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Utilization of bovine hairs recovered from the hair-save unhairing process for preparing the filling agent for retanning: environmental and economic considerations

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Abstract: Hair-save unhairing methods have become necessary due to the increasing environmental concerns and legislation, while the accumulation of recovered bovine hairs has raised disposal problems and has set back the widespread use of hair-save unhairing methods to some extent. The objective of this work was to report an application of the hairs, i.e., preparing the filling agent for retanning, and the environmental and economic aspects of the utilization were discussed. After the recovery of bovine hairs through a hair-save unhairing method, the hairs were subjected to a series of pretreatments and then hydrolyzed to obtain the filling agent for retanning. The retanning experiments showed that the fullness, softness and elasticity, as well as the thickness of the leather retanned with this filling agent were increased, and the retanned leather had fine and tight grain. Furthermore, the filling agent had assistant dyeing properties, and the tensile strength and tearing strength of the retanned leather were improved. Besides, due to the recovery of hairs, the concentration of suspended solids, total nitrogen, sulphide and chemical oxygen demand were reduced in wasted unhairing-liming liquor, resulting in an easier handling of the tannery wastewater. Finally, cost-benefit analyses of both the hair-save unhairing process and the recycling of recovered hairs were detailed.

Key words: recycling of hairs from hair-save unhairing; filling agent for retanning; environment-friendly; cost-benefit analyses

1. Introduction

Due to the dissolution of bovine hairs, hair-destroying unhairing methods result in high organic pollution in the wasted unhairing-liming liquor and a large amount of sludge during the wastewater treatment.[1] As the environmental concerns and legislation are increasing, hair-save unhairing methods which can eliminate the dissolution of hair into wastewater have become necessary.[1,2] However, the accumulation of recovered bovine hairs has raised disposal problems and has set back the widespread use of hair-save unhairing methods to some extent. Therefore, achieving the effective utilization of bovine hairs is important when considering the introduction of the hair-save unhairing method.

Bovine hairs recovered from the hair-save unhairing process might be used as a fiber

material in felt production, but this utilization is limited by the reduced fiber strength of hair due to the hair degradation occurred in the unhairing process.[3] Moreover, as a source of slow-releasing organic nitrogen, the recovered hair waste would be used for agricultural purposes.[4] Owing to the high cysteine content in the hair protein, the recovered bovine hairs can also be used in the manufacture of animal feedstuffs.[5] Currently, however, there is no information about the recycling of the recovered hair waste in leather manufacture itself.

The objective of this work was to report an application of the bovine hairs from hair-save unhairing, i.e., preparing the filling agent for retanning, and the environmental and economic aspects of this utilization were discussed.

2. Recovery of Bovine Hairs with a Hair-save Unhairing Method

Fig.1 shows the hair-save unhairing method used in Zhaofu Leather Product Co., Ltd., Nanhai, Foshan, China. The lime-sulphide unhairing was carried out in a drum, where the hair was loosened by mechanical action and the friction among pelts during the chemical unhairing process that only attacked the hair roots. Then the unhairing liquor containing hair was discharged and filtered to obtain the bovine hairs and the filtrate which was recirculated after sedimentation. It should be noted that a self-developed machine was used to recover the bovine hairs with a high recovery ratio of above 97% (Fig.2).

