engineering proceedings

MDPI

Proceeding Paper

A New Cost-Effective and Eco-Friendly Way to Recover Sulfuric Acid Waste Using Bleaching Soil †

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† Presented at the 1st International Electronic Conference on Processes: Processes System Innovation, 17–31 May 2022; Available online: https://sciforum.net/event/ECP2022.

Abstract: Sulfuric acid is one of the acidic wastes produced in the edible oil refining industry during testing to determine the oxidation stability of the oil. Sulfuric acid is required as a rinsing solvent to clean Rancimat glass tubes. This acid cannot be discharged directly into the environment. Use processing and acid consumption must be performed to comply with environmental quality standards. The aim of this study was to purify and recover acid waste. In this new method, first water and other solvents are removed under a vacuum system at 80 °C, then bleaching soil is added to sulfuric acid and placed at 80 °C for half an hour, and then white soil is added. The solvent is separated by centrifugation. Recovery was about 90%. An identical sample of oil with oxidation stability was tested with a Rancimat device and the results showed no change with fresh sulfuric acid. This study developed an innovative, effective, and simple method for the recycling of acid waste that can successfully resolve this significant problem in the industry. This method both reduces carbon emissions and recycles valuable resources, which is of important environmental and economic significance.

Keywords: sulfuric acid; waste; recovery; environmental

Citation: Fanimoghadam, H.; Kalantari, F.; Shoaie, E. A New Cost-Effective and Eco-Friendly Way to Recover Sulfuric Acid Waste Using Bleaching Soil. *Eng. Proc.* **2022**, *19*, 17. https://doi.org/10.3390/ECP2022-12619

Academic Editor: Giancarlo Cravotto

Published: 17 May 2022

1. Introduction

Industrial waste, which is a range of different processes that may be obtained, exists in solid, liquid, or gaseous forms. Its impact on environmental targets is considered due to its intricate and perilous nature, which affects active and inanimate living environments that environmentalists favor. Increasingly, there are common, important and difficult regulations regarding the discharge of acid and metal into the environment. the development of recycling/reuse of these effluents after proper treatment, the opinion of the research community to develop approaches and find new methods Acid recycling has attracted [1–3]. This paper presents a new approach to the recycling of acid waste generated by the edible oil refining industry, especially from oxidative stability experiments. We have examined various aspects of the production of these streams and the methods used to treat them to recover the acid for reuse or disposal [4–7].

Solvents determine axial attributes for chemical processing and chemical reactions, and are changing the game as much as catalysts. "Sustainable development", similar to the earlier ideas of "protection of the environment" or "ecology", has become a favorite phrase [8,9].

Green chemistry is trying to achieve stability at the molecular level. Since this goal is not surprising, it has been applied to all sectors of the industry. As a result of the increasing quantities of "necessities", products and consumer goods in everyday life, that are consumed, the label of homotechnology has been used many times for contemporary human beings. They may use the environment and its resources in vain. Alternatively, they may be eco-friendly by using little-waste technologies and restricting material consumption and by recycling waste and by-products. The small-measure activities of chemists, likewise laboratory experiments, can also have a negative impact on the environment, e.g., by the uncontrolled disposal of chemical wastes and spent reagents [8,9].

Recycling is a set of activities that involves collecting all kinds of recyclable materials and equipment. More than 5000 recyclable materials are available worldwide based on economic, social, and technological developments. Failure to reuse recyclable materials, meaning that they are spoiled or then perfectly destroyed by nature, demonstrates a great waste of resources and environmental damage [10].

Today, severe resource scarcity and environmental pollution remain a mystery of sustainable human development. Saving energy and reducing greenhouse gas emissions are inevitable historical trends [11].

