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DEVELOPMENT OF PERMANGANAT ALTERNATIVE EFFECT WASHING CHEMICALS IN DENIM WASHING PROCESSES

DENİM YIKAMA İŞLEMLERİNDE PERMANGANAT ALTERNATİFİ EFEKT YIKAMA KİMYASALLARI GELİŞTİRİLMESİ

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ABSTRACT

The process of giving effect or attrition on the denim is a situation that develops day by day according to the fashion trends that have developed in recent years. The effect is to try to achieve a more matte appearance by gradually removing these materials by means of paint deformation, while the fiber is not allowed to break brittle on the working surfaces of the particles, where the hard and amorphous surfaces provide a kind of fine sanding function. The aging process is generally done to provide a random wear look and to break the uniform denim paint look. The most important of these can be listed as the difficulty of use, the fact that it contains permanganate, which is harmful to the environment, expected to be banned in the near future, and the absence of repeated use. By using Al_2O_3 material, which is in the oxide abrasive class, by adding liquid paraffin and TEA, which acts as a compatibilizing agent, at different rates, abrasion slurry was produced and its effects on denim products were investigated. In this study, the effects of particle size of oxide species, α- Al_2O_3 ratio in Al_2O_3 specific surface areas and impurities in Al_2O_3 were also investigated.

Keywords: Aluminum oxide, denim, tumbled

ÖZET

Denim ürün efekt verme işlemi veya yıpratma, son yıllarda gelişen moda trendlerine göre uygulama alanı günden güne gelişen bir durumdur. Efekt, özellikle sert ve şekilsiz yüzeylerin ince zımpara işlevi kazandırdığı parçacıkların çalışma yüzeylerinde lifin gevrek kırılmalara izin vermeden gerçekleştirilirken, boyayı deformasyona uğratıp yavaş yavaş uzaklaştırarak daha mat bir görünüm elde etmeye çalışmaktır. Eskitme işlemi genel olarak gelişi güzel bir yıpranma görünüşü sağlamak ve tek düze denim boya görüntüsünü kırmak için yapılır. Geleneksel efektlendirme işlemi olan ponza taşı ve permangat birlikteliği kullanım açısından ciddi dezavantajlar içermektedir. Bunlardan en önemlisi kullanın zorluğu, çevre için zararlı, yakın zamanda yasaklanması beklenen permanganat içermesi ve tekrarlı kullanımının olmaması olarak sıralanabilir. Oksit aşındırıcı sınıfına giren Al_2O_3 malzemesi kullanılarak, sıvı parafin ve uyumlaştırıcı ajan görevi yapan TEA farklı oranlarda eklenerek aşınma bulamacı üretimi yapılmış ve denim ürünler üzerinde etkileri incelenmiştir. Bu çalışmada oksit türlerinin parçacık boyutunun, alüminyum oksit içindeki α-Al_2O_3 oranının, spesifik yüzey alanlarının (BET) ve Al_2O_3 içindeki safsızlıkların da etkileri araştırılmıştır.

Anahtar Kelimeler: Alüminyum oksit, denim, eskitme

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INTRODUCTION

When we look at the textile sector, processes such as aging, patterning, dyeing, resin and chemical application are applied on clothing products such as trousers, shorts and jackets, which are produced from all kinds of fabrics such as jeans and linen (Petrie,1976). As a traditional method, some attrition processes are carried out in order to give the denim fabric trousers or shirts a worn look. Clothing products are generally processed in a waterless environment with stones impregnated with chemicals. The stone used here is mostly pumice. Permanganate or hypochlorite is often used as a chemical. This is a type of wash in which deep spot effects are achieved. In such washings, the color to be obtained after washing completely changes depending on the fastness values of the dyestuffs used in the dyeing phase of the fabric against the chemicals used in snow washing. In recent years, the above mentioned decolorizing chemicals have also been used by impregnating or mixing with various fillers, thus preventing the problems such as holes caused by the stone, especially in knitted products (Technical Guide,2017).

