

Dyeing of Nylon66 Fabrics Using Disperse Dyes by Microwave Irradiation Technology.

A B S T R A C T

Dyeing of nylon66 (polyamide) fabrics with disperse dyes, blue 56 and red 60 was done using microwaves irradiation technique. Different parameters such as dyeing time, dye concentration, power of microwave used and Liquor ratio were studied. Compared the results obtained upon using conventional technique and microwave technique was done. From the results obtained, the microwave technique save about 40 min. in the dyeing time, also zero carrier and dispersing agent used, this means that save in time, energy and money. The overall fastness properties to rubbing, washing, light and perspiration for the dyed samples their values ranging from very good to excellent.

Keywords: *Dyeing, Nylon fabrics, Disperse dyes, Microwave irradiation.*

1. Introduction

Microwave irradiation is one of powerful techniques of non-contact heating, because the dielectric substances with large dielectric loss constant vigorously fever by vibration and rotation of permanent dipoles in microwave field. Microwave has been used for reacting, heating and drying cellulose materials [1]. The main difference between conventional heating and microwave heating is the way in which heat is generated. In conventional processing, energy is transferred to material through convection, conduction and radiation of heat from the surface of the material. In contrast, microwave energy is derived directly to materials through molecular interactions with the electromagnetic waves. The uniqueness of the microwave is to process materials with selective energy, higher rate, uniform heating and energy conservation [2-7]. The utilization of green chemistry techniques is dramatically reducing chemical waste and reaction times as has recently been proven in several organic syntheses and chemical transformations [8]. Methods to lower the curing temperature have received the most attention because the high temperature cure process not only wastes energy but also creates the risk of destroying substrates that cannot endure high temperature processes. Radiation curing technologies (UV and microwave) are used in much industrial applications as well as in the textile area [9,10] because of low energy consumption, short start-up period, fast and reliable curing, low environmental pollution, fixation at room temperature, space saving, etc. Microwave irradiation is a well-known method for heating and drying materials and is utilized in many private households and industrial applications. It offers a number of advantages over conventional heating, such as noncontact heating (circumventing the decomposition of molecules close to the walls of the reaction vessel), instantaneous and

rapid heating (resulting in a uniform heating of the reaction liquor), and highly specific heating (with the material selectivity emerging from the wavelength of microwave irradiation that intrinsically excites dipolar oscillation and induces ionic conduction) [11]. The main objective of the present work was to dye the polyamide fabrics with disperse dyes using microwave irradiation to save time, energy and money.

2. Materials and Methods

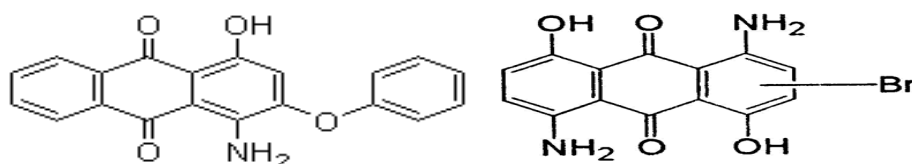
2.1. Materials

2.1.1. Nylon66 fabric

Nylon 66 fabric of about 150g/m² (supplied by El-Nasr Company for spinning, weaving and knitting) was treated with a solution containing 2 g/l detergent, 2g/L sodium carbonate at 80°C for 1 hours, then thoroughly washed and air dried at room temperature.

2.1.2. Dyestuffs

Disperse red (C.I. Red 60) and Disperse blue dyes (C.I. Blue56), supplied by Clarinet Co.



Disperse red 60 Disperse blue 56

2.1.3. Chemicals

Carrier, dispersing agent, acetic acid, were of laboratory grade chemicals were used.

2.2. Methods

2.2.1. Dyeing Procedure

Samples of polyamide fabrics were dyed using disperse dye 0.5- 3% owf, 1g/l carrier, 1g/l dispersing agent, with L: R 1: 20. The temperature was slowly raised to 100°C and dyeing continued farther for 45 min., another samples of polyamide fabrics were dyed using disperse dye 0.5- 3% o.w.f., 0g/l carrier, 0g/l dispersing agent, with L: R 1:5 to 1: 20,

using microwave (Milestone Start synthesis Microwave Synthesis Lab station, USA) irradiation with power 200-600 Watt, for 1-5 min., hot rinsing and air-dried. Finally the samples were dried and assessed for color strength and over all fastness properties.

