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THE CHEMICAL EFFECTS OF PRESSURE

PART 6.—THE ELECTRICAL CONDUCTIVITY OF SEVERAL LIQUIDS AT HIGH SHOCK PRESSURES

By H. G. David and S. D. Hamann
C.S.I.R.O. Division of Physical Chemistry, High Pressure Laboratory,
Sydney University, Australia

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This paper reports some measurements of the electrical conductivities of liquids compressed by explosive shock waves. Water, methyl alcohol, acetic acid, propionic acid and a 1 : 1 mixture of water and ethyl alcohol all became good conductors ($\kappa > 10^{-2}\ \Omega^{-1}\ cm^{-1}$) at shock pressures of about 100,000 atm. But ethyl alcohol, acetone and glycerol remained poor conductors under the same conditions. It is likely that the high conductivities of the first group of liquids arose from enhancement of their self-ionization.

The shock conductivity of water was found to be increased by the reflection of a shock wave or by the head-on collision of two equal shocks.

In the last paper of this series [1] we described some measurements of the electrical conductivity of water in the pressure range 33,000 to 127,000 atm. We produced the pressures by detonating charges of high explosive in contact with the water. The explosions drove strong shock waves into the water, compressing it very quickly to high densities and temperatures. We found that the shocked water was a good electrical conductor and we concluded that the conductivity arose from extensive ionization of the water to H_3O^+ and HO^- ions. It appears that the ionic product of water may have increased by a factor as great as 10^{12} under our most extreme conditions.

We have now extended these measurements to some other liquids which can also ionize by autoprotolysis:

$$2ROH \rightleftharpoons ROH_2^+ + RO^-$$

$$K_{auto} = [ROH_2^+][RO^-].$$

The following is a list of the liquids studied, together with their autoprotolysis constants where they are known.

TABLE 1

liquid	K_{auto}/mole l.$^{-1}$ at 25°C and at 1 atm
water	$1{\cdot}0 \times 10^{-14}$
methyl alcohol	2×10^{-17}
ethyl alcohol	8×10^{-20}
acetic acid	3×10^{-13}
1 : 1 (vol.) water/ethyl alcohol	(*ca.* 10^{-17}) *
propionic acid	—
glycerol	—
acetone	—

* estimated from the values of K_{auto} for water and ethyl alcohol.

We have also tried to increase the pressure range for water by reflecting secondary shock waves back into the incident waves, and by causing the head-on collision of pairs of shock waves.