

Determination of Hydrogen Peroxide in Bleaching Agent

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Abstract

An appropriate analytical procedure was offered for correct determination of hydrogen peroxide in commercially available bleaching agents normally containing nonionic surfactants. Nonionic surfactant retarded markedly the catalysis for hydrogen peroxide decomposition probably due to complex formation from molybdenum atoms in catalyst, e.g. ammonium molybdate, and polyoxyethylene groups of surfactant. This retardation effect of surfactant caused incorrect estimation of hydrogen peroxide concentration in bleaching agent. Correct determination became possible when bleaching agent was diluted to less than 1.0% in order to minimize the retardation effect of nonionic surfactant on hydrogen peroxide decomposition catalyst.

Keywords: hydrogen peroxide, bleaching agent, analysis

1. Introduction

Currently available bleaching agents for domestic use mostly contain anionic or nonionic surfactants intending to make bleaching more effective. Nonionic surfactants are used in hydrogen peroxide bleaching agents for the treatment of protein fibers (wool and silk), and anionic surfactants in hypochlorite bleaching agents for cellulose fibers (cotton and hemp). The determination of hydrogen peroxide or hypochlorite is necessary to estimate oxidizing ability of bleaching agents. Iodometry¹⁾ is generally applicable to determine these oxidants. In the determination of hydrogen peroxide in bleaching agent by means of iodometry, ammonium molybdate is often added as catalyst to accelerate the decomposition of hydrogen peroxide. Recently the author noted that nonionic surfactant retarded markedly the catalysis of molybdate possibly by complex formation, resulting in incorrect estimation of oxidizing ability of the bleaching agents containing hydrogen peroxide.

The present paper aims to offer an appropriate analytical procedure for the determination of hydrogen peroxide in the presence of nonionic surfactant through detailed examination of the poisoning effects of the surfactant on hydrogen peroxide decomposition catalysts.

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2. Experimental

2.1. Material

Catalysts for hydrogen peroxide decomposition: 12-Tungstophosphoric acid ($\text{H}_3\text{PW}_{12}\text{O}_{40}\cdot 25\text{H}_2\text{O}$), 12-tungstosilicic acid ($\text{H}_4\text{SiW}_{12}\text{O}_{40}\cdot 26\text{H}_2\text{O}$), 12-molybdophosphoric acid ($\text{H}_3\text{PMo}_{12}\text{O}_{40}\cdot 28\text{H}_2\text{O}$), and ammonium molybdate ($(\text{NH}_4)_6\text{Mo}_7\text{O}_{24}\cdot 4\text{H}_2\text{O}$) were of commercially available purity. The heteropolyacids²⁾ were dried at 333 K for 48 h prior to use.

Bleaching agent: a commercially available liquid-type weakly acidic bleaching agent (“Waido Haita[®]”, Kao) was used. The bleaching agent contains hydrogen peroxide (ca. 4 wt%) and polyoxyethylene alkyl ether (nonionic surfactant).

Hydrogen peroxide: 30 wt% aqueous solution of commercially available purity.

2.2. Analytical procedure

Determination of aqueous hydrogen peroxide in the presence of surfactant was performed by means of iodometry. After the sample solution was acidified with acetic acid, potassium iodide and catalyst were added to liberate iodine. The iodine liberated was titrated with a standard sodium thiosulfate solution using starch as an indicator.

3. Results and Discussion

3.1. Catalyst efficiency for hydrogen peroxide decomposition

The accelerating effects of several types of molybdenum and tungsten catalysts on the decomposition of hydrogen peroxide in iodometry were examined using an aqueous solution of hydrogen peroxide (0.103 wt%) in the absence of nonionic surfactant. The result was illustrated in Fig. 1.

