Fatty Acids based Fatliquor with Antifogging Properties

Conference: 13th AICLST, Kolkata, 6–8 March 2026

Paper reference: TI-44/O

Printed pages: 146–148

Source: *Leather 2050: Challenges & Opportunities*, ILTA (2026)

Fatty Acids based Fatliquor with Antifogging Properties

1Principal Scientist, Inorganic and Physical Chemistry, Central Leather Research Institute, Council of Scientific

2Project Associate, CSIR Funded- Mission Mode project- Speciality chemicals, CSIR-Central Leather Research

Institute, Chennai, Academy of Scientific and Innovative Research (AcSIR), Ghaziabad-201002, India

Ref. No. TI-44/O

1Bindia Sahu, 2Aparna KT

and Research, Adyar, Chennai 600020, India

Abstract-

Fatliquoring is a crucial step in leather processing, where oils and lubricants are applied to improve leather's softness, flexibility, and durability. Traditional fatliquors, derived from animal fats, vegetable oils, and synthetic compounds, are valued for their cost-effectiveness and desirable properties. However, these conventional formulations often pose challenges related to fogging—a common issue where fatty residues volatilize and cause surface haze on leather products. The antifogging efficiency of fatliquors is greatly influenced by the molecular interactions within the fat matrix. Increased interactions between functional groups in fatty acids restrict their mobility, leading to higher fogging tendencies. To mitigate this, selecting suitable process and adopting emulsifier-free preparation methods are essential. Improved stability minimizes the volatilization of fatty residues, thereby significantly decreasing fogging effects. The transesterification of oil provides fatty acid ester which are derivatives of fatty acids which in turn act as antifog fatliquor. The castor oil and polyglycerol with 5 glycerol unit have been used for the transesterification process. The resultant fatliquor when applied on goat skin shows the antifog value less than 5mg. The other physical properties of experimental leathers are on par with the control leathers treated with commercial antifog fatliquor leather.

Key words- Fatty Acids, Fatliquor, Post tanning, Leather

Corresponding author email : bindia.clri@csir.res.in; bindiya1480@gmail.com

Introduction

Fatliquoring is an indispensable stage in the leather manufacturing process, serving to enhance the physical and aesthetic qualities of leather products. It involves the application of oils and lubricants—collectively known as fatliquors—that impart softness, flexibility, and durability, thereby elevating the overall quality of the finished leather1. Traditionally, fatliquors have been formulated from natural sources such as animal fats and vegetable oils, as well as synthetic compounds. These formulations are highly valued for their cost-effectiveness and ability to confer desirable properties to leather, making them a mainstay in the industry2.

Despite their numerous advantages, conventional fatliquors are associated with certain challenges that compromise both product quality and environmental sustainability. One prominent issue is fogging, a phenomenon characterized by the volatilization of fatty residues during or after the finishing process, which results in surface haze on the leather. Fogging not only detracts from the visual appeal but also raises concerns related to safety, cleanliness, and environmental impact. The antifogging efficiency of fatliquors is predominantly governed by the molecular interactions within their fat matrices. Increased interactions between functional groups in fatty acids tend to restrict molecular mobility, thereby elevating the likelihood of volatilization and subsequent fogging3.

To address these issues, it is essential to understand and control the molecular interactions within fatliquor formulations. Techniques such as selecting appropriate solvents and employing emulsifier-free preparation methods have been identified as effective strategies to mitigate undesired molecular interactions. These approaches promote better dispersibility and enhance the stability of fatliquors, which in turn reduces the volatilization of fatty residues and minimizes fogging. Achieving an optimal balance between formulation stability and performance is crucial for developing antifogging fatliquors that preserve leather quality while ensuring a clean, haze-free surface4.

This paper explores the underlying molecular mechanisms influencing the antifogging properties of fatliquors and investigates innovative formulation strategies aimed at reducing fogging. Emphasis is placed on the role of solvent selection and emulsifier-free techniques in enhancing stability and dispersibility. Through this study, we aim to contribute to the development of environmentally sustainable, high-performance fatliquors that meet the evolving demands of modern leather manufacturing, ultimately improving product quality and process efficiency.

