

Analysis and Comparison of Different Dewatering Methods On Salt Quality

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Abstract. The salt quality was studied by dewatering methods such as centrifugal hydro extraction, fixed bed dryer, and rotary drum dryer. The effect of different salt particle sizes was also analyzed. The centrifugal hydro extractor is found to be effective when reducing the high-water content of salt and suitable for reducing water content after the salt wash stage. Fixed bed dryers produce lower water content than rotary drum dryers. A water content lower than 1% can be achieved using fixed bed dryers. Finally, all dewatering methods such as centrifugal hydro extractors, fixed bed dryers, and rotary bed dryers are suitable for salt production methods. Reduced salt particle size from 30 to 60 mesh also improved the drying performance.

Keyword: Salt Quality, Dewatering Methods, Centrifugal Hydro Extraction

1 Introduction

Madura Island has a massive number of solar salt ponds. It is spread over in all districts in Madura Island and has developed since the Dutch occupation era [1]. Farmer in Madura produces salt with traditional methods, and they highly depend on the weather condition [2], [3]. The produced salt is packed in blue sacks then stored at the warehouse around the solar salt pond, as shown in Figure 1. The crude solar salt is processed in the factory to improve the quality and consumed by industry. Several chemical and engineering methods have been proposed to produce better salt quality [4]–[8]. The dewatering method was used to reduce particle water content by centrifugation and drying [9]. Commonly in industry, the crude solar salt is ground then washed with saturated brine water in the initial stage. A Centrifugal hydroextractor is used to reduce the water content after the washing stage. The drying process is used before salt is ready to pack. The drying method has been widely used in industry to improve the quality of the product [10]–[13]. In addition, salt drying is a critical method in the salt industry to improve salt quality [14]. To reduce the cost of production, necessary to adapt the effective salt drying technology. However, drying is one of the most energy-consuming in industries and has its advantages and disadvantages [15]–[17]. The selection of drying technology is essential to produce better salt quality at an economical price. The objective of this

work was to analyze and comparison of different dewatering methods on salt quality. The dewatering methods such as centrifugal hydroextractor, fixed bed dryer, and rotary drum dryer were examined.



(a)



(b)

Fig.1. Traditional salt (a) packed in a blue sack, (b) storage near the solar salt pond

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The effect of different salt particle sizes was also compared. In addition, the quality of salt will be measured on water content percent. This study result was significant as guidance for developing a salt processing industry, mainly producing dried salt products required by industry.

2 Materials and methods

2.1 Salt materials

Crude solar salt was supplied by the traditional solar salt pond and taken from the exact location to ensure the same quality. The crude solar salt was milled to a particle size 30 and 60 mesh by micro mill equipment.

2.2 Dewatering Methods

Centrifugal hydro extractor procedure: The salt sample was washed in saturated brine for 2 minutes. After the salt wash process, salt drained until 30% water content and then put on 50 microns white fine transparent wrapping cloth before dewatering process. The dewatering process by centrifugal hydro extractor was conducted at different dewatering times (10, 15, 20, 25, 30 minutes). The rotational speed was maintained at 750 rpm.

Fixed bed dryer and rotary drum drying procedure: The salt sample was first washed in saturated brine for 2 minutes, and it drained by the centrifugal hydro extractor to reduce the water content until 11%, then it was dried at 70°C for 5 minutes to ensure the sample has 10% water content uniformity. The dried crude solar salt samples were stored on a polyethylene storage box before the drying process. The dewatering process by fixed bed hot air and rotary drum drying was conducted at different dewatering times (10, 15, 20, 25, 30 minutes). For the rotary drum dryer, the different dewatering times were conducted by varying rotational rpm. The drying temperature was fixed at 80°C for both dryers. The fixed bed dryer using no head cover, so the moisture is quickly released into the environment.

2.3 Water Contents

The water content of salt samples was determined by oven drying to a constant mass at 105°C for 6 hours [14].

3 Results and discussion

3.1 Centrifugal hydro extractor

Centrifugal hydroextractor was critical equipment to reduce the water content after the salt wash process. With increasing dewatering time from 10 to 30 minutes, the water content reduced slightly for all particle sizes, as shown in Figure 2. In addition, a centrifugal hydro extractor has a high potential to reduce high water content in a short time. The water content reduced from 30% to 10,5% and 9,89 in 10 minutes for 30 mesh and 60 mesh salt particle size, respectively. However, this

equipment does not effectively reduce small water content, after 10% water content is achieved, the slightly reduced water content is gained. Increase the dewatering time from 10 to 30 minutes only 1,55% and 1,78% water content reduced for 30 mesh and 60 mesh, respectively. Reduced particle size improves the dewatering process. For example, in 10 minutes of dewatering time, 60 mesh salt particle size has lower water content than 30 mesh, as shown in Figure 2

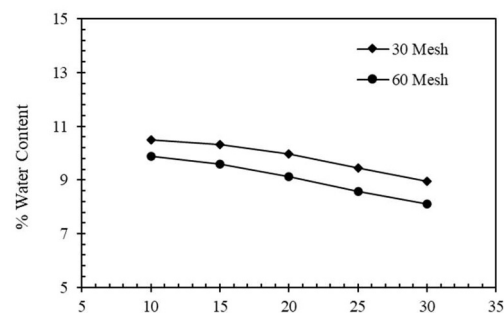


Fig.2. Effect of dewatering time on water content using centrifugal hydroextractor

3.2 Fixed Bed Dryers

The drying process was a vital process for salt industry application to produce dry salt crystals. Figure 3. shows that increased the dewatering time will reduce the water content. The water content reduced from 8,43% to 1,18% when the dewatering time was increased from 10 to 30 minutes for 30 mesh particle size.

