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Waste Management Of Migas Industry As An Alternative Source Of Iodium Production Control Of Environment Pollution

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ABSTRACT: *Oil and gas industry has the same process that is industry in mining sector. One of the oil and gas industries in Wunut and Tanggulangin is the industry of natural gas and mining byproducts with water formation that still contains some materials such as iodine content. It is interesting to be examined and studied regarding how it can be an alternative source for the iodine industry. From one side, iodine must be produced through the formation of production wells and distribution, on the other hand, iodine is thrown away without any treatment for its exploitation. Regarding the application of blue-green economy, its purpose is the utilization of waste into raw materials by firstly treating the waste into the processed raw material. This research was started from the stage of possible utilization of iodine alternative source taken from wastewater produced from oil and gas industry wells; continued with initial treatment stage that is eliminating impurities contained in the wastewater formed in oil and gas mining by using selected separation method until the expected result was obtained according to specification of brine water iodium; continued with experiments on iodine production process with alternative raw materials; lastly reviewed its feasibility from technical, economic and environmental aspects. Regarding the application of blue-green economy, The purpose of this study is to analyze the wastewater produced from oil and gas industry wells to be used as an alternative source of iodine production raw materials studied from the content capacity and the level of difficulty of its implementation and find the efficiency of utilization of waste water produced from oil and gas wells which can be used as an alternative source of iodine raw materials production from technical, economic, and environmental aspects. The method used in this study is qualitative exploratory. Based on the study results, it can be explained that the iodine content in wastewater produced by oil and gas industry wells is equivalent to 11.52 kg iodine per year or equivalent to Rp 11.289.600,- on selling price. From the IRR calculation, it is known that profit gained when reusing the iodine contained in wastewater produced by gas wells is amounting to Rp 8,901,686 per year with a payback period of 0.04 years. The NPV value is 23.254.358 (positive) with B / C Ratio value of 48.79 (greater than 1). Environmental aspect: From the study results by using environmental risk analysis, there is evaluation results obtained that The exposure of water produced by the oil and gas industry wells around the study area has a low risk due to its momentary occurrence that is if the water / oil blocked in the gas well, There is no significant value showed regarding the exposure of water produced by oil and gas industry wells around the study area if it is evaluated from the environmental aspect.*
KEYWORDS: *Iodine, Blue-Green Economy, Wastewater Produced*

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I. INTRODUCTION

The development of chemical raw materials processing industry is very profitable. This is true because it can add more value to products and reduce import dependence, which ultimately affect the state's savings. In addition, the production process using local raw materials and technology can directly create a sense of confidence and independence on the nation regarding the potential and ability in global competition. One of the raw materials / chemical compounds widely used for industrial purposes and only produced in small quantities in Indonesia is

iodine. Iodine (I_2) is widely used, among others, as a catalyst for chemical reactions, fodder mixtures, ink and paint materials, stabilizers, as an active ingredient of drugs in pharmaceutical industries (e.g. antiseptics, wound medicines, sanitation, disinfectants), photography, organic and inorganic compounds production, as well as a mixture of electric conducting polymers. In Indonesia, iodine is primarily used as a raw material of iodized salt production, especially the raw material of Potassium Iodate ($KI0_3$). There are several main sources of iodine, some of which can be obtained through mineral mining in the form of Chilean Salt, from Laminaria seaweed, gas and petroleum well water association, by-product of nitrate production and artesian well water. Currently in Indonesia, the only iodine producer is PT Kimia Farma Plant Watudakon located in Jombang, East Java. The factory which was established since the Dutch colonial era in 1926 has an installed production capacity of 100-120 tons per year and most of its production is used to meet the domestic and export markets. The company produces iodine from artesian well water drilled to a depth of 200 meters for shallow wells and 700-800 meters for deep wells. The iodide ion content of well water ranges from 60-130 mg / L.

Considering the great potentials of iodine export market and economic, its production capacity in Indonesia must be increased. Iodine production capacity can be increased in two ways. First, the intensification program which is done by PT Kimia Farma by drilling new wells or improving the production process. Second, the extensification program, which is looking for alternative sources of new iodine raw materials. In addition to the drilling of new iodine wells, the intensification process that has been done is the management of iodine gas emissions during the production process with the evaluation result that it can reduce the iodine gas emission to be reused by 44.6% for iodine production process and 83.7% for the production of potassium iodate. The process of iodine mining and production is highly dependent on the debit of iodine well water where the debit is affected by the surface level of well water iodium (brine). Iodine water is a source that cannot be renewed so that its level decreases more and more. This makes the cost for frilling the new well become more expensive, means the deeper of the drilling the larger diameter of the casing and the pump specification, as well as to the increased cost of land acquisition and leasing for road access, pipeline transmission and compensation for the affected project. Oil and gas industry has the same process that is industry in mining sector.

