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UV AND SONIC DEGRADATION OF NONWOVEN FABRICS USED AS WET WIPES

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Abstract. *This research investigates one of the degradation cases for nonwovens as wet wipes, whose consumption is increasing a lot, and an alternative degradation method is examined. Consumption of wet wipes increases every day and unfortunately used wet wipes were left on the mainland by human beings. For this reason, nonwoven fabrics such as wet wipes containing viscose and Tencel fibers, polyethylene terephthalate (PET) fiber, and their blends were used in the current research. Dry and prepared wet wipes with a wetting solution were kept under sunlight for four months to examine UV degradation and control at the end of the period. Photographs and microscopic views were taken and degradation behavior was evaluated visually. Color change and visual change were reported and weight loss values were calculated to examine the degradation behavior objectively. As an alternative degradation method, a sonicator was used and the test samples were exposed for 30 hours for sonic degradation. Degradation was observed for all fabric types and examined by microscopic views. It was determined that all the test fabrics show important differences in color change and fabric handle under the same UV degradation conditions. After sonic degradation, decomposition was observed for the allowed time used in the research and it was supposed as a hopeful method for further research.*

Keywords: *nonwoven, fabric, wet wipes, degradation, UV*

1. INTRODUCTION

Wipes become very useful in many aspects of daily life and they are divided into two main categories such as consumer and professional products. Consumer wipes are divided into personal care usage and household care usage, as professional wipes are the ones used in industrial applications and the medical sector [1].

Human beings use many different types of wipes that make his/her life comfortable but a less amount of them are degradable. Unfortunately, the waste load of single-use nonwovens and also wipes are getting higher and higher every day.

Dispose of waste nonwoven materials is an important subject. For that reason, the reuse or recycling of nonwoven products or their degradation is the topic that many researchers focused on. In the last decades, the degradability of textiles and degradability conditions were studied by some researchers [2-5,7-9]. The studies continue on the production of new biodegradable nonwovens as a result of the higher amount of post-use journeys and increasing waste of wet wipes [6].

However, the effect of UV exposure on the extent of additive leaching has not previously been quantified and it is reported that UV-degradation may cause the formation of water-soluble polymer degradation products, but this process has also yet to be investigated for textile polymers[9]. Moreover, sonic degradation is a common method for tissues and it is a new attempt to evaluate nonwoven structures in the current research.

In the context of this research, six nonwoven fabrics proper for wet wipes were used to evaluate dry and wet states and two different degradation environmental conditions.

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2. EXPERIMENTAL PART

In the current research, nonwoven fabrics that are suitable to produce wet wipes were used. The test materials were supplied by a nonwoven fabric producer and dry and wet wipes were prepared for the aim of the study. Six dry and six wet wipes, a total of 12 fabric samples were exposed to sunlight for UV degradation. As another stage of the research, these nonwoven fabrics were also tested in a sonicator for sonic degradation. In Table 1, the basic properties of the samples were given.

Table 1
Basic structural parameters of the test samples

Fabric code* and raw material	Fabric unit weight (g/m^2)	Fabric thickness (mm)
1K, 1Y 100% Tencel	73.2	0.68
2K, 2Y 70/30% Tencel /CV	66.0	0.60
3K, 3Y 50/50% PET/CV	48.9	0.55
4K, 4Y 60/40% PET/CV	70.4	0.38
5K, 5Y 80/20% PET/CV	54.4	0.71
6K, 6Y 100% PET	42.4	0.57

*K and Y show dry and wet test samples respectively.

The nonwoven fabrics used in the experimental study were prepared as dry and wet samples. The sample fabrics were prepared in 10×10 cm dimensions and conditioned, their weights were measured. For UV degradation, the test samples were kept in the open area for four months during the summer season in a way that they would receive UV rays directly. After this period, the samples were evaluated visually and photographically. The weight loss values were calculated in terms of degradation.

