OXIDATIVE DECOLORIZATION OF TEXTILE WASTEWATER

A. Bertea, A. P. Bertea
Technical University, Iaşi, Romania

INTRODUCTION

Besides the necessity of reaching high quality requirements in the condition of a permanent augmentation of the process speed, the textile chemists must take into account the ecological impact of the finishing technologies. They have to take severe cautions to prevent pollution and to ensure environment protection.

The finishing operations are not polluting the air to any significant degree, perhaps with de exception of the odors. Things are completely different with respect to water pollution. The following factors contribute to the pollution of the effluents: solids, pH – relevants, organic substances, nutrients, inerts, temperature.

Most of the pollutants contained in the effluents are caused by preparation processes (about 70%). For the remaining 30% dyeing and printing are responsible. The impact of dyes on environment is highly variable, but the colour removal is of great interest.

Because the biological decomposition of the dyestuffs is very low – several studies, that report on this matter, specify that over 85% of the tested dyestuffs have a biodegradability lower than 10% – the decolorization processes are mostly of physical and/or chemical nature. The most important methods for the colour removal are coagulation, adsorption using activated carbon and chemical oxidation processes [1]. At the latter category belongs the hydrogen peroxide decolorization wastewater process. The use of hydrogen peroxide has the very important benefit that no harmful chemicals are used, even more – H_2O_2 is an environmental friendly substance[2].

The oxidising action of the hydrogen peroxide is the result of its decomposition in hydroxyl radicals. The speeding up of the reaction can be made by adding a catalyst, frequently iron salts. Following the reactions, no soluble pollutant are formed but H_2O_2, O_2 and $Fe(OH)_3$. Additionally, $Fe(OH)_3$ is a coagulation agent that helps the removal of the suspended particles [3].

1. EXPERIMENTAL

The purpose of the present paper is to examine the possibilities to achieve the decolorisation of wastewater containing direct, acid, reactive and disperse dyes with hydrogen peroxide. Three dyestuffs of each category have been studied: Direct Red 4A C.I. 23500, Direct Blue A C.I. 22610, Direct Orange RN C.I. 22130, Acid Red 6A C.I.16250, Acid Blue BS C.I. 62058, Acid Orange R C.I. 16100, Reactive Red M3A, Reactive Blue MV, Reactive Orange MG, Disperse Red FL (Disperse Red 72), Disperse Blue 2R (Disperse Blue 19) and Disperse Orange RL (Disperse Orange 25). The tests have been performed in the following conditions:

- pH adjustment with acetic acid (to obtain a pH equal to 3) or sodium hydroxide (to obtain a pH equal to 10);
- adding of the Fe^{2+} salt, at a Fe^{2+}:H_2O_2 ratio of 1:20;
- adding hydrogen peroxide, 1 ml/l;
- neutralisation with sodium hydroxide or acetic acid, after 30 minutes of reaction time.

In order to estimate the decolorisation degree the extinction has been measured using a colorimeter and this value has been divided to the extinction of an untreated sample. The results are shown in the figures 1-4. The notations that we made in these figures have the following meanings:

1. variant with catalyst, pH=3, without neutralisation;
2. variant with catalyst, pH=3, with neutralisation;
3. variant with catalyst, pH=7;
4. variant with catalyst, pH=10, without neutralisation;
5. variant with catalyst, pH=10, with neutralisation;
6. variant without catalyst, pH=3, without neutralisation;
7. variant without catalyst, pH=3, with neutralisation;
8. variant without catalyst, pH=7;
9. variant without catalyst, pH=10, without neutralisation;
10. variant without catalyst, pH=10, with neutralisation.

2. RESULTS AND DISCUSSIONS

From fig. 1 it can be seen that in the case of the tested direct dyes it is possible to realise the decolorization with hydrogen peroxide.

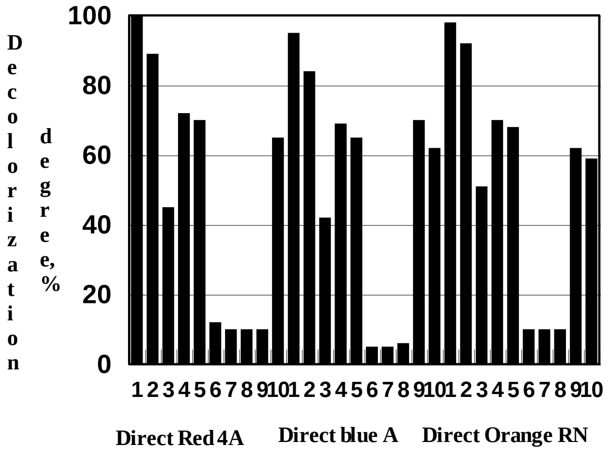

Figure 1. Direct dyes decolorisation.