Sulfuric acid is a highly corrosive mineral acid, formerly known as vitriol oil, which is a mineral acid composed of the elements sulfur, oxygen, and hydrogen with the molecular formula H_2SO_4. It is a colorless, odorless, and viscous liquid that can be mixed with water. With over 200 million tons per year, it is the most widely consumed chemical in the world [12]. Chemical plant waste acid streams are often simply neutralized prior to transfer to wastewater treatment facilities. Rising operating costs in difficult economic times create the need to recover the sulfuric acid for further use. Stricter environmental regulations globally also mandate recovery of sulfuric acid rather than disposing of it through waste treatment [13–15].

In this study, the R&D Team of Behshahr Industrial Company (BIC) developed a method using decolorizing soil for sulfuric acid recycling, which is one of the positive points of the non-emission of toxic gases, and it is cheap, simple, up to date, effective, and high efficiency.

2. Experimental Section

2.1. Materials and Equipment

All commercially available chemicals were purchased from the Merck or Aldrich companies and used without further purifications; the 743 Rancimat model was used to determine the oxidation stability. Active bleaching soil was prepared from the Iran Jam Mining Company.

2.2. Method of Recycling Sulfuric Acid Using Bleaching Soil

The 100 cc of sulfuric acid obtained during the washing of glass tubes was transferred to a 3-port balloon. Then, the temperature was raised to 80 °C and a trap was closed in the path of the vacuum pump to prevent the release of possible toxic gases. Next, the possible solvents were removed from the acid under vacuum. Then, the vacuum was turned off and 0.5% *w*/*w* by weight of bleaching soil was added in a vacuum at 80 °C for 30 min. The acid was allowed to cool, and the bleaching soil was separated with a centrifuge. See the figure for the new method of sulfuric acid recycling with the help of bleaching soil (Figure 1).

Figure 1. New sulfuric acid recycling system with bleaching soil.

3. Results and Discussion

3.1. Optimization of Conditions for Sulfuric Acid Recycling Using Bleaching Soil

To demonstrate the efficiency of this method, we optimized the amount of bleaching soil used for 100 cc of sulfuric acid recycling, which yielded an optimized amount of 0.5% *w*/*w* of bleaching soil at 80 °C under vacuum (Table 1).

Table 1. Optimization of conditions for sulfuric acid recycling using bleaching soil.

Entry	Bleaching Soil Loading (*w*/*w*%)	Conditions	Temperature (°C)	Time (min)	Yield (%)
1	0.25	Vacuum	80	70	50
2	0.5	Vacuum	80	30	90
3	1	Vacuum	80	45	81
4	2	Vacuum	80	40	78
5	0.25	Reflux	80	120	30
6	0.5	Reflux	80	100	45
7	1	Reflux	80	90	55
8	2	Reflux	80	80	60

3.2. Comparison of Fresh and Recycled Sulfuric Acid and Not Recycled Sulfuric Acid, by Means of Oxidative Stability Test of Sunflower Oil

To compare recycled sulfuric acid with fresh sulfuric acid and unrecycled sulfuric acid, we transferred a certain amount of the same amount of sunflower oil to the pipes of the Rancimat device, which were washed with each of these three types of sulfuric acid. We measured its oxidative stability using a Rancimat device and found that there was no difference between recycled sulfuric acid and fresh sulfuric acid. The oxidative stability value for sunflower oil, the tubes of which were washed with freshly recycled sulfuric acid, was about 11.7 h, which confirms the correctness of this method (Figure 2).

