VERIFICATION OF CONDITIONS FOR APPROPRIATE STORAGE OF DYED CELLULOSIC TEXTILES

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The storage conditions (temperature, humidity, light, pollution) influence the lifetime of textiles. This brings up a question of whether dyed and undyed textiles react on storage conditions identically or whether the presence of dyes affects the reaction of the material on individual factors influencing the lifetime of textiles. The degradation degree of dyed and undyed textiles made from vegetable fibres was studied under different artificial ageing conditions (equal aging time). The properties of the material before and after artificial ageing were compared. For better transparency only the results for linen samples are presented, the results for cotton samples were similar.

Dyes:
alkanna, annatto, barberry root, cochineal, galls, logwood, madder, Persian berries, redwood, turmeric, walnut
(mordant: $KAl(SO_4)_2.12H_2O + KNaC_4H_4O_6.4H_2O$,
dyeing process according to H. Schweppe [1])

Ageing conditions:

1) light ageing: 25°C and 20 % RH, 21 days, VIS (11 klx) and UV (0,06 $mW.cm^{-2}$) light,

2) heat-dry ageing: 80°C and 0 % RH, 21 days, dark,

3) heat-humid ageing: 80°C and 60 % RH, 21 days, dark,
(21 days of accelerated ageing at 80°C simulate cca 25 years of the natural ageing at 25°C [2])

Degradation evaluation:
polymerization degree of cellulose,
reducing power of cellulose (copper number),
colour difference

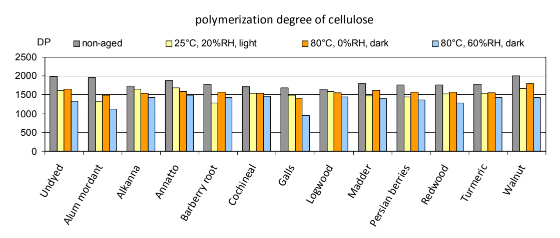

Fig. 1: Polymerization degree of cellulose before and after ageing

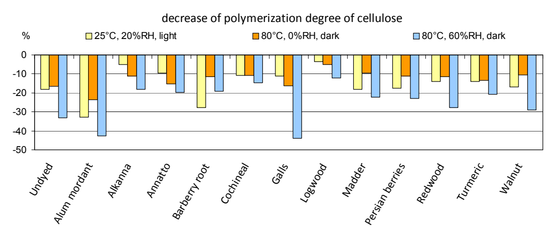

Fig. 2: Decrease of polymerization degree of cellulose
(percentage loss is relative to polymerization degree of non-aged sample)

RESULTS

Cellulose is the main building polymer of vegetable fibres and the damage of textiles is accompanied by the decrease of the polymerization degree of cellulose. The average polymerization degree of cellulose (DP) was determined by viscosimetry [3], for dissolving cellulose a solution of iron-natrium-tartarate complex solvent (FeTNa) was used. The results of DP and percentage decrease of DP caused by artificial ageing are presented in fig.1 and 2.

The decrease of DP of cellulose (i.e. damage of material) was caused not only by the artificial ageing but a partial decrease took place already during the dyeing process A more significant decrease of DP was observed on undyed textiles (with the exception of gall-dyed materials). The damage of the material is significantly influenced by higher humidity. From the comparison of the decrease of DP during aging under light and dark conditions, with regard to the temperature and aging time, light results as an extremely significant degradation factor. The decrease of DP of certain samples exposed to light aging is comparable with the decrease of DP caused by ageing under dark with more drastic light-humid conditions.

The damage of cellulose shows by the increasing copper number of cellulose (CN) [4]. This quantity depends on the number of reducible groups within the molecule of cellulose, i.e. hemiacetal hydroxyls and aldehyde groups. In other words, the CN increases with the decreasing DP and growing oxidation damage. The results of CN are presented in fig. 3. Unproportionally high CNs on gall-dyed samples are caused by reactions of the present tannins with reagents used for the determination of CN. Tannins probably increase also CN of samples dyed with logwood and redwood. In general, the results of CN prove the negative influence of light and humidity on the lifetime of textiles. No significant difference between the degradation degree of dyed and undyed textiles was found.

The damage of textiles is apparent also in the colour difference (ΔE). However, the colour difference of dyed textiles demonstrates rather the degradation (fading) of the dye than the degradation of the textile material. The colour differences are presented in fig. 4.

Yet again, the negative influence of humidity and light is apparent. The increased humidity accelerates not only the degradation of the textile material but also the degradation of dyes. The colour difference caused by the degradation of the dye may prevail over the colour difference evoked by the degradation of the textile material. A significantly low lightfastness of turmeric is evident. By comparison of results (fig. 1 – 4) it seems that the stability of the dye is not generally connected with the degradation degree of the textile material.

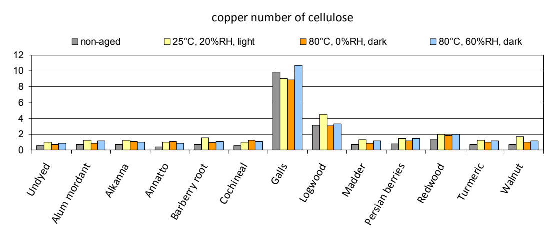

Fig. 3: Copper number of cellulose (reducing power of cellulose)

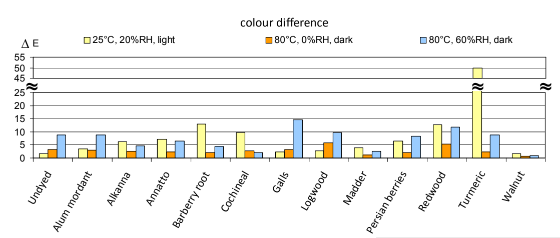

Fig. 4: Colour difference after ageing

$$\Delta E = \sqrt{(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2}$$

L*, a*, b* - colour coordinates

CONCLUSIONS

On dyed and undyed textiles made from vegetable fibres was observed a negative influence of increased humidity not only on the lifetime of textile materials but also of the dye (also in the dark). The light itself accelerates the degradation of the textile material and of the dyes. It appears that there isn't any connection between the stability of the dye and the degradation of the textile material dyed with the respective dye. No significant difference between the degradation degree of undyed textiles and textiles dyed with the use of the given natural dyes was found. We can state that when the storage conditions recommended for textiles are maintained, there is no need to create special storage conditions for dyed textiles.

Literature:
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3) CZ standard ČSN 800811: *Stanovení vnitřní viskozity a průměrného polymeračního stupně celulózy v rozpouštědle EWN*
4) Felix V.: *Chemicko-technické textilní rozbory II*, Průmyslové vydavatelství, Praha 1951, p. 1191

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