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# Controller Optimization Evaporation Process of Salt Solution in Green House using Fuzzy Logic Controller

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A B S T R A C T

Salt processing commonly conducted by using heat energy from solar. Process begins with heating salt water from sea on the embankment with a period approximately 30 to 40 days. In the rainy season the quantity of salt produced decreases due to weather. Some salt farmers prefer not to produce in the rainy season because it's a high risk percentage. The aim from this research is to help them, we create greenhouse technology that can optimize the process of evaporation of old salt water into salt. This technology allows salt farmers to produce salt without regard to the influence of the weather, both dry and rainy seasons. This technology maintains indoor temperatures according to the best temperature of the evaporation process using heating elements. Technology in the form of a greenhouse with a prism-shaped roof. If the temperature in the room exceeds the optimal temperature, then the heat in the room will be released through the exhaust air until the temperature becomes optimal again. This system uses the Fuzzy Logic Control method to regulate temperature, humidity and air pressure.

**Keywords:** Green house, salt, evaporaion, temperature, humudity, air Pressure, Fuzzy Logic Controller

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## 1. Introduction

One of strategic commodities in the national scale is the salt [1]. Indonesia is a salt-producing country to supply national salt demands. The salt produced are consumption and industrial salt. They produce the salt from local people salt [1]. The stages of making salt produced by people start from taking and collecting seawater, aging of seawater, crystallization of seawater and the last steps is harvesting and salt compaction [2].

Almost salt farmers using solar energy as evaporating salt water. This condition caused by the tropical climate that occurs in Indonesia [2,3]. Therefore, it can say that climate is the most influential factor on the salt production because as an energy source that affects the rate of evaporation of sea water in salt embankment. Producing salt conducted by taking salt in sea water with the natural evaporation method with sunlight. Process begin from handling sea water intake until harvesting salt takes approximately 30-40 days [2]. During the rainy season with erratic weather, i.e. rainfall falls throughout the year causing salt production to decrease dramatically. This is a significant cause and inhibitor for the income of salt farmers.

Another problem that occurs in process salt are the quality of people salt on average with percentage 85% NaCl [3]. This happens because the techniques and tools used in processing salt are traditional and not applying technology to improve the quality of salt [4]. While salt quality must be meet percentage over 94% NaCl. Meanwhile, increasing import salt make local salt price become depression, beside their quality. This condition impacts to the welfare of salt farmers [5].

Some factors that influencing evaporation process such as temperature, humidity, pressure and the rate of evaporation. When temperature increasing temperature because continuous heat from sun and the lower pressure [6]. Besides the temperature and pressure the rate of evaporation influenced by the water content on solution where the lower the water content, the solution becomes more concentrated so that the rate of evaporation decreases because steam is more difficult to form. Other factors that influence rate of evaporation are surface area, evaporation duration, and material conductivity [7]

A research conducted on the prism-shaped greenhouse effect has the aim of temperature distribution has a relative homogeny with a room temperature about 45°C - 60°C at average temperature 53°C as a heat storage room. The stored heat is 40 ° C with a range of room temperatures from 30°C to 37°C. A rectangular prism greenhouse with stone variations as a heat storage has a faster drying efficiency [8,9].

Salt water evaporation process by using sunlight have a tendency wasting time [10]. Therefore, in this research we made a greenhouse to accelerate the evaporation process. The greenhouse will have a prism shape roof. this shape aims optimization heating process. Greenhouse also equipped with a temperature sensor to find out room temperature, then a humidity sensor has a function to find out room humidity. The Fuzzy Logic Control method will control both sensors to meet setting of heat by PWM output. If the input value of temperature and humidity is very low or the condition at night, then the heating element will be activated,

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conversely if the value of the two inputs is too high then the heating element will be stopped as for the use of air pressure sensors that function to determine the air pressure in the room, the exhaust will light to dispose of hot air in a greenhouse, Water level control is used to determine evaporation rate.

