

Application of Iodized In Farm and Haloferax Bacteria Technology for Salt Production in Order to Make Zero Waste Salt Consumption Industry

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Abstract. The consumption salt industry produces wastewater in the raw material washing unit. The washing water generated if water concentration already exceeds 250Be, most of its water removed, usually dumped into the environment around the factory, with a volume of about 1.5 m³ per 10 tons of salt washed. Everyday industry wash 60-70 tons salt. So the environment would pollute, because there were metals and chemical contaminants, such as MgSO₄, MgCl₂, and CaSO₄. The aims this research to produce iodized salt from the field and containing NaCl above 94 percent which combines technology with the injection iodized in farm and Haloferax bacteria so consumed salt industry will not need washing and iodizing again. Application experiment performed 3 times which 2 replication without and with using Haloferax bacteria and additional treatment KIO₃ solution concentration of 70 and 80 ppm. Results showed that best treatment was addition KIO₃ 70 ppm and treatment of bacterial Haloferax with KIO₃ 51,89- 56.58 ppm and NaCl were 94.44 to 94.95 percent. SEM EDX test results, salt cube-shaped or rectangle, treatment without addition the bacteria and the crystal morphology of appearing smaller.

Keywords: Iodized in the farm; Haloferax; KIO₃; NaCl.

1 Introduction

The iodized salt production process is the very simple beginning of the washing process raw materials, draining, iodized salt and printing for briquettes, cooking or drying, cooling, and packaging. Salt washing process the raw materials are beginning the process of a series of iodized salt production by using a saline solution 22-25⁰ Be so that the levels of NaCl qualified SNI 4435-2010 (minimum 94.7% NaCl). If washing solution salt concentration already exceeds 25⁰Be then most of the wash water must be removed, usually dumped in the factory environment. Discarded washing water combined with water in order to maintain the concentration of the washing water remains in 22-25⁰Be. The volume of washing water discharged about 1.5 m³, equivalent to 500 kg of salt or 10 tonnes of salt-washed [1]; [2]. Every day 60-70 tons of salt wash industry raw materials. The largest component in the wastewater is NaCl and partly comprised of MgSO₄, MgCl₂, and CaSO₄ which is an impurity of salt. Liquid waste dumped around the factory would pollute the environment because there are metal and chemical contamination.

Salt is one of the commodities that are needed by all sectors of industry. Salt consumption is included in the

group of food so that is included in the priority industries in the Industrial Research and Development Agency program the Ministry of Industry. Research salt with Halophilic bacteria biotechnology has been done by previous researchers with an output that can improve the quality of the raw material salt [3]. The research has been produced by CIPPT [2]; [4-7]. All the research results obtained by raw material salt NaCl higher but salt consumption industry should be performed the iodized process again. The advantages of this research were obtained salt the raw materials were high quality, clean and contain KIO₃ from the table crystallization in farm directly. The industry can be directly molded to be used as salt briquettes. As for the fine salt must be heating before packed. Some of the benefits in industry with iodized in farm technology, the first is to conserve water because it does not require washing and NaCl was already high so it does not generate liquid waste and solid waste at unit salt washing, the second is energy-efficient machine iodized and labor, and also obtaining a homogeneous KIO₃ in salt consumption. In this applied research, this was not observed yet the stability KIO₃ obtained. Previous on a laboratory scale research iodized salt *in situ* on the waste salt that has been purified obtained KIO₃ salt products decreased by 0.2 to 1.3 ppm during storage of 1-4 months [8]. Another similar research was carried out in the fields of salt iodized salt but

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using iodized spraying system and using the isolators media [9]. The difference with this research was iodized injection system in the farm enter KIO_3 and bacteria *Haloferax* into the water 25⁰ Be at the table crystallization directly.

The aim of iodization process is mixed KIO_3 with saltwater evenly in order to obtain an iodized salt product which according to the requirements of SNI. Potassium iodate used recommended 40 grams diluted in water so that a concentration of 2% or 4% and used for iodized salt 1 ton [10]. Aim of this applied research was determined the effectiveness of iodized salt in the farm system to produced KIO_3 homogeneous and clean salt, and do not produce liquid and solid waste in the industry.

The benefits to be obtained from this study is the product of the salt has been iodized directly from in the farm that can be directly used by the industry without having washed again so as to save water and produces no liquid waste, assuming the salt free from contamination, physical and chemical industry does not require iodized process thus saving electric energy and labor. And makes the salt industry consumption with zero-waste.

2 Materials and Methods

2.1 The Locations and Time of Application Research

Application of this research in farmer's salt fields in Pati District. Central Java Province. Indonesia. The research was conducted between June until September 2019.

2.2 Materials and Tools

Materials used include KIO_3 , distilled water, the growth cultivation medium of bacteria *Haloferax*, that were yeast extract, Tryptone, saline water (22^o Be) got from farmer's salt fields in Pati Distric., geomembrane, starter *Haloferax* bacteria, the chemical reagent for analysis KIO_3 and NaCl, plastic containers and sacks plastic.