One of the oil and gas industries in Wunut and Tanggulangin is the industry of natural gas and mining byproducts with water formation that still contains some materials such as iodine content. It is interesting to be examined and studied regarding how it can be an alternative source for the iodine industry. From one side, iodine must be produced through the formation of production wells and distribution, on the other hand, iodine is thrown away without any treatment for its exploitation. Regarding the application of blue-green economy, its purpose is the utilization of waste into raw materials by firstly treating the waste into the processed raw material. This research was started from the stage of possible utilization of iodine alternative source taken from wastewater produced from oil and gas industry wells; continued with initial treatment stage that is eliminating impurities contained in the wastewater formed in oil and gas mining by using selected separation method until the expected result was obtained according to specification of brine water iodium; continued with experiments on iodine production process with alternative raw materials; lastly reviewed its feasibility from technical, economic and environmental aspects. Regarding the application of blue-green economy, its purpose is processingwaste into raw materials.

II. MATERIALS AND METHODS

1.1 Literature Review

Economic development is a process of activities taken by a country to develop economic activities to improve the living standard / prosperity in the long run. Meanwhile, according to Meier & Rauch (2000), development is a process whereby per capita income of a country increases over a long period of time, noting that the number of people living below the absolute poverty line does not increase and the income distribution is in stabil condition. The elements included therein are economic development as an ongoing process of change within which it contains elements of its own power for new investments, Efforts taken for increasing income per capita, whereit must last in the long term. According to the Brundtland Report of the United Nations (1987), sustainable development is the process of development (land, city, business, community, and others) with the principle of meeting present needs without compromising the needs of future generations. To achieve these objectives,an implementation strategy is very needed, and there are four things to note namely equity, participation, diversity, integration and long-term perspectives followed by an ideal approach. Sustainable development covers various aspects of life; ecological, economic, socio-cultural, political, as well as defense and security.

Petroleum, natural gas, and coal are created from weathering the remains of living things, thus called fossil fuels. The formation process takes a very long time so that it classified into unrenewable natural resources. Petroleum is often referred to as black gold or liquid gold which is a viscous or greenish liquid, flammable and is

in the uppermost of some of the earth's crust and has a very high value in modern society. Agriculture, industry, transportation, and communication systems are heavily dependent on this fuel, thus affecting all life aspects of a nation. Oil and natural gas are the world's major sources of energy, reaching 65.5%, then coal 23.5 %, hydro power 6%, as well as other energy sources such as geothermal, firewood, sunlight, and nuclear energy. The country with a lot of crude oil reserves occupies a favorable position because it has a lot of energy supplies for industrial and transportation purposes, in addition to the importation of state's foreign exchange through oil exports. Petroleum (Latin: *petrus* = rock, *oleum* = oil) is a slippery, flammable liquid and consists mainly of hydrocarbons. The hydrocarbon level in petroleum ranges from 50% to 98%. The rest consists of organic compounds containing oxygen, nitrogen, and sulfur.

Strategies used to reduce or eliminate waste before it resulted (preventive strategy) are preferred over strategies that deal with waste treatment (treatment strategy) (Bratasida, 1997). This strategy consists of Elimination: this strategy is included as a total waste reduction method. If necessary, zero discharge must be put into realization. Regarding the concept of implementing clean production, this is categorized into a method of pollution prevention; Waste minimization (reducing waste source): for reducing waste, the best way is using a strategy that prevent waste production at an early stage. Waste prevention may require several important changes to its process, but it gives the greatest results towards environmental and economic improvement; Recycling: if waste cannot be avoided to produce in its process, strategies to minimize such waste to the highest possible extent should be sought, such as recycle and / or reuse it. If waste production cannot be prevented or minimized through reuse or recycle, strategies that can reduce waste volume through waste management can be done. Although "this end-of-pipe" strategy may sometimes reduce the waste level, however this strategy is not as effective as preventing waste production at its early stage; Pollution control: a strategy that have to be implemented considering the process of production design, the company has not anticipated the presence of new technology that free of waste. This means that waste has already created and is in the production system, but quality and quantity of the existing waste is controlled so as not to exceed the required quality standard; Waste processing and disposal: the last strategy to consider is alternative disposal methods. Proper waste disposal is an essential component of the overall environmental management program, however, this is the least effective technique; and Remediation: strategy of reusing materials disposed with waste. This is done to reduce the poisoning level and the waste quantity existed.

