

lower percent of dye utilization and the serious environment pollution problem caused by high salt dosages and residual dyes in dyeing solution.



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## References

1. Wang Q, Li G. *Chemical Fibers International* 2003; 53: 12414-417.
2. Tang RC, Song XY, Chen W. *Journal of Donghua University* 2007; 24, 1: 11-16.
3. Tang RC. *Studies on the structure, properties, dyeing and finishing process of soybean fiber*. Ph.D. Thesis, Donghua University, Shang Hai, 2006.
4. Hauser PJ, Slopek RP. *Colourage* 2005; 52, 9: 61-62, 64-66.
5. Teng XX, Ma W, Zhang SF. *Chinese journal of chemical engineering* 2010; 18, 6: 1023-1028.
6. Zhang F, Chen YY, Lin H, Wang H, Zhao B. *Carbohydrate polymers* 2008; 74: 250-256.
7. Lim SH, Hudson SM. *Coloration Technology* 2004; 120: 108-113.
8. Giri Dev VR, Venugopal J, Sudha S, Deepika G, Ramakrishna S. *Carbohydrate Polymers* 2009; 75: 646-650.
9. Davarpanah S, Mahmoodi NM, Arami M, Bahrami H, Mazaheri F. *Applied Surface Science* 2009; 255: 4171-4176.
10. Struszczyk MH, Brzoza-Malczewska K, Szalczyńska M. *Fibres & Textiles In Eastern Europe* 2007; 15, 5-6(64-65): 163-166.
11. Lim SH, Hudson SM. *Journal of Macromolecular Science, Part C: Polymer Reviews* 2003; 43, 2: 223-269.
12. Lim SH, Hudson SM. *Carbohydrate Research* 2004; 339: 313-319.
13. Chen XG, Park HJ. *Carbohydrate Polymers* 2003; 53: 355-359.
14. Yang YQ, Xu L. *American Dyestuff Reporter* 1996; 3: 27-34.
15. Lv JC, Lin HQ, Zhou QQ. *Advanced Materials Research* 2012; 502: 306-311.
16. Gupta D, Haile A. *Carbohydrate Polymers* 2007; 69: 164-171.

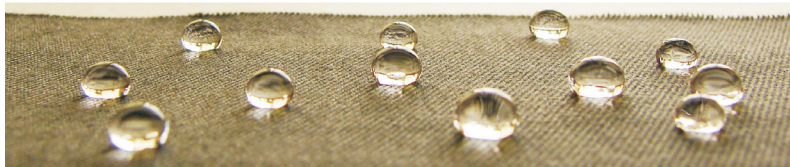
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