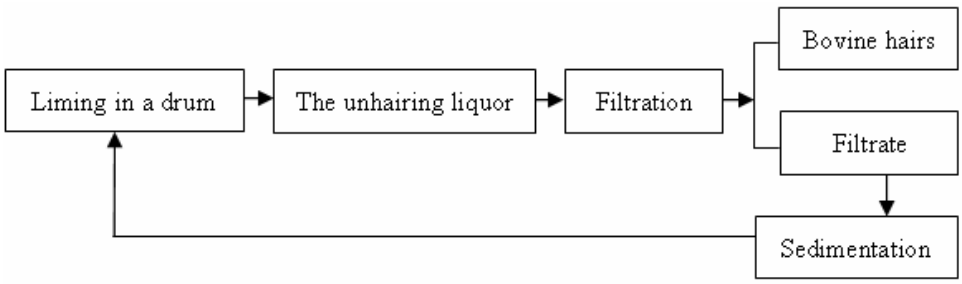

Fig.1 The hair-save unhairing process

3. Pilot-Scale Preparation of the Filling Agent for Retanning Using Bovine Hairs

Fig.3 indicates the use of bovine hairs for preparing the filling agent for retanning. The bovine hairs recovered from the unhairing process were firstly washed until a neutral or faintly basic pH was achieved and then the hairs were dehydrated by using a perforated container. Next, the hairs were subjected to a series of pretreatments and then hydrolyzed and filtered to obtain the filtrate, which was modified before concentrating and drying. The final product is powder and has a coffee appearance (Fig.4). Up to now, approximately 1200 tons of bovine hairs from hair-save unhairing were processed and about 380 tons of filling agents were prepared in Zhaofu Leather Product Co., Ltd., Nanhai, Foshan, China. Fig.5 shows the newly built workshop for preparing the filling agent for retanning by use of bovine hairs.

Fig.2 The self-developed machine for recovering bovine hairs in Zhaofu Leather Product Co., Ltd., Nanhai, Foshan, China

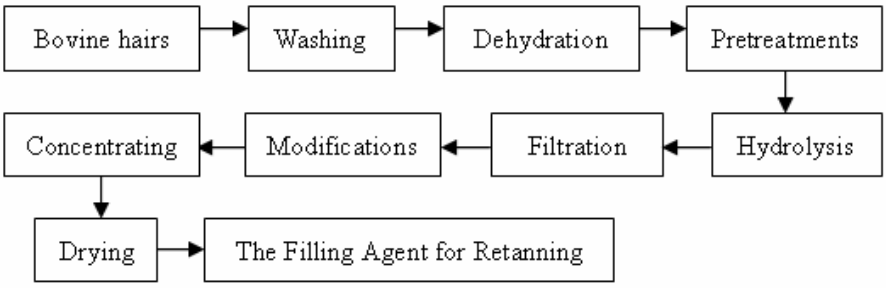

Fig.3 The use of bovine hairs for preparing the filling agent for retanning

Fig.4 The filling agent for retanning prepared from bovine hairs

Fig.5 The newly built workshop for preparing the filling agent for retanning in Zhaofu Leather Product Co., Ltd., Nanhai, Foshan, China

4. Pilot-Scale Leather Retanning with the Filling Agent

The filling agent prepared from bovine hairs was applied for retanning the wet blue in several tanneries. The retanning results showed that the fullness, softness and elasticity, as well as the thickness of the leather retanned with this filling agent were increased, and the retanned leather had fine and tight grain. Furthermore, the filling agent had assistant dyeing properties, and the tensile strength and tearing strength of the retanned leather were improved.

5. Environmental and Economic Benefits Analysis

Due to the recovery of bovine hairs, the concentration of suspended solids, total nitrogen, sulphide and chemical oxygen demand were reduced in wasted unhairing-liming liquor, resulting in an easier handling of the tannery wastewater. The testing of the unhairing liquor showed that chemical oxygen demand and total nitrogen were respectively reduced for 0.9094~0.9579 kg and 0.1179~0.1237 kg when recovering 1 kg bovine hairs on a dry weight basis. As far as the recovery of 1200 tons of bovine hairs is concerned, about 430 tons of chemical oxygen demand and 58 tons of total nitrogen were avoided discharging into the environment. In addition, the wastewater treatment charge decreased RMB 1.0 and the transport charge for tannery sludge was also reduced. Up to now, the environmental benefits amount to about RMB 750,000 has been produced as a result of the adoption of hair-save unhairing method in Zhaofu Leather Product Co., Ltd., Nanhai, Foshan, China.

The 380 tons of filling agents prepared from bovine hairs were all used in Zhaofu Leather Product Co., Ltd. to replace with the plant protein filling agent, which was purchased from the market with the price of RMB 12,000 per ton. Subtracting the production cost (about RMB

1,000 per ton) for preparing the filling agent from bovine hairs, the economic benefit of approximately RMB 4,200,000 has been brought for Zhaofu Leather Product Co., Ltd. due to the use of bovine hair protein filling agent for retanning.

6. Conclusions

This work has demonstrated that the bovine hairs recovered from hair-save unhairing could be used to prepare the filling agent for retanning with good filling effect. The pilot-scale utilization of bovine hairs presented here could produce relative considerable environmental and economic benefits, and would be beneficial to the widespread use of hair-save unhairing methods in leather industry.

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