Evaporation Rate, Meteorological And Physical Condition Of Salt Crystallizer Pond In Pamekasan, Indonesia

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Abstract. Salt is a strategic commodity that is no less important than other basic needs, this is because salt is an industrial raw material and foodstuffs including for households, the food industry, the CAP industry, pharmaceuticals and petroleum.. The main sources of salt are sea water, rock salt (NaCl mineral halite), and salt lake water. Evaporating sea water is the common method that used to produce salt in Indonesia. Therefore by using the seawater evaporation method, the weather and physical factors of the salt pond will affect salt production. This research purpose to determine evaporation rate, meteoroogical and physical condition of salt cristalizer pond. Measurement of relative humidity, wind speed, brine consentration, temperature (air, soil, and brine), and brine volume were conducted at three salt crystallizer ponds. This parameters were meassured every six hours. The meassurement started from brine entering the salt crystallizer pond until salt harvesting. The result showed that salt could be produce even though the humidity and wind speed in this area were out of the standart criteria recomended (<50% humidity and >5 m/s for wind speed). in addition, the soil temperature is several times higher than the temperature of water and air because the soil is able to withstand the absorbed heat. The highest evaporation of brine in crystallizer pond occurs at 7 am to 7 pm.

1. Introduction

Salt is a strategic commodity that is no less important than other basic needs, this is because salt is an industrial raw material and foodstuffs including for households, the food industry, the CAP industry, pharmaceuticals and petroleum. The need for salt in Indonesia (food and non-food salt) is increasing every year. In 2007, it was recorded that the need for salt was 2.7 million tons, increasing to 3.7 million tons in 2015. Based on this data, a total of 647.6 million tons (17.3%) is the need for consumption salt and 3.1 million tons (82.7%) is industrial salt [1]

East Java Province is one of the largest salt producing regions in Indonesia, even Madura, which consists of Bangkalan, Sampang, Pamekasan and Sumenep districts, is dubbed the "Salt Island", because it is the largest salt producing island. Indonesia, especially the island of Madura, has regional conditions suitable for the development of a salt business, tropical climatic conditions where there is full radiation throughout the day so as to optimize salt production. However because the salt production method used is the evaporation method so that in the course of the production of salt it depends on the weather[2], [3].. Salt production problems faced by salt farmers are the low quality of salt. Most of the salt-making processes in Indonesia use total crystalization technology, so the resulting salt products tend to have NaCl levels of less than 80% and fall into the 3rd quality category, where NaCl levels are <94%. The quality of salt produced in people's salt production is influenced by the source of sea water used for salt raw materials and salt production methods [4, 5]. Compounds contained in seawater such as sodium, magnesium, calcium, chloride and sulfate are undesirable compounds and affect the levels of NaCl found in the production of public salt. Arwiyah stated that

apart from weather conditions, the physical conditions of the salt pond land can also affect the quality of the salt produced [6]. In addition, the evaporation rate and other environmental factors can be used for salt pond land management[4] The purpose of this study was to investigate the rate of evaporation, meteorological and physical conditions of the salt ponds in Lembung village, Galis subdistrict, Pamekasan district.

2. Methodology

The research was conducted on September 22th to October 2nd , 2020 in Lembung village, Galis subdistrict, Pamekasan district. The map of research site is shown in figure 1. The research method used in this research is descriptive method. The salt pond operated with Teknik Ulir technology. The measurement of evaporation rate, meteorogical and physical parameter of salt pond were performed every six hour (7 am, 13 pm, 7 pm and 12 am) in crystallizer pond.

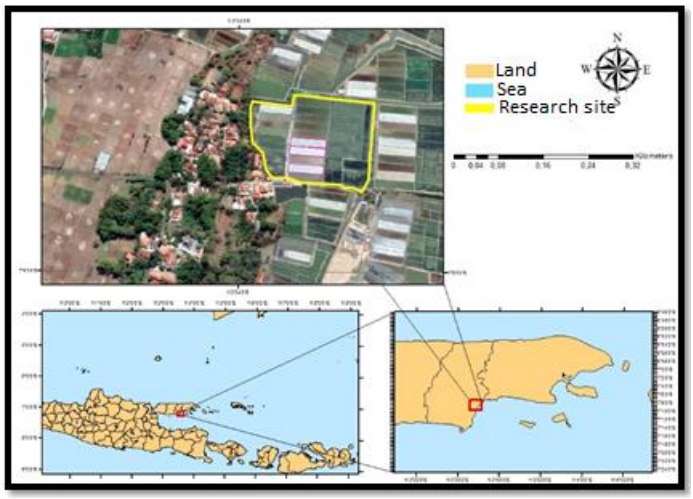

Figure 1. Map of Research Site

2.1. Meteorological Parameter

Meteorological parameters measured consist of wind speed, relative humidity and air temperature. Wind speed measurement used an anemometer, while for relative humidity and air temperature using a hygrometer.