The water produced is an unexpected part in gas mining. The content found in the water is generally halophyte or it has high salt content and some are containing iodine, depending on the well and the formation of the soil layer. One of the raw materials / chemical compounds widely used for industrial purposes and produced in small quantities only in Indonesia is iodine (1_2). It is widely used, among others, as a catalyst for chemical reactions, fodder mixtures, ink and paint composition, stabilizers, pharmaceutical industries as an active ingredient of drugs (e.g. antiseptics, wound drugs, sanitation, disinfectants), photography, organic and inorganic compounds processing, as well as mixture of electrical conductive polymer. In Indonesia, iodine is primarily used as a raw material of iodized salt production, especially the main composition of Potassium Iodate ($KI0_3$). Iodine is usually found in small quantities in the nature, especially in seawater, rocks, soil and underground water. Its presence is always found together with chlorine which is a halogen group, but chlorine is 2000 times greater than iodine. If stand alone, usually iodine takes form of alkaline salt. The world's largest iodine source is found in underground water of Japan and caliche and brine deposits in Chilie. There is iodine in the form of iodic salt ($NaIO_3$) and periodic ($NaIO_4$) in this deposit, which is derived from laurite mineral (anhydrous calcium iodidate). From this mineral, iodine is precipitated as natrium iodide. Before nitrate reserves developed in Chilie in 1808, algae were the most important source of iodine, especially in Japan. Brown algae such as Laminaria family can contain 0.45% of iodine in dried condition and produce 1.4% - 1.8% of iodine after burned under certain conditions.

Iodine is an element of halogens and "trace elements" that are very essential for the environment and human life due to its wide use. Iodine is a mineral substance in the body, means it is an inorganic substance that is very essential for maintaining body functions such as: regulate enzymes work, maintain the balance of acid-base, and form hemoglobin. Micro-minerals are precisely include: iron, manganese, copper, zinc, cobalt and fluorine. Iodine is needed by the thyroid gland to produce thyroxin. Thyroxin is a hormone that regulates the activity of various organs in the body, controls growth, and helps the metabolism process in the body. If the iodine supply in the body is very low, then the thyroid gland will be grown so form a lump in the neck, often called Hypothyroid Disease. The recommended Mineral Sufficiency Rate per person for infants / children (0-6 months) by 90 µg; infants / children (7 months - 12 years) and adolescent girls (10 years - 12 years) by 120 µg; teenage boys (10 years - 12 years) and adults by 150 µg; and pregnant and lactating women of 200 µg - 250 µg per day (J. Untoro 1999).

Sutamihardja (2004) states that targets of the sustainable development include even distribution of development benefits (intergeneration equity), which means that the utilization of natural resources for the sake

of development needs to consider the reasonable limits in ecosystem or environment and directed to replaceable natural resources and emphasize the lowest possible exploitation of unreplaceable natural resources. In addition, Barrow (1999) explains that sustainable development is based on the principles of conservation of ecological integrity, the combination of development and environmental conservation, the adoption of an internationalist view (interdependence), benefited conservation, and taking account of equality among generations, groups and species, The application of science technology and environmental knowledge to the development implementation throughout the world, Continued economic growth, and Adoption of long-term views in development. One of the important challenges faced in economic development is how to deal with trade-offs between the fulfillment of development needs on the one hand and efforts to maintain environmental sustainability on the other (Fauzi, 2004). The Blue-economy concept is over 10 years, generating 100 innovations and creating 100 million jobs (Gunter Pauli, 2010). This concept was developed to answer many challenges in the world economic system that tend to be more exploitative and destructive of the environmental ecosystem regarding the waste generated and environmental damage due to excessive exploitation.

1.2 Research Location

This research was taken in 2 (two) locations of oil and gas industry namely WunutSidoarjo and TanggulanginSidoarjo, and 1 (one) location of iodine production in WatudakonJombang Plant. These sites were selected as research location with consideration that there is a significant source of iodine produced from these locations. The timing of the research was started from January 2016 to May 2018 until the dissertation hearing in July 2018. One of the steps taken is literature study. In this phase, theoretical information search is conducted related to the method used for testing iodine content in oil and gas waste, isolation method for iodine contained in oil and gas waste, design of iodine production process with the result of isolation from oil and gas waste. The literature sources used are textbooks, research reports, scientific journals related to the research to be undertaken and existing iodine production processes. The research was started by primary and secondary data collection. Primary data is data obtained from direct observation, research, and calculation. Secondary data is data obtained from continued evaluation of the data obtained for analysis so that hypotheses validity can be proved.