2.3. Measurements and Analysis

2.3.1. Color measurements

Color strength expressed as K/S was measured according to a previously reported method [12].

2.3.2. Fastness Properties

Fastness properties to washing, rubbing and perspiration were measured according to a standard method [13].

3. Results and Discussion

3.1. Dyeing of nylon fabric using conventional heating technique.

Polyamide obtained from poly condensation of hexamethelene diamine with adipic acid , so the nylon contains amide groups, carboxylic end groups, amino end groups, amide end groups, a greater part of the polar groups are amide groups , there are few strongly hydrophilic groups , fiber swelling is little and dye penetration in difficult.

Fig. 1 show the effect of dye concentration on the color strength of dyed polyamide fabrics at Liquor ratio 1:20, Temperature of dyeing 100°C, dyeing time 45 minute, carrier 1 g/l, dispersing agent 1g/l at PH=4.5, using disperse dye blue56. It is noticed that the increase in the dye concentration this is lead to increase in the color strength, for example the increase the dye concentration from 0.5, 1, 2 and 3% the K/S increase from 3.5, 7.9, 12.37 and 14.6 respectively.

Table1, show the effect of dye concentration on the color strength and the overall fastness properties of dyeing polyester fabric using disperse dye blue56 using conventional heating technique. Generally speaking, the fastness properties to rubbing, either wet or dry,

washing, light fastness and color fastness properties to both acidic and alkaline perspiration for the dyed samples their values ranging from very good to excellent.

3.2. Dyeing polyamide fabric Using microwave irradiation technique.

3.2.1. Effect of dyeing time on the color strength

Fig. 2 shows the effects of dyeing time on the color strength of the dyed polyamide fabrics upon using disperse blue 56 using microwave irradiation. From Fig. 2 we noticed that increase the time up to 3 min. this is lead to increase the K/S, after that increase the time of dyeing up to 5 min. this is lead to either constant or slightly increase in the K/S, especially at lower concentration used, so we recommended that the time of dyeing not more than 5 min.

Comparing between the conventional and microwave technique as shown in Table 1 & 2, for example, the color strength and the overall fastness properties of dyeing polyamide fabric using disperse blue 56 using conventional technique i.e. (Liquor ratio 1:20, Temperature 100°C, dyeing time 45 minute, Carrier 1 g/l, dispersing agent 1g/l , PH=4.5 and dye concentration 0.5 & 3%) and the color strength and the overall fastness properties of dyeing polyamide fabric using disperse dye blue 56 using microwave irradiation technique i.e.(Microwave power 200, Liquor ratio 1:20, Temperature 100°C, dyeing time 5 minute , Carrier 0 g/l, dispersing agent 0g/l, PH=4.5, and dye concentration 0.5 & 3%) are 3.5&14.6 and 5.6&15.5 respectively , the increase in the K/S upon using microwave irradiation may be due to the use of microwaves made chemically modifying textile surfaces could provide significant advantages over conventional systems with regard to reducing the time and energy needs associated with conventional system [14].

Table 2 shows, the overall fastness properties to rubbing, washing, light and perspiration for the dyed samples and their values ranging from very good to excellent. From the data we found that upon using microwave irradiation technique save about 40 min., zero carrier and dispersing agent used and this is also means that save in time and energy used for complete dyeing process.

3.2.2. Effect of liquor ratio on the color strength

Fig. 3 shows the effect of liquor ratio on the color strength of the dyed polyamide fabrics upon using dispersed dye blue56 using microwave irradiation. From Figure3 we noticed that increase the liquor ratio from 1:5 to 1:20, this is lead to slightly decrease in the K/S. For example increase the liquor ratio from 1:5, 1:10, and 1:20 the K/S is 16.2, 15.9, and 15.5 up on using 3% dye concentration. So we recommended to using L: R 1:5, to save water.

