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Concentration of Ammonia Pollution in Madura Traditional Salt Production Water

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ABSTRACT

Ammonia (NH_3) is one of the impurities in salt-producing water, which is often found in the traditional salt ponds of the Madurese. The purpose of this study was to determine the concentration of ammonia contamination as an impurity in salt production process water from raw water, reservoir ponds, evaporator ponds to geomembrane crystallizer ponds when salt production takes place in the salt ponds of Tanjungan Village, Bangkalan Regency. Determination of ammonia concentration using the phenate method based on SNI 06-6989.30-2005 with a spectrophotometer reading tool (UV-2700 Serial No. A11674900027) at a wavelength of 420 nm. The average concentration of ammonia as an impurity in raw materials in traditional pond ponds in Tajungan village, namely raw water is 2.31±0.24 mg/L, reservoir ponds are 2.56±0.57 mg/L, evaporator ponds are 2, 39±0.84 mg/L and the geomembrane crystallizer ponds are 1.37±0.09 mg/L. The highest average ammonia concentration was found in the reservoir ponds raw saltwater sample, while the lowest concentration was found in the geomembrane crystallizer ponds sample. The high average ammonia concentration in the salt ponds of Tajungan Village, Bangkalan Regency indicates that all raw saltwater in these ponds is contaminated with ammonia. The high concentration of ammonia in the salt ponds may be due to the entry of household waste.

Keywords: (NH_3), raw water, reservoir ponds, evaporation ponds, geomembrane crystallizer ponds

ABSTRAK

Amoniak (NH_3) merupakan salah satu unsur pengotor air produksi garam yang sering ditemukan di tambak garam tradisional rakyat Madura. Tujuan penelitian ini adalah pengujian awal untuk mengetahui konsentrasi cemaran amonia sebagai pengotor pada air proses produksi garam mulai air baku garam, bozem, peminihan hingga meja kristalisasi garam saat produksi garam berlangsung di tambak garam Desa Tanjungan Kebupaten Bangkalan. Penentuan konsentrasi amonia menggunakan metode fenat berdasarkan SNI 06-6989.30-2005 dengan alat pembacaan spektrofotometer (UV-2700 Serial No A11674900027) pada panjang gelombang 420 nm. Rata-rata konsentrasi amonia sebagai pengotor bahan baku di kolam tambak tradisional desa Tajungan yaitu air baku sebesar 2,31± 0, 24 mg/L, waduk/bouzem sebesar 2,56±0,57 mg/L, kolam peminihan sebesar 2,39±0,84 mg/L dan meja kristalisasi geomembran sebesar 1,37±0,09 mg/L. Rata-rata konsentrasi amonia tertinggi terdapat di sampel air baku garam reservoir ponds, sedangkan konsentrasi terendah ditemukan pada sampel geomembran crystalyzer ponds. Tingginya rata-rata konsentrasi amoniak di tambak garam masyarakat Desa Tajungan, Kabupaten Bangkalan mengindikasikan bahwa semua air baku garam pada tambak ini tercemar amonia. Tingginya konsentrasi amonia di tambak garam kemungkinan disebabkan masuknya limbah rumah tangga.

Kata kunci: Amonia (NH_3), air baku, waduk, kolam peminihan, meja kristalisasi geomembran

1. Introduction

Salt is one of the mineral-rich products for food and non-food needs. According to Redjeki and Iriani (2021) the use of salt is not only for consumption but on an industrial scale requires, salt also use for pharmaceutical needs. The

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total need for salt for national food and non-food needs has increased every year. The total national salt demand in 2013 was 3,57 million tons, then increased in 2021 to 4.6 million tons, with a local salt absorption target of up to 1,5 million tons (Ministry of Industry, 2021). Salt is formed from the central element in the form of NaCl (Sodium Chloride) and the rest in the form of other elements in small concentrations in the form of Fe_3O_3, Ca, Mg and SO4, are impurities (Efendy *et al*., 2012). These impurity elements are not expected to exist in industrial salt. An ammonia compound that can be categorized as a salt impurity, especially in raw saltwater, is ammonia.

