of the essential ingredients used. With new knowledge now available it may be expected that better explosives should result in the future, but Dr. Hibben was unwilling to forecast this step as an outgrowth of his work.

Dr. Hibben's studies of sulfuric and nitric acid were made as part of the general problem of the Geophysical Laboratory in understanding the constitution of compounds as part of the essential knowledge necessary for fathoming geophysical problems.

Science News Letter, February 5, 1938

CAN STILL CHASE CATS

Paul, a Philadelphia dog belonging to the family of Dr. George C. Kieffer, lost his own leg seven years ago while chasing a cat. During that time, unlike most dogs who have been fitted with man-made legs, he has learned to use his artificial limb as though it were his own. Here he is showing off his new limb, which is made of aluminum. It had several predecessors, made from a variety of materials, but so much did Paul use the leg that the limbs all wore out.

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