The OCl^- ion decomposes, liberating oxygen. In general, bleaching powder is an oxidizing agent. Its activity, however, is measured in what is termed *available chlorine*, which is, by definition the weight of chlorine that would exert the same action as the chlorine compound in question. In the case of bleaching powder ($CaOCl_2$) the available chlorine is the same as the percentage of chlorine, but in the case of calcium hypochlorite $Ca(OCl)_2$, the available chlorine is twice the percentage (49.6) of chlorine present (99.2%). This is another way of saying that 1 mol of chlorine is equivalent in oxidizing power to 1 mol of HOCl, or to the ion OCl^-. Bleaching powder by this convention contains about 35% or less of available chlorine when freshly manufactured. The available chlorine concept may be further explained by the reactions:

FOR CALCIUM HYPOCHLORITE

$$Ca(OCl)_2 + 2HCl \rightarrow CaCl_2 + 2HOCl$$

or

$$Ca(OCl)_2 \rightarrow Ca^{2+} + 2OCl^-$$

One mole of bleaching powder will furnish only half this amount of OCl^- ions.

FOR CHLORINE

$$Cl_2 + H_2O \rightarrow HOCl + HCl$$

CALCIUM HYPOCHLORITE

Calcium hypochlorite[16] itself may be made in several ways. One method that has been used is the chlorination of calcium hydroxide, as in the manufacture of bleaching powder, followed by the separation of the $Ca(OCl)_2$ through salting out from solution with NaCl. It is also manufactured by the formation under refrigeration of the salt $[Ca(OCl)_2 \cdot NaOCl \cdot NaCl \cdot 12H_2O]$, which is prepared by the chlorination of a mixture of sodium and calcium hydroxides. This is reacted with a chlorinated lime slurry, filtered to remove salt, and dried, resulting finally in a stable product containing 65 to 70% $Ca(OCl)_2$. The final reaction is:

$$[2Ca(OCl)_2 \cdot NaOCl \cdot NaCl \cdot 12H_2O] + CaCl_2 + Ca(OCl)_2 \rightarrow 4Ca(OCl)_2 \cdot 2H_2O + 4NaCl + 16H_2O$$

The great advantage of $Ca(OCl)_2$ is that it does not decompose on standing as does bleaching powder. It is also twice as strong as ordinary bleaching powder and is not hygroscopic.

SODIUM HYPOCHLORITE

Sodium hypochlorite is employed as a disinfectant and deodorant in dairies, creameries, water supplies, sewage disposal, and for household purposes. It is also used as a bleach in laundries. During World War I, it was employed in the treatment of wounds as a stabilized

[16] Macmullin and Taylor, U.S. Patent 1,787,048 (1930).

isotonic solution. As a bleaching agent, it is very useful for cotton, linen, jute, rayon, paper pulp, and oranges. Indeed, much of the chlorine bought for bleaching cellulose products is converted to hypochlorite before use. The most common method for making it is the treatment of sodium hydroxide solution with gaseous chlorine

$$Cl_2 + 2NaOH \rightarrow NaCl + H_2O + NaOCl$$

The other once widely used method was the electrolysis of a concentrated salt solution whereby the same product was made. These electrolytic cells do not have a diaphragm or membrane and are operated at high current density in a nearly neutral solution. The cells are designed to function at low temperature and to bring the cathode caustic soda solution in contact with the chlorine given off at the anode.

SODIUM CHLORITE

Sodium chlorite ($NaClO_2$) was introduced in 1940 by the Mathieson Chemical Co. (now Olin Corp.). The 80% commercial material has about 125% available chlorine. It is manufactured from chlorine through calcium chlorate to chlorine dioxide, ending with the reaction

$$4NaOH + Ca(OH)_2 + C + 4ClO_2 \rightarrow 4NaClO_2 + CaCO_3 + 3H_2O$$

After filtering off the calcium carbonate, the solution of $NaClO_2$ is evaporated and drum-dried. $NaClO_2$ is a powerful but stable oxidizing agent. It is capable of bleaching much of the coloration in cellulosic materials without weakening the cellulose fibers. It finds uses in the pulp and textile industries, particularly in the final whitening of kraft paper. Besides being employed as an oxidizer, $NaClO_2$ is also the source of another chlorine compound, chlorine dioxide, through the reaction

$$NaClO_2 + \tfrac{1}{2}Cl_2 \rightarrow NaCl + ClO_2$$

Chlorine dioxide has 2½ times the bleaching power of chlorine and is important in water purification, for odor control and for pulp bleaching.

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