Ammonia (NH_3) is an inorganic nitrogen compound that can dissolve in water (Connel and Miller, 1995). It can turn into NH_4 compounds or what is known as ammonium (Putri *et al*., 2019). The accumulation of high ammonia concentration can kill organisms in the waters (Harahap, 2015). The threat of the toxicity of this compound was investigated as a contaminant that endangers aquaculture and tourism activities because it can trigger an increase in the population of toxic algae and mass death of phytoplankton (Hendrawati *et al*., 2008). The quality standard of ammonia concentration in seawater for marine tourism activities and marine organisms is regulated in the Keputusan Menteri Negara Lingkungan Hidup Republik Indonesia nomor 51 tahun 2004, namely 0.3 mg/l (Keputusan Menteri Negara Lingkungan Hidup Republik Indonesia, 2004). The rules and standards for determining the quality standard for ammonia concentration in seawater as a raw material for salt to determine salt quality are not yet available. However, the concentration of ammonia contamination can inform the presence of this element as an impurity and an unwanted element in the raw water for salt production. The ammonia concentration in salt production process water can also describe the diversity of organisms living in salt ponds, ranging from raw water, reservoir ponds, evaporator ponds and geomembrane crystallizer ponds during salt production. This is because ammonia is a class of chemical substances derived from the metabolic processes of living things and the decomposition process of dead organisms (Sutomo, 1989).

Observations of the concentration of ammonia contamination raw saltwater as one of the impurities in raw saltwater in traditional salt ponds are rarely carried out. It is interesting to study ammonia concentration testing because the source of this compound enters seawater as raw material for salt, which comes from the faeces of living things such as urine and faeces, microbiological oxidation of organic substances domestic wastewater (Putri *et al*., 2019). Most coastal communities on Madura Island believe that the sea is a dumping ground for garbage (Romdana *et al*., 2020). This assumption and paradigm can trigger high impurities in raw saltwater, especially ammonia. The lack of data and information about the distribution of ammonia concentration as an impurity in raw water for traditional Madura salt production, especially in Tajungan village, Bangkalan Regency, is the background of this research. The purpose of this study was an initial test to determine the concentration of ammonia contaminants as an impurity in salt production process water, starting from raw water, reservoir ponds, evaporator ponds and geomembrane crystallizer ponds during salt production during salt production. Observation of the concentration of ammonia contamination in raw water for traditional Madura salt production is vital as initial information related to the description of the distribution of ammonia contamination as an impurity in raw water (upstream) to geomembrane crystallizer ponds water (downstream).

2. Material and Method

2.1 Material

This research was conducted from September 13 to November 1, 2021. Samples of the main raw material for making salt were collected from traditional salt ponds from Tajungan village, Bangkalan Regency. The position of the traditional pond is close to the mangrove ecosystem and utilizes residents. Ammonia contamination activity from domestic waste disposal is often found in river areas towards the sea where the raw material for saltwater is made. The water samples tested came from 4 points, namely seawater as raw water, reservoir pond, evaporator pond and geomembrane crystallizer pond. Water samples were collected during the salt production process in both ponds. Ammonia concentration test was carried out at the Oceanography Laboratory of the Marine Science Study Program, Madura Trunojoyo University.

2.2 Methods

Samples of raw saltwater were taken as much as 1500 mL from raw water, stabilization ponds, evaporation ponds, and geomembrane crystallization ponds. The collected samples were stored in a coolbox so that the sample position was safe, then brought to the oceanography laboratory of the Marine Science Study Program, Madura Trunojoyo University. Analysis of ammonia testing in saltwater samples was carried out using the phenate method based on SNI 06-6989.30-2005 which was carried out in the oceanography laboratory of the Marine Science Study Program, , Madura Trunojoyo University. The principle of this method is based on reading the concentration of ammonia in the sample reacting with hypochlorite and phenol catalyzed by sodium nitroprusside. The intensity of the color produced is in the form of indophenol blue compounds. The solutions prepared were in the form of reagent solutions, blank solutions, a series of working solutions, and test samples. Ammonia concentration was read using a spectrophotometer (UV-2700 Serial No. A11674900027) level reading device at a wavelength of 420 nm. The concentration of ammonia in the sample was obtained from the results of linear regression calculation of the ammonia calibration curve.

Data processing was performed using Microsoft Excel statistical software (Microsoft Corp., Albuquerque, NM, USA) (IBM). The data is presented in the form of tables and graphs which are described descriptively which are complemented by the literature from previous research.

