The Chemistry of the Edison Storage Battery

THE fundamental principle of the Edison Storage Battery is the oxidation and reduction of metals in an electrolyte which neither combines with nor dissolves either the metals or their oxides. Also, an electrolyte which, notwithstanding its decomposition by the action of the battery, is immediately re-formed in equal quantity, and is, therefore, a practically constant element without change of density or conductivity over long periods of time. Therefore, only a small quantity of such electrolyte is necessary, permitting a very close proximity of the plates. Furthermore, it is unnecessary to take hydrometer readings until about three hundred cycles of charge and discharge have been made; this is simply to determine when it is necessary to empty out the old solution and put in new. The active materials of the electrodes being insoluble in the electrolyte, no chemical deterioration takes place therefrom.

The chemical reactions in charging the Edison Storage Battery are, (1) the oxidation from a lower to a higher oxide of nickel in the positive plate, and (2) the reduction from ferrous oxide to metallic iron in the negative plate. The oxidation and reduction are performed by the oxygen and hydrogen set free at the respective poles by the electrolytic decomposition of water during the charge. The charging of the positive plate is, therefore, simply a process of increasing the proportion of oxygen to nickel. The proportions of nickel to oxygen in definite oxides of nickel are as follows:

	Atomic Proportions by Weight			
	Ni	O	Ni	O
Ni O	1	1	1	.273
Ni_3O_4	1	1.33	1	.364
Ni_2O_3	1	1.5	1	.409
$Ni\ O_2$	1	2	1	.545

The relative amounts of oxygen necessary to oxidize nickelous oxide, or NiO, which is the oxide corresponding to the green nickel hydrate used in making the battery, to the various oxides are given in the three reactions:

$$(1)\quad 6\ NiO + 2O = 2\ Ni_3O_4$$
$$(2)\quad 6\ NiO + 3O = 3\ Ni_2O_3$$
$$(3)\quad 6\ NiO + 6O = 6\ NiO_2$$

The NiO_2 is capable of reacting with NiO according to the reaction $NiO_2 + NiO = Ni_2O_3$. Ni_3O_4 is considered as a combination of $NiO + Ni_2O_3 = Ni_3O_4$.

From a chemical standpoint a charged condition of the cell would, therefore, be represented in the positive plate by an atomic ratio of nickel to oxygen of at least 1 : 1.5 (or Ni_2O_3), depending on the charge. A discharged condition would be represented by a ratio of 1 : 1.33 (Ni_3O_4) or lower, depending on the discharge.

The discharge of the cell is simply the reversal of the above reactions, the hydrogen reducing the higher oxides of nickel to lower oxides and the oxygen oxidizing the iron to ferrous oxide.