Modern American Journal of Engineering, Technology, and Innovation
ISSN(E): 3067-7939
Volume 01, Issue 08, November, 2025
Website: usajournals.org

ECOLOGICAL ASSESSMENT OF WASTEWATER FROM THE DEGREASING STAGE IN THE LEATHER INDUSTRY

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Abstract

The article examines the ecological condition of wastewater generated at the leather degreasing stage. Three types of degreasing compositions were selected as the research objects: kerosene + surfactant (SFM), a surfactant composition without organic solvent, and a gasoline + surfactant (SFM) working solution based on a by-product. The results were analyzed in tables and graphs, and the ecological risk of the wastewater was assessed by comparing them with regulatory values. It was found that in the kerosene+SFM and especially in the SFM composition variants, the chemical oxygen demand (COD), nutrient content and non-natural substances significantly exceed the permissible limits, which leads to an increase in reagent consumption at treatment facilities and intensifies ecological risk. In the gasoline+SFM variant, the degreasing efficiency is satisfactory, while COD and nutrient concentrations are comparatively lower and closer to the standard values, and non-natural substances remain within the normative range. Therefore, the gasoline+SFM composition is recommended as the most balanced option from both technological and ecological viewpoints for the degreasing process.

Keywords: Ecological risk, wastewater, chemical oxygen demand (COD), nutrients, surfactant (SFM), gasoline+SFM, leather industry, degreasing, ecological assessment.

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Introduction

The leather industry is an important sector of human activity and serves as a basic source of raw materials for the production of footwear, clothing, household and special-purpose products. Leather raw materials are mainly obtained as by-products of meat production and processing industries. These by-products are converted, through special technologies, into finished leather and coated leather materials with high added value [1].

Leather processing involves multiple technological stages and requires large amounts of water and various chemical reagents. Water simultaneously serves as a technological medium and as a washing and cleaning agent. Therefore, rational use of water resources, efficient treatment of wastewater and the organization of their reuse are urgent tasks from the standpoint of environmental sustainability.

In particular, when chromium tanning technology is used, a part of chromium salts does not become firmly bound to the derma structure, passes into the wastewater and accumulates as sludge in treatment facilities [2]. Safe collection and disposal of such sludge is of special importance for environmental protection. High mineralization of wastewater, as well as contamination with nutrients and organic matter, also has a negative impact on the ecological state of water bodies.

The degreasing stage occupies a central position in the leather production chain. If the natural lipids present in the derma are not removed in a timely and sufficient manner, defects such as uneven colour, poor adhesion of the coating layer, greasy spots, and reduced mechanical strength and flexibility may appear in the finished leather. Therefore, the choice of degreasing method and working solution composition determines not only technological efficiency, but also the ecological characteristics of the wastewater generated.

Object and Methods of the Study

The research was carried out on three types of degreasing working solutions used in processing leather raw hides:

1. Kerosene + SFM (surfactant);
2. SFM composition without organic solvent;
3. Gasoline + SFM working solution based on an industrial by-product [3].

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The working solutions obtained after degreasing were analyzed in a sanitary-hygienic laboratory in accordance with current normative documents. The following main indicators were selected for evaluation: odour (in points), pH, non-natural substances, floating impurities, biochemical oxygen demand over 5 days (BOD (5)), chemical oxygen demand (COD), oils and fats, total nitrogen, phosphates.

In this study, the hygienic and ecological assessment of wastewater was carried out based on human health criteria and applicable sanitary standards. Odour, pH, the amount of non-natural substances and floating impurities, as well as biochemical and chemical oxygen demand, oils and fats, total nitrogen and phosphate concentrations were taken as key criteria. Maintaining these indicators within normative limits is considered a factor that ensures comfortable sanitary-hygienic conditions for workers, stable operation of sewerage and treatment facilities, and reduction of negative environmental impacts [4, 5].

Presentation of Results in Tabular and Graphical Form

The results obtained for the various degreasing working solutions [6–11] are presented in tabular form (Table).

The table presents a comparative analysis of the main hygienic indicators of untreated wastewater formed after processing hides with different degreasing agents. As can be seen, odour and pH in all variants are within sanitary limits, while in the Kerosene +SFM and especially in the SFM composition variants, non-natural substances, COD, total nitrogen and phosphates are significantly higher than permissible values. In the Gasolin+SFM variant, these parameters are comparatively lower, and the content of non-natural substances meets the normative limit.