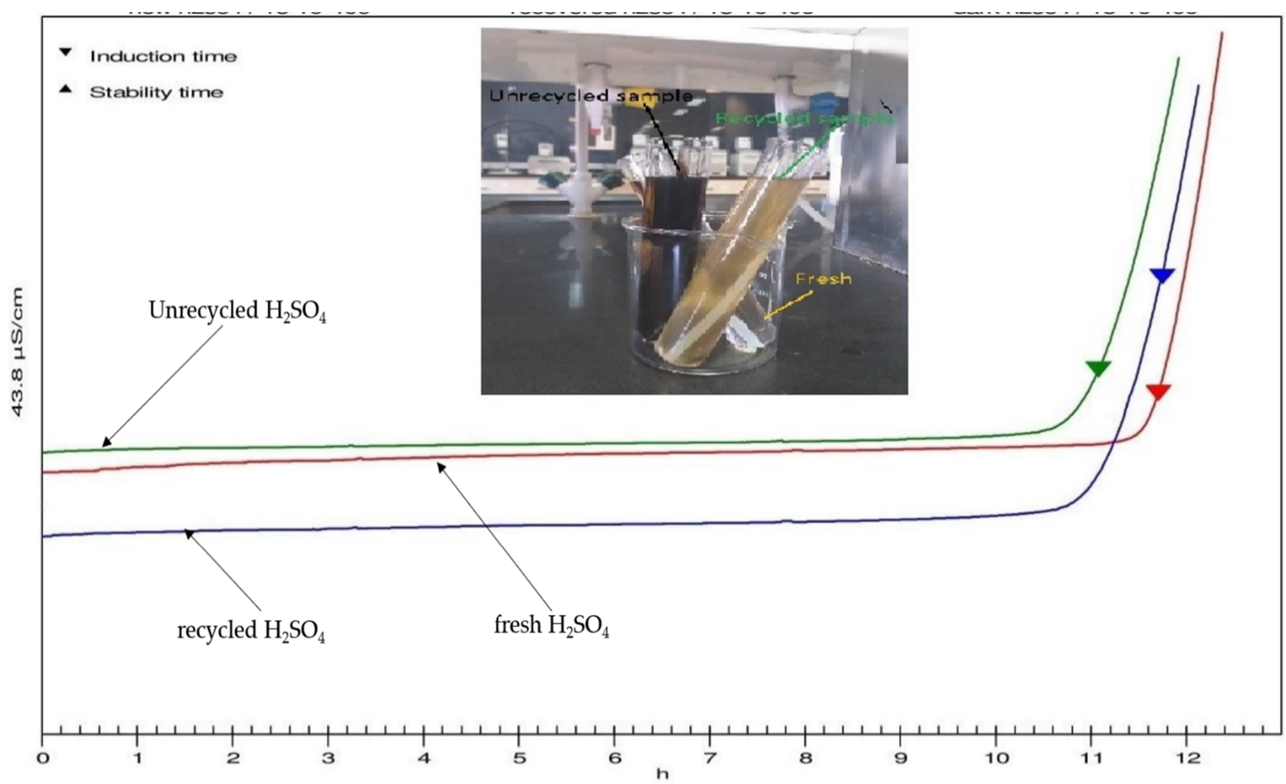

Figure 2. Comparison of fresh and recycled sulfuric acid and not recycled sulfuric acid by means of oxidative stability test of sunflower oil.

4. Conclusions

Sulfuric acid is one of the acidic wastes produced in the edible oil refining industry during testing to determine the oxidation stability of the oil. Sulfuric acid is required as a rinsing solvent to clean Rancimat glass tubes. This acid cannot be discharged directly into the environment. Use processing and acid consumption must be performed to comply with environmental quality standards. The aim of this study was to purify and recover acid waste. In this new method, first water and other solvents are removed under a vacuum system at 80 °C, then bleaching soil is added to sulfuric acid and placed at 80 °C for half an hour, and then white soil is added. The solvent is separated by centrifugation. Recovery was about 90%. An identical sample of oil with oxidation stability was tested with a Rancimat device and the results showed no change with fresh sulfuric acid. This study developed an innovative, effective, and simple method for the recycling of acid waste that can successfully resolve this significant problem in the industry. This method both reduces carbon emissions and recycles valuable resources, which is of important environmental and economic significance.

Author Contributions: Conceptualization and methodology H.F.; conducted the experiments. supervision, data interpretation, and editing of the manuscript E.S. and F.K. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Data are contained within the article.

Acknowledgments: The authors would like to acknowledge the Research and Development Laboratory, Behshahr Industrial Company (BIC), Iran and the Savola Group, who contributed to this work.

Conflicts of Interest: The authors declare no conflict of interest.

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