Dry and wet fabric samples were also kept under ultrasonic waves for 30 hours in a sonicator with distilled water. After the allowed period, the distilled water and the samples were taken carefully and filtered before observations. The fibers removed from the fabric structure were examined by the photographs.

3. RESULTS AND DISCUSSION

3.1. Degradation Behavior of Samples Under UV Light

The weight values of dry and wet fabrics were compared before the experiment and after the test period of four months and weight loss change(%) values were calculated. When the weight loss percentages are examined, the highest weight loss was seen in fabric 4 (60-40% PET/CV) fabric in the dry nonwoven fabric samples. Then, fabrics numbered 3 (50-50% PET/CV), 2 (70-30% Tencel/CV) and 1 (100% Tencel) come, respectively.

Considering these data, it can be said that viscose has lower resistance to UV rays compared to Tencel and PET fibers, and degradation of viscose fibers is relatively better under UV light.

It can be said that as the PET fiber content increases, the UV resistance of nonwoven fabric samples increase, and the degradation performance decrease. According to the literature, PET fabrics are resistant to sunlight. when exposed to sunlight till 3000 hours, there is a 50% decrease in breaking strength and it has good resistance to outdoor conditions.

When it is thought degradation under UV arrays for four months, it has been observed that PET nonwoven fabrics also require a higher degradation period. In addition, it was determined that the wetting agent did not cause any acceleration, on the contrary, a decrease was seen in degradation for the wet wipe samples.

Figure 1. Weight loss (%) of dry nonwoven samples under UV light

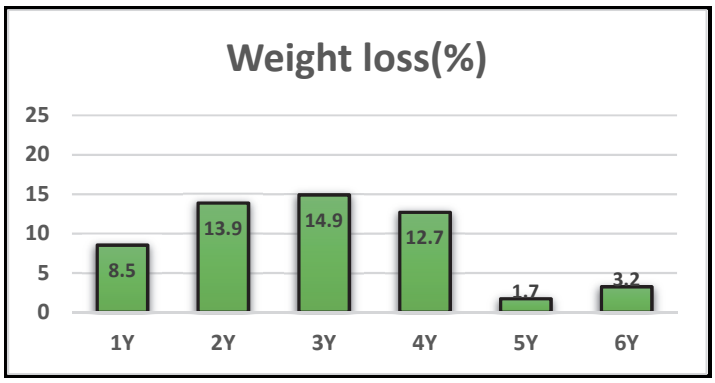
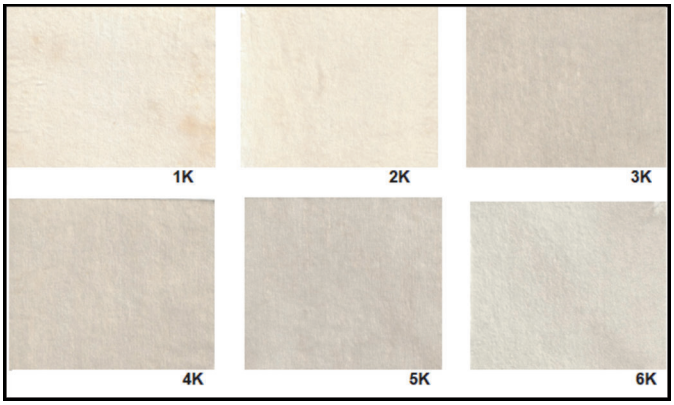
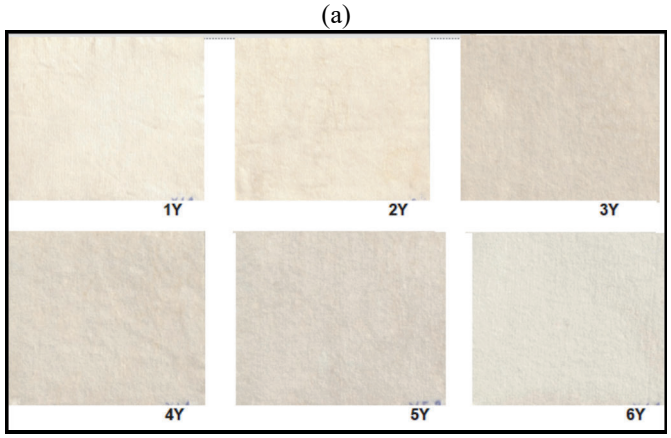