2.2. Soil temperature

The soil temperature was determined using soil test. Soil temperature measurement by inserting the soil test sensor into the soil then reading the results of the numbers shown by soil test.

2.3. Brine temperature and density

The brine temperature was measured using thermometer. Meanwhile the density was measured using baume meter.

2.4. Evaporation Rate

Evaporation rate measurement was performed by measuring the volume of water every six hours (7 am, 13 pm, 7 pm and 13 am). The volume of evaporated water is used to determine the rate of evaporation using the teoledo formula with modification:

$$W = Mw/t \quad \text{.....(1)}$$

Where W is Evaporation Rate (mm/6 hours), Mw is cross-sectional area, and T is time (6 hours).

3. Result

The salt pond consist of reservoir, evaporator with ulir system, and crystallizer ponds[7]. The salt pond in the site researh is also consist of channel and pre-crystallizer pond. The crystallizer pond area is 24m^2 with 4m wide and 6m for the length.

3.1. Meteorological Characteristc

*The meteorological p*arameter was showen in figure 2. The figure generally observed that the pattern of the wind speed was in direct proportion to the pattern of the air temperature, but inverse to the pattern of the relative humidity. interestingly, an anomaly was observed in the patterns in which the humidity was significantly increased. This was also followed by the increase of the wind speed. It can be explained that the increase of temperature accumulates the water vapor resulted from seawater/brine evaporation. Hence, it also results in the movement of saturated vapor into a less dense and drier air column, which contributes to the formation of strong sea breezes during the day [8]. The results show that wind speed contributes to the drying process in non-isothermal systems. The high wind speeds will increase heat and mass transfer by convection in the free flow area [9]

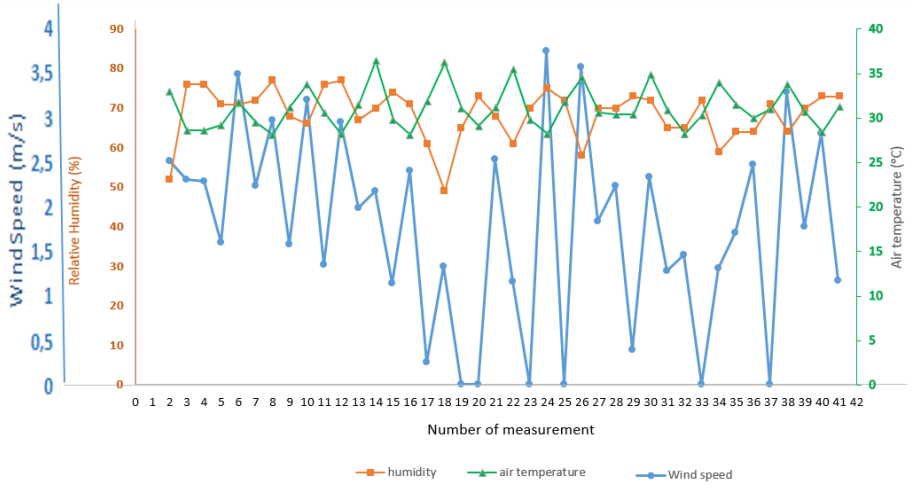

Figure 2. Measurement Result of Air Temperature, Wind Speed, and Relative Humidity

The wind speed of this area is 0 m/s - 3,652 m/s with average 1,725175 m/s. The wind speed average value is below of the wind speed recomendation of salt production. From previous several studies, the wind speed recomendation of salt production is more than 5 m/s[10],[11],[12]. The wind speeds in the area could help the iso-thermal evaporation, so that could accelerate the production of the salt. studies have been conducted Davarzani *et. al* (2014) revealed that the optimum wind speed is between 2-6 m/s[9].

