

ing forces of electrostatic origin and repulsive forces of dissociation, probably due to attraction by the molecules of the solvent. The ultrasonic absorption curve resembles strongly that which gives the probability of energy distributions. Since molecules of this nature cannot be expected to have a sharp frequency, if absorption can be taken to be a function of the number of molecules giving rise to it, the ultrasonic absorption curve gives the distribution of frequencies among various molecules.

It is probable that molecules involving a hydrogen bond between the HSO_4 ion and the oxygen atom of the water molecule are formed. Since the link H-SO_4 in this complex is not always of a covalent nature, it can give lines due to the sulphate ion only. So, the addition of sulphate ion has decreased the dissociation in accordance with the law of mass action, but instead of the formation of stable HSO_4 ions, complex molecules are formed.

The above discussion still leaves one with the conclusion that HSO_4 ions are less stable in the sulphate mixture than in the acid mixture. It is generally believed that in oxyacids the ionising hydrogen is attached to the oxygen atom. Hence, ionisation involving a separation of OH link leads to a large absorption of heat according to the scheme $\text{HSO}_4 \rightleftharpoons \text{H} + \text{SO}_4 - \text{heat}$. On this basis, one expects the dissociation to increase with increasing temperature and also when an acid is diluted with water which helps dissociation, there should be absorption of heat.

But, a study of the dissociation of nitric acid at higher temperatures by the author⁶ shows decrease in the dissociation with increasing temperature. Also, as is well known, dilution of nitric acid produces large amount of heat. These results show that there is some other factor which compensates this effect and even makes the reaction exothermic. It is probable that the ions are combining with molecules of water to form H_3O involving evolution of heat.

If the above argument is accepted, the difference in the influence of H and SO_4 ions can be understood, because on adding hydrochloric acid, dilution of the acid takes place which supplies heat favouring recombination of H and SO_4 ions, while when a sulphate is added absorption of heat is taking place which favours progress of dissociation.

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EFFECT OF FREE RADICALS ON CHROMOSOMES IN BARLEY

EARLY work on the radiation chemistry of water and aqueous solutions led investigators to conclude that the hydrogen peroxide found in such solutions might also be present in the cells of irradiated biological material and cause at least some of the genetic and physiological effects of radiation. A recent experiment reported in *Science* (1956, 124, p. 889) in which dormant barley seeds, variety Himalaya, were exposed to H, OH, and HO_2 radicals produced by combining dilute solutions of hydrogen peroxide, has given two results which seem to be of particular interest: (i) Whereas H_2O_2 per se was shown to be ineffective in causing chromosomal aberrations, the treatment by the free

radical precursors of H_2O_2 resulted in chromosome breakage, (ii) Chemically derived free radicals have much the same effect as irradiation in the production of chromosome aberrations. This aspect gains importance in the light of recent studies that attribute a major role to organic and inorganic free radicals in the X-ray induction of mutations and chromosome damage. The action of these irradiation by-products (indirect effect) is becoming increasingly important in explaining irradiation phenomena that were once attributed solely to a direct effect (target theory) of ionizing radiation.