1.3 Testing Methods and Data Analysis

This research takes samples from 2 (two) locations of oil and gas industry namely WunutSidoarjo and TanggulanginSidoarjo, and 1 (one) location of iodine production in WatudakonJombang Plant. The sampling point will be taken from several locations of the oil and gas industry production, in order to determine whether there is any effect on the formation of water discharge quality. Samples will be tested for iodine content in oil and gas waste, iodine content isolation method in oil and gas waste, design of iodine production process with isolation result from oil and gas waste. For laboratory-scale experiments, production process requires the material as used in the existing production process. Tests are taken using the suitable reagents based on the applicable specifications. Data analysis used in this research is quantitative and descriptive analysis to technical, economic and environmental aspects. From technical aspect, data on the utilization of iodine industrial waste are those that still contains iodine as a source of alternative materials of iodine production, thus the success or failure of this effort will be seen, it can be a mass balance in the production process which has correlation between oil and gas industry and iodine production industry; production process flow between oil and gas industry and iodine production industry; and maintenance of production, building, and equipment wells. Descriptive analysis takes form of financial analysis on investment value and operational cost, as well as cost saving on production preparation activity based on blue economy followed by explanation of its analysis. While environmental analysis takes form of data collection and continued by analysis based on type and its utilization characteristics. Risk analysis is conducted by taking into account technical requirements to achieve high accuracy. The analysis results are presented in tables, drawings, maps and other forms. Before conducting the initial analysis on environmental data hierarchy, the environmental variables or parameters are formulated and defined in advance. The three aspects tested were technical, economic, and environmental by comparing the source of production materials from the iodine wells and its production process.

III. RESULTS AND DISCUSSION

PT LapindoBrantas has 2 (two) plants, i.e. Wunut Plant and Tanggulangin Plant. Wunut Plant currently has 6 (six) active gas wells and the Tanggulangin Plant has 3 (three) active gas producing wells. At this stage, the sampling collection was taken on water produced from the gas wells of the two plants and the iodine content in the water produced from each active gas wells was tested. The purpose is to know the gas well point to be studied. The water produced from the gas wells in Wunut Plant is flowed and collected into the pond. This produced water

still contains sand, water and oil. This sand is involved in the gas pumping process because in the gas production layer, where the screen is installed, there is a layer of sand and this created when the gas pumped is thinning then the sand will be brought along with water or oil contained therein. Water produced by the pumped oil and sand is collected in a pond for the evaporation process or also called evaporation pond. The oil is separated manually for further oil processing. For wastewater produced, it is evaporated naturally and if it is considered as proper and cannot be evaporated, it is then injected into the injection well. For the sand, it is left separated because the sand obtained is in the fine form but in high salinity.

Table 1.Results of Waste Water Produced Teston W#15 dan Ta#2 wells

Type of Tests	Resuts Well W#15	Well Ta#2
Condition	Dark water	Clear yellow water
Smell	Petroleum	Specific to petroleum
Iodine	38,21 ppm	39,38 ppm
Chloride	22.085 ppm	20.555 ppm
TSS	376 mg/l	-
Turbidity	244 NTU	-
NH3-N	0,2724	-
Sulfide (H2S)	<0,013	-

Source: Test results of Environmental Quality Test Laboratory of East Java Province, JasaTirtaLengkong2017.

The treatment of wastewater produced is carried out on W#15 well. The oil phase that has been involved in 7 days has separated in plastic drums. The treatment methods used on wastewater produced from W#15 well include collection on tank reservoir of 8000 liters capacity with a bottom drainage system, to drain the water layer and separate the oil layer, the purification of the black and the suspended solids was taken physically by using a color adsorption system and precipitation of dissolved and suspended solids in the hope of not interrupting the subsequent production process, Determination of the adsorbent mass and type of adsorbent used. Adsorbs analysis was conducted with batch system by using jar test, for determining the active charcoal type used and comparing new activated charcoal and used activated charcoal. There are 2 (two) steps of Jar test, that is the determination of activated charcoal selected from economic aspect and the determination of amount of activated charcoal by considering % removal of TSS and % loss of iodine content obtained. The results are shown as follows:

Table 2.Test of Activated Characterization Type for Purification

Water Sample Vol 200 mL TSS(0) = 87,8 Cons (0) = 35,78 ppm	**Experiment I** Shake 150 rpm, left for 15 '		**Experiment II** Shake 150 rpm, left for 30 '	
	TSS	Iodine	TSS	Iodine
New charcoal 20 g	24,32	13,23	23,99	3,24
% Removal	72,3%	63%	72,7%	91%
Used charcoal 20 g	25,88	35,11	25,56	34,02
% Removal	70,5%	1,9%	70,9%	4,9%

Tabel 3.Determination Test of Type of Used Activated Charcoal for Purification

Water Sample Vol 200 mL TSS(0) = 87,8 Cons (0) = 35,78 ppm	**Replication I** Shake 150 rpm, left for 30 '		**Replication II** Shake 150 rpm, left for 30 '	
	TSS	Iodine	TSS	Iodine
Used charcoal 10 g	25,85	35,21	25,76	35,3
% Removal	70,6%	1,59%	70,7%	1,34%
Used charcoal 15 g	25,8	35,86	25,56	35,47
% Removal	70,6%	-0,22%	70,9%	0,87%
Used charcoal 20 g	25,56	35,11	25,4	35,5
% Removal	70,9%	1,87%	71,1%	0,78%

Based on the experiment, it was found that charcoal used is used charcoal from iodine adsorption process with 10 gram per 200 ml of sample of wastewater produced, shaker speed is 150 rpm for 15 minutes, and left for 30 minutes. Based on economic aspect, the calculation of IRR value can be done by finding NPV price of some level of discount rate so that obtained positive NPV value. The profit value calculation of iodine utilization which is obtained from the utilization of water produced by oil and gas wells can be seen in the following table. Through the calculation, there are obtained revenue, costs and profits per year for the next 5 years as shown in the following table:

Table 4.Annual Revenue, Annual Costs, and Annual Profit

Year	Revenue /year (Rp)	Cost /year (Rp)	Profit /year (Rp)
2018	-	329.994	- 329.994
2019	11.289.600	29.994	11.259.606
2020	11.289.600	129.994	11.159.606
2021	11.289.600	29.994	11.259.606
2022	11.289.600	129.994	11.159.606
Total	45.158.400	649.972	44.508.428
Rata-2	9.031.680	129.994	8.901.686

Source: Data Processed, 2018

The calculation of profit value in this research is obtained from the utilization of waste water in the form of water produced by gas wells,where it can reduce the cost of injection activity of waste water produced and in the form of iodine which is processed from waste disposal. From environmental aspect, the risk prediction due to the utilization of waste water produced by gas wells to the existing components, among others, impact on water quality, land use, ground flora, attitude and public perception as well as environmental aesthetics.

IV. CONCLUSION

Based on the results of study and research on the utilization of wastewater produced by oil and gas wells as an alternative material of iodine production, it can be concluded that significant iodine content is found in the wastewater produced by oil and gas industry wells. Iodine content is equivalent to iodine content in brine water of shallow well which is ranging from 30 to 40 ppm iodine, regarding characteristics and specifications of wastewater produced by oil and gas industry well, it is still contained crude oil and is easy to separate naturally, the treated water layer is black and there is a soluble / suspended solid, and the purification of the produced water layer is effected through the adsorbtion process and sedimentation by using activated charcoal from the used iodine production process, percent recovery of iodine production using wastewater produced by oil and gas industry wells almost equal to percent recovery using brine water well iodium that is greater than 98,0%. In addition, from the technical aspect, thewastewater produced by oil and gas industry wells can be used as an alternative raw material of iodine production by separating petroleum and clarify the color and dissolved solids / suspended by using activated charcoal, continued with the process of iodine adsoprtion to saturated activated charcoal. In terms of economic content, iodine contained in wastewater produced by oil and gas industry wells is equivalent to 11.52 kg of iodine per year or equivalent to Rp 11.289.600 of selling price, From the calculation of IRR, it is known that the profitgeneratedfrom the implementationof iodine recovery contained in waste water gas wells is approximatelyRp 8,901,686 per year with a payback period of 0.04 years. The NPV value is 23.254.358 (positive) with B / C Ratio value of 48.79 (greater than 1). Meanwhile, in terms of environmental exposure, the water produced by the oil and gas industry wells around the study area has a low risk due to its momentary occurrence that is if the water / oil blocked in the gas well,

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