Table 3 shows that the overall fastness properties to rubbing, washing, light and perspiration for the dyed samples and their values ranging from very good to excellent

3.2.3. Effect of power of microwave used on the color strength

Fig. 4 shows the effect of power of microwave used on the color strength of the dyed polyamide fabrics upon using disperse dye blue56. From Fig.4 we noticed that increases the power from 200 to 600 watt, this is lead to slightly increase in the K/S. For example increasing the power from 200, 400, and 600, the color strength (K/S) increasing from 16.2, 16.2, and 16.4 respectively. So we recommended that the power used in case of dyeing polyamide fabric not exceed 200 watt. Table4 show that the overall fastness properties to rubbing, washing, light and perspiration for the dyed samples and their values ranging from very good to excellent

3.3. Dyeing of polyamide fabric using convention and optimum condition of microwave irradiation using Disperse red60

3.3.1. Dyeing of polyamide fabric using conventional heating technique.

Fig. 5 shows the effect of dye concentration on the color strength of dyed polyamide fabrics at Liquor ratio 1:20, Temperature of dyeing 100°C, dyeing time 45 minute, carrier 1 g/l, dispersing agent 1g/l at PH=4.5, using disperse dye red60. It is noticed that the increase in the dye concentration this is lead to increase in the color strength, for example the increase the dye concentration from 0.5, 1, 2 and 3% the K/S increase from 4.5, 8.5, 11.47 and 15.6 respectively.

Table5 shows the effect of dye concentration on the color strength and the overall fastness properties of dyeing polyamide fabric using disperse dye red60 using conventional

heating technique. Generally speaking, the fastness properties to rubbing, either wet or dry, washing, light fastness and color fastness properties to both acidic and alkaline perspiration for the dyed samples their values ranging from very good to excellent.

3.3.2. Dyeing of polyamide fabric using microwave irradiation technique.

Table 6 shows the effects of dye concentration on the color strength of the dyed polyamide fabrics upon using disperse dye red 60 and using microwave irradiation. From Table 6, we noticed that increases the dye conc. this leads to increases in the K/S, for example increase the dye conc. , from 0.5, 1, 2 and 3% the K/S increase from 4.9, 8.9, 11.9 and 16 respectively. From Table 6 we show that the overall fastness properties to rubbing, washing, light and perspiration for the dyed samples and their values ranging from very good to excellent.

Comparing between the conventional and microwave technique as shown in Table 5 & 6, for example, the color strength and the overall fastness properties of dyeing polyamide fabric using disperse dye red 60 using conventional technique i.e. (Liquor ratio 1:20, Temperature 100°C, dyeing time 45 minute, Carrier 1 g/l, dispersing agent 1g/l , PH=4.5 and dye concentration 0.5 & 3%) and the color strength and the overall fastness properties of dyeing polyamide fabric using disperse dye red 60 using microwave irradiation technique i.e. (Microwave power 200, Liquor ratio 1:5, Temperature 100°C, dyeing time 5 minute, Carrier 0 g/l, dispersing agent 0g/l, PH=4.5, and dye concentration 0.5 & 3%) are 3.5 & 14.6 and 4.9 & 16 respectively. The overall fastness properties to rubbing, washing, light and perspiration for the dyed samples their values ranging from very good to excellent. From the data we found that upon using microwave irradiation technique save about 40 min., zero carrier and dispersing agent used, this also means that save in time and energy used for complete dyeing process.

4. Conclusion

The time of dyeing polyamide fabric using dispersed dyes not more than 5 min. using microwave irradiation technique. The power used in case of dyeing polyamide fabric using dispersed dyes not exceed 200 watt. The liquor ratio used in case of dyeing polyamide fabric using dispersed dyes and microwave technique method must be 1:5 which give higher values in K/S and save water. The microwave technique save about 40 min. in the

dyeing time and the dyeing process without carrier and dispersing agent used, this means that save in time, energy and money. This is true irrespective the dye used