The process focused on the preparation of fatliquor where fatty acid of castor oil has been trans- esterified with polyglycerol and the resultant product has been used as fatliquor. The trans-esterified castor oil fatliquor contains ester bonds formed between fatty acids and polyglycerol's hydroxyl groups. This creates an amphiphilic compound that forms a hydrophilic, water-retentive film on leather. The film attracts and holds a thin water layer, preventing water droplets from forming fog (antifog property). Additionally, it penetrates the leather fibers, coating them with a lubricating layer that reduces friction, enhances flexibility, and prevents cracking. When fatty acids undergo transesterification with polyglycerol, they are converted into esterified derivatives, reducing the concentration of free fatty acids (FFAs) on the leather surface. Free fatty acids are volatile compounds that can evaporate at ambient temperatures, releasing vapors that

contribute to fog formation. By increasing the degree of transesterification, the number of FFAs decreases, which in turn lowers the vapor pressure of these volatile acids. Consequently, fewer fatty acid vapors are released into the environment, diminishing fog formation. Chemically, this shift from free acids to ester bonds stabilizes the lipid layer, enhancing antifog properties while maintaining the desired lubricating and water-retentive effects on leather5,6.

Methodology

The transesterification of castor oil with polyglycerol, having 5 glycerol units are carried out in presence of p-toluene sulfonic acid at 200°C for 5 hrs7. The resultant solution shows clear miscibility with water and used as fatliquor. The 10% of fatliquor has been applied on goat skin against commercial antifogging fatliquor used as control.

Result & Discussion

The conversion of free fatty acids into trans-esterified products is a key chemical process that involves esterification, where fatty acids react with alcohol groups (such as glycerol derivatives) to form ester bonds. This reaction reduces the amount of free fatty acids present in the system. The acid value, a standard analytical parameter, measures the free fatty acid content in a sample by quantifying the amount of potassium hydroxide (KOH) required to neutralize the acids. As esterification progresses, the acid value decreases, indicating that a significant portion of free fatty acids has been converted into stable ester compounds. This reduction in free fatty acids is beneficial because free fatty acids are volatile and can evaporate, contributing to fog formation on the leather surface. By monitoring the acid value, it is possible to verify the extent of fatty acid conversion accurately. A lower acid value signifies more complete transesterification, leading to less fog formation and improved antifog properties in leather processing7. Finally, the fog value for the experimental leathers were found to be 5±2 mg as compare to control the control value 8±2 mg which indicates its efficiency towards low fog contribution.

Conclusion

In conclusion, monitoring the acid value provides a reliable and quantitative method to verify the conversion of free fatty acids into stable ester compounds during transesterification. A decrease in acid value indicates successful chemical transformation, reducing the volatility of free fatty acids that contribute to fog formation. This process enhances the antifog properties of leather by minimizing free fatty acids on the surface. Therefore, controlling and measuring the acid value is essential for optimizing the chemical treatment, ensuring effective fatty acid conversion, and achieving improved antifog performance in leather processing. The product may be applied on hides also for other industrial uses.

Reference

1. Kamely N, Fatliquors for leathers: an application of microemulsion—a review, Polymer Bulletin, 2022,79(3),1977-2002.

2. Zhang Y, Wang L, Recent research progress on leather fatliquoring agents, Polymer-Plastics Technology and Engineering. 2009,48(3),285-91.

3. Izzati Fatimah Wahab, A.R. Bushroa, Soon Wee Teck, Taium Tasneem Azmi, M.Z. Ibrahim, J.W. Lee, Fundamentals of antifogging strategies, coating techniques and properties of inorganic materials; a comprehensive review,Journal of Materials Research and Technology, 23, 2023, 687-714.

4. Jianzhong Ma, Chenyang Liu, Yuehong Zhang, Han Yao, Hongxia Yan,Toward low-misting leathers from environmentally friendly ricinoleic acid-based fatliquoring agents, Journal of Cleaner Production, 427, 2023, 139181

5. A.K. Sharma and R. K. Yadav, Role of Free Fatty Acids in Leather Fog Formation, International Journal of Leather Science,5,1, 2020, 23-30.

6. B Sahu, R Aravindhan, MA Javid, Application of Calophyllum inophyllum oil as antifungal fat-liquor for leather industry, Industrial Crops and Products, 2017,105, 104-112.

7. Y. Chen and H. Wang, Impact of Free Fatty Acids on Leather Quality, International Journal of Materials Science and Engineering,7,3,2018, 129-137.