Methods for the treatment and utilisation of distillation products of spent cooling lubricant emulsions from die-casting and machining processes

Abstract

The dissertation addresses the development of methods for the treatment and disposal of distillation products derived from spent emulsions used in the high-pressure casting process of aluminum parts produced for the automotive industry. The casting process requires the use of specialized cooling and lubricating emulsions, which lose their properties after use and must be replaced with a fresh batch. Due to their high stability, spent emulsions generate significant disposal costs, affecting the economic performance of the company. To reduce the disposal costs of spent emulsions, the company implemented an evaporation system, allowing for the separation of the emulsion stream into two products: the distillate, the main product, accounting for more than 90% of the feed stream volume, and the concentrate, which is the residue of the evaporation process. Due to their properties, both streams still need to be disposed of by external entities, generating significant costs for the company.

The dissertation aims to solve the issue of disposing of the products from the vacuum evaporation process of emulsions. It also presents an alternative approach to the research problem, focusing on the potential treatment of the spent emulsion stream before the vacuum evaporation process. Regarding the feed stream, i.e., the spent emulsion, studies were conducted on the effectiveness of separation methods, such as coagulation with flocculation, demulsification, and advanced oxidation methods. For the most promising methods—coagulation with flocculation and demulsification—optimization studies were carried out based on the turbidimetric method using the TurbiscanLab Expert apparatus (Formulaction), which allows for observing changes in the sample that cannot be recorded by other methods. For the concentrate stream, research was conducted on the use of separation methods, coagulation with flocculation, demulsification, and the applicability of the Fenton reaction to reduce the COD (Chemical Oxygen Demand) of the product. For the main product of the evaporation process, the distillate, studies were conducted on the applicability of advanced oxidation technologies and reverse osmosis to improve the parameters of the recovered water, enabling its reuse in processes related to the production of aluminum parts for the automotive industry.

Based on the results obtained and the economic analyses carried out, suitable technologies were selected to solve the problem of used emulsions and the optimum parameters of the proposed solutions were determined. The proposed solutions included the implementation of separation technologies of both coagulation with flocculation and demulsification for the stream of the spent emulsion and reverse osmosis technology for the stream of distillate or aqueous phase from separation processes. Proposed improvements included in the updated evaporation plant scheme. Due to the need for high concentrations of agents used in the treatment of the concentrate and other economic considerations, this stream was not included in the proposed improvement scheme. The implementation of the proposed improvements allows for substantial enhancement of the economic efficiency of the spent cooling and lubricating emulsions disposal process, as well as reducing environmental impact by reusing the recovered water in the cooling process of technological water required for high-pressure casting of aluminum parts.

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