The decolorization degree decreases in the following order: variant 1,2,4,5,9,10,3,6,7,8. This means that best results are obtained when an acid pH is established, in the presence of the catalyst. In such conditions the colour removal is quick and practically complete. After the neutralisation (variant 2) a slight yellow colour appears, and that makes this variant less recommendable than the variant no.1.

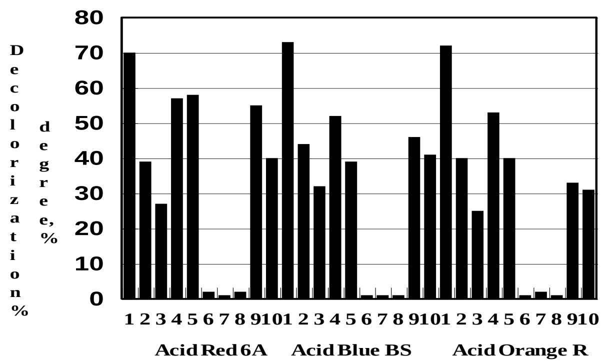

Figure 2. Acid dye decolorisation.

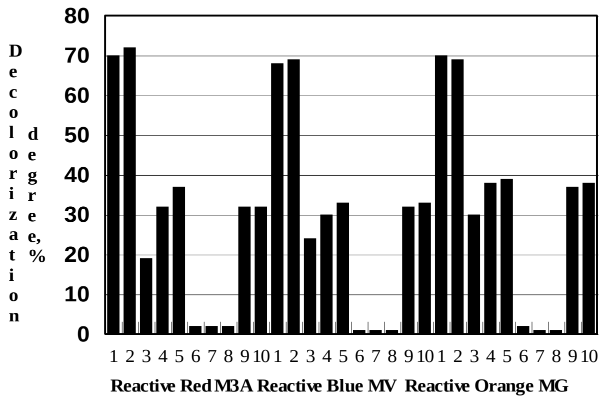

Figure 3. Reactive dyes decolorisation

From fig. 2 it can be seen that the acid dyestuffs have similar behaviour, variant 1 allowing the achievement of the best decolourization degree.

Similar results can be observed when studying fig.3, but in the case of reactive dyes, best results are obtained when, after the decolorization at an acid pH, in the presence of the catalyst, sodium hydroxide is added to obtain neutral conditions, this means in the case of variant number 2.

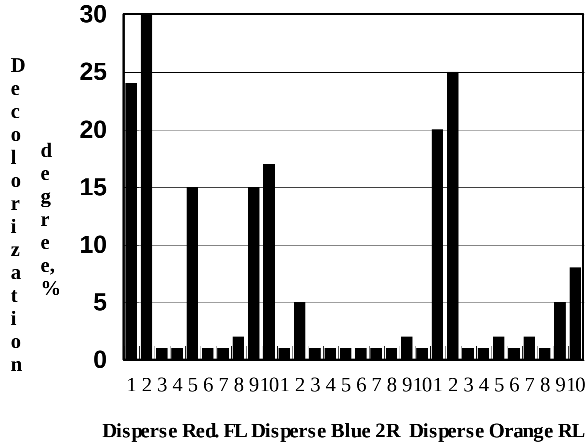

Figure 4. Disperse dyes decolorisation.

The disperse dyes, as it can be seen in the fig.4, have a very differential behaviour. Two of the tested dyes are practically not affected by the hydrogen peroxide treatment, while the third shows a good decolorization degree. That means that in this case a major role is played by the chemical structure of the dyestuff.

3. CONCLUSIONS

The use of H_2O_2 could represent a solution for the colour removal of the textile wastewater, especially in the case of the effluents that contain direct, acid or reactive dyes. It must be made a very severe correspondence between the concentration of the dyestuff and the quantity of the hydrogen peroxide that is added, at a general reaction time of 30 minutes. The process must be conducted at an acid pH (about 3), and, for some special situations, final neutralisation is advisable.

Bibliography

1. ***Bertea, A.P., Voroniuc, O., Bertea, A.*** *Protecţia mediului în finisarea textilă, Casa de Editură Venus Iaşi, 2003.*
2. ***Bertea, A.P.*** *Ape uzate,* *Editura Coda, Iaşi, 2001.*
3. ***Bertea, A.P.*** *Decolorarea apelor uzate cu apă oxigenată şi UV, Ind. Uşoară, nr. 4, 1998, p. 277.*

Recomandat spre publicare> 02.05.2006