The tools used were the scales, injectors KIO_3 , baker glass, measuring cups, Baume meter and

laboratory equipment for chemical analysis. The result of the product of table salt crystallization will be tested in the laboratory include KIO_3 test, NaCl, water content and SEM EDX.

2.3 Research Design

Application research performed 3 times, where 2 times without using bacteria *Haloferax* and for the 3 times trial using bacteria *Haloferax*, and all treatments used KIO_3 . KIO_3 concentrations were 70 and 80 ppm [11]. Applications are done 3 times each 2 replications.

The application process research, the first step was preparing the land or tables that have been prepared for the crystallization of the salt, the second was planned geomembrane plastic, third was flowed saline water with a viscosity 25⁰ Be measured with Baume meter with a pond 4 m x 2 m water height 10 cm simultaneously by entering KIO_3 solution at concentration 70 and 80 ppm, a flow rate 80 ml/sec. The crystallization process lasts up to saline water reached 29.50 Be that lasted until 4-5 days. After the salt formed carded and drained. Iodized salt consumption ready to be transported to the factory and processed further without washing, and iodized again. Salt is maintained to be free from physical and chemical contaminants.

3 Result And Discussion

3.1 Levels of KIO_3 in Salt crystals

Trials 3 times in farm with 2 times without bacteria *Haloferax* and phase 3 trials crystallization using bacteria *Haloferax* and control treatment.

At the time of the crystallization process takes place was done also monitoring water quality and environmental conditions in the table crystallization, data showed that the water temperature ranges from 33-39^oC, 29-33^oC air temperature, wind speed 2.6 to 6.0 m/sec, humidity 48,8 to 70,1 percent. The results in table salt crystallization obtained salt with a rather diverse KIO_3 content during the third stage of the experiment, the data as presented in Table 1.

Table 1. Trial of iodized In Farm Phase I, II and III in Salt Farmer's Field in Pati District

Trial Phase	KIO_3 concentration (ppm)	KIO_3 (ppm)	NaCl (%)	Water content (%)
	Control 1	2,82	91.16	3.573
	Control 2	2.24	92.15	4.646
I	70-1	<0.349	82.15	10.041
	70-2	<0.35	88.17	8.065
	80-1	<0.35	89.35	8.040
	80-2	<0.35	89.26	8.364
II	70-1	42.81	91.63	6,655
	70-2	48.27	91.42	3,881
	80-1	61.89	91.76	4.237
	80-2	52.37	90.98	3,810

III	70-1	56.48	93.37	5.662
	70-2	51.89	93.35	5.098
	80-1	61.45	94.44	5.811
	80-2	68.80	94.95	5.211

Results of the Phase I application KIO_3 content was still below 0.35 ppm. The reason because it allowed rainwater into the water to overflow in the farm, but the process is waiting to happen salt until the brine reached 29.5⁰Be. For the phase II trial, obtained his KIO_3 levels according to the expected value varies, with the result 70 contains KIO_3 42.81 ppm and 47.27 ppm, 80 ppm while containing KIO_3 at 52.37 and 61.89 ppm. Phase III treatment trial using bacteria *Haloferax* then the resulting value KIO_3 to increase the concentration of 70 ppm in value by 51.89 and 56.48 being the addition KIO_3 got 61.45 to 68.80 ppm to 80 ppm. SNI requirements iodized salt consumption was at least 30 ppm. KIO_3 user so that as much as 70 ppm in crystallization table already applied. For the control treatment, there also KIO_3 content 2.24 to 2.82 because in the seawater the KIO_3 content is also very small quantities. Compounds Fe^{2+} and Cu^+ (contained in salt) KIO_3 in salt were able to decompose into I_2 . Thus, any amounts of reducing agent contained in the salts the greater the number of KIO_3 that will decompose and disappear as I_2 (g) [2].

3.2 Levels of NaCl

The result was the control treatment containing NaCl content of 91.16 to 92.15 percent. In the second stage of Phase, I containing NaCl decreased from 82.15 to 89.28 percent, from 90.88 to 91.76 percent in value phase II and phase III of its value from 93.93 to 94.95 percent. The high NaCl in the treatment of bacterial *Haloferax* addition, due to these bacteria can degrade the compounds of impurities contained in the brine solution as Mg and Ca compounds, such research has been done that *Haloferax* that bacteria can improve the quality and quantity of salt [12].

The *Haloferax* bacterial cells are templates in the formation of halite/crystal NaCl and organic compounds produced by *haloferax* bacteria also have an influence on the shape and formation of formed salt crystals. [13].

3.3 Results Analysis of SEM EDX

SEM is Scanning Electron Microscopy and EDX is Energy Dispersive X-Ray analysis results of experiments in the fields for the control treatment and the addition of bacteria *Haloferax* treatment show similarity. Form *Haloferax* bacterial cell is a template in the formation of halite or NaCl crystals and organic compounds produced by bacteria *haloferax* also have an influence on the shape and the formation of salt crystals formed [13]. Besides the secretions of organic substances from bacteria *Haloferax* such as glycine, betaine, and polysaccharides also influence the quality

of the resulting salt crystals [3]. There appears to be a similar shape of salt crystals that tendency cube-shaped box or a rectangle, but for the addition of the crystal morphology of the bacteria appear smaller pieces.