After the ready-to-wear stage of denim fabrics, effect washing processes are applied. For this, pumice stone and chemicals that are harmful to the environment working in low liquor are used. The use of these materials also brings about fastness problems. In order to achieve the bleaching effect in classical methods, the machines work for an average of 90 minutes and cause fatigue and wear of both energy and mechanical parts. The average water consumption for a product is around 80 liters. Especially the high amount of water is quite thought-provoking. In addition, for production facilities, processes such as storing, transporting and loading stones into machines are long and difficult processes. Both materials used in this process have many disadvantages. potassium permanganate is a very strong oxidizing compound. This makes it very harmful for the environment. Today, its use is restricted in many areas. Pumice stone is also a material that needs continuous use due to its difficulty in use (transportation, transportation, loading, storage) and not being long-lasting (low strength). Its reuse is very low. Worn pumice stones after use turn into fine powder and are used in different areas as waste such as aerated concrete and pumice production (Baran et al., 2010).

The main bleaching agent in bleaching fluids used in abrasion or paint removal processes is not sodium hypochlorite itself, but hypochlorous acid formed from it in a pH-sensitive balance. In order to provide analytically mild bleaching conditions, the optimum range for the most effective bleaching known should be between pH 9.0-11.5 (Bosman, 2007). Since under practical conditions in industrial production it is difficult to keep pH levels below 10 constant, it is necessary to initially select chemicals that will have a pH range of 11.0-12.5 (BS EN ISO 105-X12, 2017). Aluminum oxide is one of the inorganic materials with abrasive effect (BS EN ISO 13934- 1,2017). Aluminum oxide is chemically stable and very hard and corrosive in terms of its crystal structure. Generally, it is used intensively to remove the surface roughness in polishing processes (Wiberg & Holleman, 2001).

METARYAL AND METHOD

In this study, it is aimed to use pure aluminum oxide powders in micro size (250-500 μm) as an alternative to the use of pumice stone and potassium permanganate in order to achieve a washing effect. First of all, in order to get rid of possible moisture or other impurities in the commercially available Al_2O_3 powders from ZİBO; It was mixed with ethyl alcohol at a ratio of 1:3 in a mini reactor under pressure at 100 °C for 1 hour. It was then cooled to room temperature and removed from the evaporator to separate it from its solvent. The resulting powders were dried in an oven at 1000 °C for 3 hours. In the second part, 100 g of Al_2O_3, 250 mL of water and 1.7 mmol of liquid paraffin were added to the mini-reactor and mixed under 2 bar pressure, 120 °C, for approximately 1 hour. 50 gr Al_2O_3 and 0.4 mmol TEA as a compatibilizing agent were added on it to provide consistency, and mixing was continued at 350 rpm for about half an hour and at room temperature. At this stage, the sample turned into slippery and irregular lumps of approximately 2-3 mm in diameter. The resulting material will hereinafter be denoted by the A1 code. The material that came to room temperature was weighed and preserved. Figure 1 shows the synthesis phase and the material produced. The obtained material was characterized by FTIR and SEM/EDX analysis.