REFERENCES

- [1]Ai Qin Hou , Xiaojun Wang, Lianghua Wu, Carbohydrate Polymers 74 (2008) 934–937
- [2]Y .Kong, C.Y.Cha, Carbon 34(8) (1996)1035–40.
- [3]L.S. Clark, W.R. Tinga, J.R. Laia, In: Ceramic transaction, vol.36, Ohio: The American Ceramic Society, (1993) 3–18.
- [4]J.A. Menendez, E.M. Menendez, A. Garcia, Parra JB, Pis JJ. JMicrowave Power Electromagn Energy, 34(3)(1999)137–43.
- [5]J.A. Menendez, E.M. Menendez, M.J. Iglesias, A .Garcia, PisJJ.NMP-based carbon; (b) PFO-based carbon. Carbon 1999; 37(8):1115–21.
- [6] F. Langa, P. Cruz, E. Espildora, Garcia JJ, Perez MC, Hoz A.Carbon 2000; 38(11–12):1641–6.
- [7]D.S. Kim, J.Y. Kim, D.K. Lee, Carbon Sci 2001; 1(3–4):143–7.
- [8]K.A. Ahmed, M.M. El-Molla, M.S.A. Abdel-Mottaleb, Mohamed S. Attia and S. El-Saadany , Research Journal of Chemical Science, Vol. 3(4), April (2013)1-16
- [9]M. M. El-Molla, K. Haggag, N. O. Shaker & F. N.El-Shall, Indian Journal of Fiber & Textile Research, Vol. 38, March 2013, pp. 57-65
- [10]S. Li, H. Boyter & Neil Stewart, AATCC Revi 4(8) (2004) 44-9.
- [11]J .G. Belton, Int. Dyers Text Printer, 43(5) (1980) 662.
- [12]D. B. Judd, G.Wyszenki, “Color in Business, Science and Industry”3rd Ed., John Wiley and Sons, New York (1975).
- [13]J.S.D.C., "Standard Methods for the Assessment of Colour Fastness of Textile", third report of the fastness tests coordinating committee, Yorkshire, England, P. 24 (1995).
- [14]J. Owens, Microwave promoted addition of organosiloxanes

to hydroxyl containing substrates for facile synthesis of chemical and biological warfare agent reactive polymers, in college of science and mathematics. Auburn University, Auburn (2007)

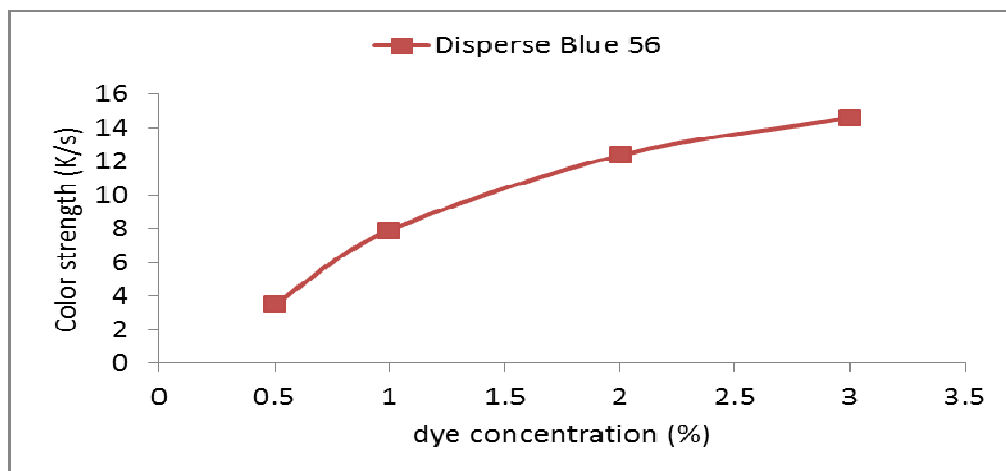


Fig. 1 The effect of dye concentration on the color strength of dyed polyamide* fabric with disperse dye blue 56 using conventional method

* Liquor ratio 1:20, Temperature 100°C, dyeing time 60 minute, Carrier 1 g/l, dispersing agent 1g/l PH=4.5.