The relative humidity of this area is 49%-77 %, the lowest occurred at measurement No. 11 at 1 pm and the highest at measurement no. 17 at 1 am. Based on this, according to the conditions of relative humidity in this area it is less favorable for salt production. This is because several previous studies have revealed that the relative humidity suitable for salt production is less than 50% [10],[11],[12].

3.2. Air, Brine and Soil temperature

The present study showed that the highest temperature of brine was observed at noon (1 pm) and morning (7 am) i.e 43,8^{O}C and the lowest temperature at midnigth (1 am) 26^{O}C (Figure 3). The figure showed that the air, brine and soil temperature has similar pattern, but in several time the soil temperature and water temperature were higer than air temperature. Previous studies have also shown that water and soil are able to store heat[8].

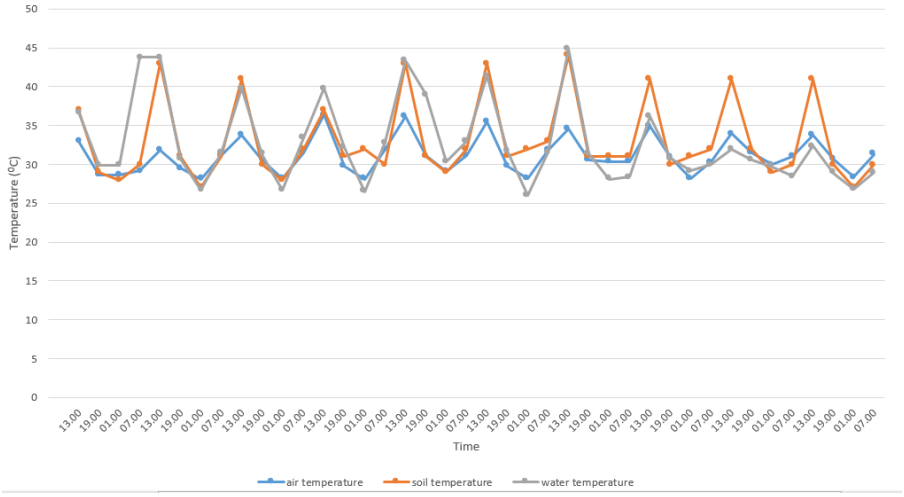

Figure 3. Temperature of Water, Air and Soil in Salt Pond

3.3. Brine Evaporation Rate

The graph shows that a high rate of evaporation occurs from 7 am to 7 pm (figure 4). This is because the sun's energy at that time is bouncing optimally so that the brine is evaporated properly, besides that the weather factor also greatly determines the rate of evaporation. In the figure 4 at 7 am to 7 pm there is no evaporation rate, this is due to the addition of brine to the cristallyzer.

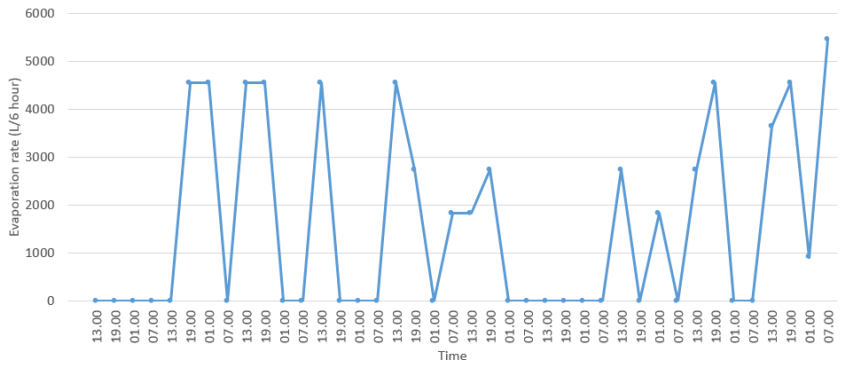

Figure 4. Evaporation Rate of Brine in Crystallizer pond

4. Conclusion

The meteorological parameters (relative humidity and wind speed) in the salt pond are below of the value that recomendation for salt production. in addition, the soil temperature is several times higher than the temperature of water and air because the soil is able to withstand the absorbed heat. The highest evaporation of brine in crystallizer pond occurs at 7 am to 7 pm

5. Reference

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