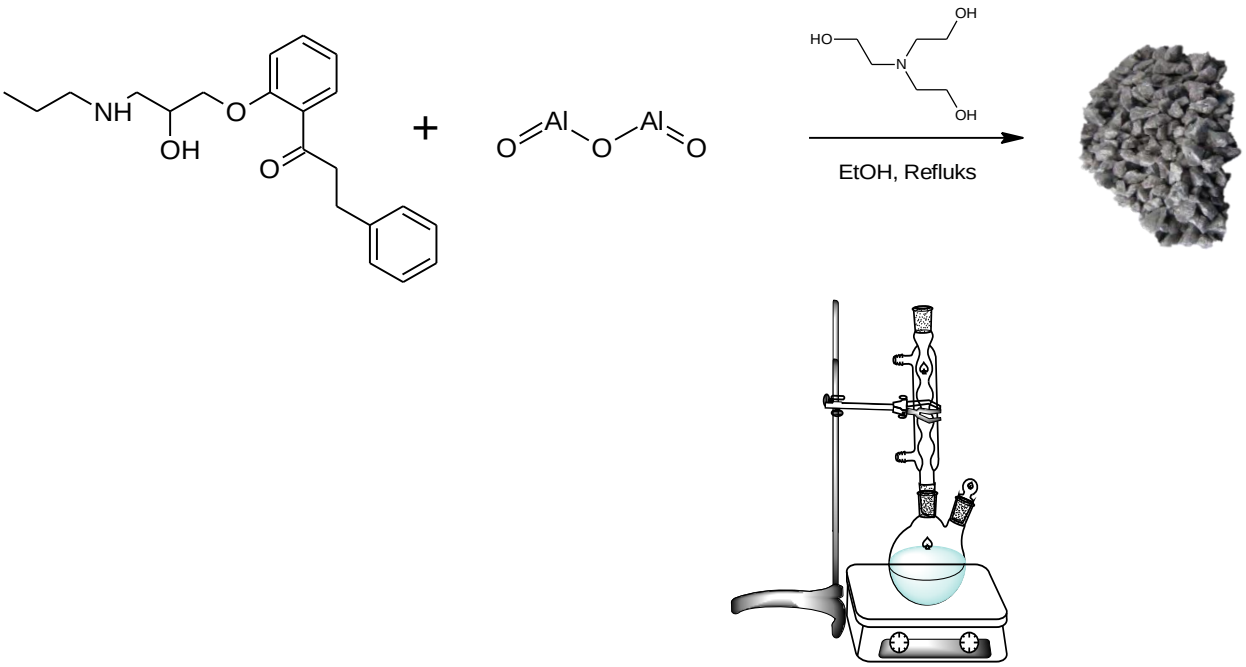

Figure.1 Diagram Showing the Synthesis Steps of A1

In the third part, denim samples determined with the abrasive sludge obtained were subjected to dry washing process in BAYKAN Denim. We used the dry washing option in the business where wet and dry washing is usually carried out. For this; samples were placed in a pilot drum wash at room temperature (Figure 2). A1 coded aluminum oxide-based abrasive mud that we prepared on denim was added. It was washed dry for approximately 45 minutes. Afterwards, the samples were taken to the drum dryer and subjected to the drying process. This process was continued at 75°C for 30 minutes. The samples were checked under the light cabinet and the wear effects were observed.

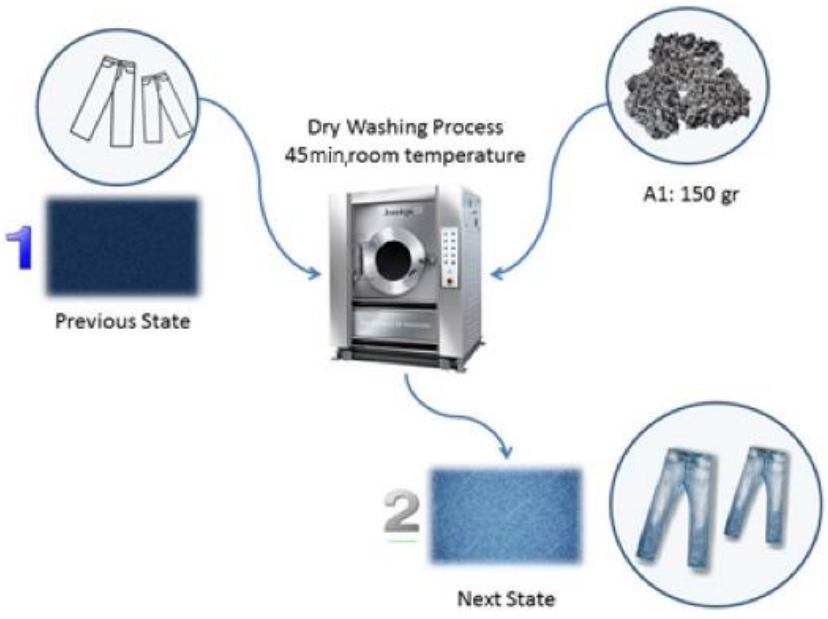

Figure 2. Dry Washing Process

In this study, in the washing and drying processes; changes on the effect were investigated depending on temperature, time and A1 concentration. Looking at Table 1, changes in time, temperature and amount of material used for the effective washing process were examined.