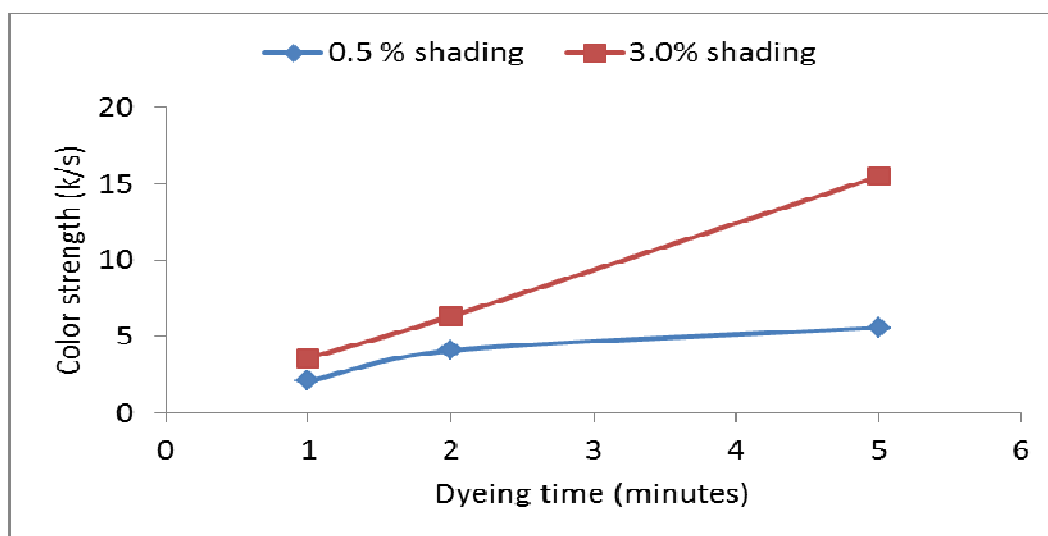


Fig. 2 Effect of dyeing time on the color strength of dyed polyamide* fabrics using disperse blue56 using microwave irradiation technique.

* Microwave power 200, Liquor ratio 1:20, Temperature 100°C, Carrier 0 g/l, dispersing agent 0g/l, PH=4.5

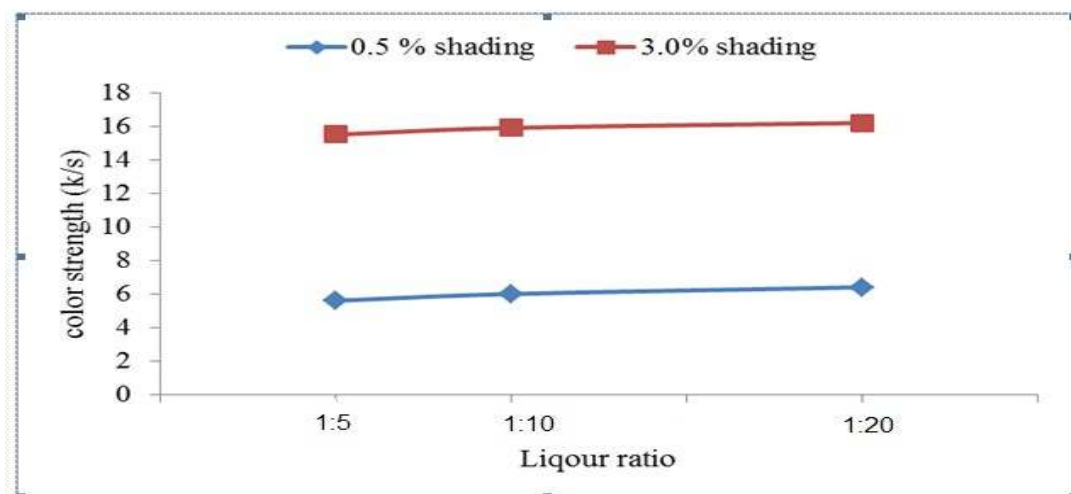


Fig. 3 Effect of liquor ratio on the color strength of dyeing* polyamide fabric using disperses dye blue56 using microwave irradiation technique.