3. Result and Discussion

The concentration of ammonia in raw water to geomembrane crystallizer pond during traditional salt production in Tajungan village varies. The test results showed that the ammonia concentration in raw water ranged from 2.02 - 2.60 mg/L, reservoir ponds ranged from 1.84 - 3.23 mg/L, evaporator ponds ranged from 1.34-3.40 mg/L, and the geomembrane crystallizer ponds ranged from 1.29-1.50 mg/L. The highest ammonia concentration identified was in the evaporator ponds of 3.40 mg/L, while the lowest concentration was found in the geomembrane crystalyzer ponds of 1.29 mg/L. Parameter data were also measured to describe water quality in raw saltwater in Tajungan village (Table 1). The field measurements showed that the water concentration of water density in the raw materials ranged from 2-4 ^{o}Be, reservoir water ranged from 5-7 ^{o}Be, purification ranged from 10-13 ^{o}Be, and the geomembrane crystallizer ponds was 23-25 ^{o}Be. Overall pH levels in salt production water ranged from 6.33 - 7.47.

The average concentration of ammonia contained in the salt production water of Tajungan village, Bangkalan Regency is very high, namely raw water of 2.31 ±0.24 mg/L, reservoir pond of 2.56 ±0.57 mg/L, evaporator pond of 2 .39 ±0.84 mg/L and geomembrane crystallizer pond of 1.37 ±0.09 mg/L (Figure 1). This data shows that the concentration of ammonia in salt raw water, namely seawater from around the waters of the village of Tajungan, has been above the threshold for ammonia concentration in marine waters for marine organisms, as stated in the Keputusan Menteri Negara Lingkungan Hidup Republik Indonesia nomor 51 tahun 2004 was 0.3 mg/L. This data describes that seawater, which is the raw material for salt around the waters of the

Table 1. Water quality parameters in Madura Traditional Salt Ponds

Salt Water Source	Water quality parameters		Ammonia concentration (mg/L)
	Water density (^{o}Be)	pH	
Raw Water 1	2	6.93	2.02
Raw Water 2	4	7.33	2.60
Raw Water 3	3	7.25	2.30
Reservoir pond 1	5	7.11	2.60
Reservoir pond 2	7	7.26	1.84
Reservoir pond 3	5	7.47	3.23
Evaporator pond 1	10	7.21	2.42
Evaporator pond 2	10	7.29	3.40
Evaporator pond 3	13	6.84	1.34
Crystalyzer pond 1	23	6.61	1.50
Crystalyzer pond 2	25	6.62	1.29
Crystalyzer pond 3	23	6.33	1.31

Tajungan village, has been contaminated with ammonia.

The average concentration of ammonia contaminants in salt production water in each pond from raw water to geomembrane crystallizer pond varied (Figure 1). The highest average concentration of ammonia contamination was in the reservoir pond water of 2.56±0.57 mg/L. The high concentration of ammonia in the reservoir can indicate that the reservoir pond is still capable of living several microscopic organisms such as bacteria or macroscopic organisms such as small fish, worms, gastropods and others. These organisms indicate as suppliers of ammonia concentrations in seawater reservoirs ponds.

The lowest average concentration of ammonia found in geomembrane crystallizer ponds was 1.37±0.09 mg/L. The range of ammonia concentrations in the crystallizer ponds are the lowest compared to other ponds. The lower average concentration of table ammonia crystallization compared to other ponds indicates that the concentration of ammonia as an impurity element in salt production water is getting lower as it leads to the formation of salt crystals. This data is by the nature of the element ammonia. According to Rahmawati (2010), ammonia has a solubility in water of 89.9 g/100ml, a melting point of -77.73^{o}C and a boiling point of -33.34°C. The process of volatilization can remove ammonia in water.

The low range of ammonia in the geomembrane crystallizer pond is by the character of the saltwater in the crystallizer ponds. Adimas *et al*., (2015) stated that the concentration of saltwater in salt crystallizer ponds water was around 22°Be, then the concentration of water content would rise to 30°Be for 3-4 days. The water concentration level of 30°Be is the final concentration level and the deposition of all salt crystal grains on the crystallizer pond. In contrast, the concentration level of 32°Be is included in the bittern category (Sudarto, 2011). This is by the results of the measurement of water density in the salt production process obtained (Table 1). The water density in the geomembrane crystallizer pond is the highest water concentration ranging from 23-25 ^{o}Be compared to the water density in other ponds. The high water concentration in the crystallizer pond is inversely proportional to the ammonia concentration in the geomembrane crystalyzer ponds. This data means that the higher the concentration of salt production, the lower the ammonia content in the water.