Figure 2. Weight loss (%) of wet wipe nonwoven samples under UV light

Photographic images of dry and wet wipe samples taken after the UV degradation test are given in Figures 3 and 4.



(a)



(b)

Figure 3. Photographic views of the samples under UV degradation for four months (a)dry, (b) wet

The color change is shown in the figures and shows the difference between dry and wet samples. When the dry nonwoven samples (fabric code K) and wet samples prepared with a wetting solution (fabric code Y) were visually examined, after a 4-month UV resistance test; yellowing was observed for all of them.

The worse fabric handle and stiffer touch were evaluated especially for the nonwoven fabrics coded 3, 4, 5, and 6. In fabrics 1 and 2, yellow stains were observed from place to place for dry and wet samples.

For sonic degradation, fiber distribution was reported. Besides, no significant change was observed in the weight measurements made by a balance having a sensitivity level of 0.0001.

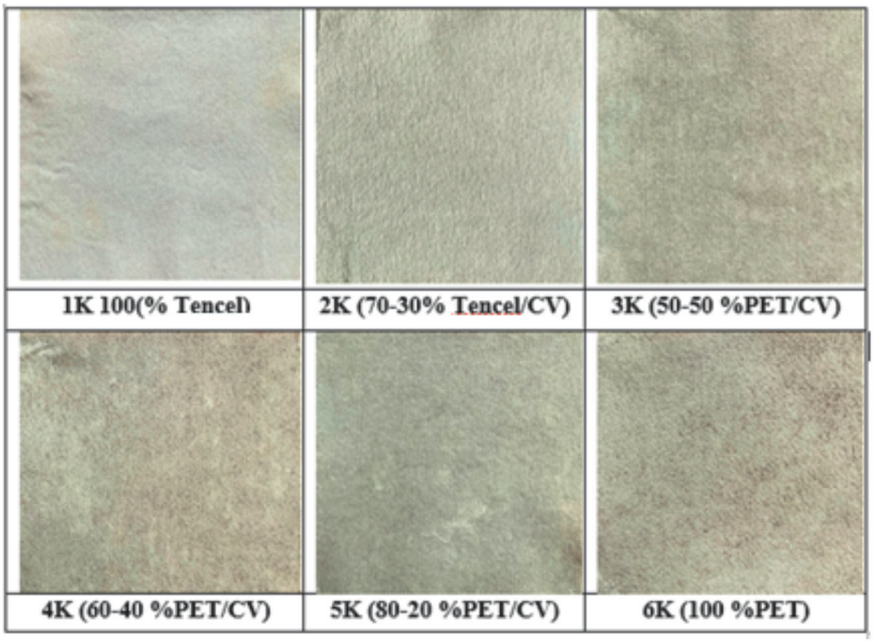


Figure 4. Photographic views on a dark background of the samples after UV degradation for four months

However, when the pure water they are in was filtered through suitable filter papers, it was observed. These images are given in Figures 5 and 6. One of the reasons for the separation of fibers from the fabric is; while the natural requirement of nonwoven fabric structure, another reason is thought of as ultrasonic waves. This issue could be extensively studied in another study. Microscopic images of fiber samples taken from distilled water are as follows.