Table 1. Washing Effect Run Rating For A1

			Washing			Drying		
	Temperature (°C)		25			75		
	Time (min)		15	30	45	15	30	45
A1	Mass (gr)	100	*	*	**	*	**	***
		200	*	**	***	*	**	***

*:bad, **:good, ***:best

In Table 1, washing and drying are examined as two separate processes. Strong effects are seen as the amount of substance increases and the washing time increases in the washing process. However, in drying, even if the amount of substance increases, there is an improvement in effecting with increasing time, but good results are seen even with low amount of substance.

RESULTS AND DISCUSSION

In this study, carried out in Baykan Denim R&D center, it is aimed to achieve an aging effect on denim without the use of chemicals that are harmful to the environment, especially in a waterless environment. For this, firstly, the purification of α forms of aluminum oxide in ethyl alcohol was carried out. First of all, an laboratory-type condensation system was set up and mixing was carried out in an air atmosphere, at 100 °C, for approximately 1 hour. Particle sizes and distribution of aluminum oxides were determined from the images obtained by the Bruker brand SEM device in Kahramanmaraş Sütçü İmam University, USKIM Central Laboratories (Figure 3).

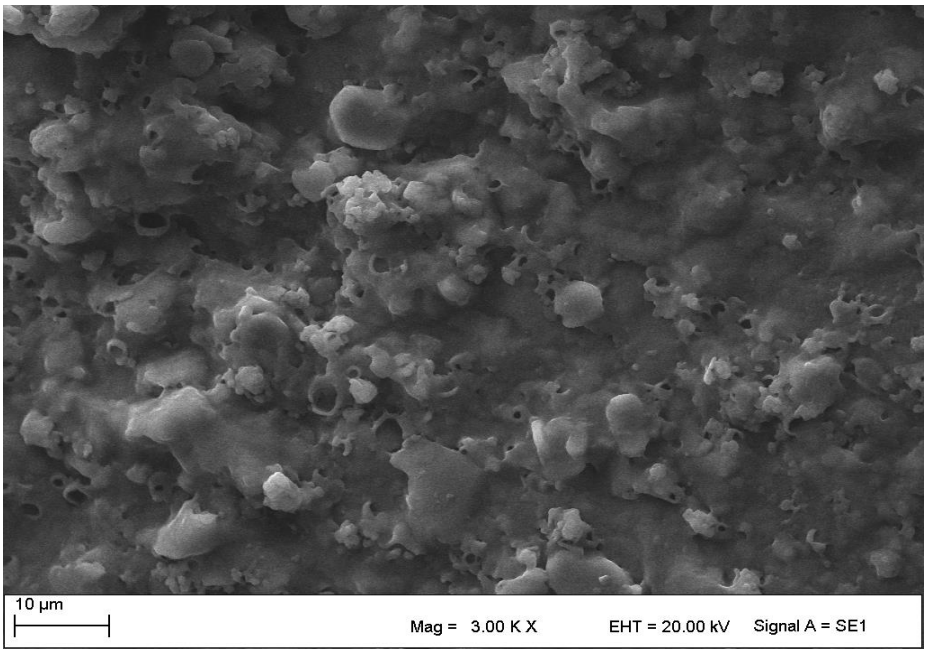

Figure 3. SEM image of Al_2O_3 Particles

When Scanning Electron Microscope (SEM) image was examined, it was determined that it contains 0.13% Na_2O, 0.026% CaO, 0.021% Fe_2O_3, 0.044% SiO_2 and 94.6% α-Al_2O_3. The particle size distribution is; measured as >112 µm (%) 29-47, 110-60 µm (%) 31-57, 60-45 µm (%) 11-3, <45 µm (%) 1-0. As it can be understood from the EDX analysis, it is seen that α-Al_2O_3 is prepared in pure and balanced particle size. The carbon peaks seen in the structure are due to the coating of the sample with carbon before the SEM analysis (Figure 4) (Srisawad et al.,2012; Ersching et al.,2012; Greer & De Hosson, 2011)

