One Step Natural Indigo Dyeing Technology

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Abstract

전통 쪽 염색과정을 단순화하여 기존의 환원과 발생이 동시에 이루어지는 공정조건을 다룬다.

1. Introduction

Synthetic indigo dye is currently consumed about 33 million kg annually mainly on blue jeans and denims[1)]. In indigo dyeing, the dye molecules are required to reduce to a colorless, water-soluble leuco form to enable to absorb and diffuse into the fiber and then oxidize back to blue, water-insoluble form [2)]. The main obstacles of traditional indigo dyeing are due to the conversion of plant glycoside to natural indigo dye and complexity of dyeing process. In traditional Niram method. the reduction of water-insoluble indigo was carried out by adding lye of pH 11-12 and storing in a ceramic jar and keeping it in warm place (25-30^{o}C) for a certain period of time, 7-10 days depending on environmental conditions. In this method, the role of natural micro-organisms acting on indigo reduction is as yet known[2)]]. Moreover, it is very complex and gives unpredictable results such as low color reproducibility. Recently developed, chemical reduction process using sodium dithionite is known to be environmentally unfavorable[2)]. For getting better quality in natural indigo dyeing, balance of reduction procedure and more efficient process has to be explored. In this study, we focused on the modification of traditional process balance by using glucose in alkaline media.

2. Experimental

2.1 Materials

100% ramie fabric was used after scouring. Natural indigo dye was prepared by the procedure as described in other proceeding of this conference. The indigo content in crude indigo was 14.8% and indirubin was 0.622% by HPLC analysis[3)]. D-(+)-glucose (Sigma) and $Ca(OH)_2$ were obtained commercially and used without further purification.

2.2 Procedures

Fabric samples were placed in reduction bath at the beginning. Indigo dyeing was carried out in

one-step process using an automatic laboratory dyeing machine (Aiba Nuance, Data Color International, USA). Liquor ratio was 1:100 and oxidized in air and washed. Factors such as reducing-dyeing temperature (60-80°C) and time (20-60 min), dye concentration (4-20 g/L), glucose concentration (2-20 g/L), and the concentration of $Ca(OH)_2$ were investigated for obtaining better quality of products. The color of dyed fabrics in varied conditions was characterized by using a Color-eye 3100 (Macbeth).

3. Results and Discussion

A recent research reports that glucose reduces indigo readily in alkaline media at 65℃[1]. In this study, the highest color strength (K/S) was obtained at 70°C. As reducing and penetration time increased, color strength increased with maximum value at 50 min and rather decreases for longer reaction time. However, the shade of dyed fabrics became duller with increasing temperature. The fabric showed more vivid PB color at 60°C. Considering color strength and shade of the dyed fabrics, reduction/penetration temperature and time were balanced at 60°C and 50min. Vuorema *et al.* obtained the maximum rate of leuco-indigo formation at 65°C[1]. $Ca(OH)_2$ also affected reduction efficiency, eventually dye uptake, and the shade of dyed fabrics. As $Ca(OH)_2$ concentration increased, color strength increased up to 8 g/L and further increase lowered dye uptake and the shade of fabrics got duller. At the same glucose concentration, higher dye uptake was obtained at higher indigo concentration. This result indicates that leuco-indigo formation is proportional to the amount of indigo present, or the surface area of indigo particles in suspension[1]. At less than 6 g/L of indigo concentration, color strength was obtained at 8 g/L of glucose concentration, while at more than 8g/L pf indigo concentration, maximum color strength was obtained at 10 g/L of glucose concentration. Further increase of glucose concentration caused the decrease of color strength. The dyed ramie fabrics showed PB colors and the shade got darker and duller as indigo concentration increased. From the results obtained, reduction process using glucose as a reducing agent in indigo dyeing may be limited to pale to medium strength of color.

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References

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