## 2. Research Methods

### 2.1. System description

The whole system can see on Figure 1. Input on this system consist of some component and sensors. We using temperature, air pressure, humidity, LDR and water level control.

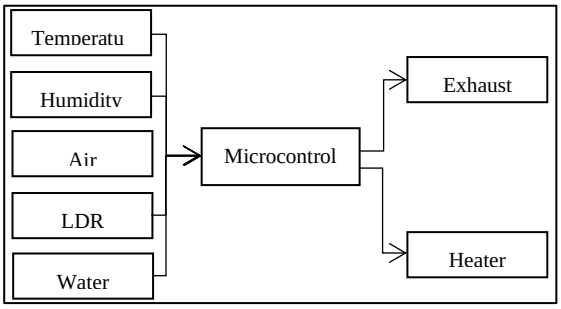



**Figure 1**. Diagram Block

This system has 3 parts, there is input, proses and output. Sub-section input consist of 5 part such as :

a. Temperature calculation is converting analog values from temperature sensors that have changed by the micro-controller.
b. Humidity calculation is converting analog values from humidity sensors that have changed by the micro-controller.
c. Pressure calculation is converting analog values from humidity sensors that have changed by the micro-controller
d. LDR to activate the heating system in a greenhouse Water level control is used to find out how much the value of evaporation that occurs from seawater to salt
e. Water level control is used to find out how much evaporation occurs from seawater to salt

### 2.2. Fuzzy Logic Controller

Method is an important part of the control process. Method of applying in this system is a fuzzy logic control. This method allows system to maintain ideal room temperature and humidity stability in the optimization process. In this research we apply Sugeno fuzzy method because this method has a linear equation output so it is very easy to apply. In this method there are some important parts in the form of determining the membership function of input and rule base. The membership function in this system is a function of temperature and humidity membership as shown in Figure 2 and Figure 3.

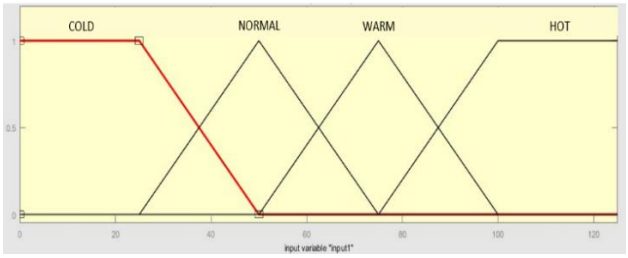



**Figure 2**. Temperature Membership Function

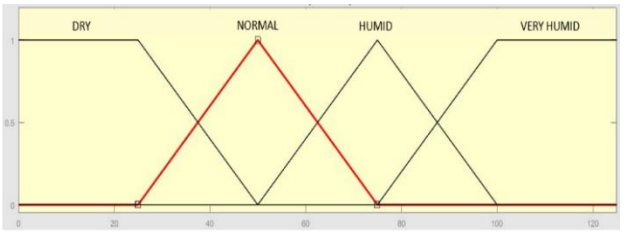



**Figure 3**. Humidity Membership Function

Temperature membership function consist of COLD, NORMAL, WARM and HOT. COLD have score range from 0 to 50, NORMAL have score range from 25 to 75, WARM from 50 to 100, HOT have score range from 75 to 100. Meanwhile humidity membership function consists of DRY, NORMAL, HUMID, and VERY HUMID. DRY have score range 0 to 50, NORMAL have score range 25 to 75, HUMID have score range 50 to 100, VERY HUMID have score range 75 to 100. Both of temperature membership functions represent the X function and the humidity membership function represents the Y function. Besides the two functions there is a Z function in the form of an output value in this system in the form of COLD (C) with a value of 0, NORMAL (N) with a value of 40, WARM (W) with value 80 and HOT (H) with a value of 120. Besides the membership function there is a rule base that has an important role in executing the fuzzy method. This rule base is in the form of rules performed in the fuzzy method. Rule base that has shown in Table 1.Table 1. Rule Base

| X / Y | Cold | Normal | Warm | Hot |
|---|---|---|---|---|
| Dry | W | N | C | C |
| Normal | N | N | N | C |
| Humid | E | W | W | N |
| Very Humid | H | H | H | C |