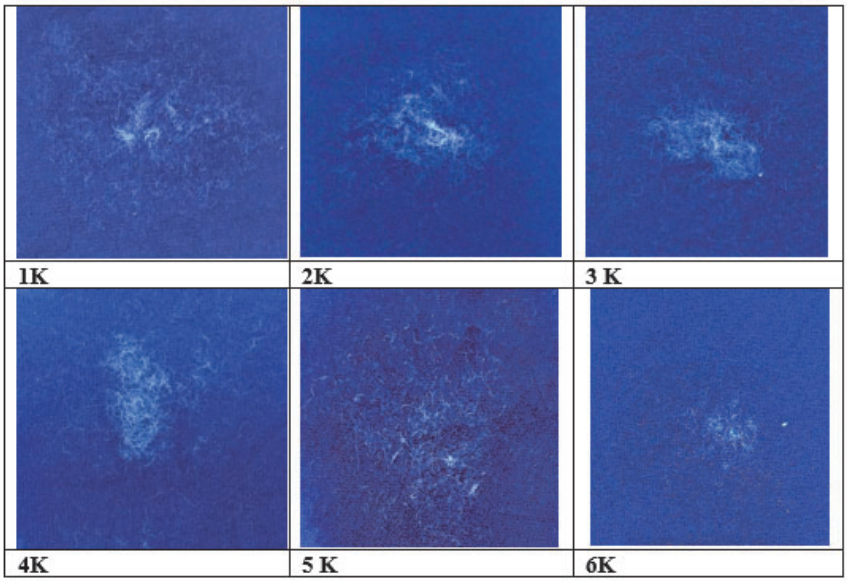


Figure 5. Photographic views of the test samples after the ultrasonic effect

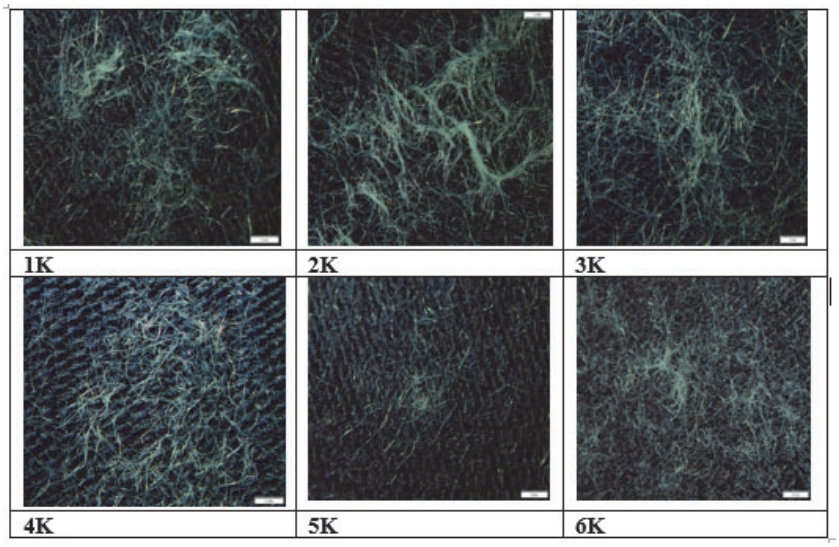


Figure 6. Microscopic views of the test samples after the ultrasonic effect

4. CONCLUSIONS

In the research, six nonwoven fabrics suitable for wet wipes were used and a wetting solution was used to prepare wet wipes, a total of twelve test samples were used in the experiments. UV degradation and sonic degradation conditions were tested and evaluated by weight loss, and visual and microscopic examination. Certain color changes were obtained for UV degradation conditions meaning that after four months, degradation began for the nonwoven fabrics suitable for wet wipes.

Besides, although four months passed, the maximum weight loss was determined as 20% and it seems to be it will take a longer time for degradation although the fabric weight and thickness are too low in comparison to the classical textile fabrics. Wetted nonwoven fabrics showed no important difference from dry ones. Detailed morphological analyses may explain the differences in detail about degradation. Sonic degradation is a more common method for tissues, and the findings of the research, it is supposed to evaluate the degradation of nonwoven structures in further research.

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