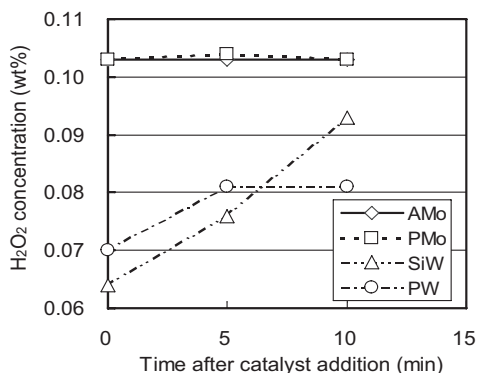


Fig. 1. Catalyst efficiency for H_2O_2 (0.103 wt%) decomposition. AMo: ammonium molybdate, PMo: molybdophosphoric acid, SiW: tungstosilicic acid, PW: tungstophosphoric acid.

Amongst the catalysts tested, ammonium molybdate and molybdophosphoric acid effectively catalyzed the decomposition of hydrogen peroxide. Both catalysts worked likewise efficiently in the determination of hydrogen peroxide in the presence of nonionic surfactant, although the end point of the redox titration was somewhat indistinguishable when ammonium molybdate catalyst was applied.

3.2. Influence of nonionic surfactant on catalyst efficiency

Figure 2 shows the influence of nonionic surfactant (polyethylene glycol mono-4-nonylphenol ether, $n=10$) on the determination of hydrogen peroxide (0.318 wt%) catalyzed by ammonium molybdate and molybdophosphoric acid. The analytical values of hydrogen peroxide concentration were clearly lowered with higher concentrations of the surfactant. This means that the nonionic surfactant strongly retarded the catalysis of decomposition probably due to the complex formation from molybdenum atoms of catalyst and polyoxyethylene groups of surfactant. The correct analytical value of hydrogen peroxide (0.318 wt%), therefore, was obtained only when the concentration of nonionic surfactant was less than 0.5 wt %.

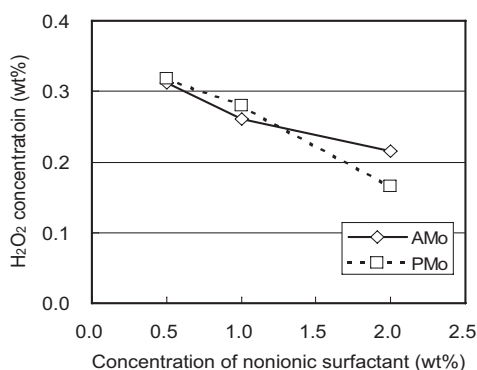


Fig. 2. Influence of nonionic surfactant (polyethylene glycol mono-4-nonylphenol ether, $n=10$) on the determination of H_2O_2 (0.318 wt%). Catalyst AMo: ammonium molybdate, PMo: molybdophosphoric acid.

3.3. Hydrogen peroxide determination of bleaching agent

The retardation effect of nonionic surfactant on the catalysis for hydrogen peroxide decomposition suggests that the dilution of bleaching agent prior to redox titration is decisively important for correct determination of hydrogen peroxide in the presence of nonionic surfactant.

Figure 3 depicts the influence of concentration of commercially available bleaching agent containing nonionic surfactant on the determination of hydrogen peroxide. The analytically correct concentration of hydrogen peroxide (4.1 wt%) was obtained when the bleaching agent was diluted to less than 1.0 wt% in order to minimize the retardation effect of nonionic surfactant on hydrogen peroxide decomposition catalyst.

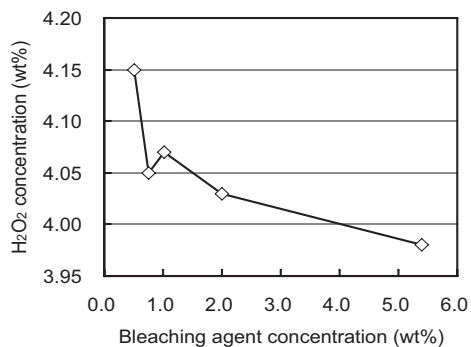


Fig. 3. Influence of the concentration of commercially available bleaching agent containing nonionic surfactant on the determination of H₂O₂.
Catalyst : molybdophosphoric acid.

Acknowledgement

The present paper describes a part of the research works for the graduation theses in 2003 performed by Misses Akiko Kondoh and Kei Watanabe under the supervision of the author. The author greatly appreciates their energetic collaboration.

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