## 3. Result and Discussion

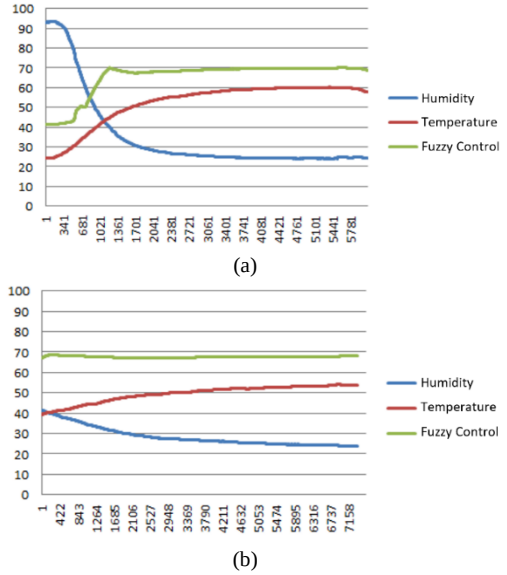
Trial using conventional methods and greenhouse technology methods. First step is to make sure shelter rack filled with salt solution. Salt solution has a salt content of 25-29 Be. There are 9 tests for each method. Salt solution conducted a trial with a volume 25 Liters, 23 Liters, 20 Liters, 18 Liters, 15 Liters, 13 Liters, 10 Liters, 8 Liters and 5 Liters. Trial conducted simultaneously as a comparison results of conventional methods and methods applied to the tool. Furthermore testing using conventional methods using solar energy as a source of heating or

evaporation process into salt. While the technology applied to greenhouse using heating elements that are controlled using temperature and humidity sensors. Trial results are shown in Table 2.

Table2. Test Result

| No | Sampling test (Litre) | Time requirement | | Producing Salt (Gram) | Note (Succeed / Fail) |
|---|---|---|---|---|---|
| | | Conventional Methods (Days) | Fuzzy Methods (Days) | | |
| 1 | 25 | 20 | 5 | 875 | Succeed |
| 2 | 23 | 18 | 4,5 | 782 | Succeed |
| 3 | 20 | 16 | 4 | 700 | Succeed |
| 4 | 18 | 14 | 3,5 | 648 | Succeed |
| 5 | 15 | 12 | 3 | 525 | Succeed |
| 6 | 13 | 10 | 2,5 | 455 | Succeed |
| 7 | 10 | 7 | 2 | 350 | Succeed |
| 8 | 8 | 6 | 1,5 | 272 | Succeed |
| 9 | 5 | 3 | 1 | 175 | Succeed |

Based on overall test results, the system runs well. This is evidenced by the comparison of test result data. Data shows that the conventional method of the system takes longer than the system in the greenhouse. The method applied to the greenhouse is able to produce salt with a shorter time. Salt water with an amount of 25 liters can be used as salt with a period of 5 days with a normal time of 20 days. This shows the optimization of the process of evaporation of old salt water into salt using greenhouse technology supported by fuzzy methods that work well on the system. The success of the method in the system is shown in the graph of test results in Figures 4a and 4b.




(a)

(b)

**Figure 4.** (a) Daytime Result Testing. (b). Nights Testing Result

## 4. Conclusion

Overall, the system is working excellent. This condition supported by sensor readings with fast and accurate responses. The heating element works well so that the fuzzy method applied to the system runs well. Technology applied on greenhouses has shown very significant results. Applied methods running well to optimize evaporation of salt solution into salt. To ensure that we can use this system on a large scale it is necessary to calculate the process of production costs with the results obtained from production. This is to ensure that salt farmers benefit more by using this system.

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