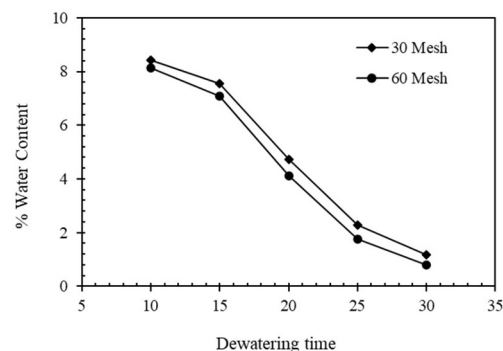


Fig.3. Effect of dewatering time on water content using fixed bed dryer

The lowest water content was obtained in 60 mesh particle size, indicating that reducing particle size improves the drying process. This was due to smaller particle sizes provide a larger surface area then it improves the drying process [18], [19]. In addition, reduced particle size also breaks the porosity of the salt crystal then releases the water content inside the salt crystal. Drying salt with a fixed bed dryer is suitable for producing high-quality dry salt crystals accepted by the industry. The lowest water content obtained by using a fixed bed dryer was 0,8%, as shown in Figure 3.

3.3 Rotary Drum Dryers

A rotary drum dryer is commonly used in the salt industry to reduce salt the water content of salt particles [20]. Figure 4. shows that the rotary drum drying removed the water content with increasing temperature.

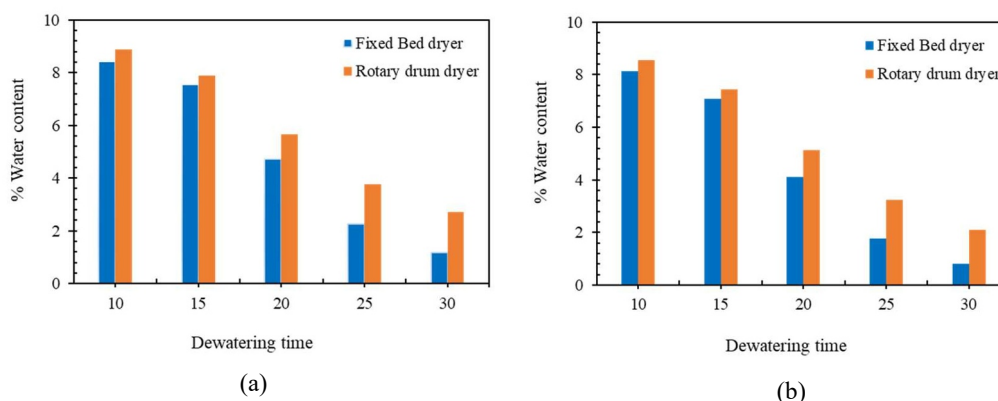


Figure 5. Effect of dewatering time on water content from different dewatering methods for (a) 30 mesh, (b) 60 mesh particle size

The water content reduced from 8,89% to 2,72% when the dewatering time was increased from 10 to 30 minutes for 30 mesh particle size. Like a fixed bed dryer, the water content decreased significantly after 15 minutes of dewatering time and decreased slowly after 25 minutes. It also indicates that the dewatering time required to reach the lowest water content was 30 minutes, as shown in Figure 4.

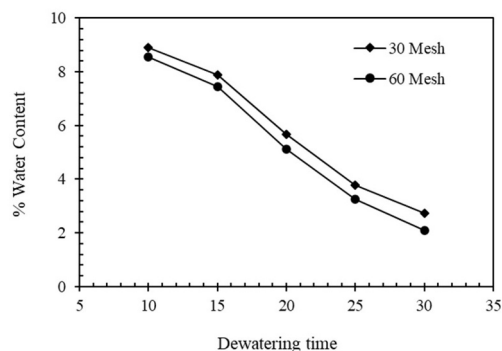


Fig.4. Effect of dewatering time on water content using rotary drum dryer

3.4 Comparison dewatering methods

Water content is considered one of the critical requirements for the salt industry. Fig. 5 gives results of reducing water content with increasing dewatering time in fixed bed and rotary drum dryers. It has been shown that 30 minutes of dewatering time is needed to obtain the water content below 2% for both dewatering methods. The water content result of using a fixed bed dryer was lower than the rotary drum dryer. At 30 minutes with 30 mesh particle size, the water content was 1,18% and 2,72% obtained by the fixed bed and

rotary drum dryer, respectively. Using a fixed bed dryer provides a higher drying rate and thus leads to a reduced high amount of water content [17]. This is why the water content of the fixed bed dryer was lower than the rotary drum dryer.

Reduced particle size also improved the dewatering performances. For example, using a fixed bed dryer in 30 minutes provides 1,18% and 0,8% water content for 30 and 60 mesh, respectively. The lowest water content was obtained for the fixed bed and rotary drum dryer in 30 minutes were 0,8% and 2,1%, respectively.

4 Conclusions

The salt property, such as water content, is fundamental in industry and is significantly impacted by dewatering methods. The dewatering methods such as centrifugal hydroextractor, fixed bed dryer, and rotary drum dryer have been investigated. Based on this study, several dewatering methods have different functions and must be correctly chosen in the salt industry. Centrifugal hydroextractor is suitable for utilization after the salt wash process due to quickly reducing a high amount of water content. However, this method does not give any advantages to reduce small water content. Among the drying methods, a fixed bed dryer led to the lowest water content. A fixed bed dryer is an appropriate drying method for industrial-scale because it produces salt with water content lower than 1%. Reduce the particle size also improve the performance of the drying method.

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