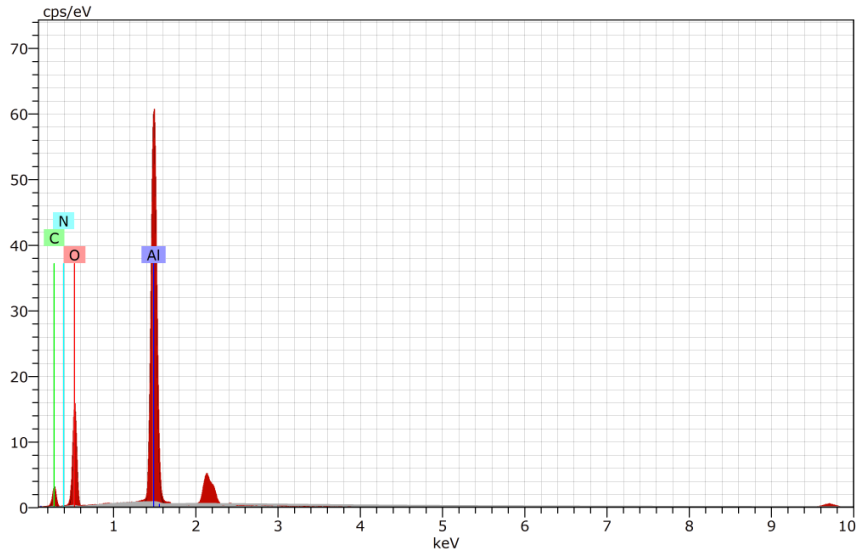

Figure 4. Al_2O_3 SEM/EDX graph

The images obtained as a result of the studies on denim of the prepared abrasive slurry are shown in Figure 5. Studies were carried out on the front, back and leg parts of the denim trousers sample. It contains 98% cotton and 2% Elastane in black and blue denims. As seen in examples 1 to 5 in Figure 5, wear marks are clearly visible on the hems, especially in the seam areas. On the front, the worn surfaces are more prominent, especially in the pockets and seams. On the zipper part (7), the most obvious wear effect is seen. It exhibited intense wear patterns on the seams on the back parts.

Figure 5. Images of the Denim Parts Before and After Washing, 1-5 Hems, 6,7 and 9 Front Parts, 8,10 Back Parts

Potassium permanganate and pumice stone are used in etching with traditional methods. The difference between the aging effect obtained as a result of the washing and drying processes made with this method and the effecting process made with aluminum oxide-based abrasive mud is given in Figure 6.

Figure 6. Aging Effect Study With Different Materials, 1) Pumice Stone and KMnO4, 2) Al2O3 Based Abrasive Slurry

As seen in Figure 6, in the first image, the appearance obtained after washing and drying with pumice stone and $KMnO_4$ used in the traditional method and the appearance obtained by using Al_2O_3-based abrasive slurry are compared. In the first image, the rate of wear and tear is quite high and it destroys the fibers. It gives more destruction than the desired abrasive appearance effect.

However, in the second image, the desired aging effect shows the desired effect without damaging the fibers too much.

CONCLUSION

In general, the combination of $KMnO_4$ and pumice stone, which is used in denim effecting processes made with classical methods, may be restricted or even banned and prevented from being used in the future due to the cost and the fact that permanganate is quite harmful for the environment. For this reason, it is quite remarkable that the aluminum-based slurry, which we recommend in our study, which is environmentally friendly and will abrade the fibrous structures more softly in terms of its crystal lattice structure, is suitable both in terms of effecting and cost. The findings we obtained in the effects studies, even when applied only as a slurry, gave very good visuals. Significant aging effects were observed especially on the hems, back pocket edges and seams. In the next step, in order to bring the prepared slurry to the pumice stone structure, it will be combined with phenolic resin to obtain a stone image. The biggest difference here is that the pumice stone cannot be recycled. On the other hand, as the aluminum oxide particles erode, they will turn into dust and be recovered from the system. The recovered aluminum oxide particles will be used as input material in the abrasive sludge process again.

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