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Table. Comparative analysis of the composition of wastewater containing different degreasing agents (without treatment)

Indicator	Normative value	Kerosin + SFM	SFM composition	Gasolin + SFM
Odour, points	≤ 2	1.8	0.7	1.5
pH	6.5–8.5	8.2	7.3	7.2
Non-natural substances, mg/dm^3	≤ 0.75	2.034	3.82	0.61
Floating impurities	Must not be detected	Detected	Detected	Detected
BOD(_5), mgO_2/dm^3	≤ 25	0.0	0.0	18.4
COD, mgO_2/dm^3	≤ 125	509.6	569.4	186.6
Oils and fats, mg/dm^3	≤ 0.8	0.84	0.5	0.6
Total nitrogen, mg/dm^3	≤ 15	45.4	45.3	18.3
Phosphates, mg/dm^3	≤ 2	4.34	4.52	3.2

One of the main integral indicators for assessing organic pollution in wastewater is chemical oxygen demand (COD). Figure 1 shows the comparative distribution of COD values for different degreasing compositions. The color scale reflects ecological risk: red – high, yellow – medium, green – relatively low risk.

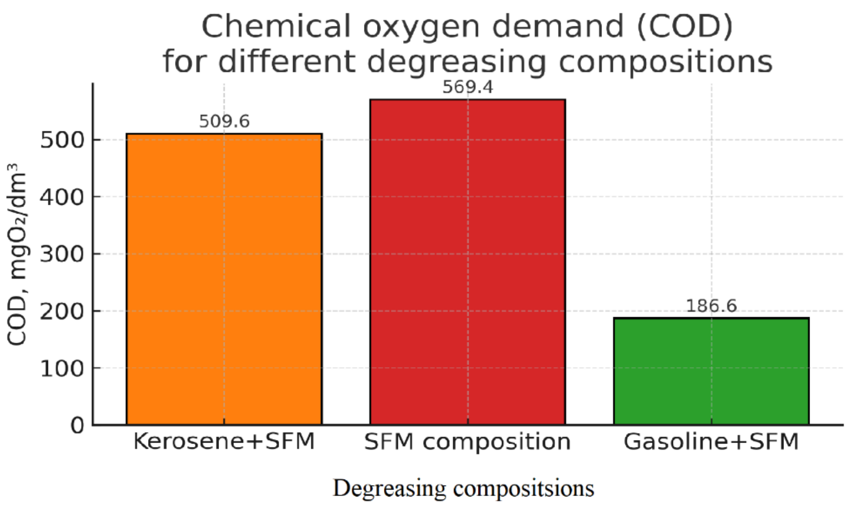

Fig. COD values of wastewater for different degreasing compositions.

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The highest COD value is observed in the SFM composition, while the lowest one is found in the Gasolin+SFM variant.

Discussion

The table and graphical data clearly demonstrate that COD values in the Kerosin+SFM and especially in the SFM composition variants are very high. This indicates a high content of chemically oxidisable organic substances in the wastewater and leads to an increase in reagent consumption at treatment facilities. In contrast, COD in the Gasolin+SFM composition is much lower, which means a reduction in overall organic pollution.

From the viewpoint of degreasing efficiency, the lowest residual fat content is recorded in the SFM composition. However, this variant is characterised by high concentrations of non-natural substances and nutrients, and therefore requires ecologically reinforced treatment systems. In the Gasolin+SFM variant, degreasing efficiency is satisfactory, non-natural substances remain within the standard limits, and nutrient levels are comparatively low. Thus, from the standpoint of balancing technological and ecological performance, this composition can be evaluated as the most favourable option.

Conclusion

The research has shown that the degreasing stage in leather production is a key link that determines not only the quality of the finished product but also the hygienic and ecological condition of the resulting wastewater. The Gasolin+SFM composition based on a by-product is recommended as the most balanced variant in terms of degreasing efficiency, COD, nutrient content and concentration of non-natural substances.

When using the SFM composition and Kerosin+SFM formulations, it is necessary to modernise treatment facilities, optimise reagent consumption and expand possibilities for wastewater reuse. Based on the results presented, enterprises can select a suitable degreasing regime and gradually reduce ecological risk.

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