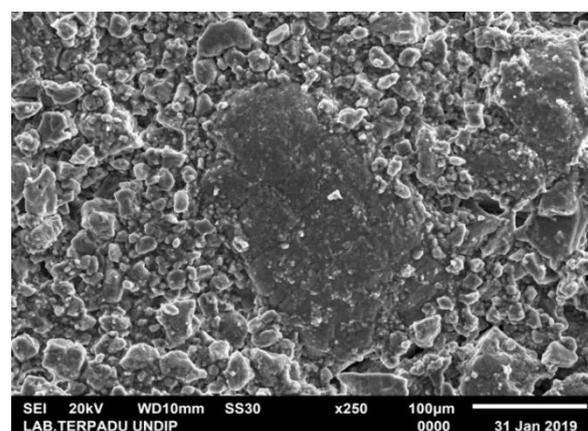


Fig. 1. Results of Test SEM EDX Iodized Salt Crystal Without *Haloferax* Bacteria Treatment Enlargement 250x

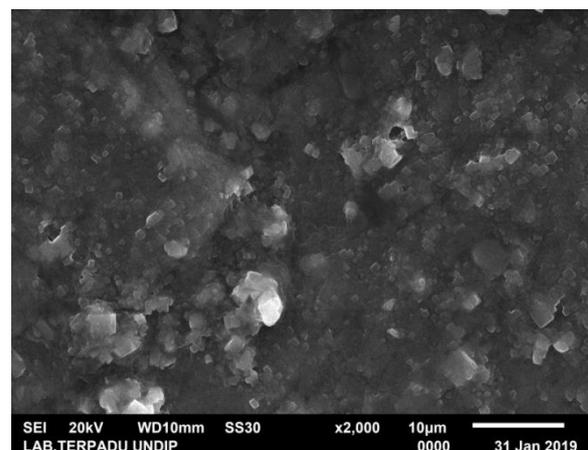


Fig. 2. Results of Test SEM EDX Iodized Salt Crystal Without *Haloferax* Bacteria Treatment Enlargement 2000x

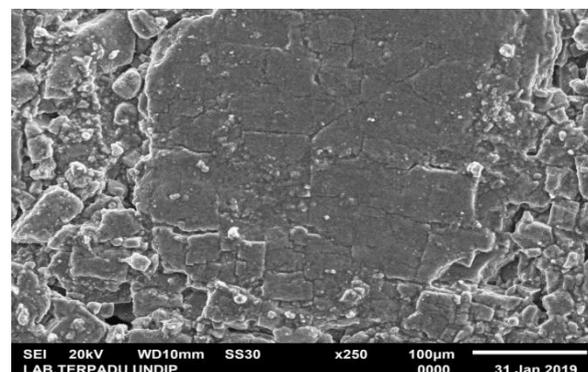


Fig. 3. Results of Test SEM EDX Iodized Salt Crystal with *Haloferax* Bacteria Treatment Enlargement 250x

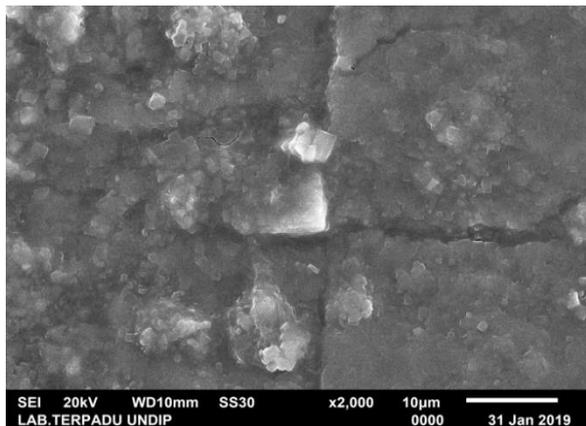


Fig. 4. Results of Test SEM EDX Iodized Salt Crystal with Haloferax Bacteria Treatment Enlargement 2000x

4 Summary

The results of applications research of salt iodized in farm gave KIO_3 value of the first phase is still below 0, while the second phase KIO_3 that 70 and 80 ppm, the results thereof containing KIO_3 were 42.81 to 61.89 ppm, then the third stage used *Haloferax* bacteria gave the resulting value of KIO_3 were 51.89 to 68.80 ppm. Phase I trials contain NaCl obtained by 82.15 to 91.46 percent, phase II and phase III from 90.92 to 92.15 91.63 to 94.44 percent.

SEM EDX test results tendency the form of salt crystals is a cube-shaped box or a rectangle, but for the control of the crystal, morphology appears smaller pieces.

Result of application iodized salt in the farm with giving concentration KIO_3 70 ppm treatment was able to generate content KIO_3 above 30 ppm in a salt crystal.

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