* Microwave power 200, dyeing time 5minute, Carrier 0 g/l, dispersing agent 0 g/l PH=4.5

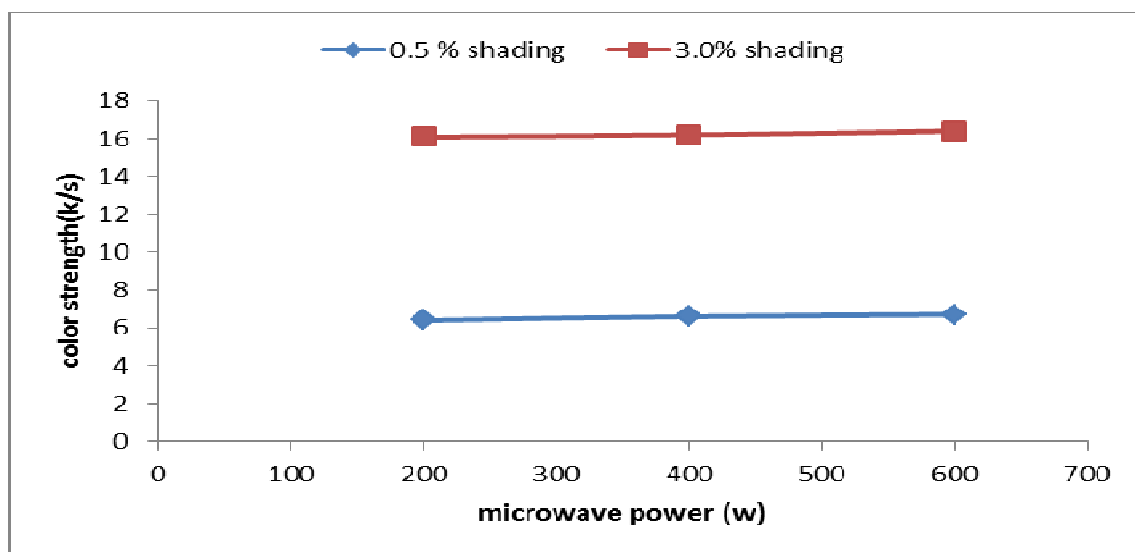


Fig. 4 Effect of microwave power on the color strength of dyed polyamide* fabrics using disperse dye blue56 using microwave irradiation technique.

* Liquor ratio 1:5, Temperature 100°C, dyeing time 5minute, Carrier 0 g/l, dispersing agent 0 g/l PH=4.5

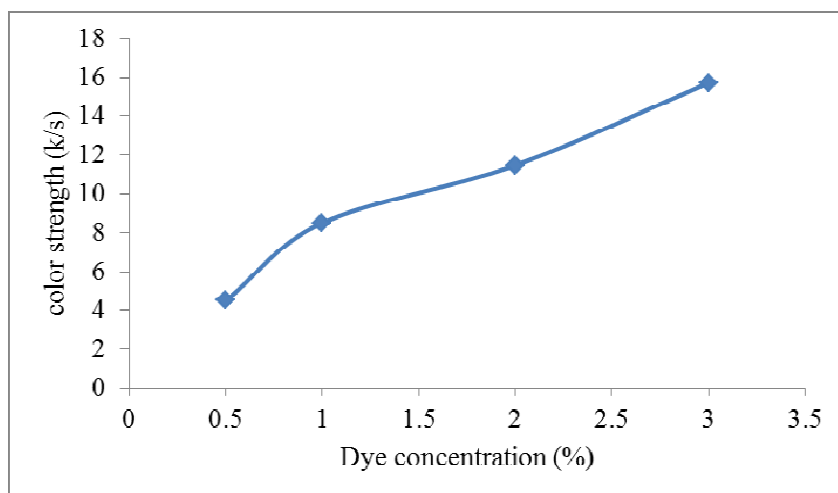


Fig.5 The effect of dye concentration on the color strength of dyed polyamide* fabric with disperse red60 using conventional method

* Liquor ratio 1:20, Temperature 100°C, dyeing time 60 minute, Carrier 1 g/l, dispersing agent 1g/l PH=4.5