ANALYSIS OF COMMERCIAL BLEACH

To determine the amount of sodium hypochlorite (NaClO) in commercial bleach by means of an oxidation-reduction "back-titration".

Some commercial products that contain oxidizing agents are bleaches, hair coloring agents, socuring powders, and toilet bowl cleaners. The most common oxidizing agent in bleaches is NaClO. Commercial bleach is made by bubbling chlorine gas into a sodium hydroxide solution. Some of the chlorine oxidizes to the hypochlorite ion ClO', and some reduces to the chloride ion Cl'. The solution remains strongly basic. The net ionic equation for this process is:

$$Cl_{2(g)} + 2OH^{-}_{(seg)} ---> ClO^{-}_{(seg)} + C\Gamma_{(seg)} + H_2O_{(l)}$$
 (1)

The hypochlorite ion CIO contains the chlorine atom in the +1 exidation state. Since the chloride ion CI is much more stable (less potential energy) than the CI^{*1} atom in the hypochlorite ion, the CI^{*1} readily reduces to CI^{*1} and thus serves to "exidize" other substances during the bleaching process.

The amount of hypochlorite ion present in a bleach solution is determined by an oxidationreduction titration called a "back-titration". While the CIO ion cannot be titrated directly, it easily oxidizes the iodide ion Γ in KI to form iodine I₂ which is then titrated with a standard solution of sodium thiosulfate Na₂S₂O₃.

The analysis takes place in a series of steps:

Acidified iodide ion is added to hypochlorite ion solution, and iodide oxidizes to iodine.

$$2H^{+}_{(sq)} + CIO^{-}_{(sq)} + 2\Gamma$$
 ---> $C\Gamma_{(sq)} + I_{2(sq)} + H_{2}O_{(l)}$
(2)

2) lodine, only slightly soluble in water, dissolves very well in an aqueous solution of iodide ions, in which it forms a colored complex ion called the triiodide ion I₃. Triiodide ion is a combination of a neutral I₂ molecule with an I' ion. The I₃ ion is yellow in dilute solution, and dark red-brown when concentrated.

$$I_{2(eq)} + I'_{(eq)} - I_{3'(eq)}$$
 (3)

 The triiodide ion is titrated with a standard solution of thiosulfate ions, which reduces the iodine back to the colorless iodide ions.

$$I_{3^{\circ}(eq)} + 2S_{2}O_{3^{\circ}(eq)} - 3I_{(eq)} + S_{4}O_{4^{\circ}(eq)}$$
 (4)

During the last reaction, the red-brown color of the trilodide ion fades to yellow and then to the colorless iodide ion. While it is possible to use the disappearance of the color of the I₃ i_{sep} ion as the method of determining endpoint, this is not a very sensitive procedure. Addition of starch to a solution containing iodine (or trilodide ion) forms a reversible blue complex. The disappearance of this blue complex is a much more sensitive method of determining endpoint. However, if the starch is added to a great deal of iodine, the complex which forms may not be reversible. Therefore, the starch is not added until shortly before the endpoint is reached. The quantity of thiosulfate used in step (3) is directly related to the amount of hypochiorite initially present. The S₄O₆² ion is called the tetrathionate ion.

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