The extreme environmental conditions on the crystallizer pond allow no organisms to tolerate the level of saltwater concentration as in the geomembrane crystallizer ponds. One of

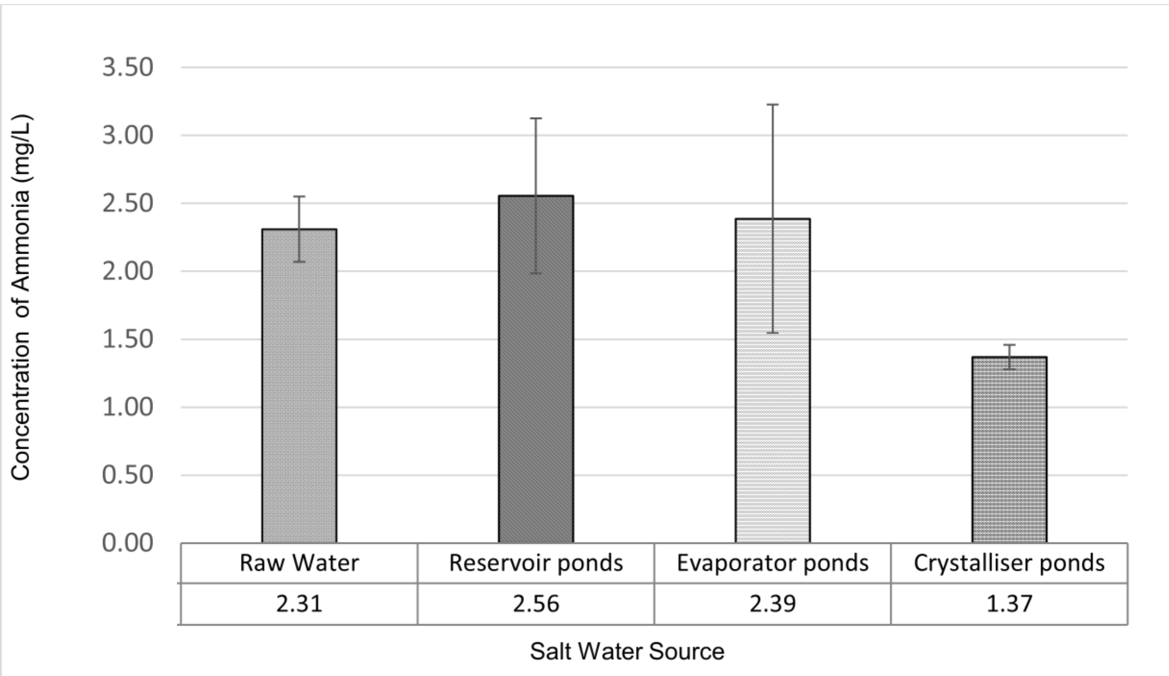

Figure 1. Concentration of ammonia contamination in traditional salt production water in Tajungan Village, Bangkalan Regency

the tolerant organisms is extreme halophilic microorganisms such as halophilic bacteria. The presence of halophilic bacteria, which are red from the salt cultivation process, contributes significantly to producing NaCl salt with high purity >94% (Oren, 2010) because extreme halophilic bacteria are capable of absorbing sunlight so that the temperature of old water will increase and then will increase the evaporation rate which can accelerate the process of forming salt crystals (Javor, 2002).

The high average level of ammonia contained in the raw water of the salt production process in the waters of the Tajungan village is most likely caused by the entry of domestic waste contamination produced by the community around the village Tajungan. Field observations show that Tajungan village does not have adequate waste disposal sites. People generally throw garbage in rivers and around mangrove ecosystems close to their homes. Several factors can trigger the high concentration of ammonia in the waters. According to Hamuna *et al*., (2018), most of the high concentrations of ammonia contamination were caused by the input of residential waste and the disposal of manure and animal waste in the form of urine. Ammonia that naturally accumulates in waters also comes from the breakdown of organic nitrogen (protein and urea) and inorganic nitrogen in water (Effendi, 2003). This compound also comes from the metabolic processes of aquatic organisms and decaying organic matter or organic waste such as household waste which is decomposed by bacteria and carried by currents (Fathurrahman, 2014).

4. Conclusion

The average concentration of ammonia as an impurity in raw materials in traditional pond ponds in Tajungan village, namely raw water is 2.31±0.24 mg/L, reservoir ponds are 2.56±0.57 mg/L, evaporator ponds are 2.39 ±0.84 mg/L, and geomembrane crystallizer ponds are 1.37±0.09 mg/L. The highest average ammonia concentration was found in the reservoir ponds raw saltwater sample, while the lowest concentration was found in the geomembrane crystallizer pond sample. The high average ammonia concentration in the salt ponds of Tajungan Village, Bangkalan Regency indicates that all raw saltwater in these ponds is contaminated with ammonia. Ammonia contamination as an impurity for raw material for salt production in this village is due to the entry of household waste into saltwater in Tajungan village, Bangkalan Regency.

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