# Humidity Generation and Measurement Using Saturated Salt Solutions

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**Abstract:** - The level of humidity required at different places varies depending upon the type of objects placed in the store. Humidity fluctuations affects the shelf lives of objects. Hence, it is necessary to maintain a particular specified level of humidity for the maintenance and preservation of the objects. There are different methods which are employed to maintain specific level of humidity ranging from expensive scientifically designed humidity generator working with the help of electricity and inexpensive methods involving usage of saturated salt solution working without any usage of electricity. The present study aims to study the ability of saturated salt solution in creating environment with different humidity level.

**Key Words: —** ***Relative Humidity, Saturated salt solution, Non hygroscopic, Hygrometer, Passive humidity generation method.***

## I. Introduction

It has been scientifically proved that all objects of the environment are affected due to fluctuations in relative humidity. At various places such as museum, cold storage, paper industry, textiles industry, etc., humidity of a particular range is required to ensure smooth functioning and protection of objects. Excessive humidity may result in problems such as corrosion , fungus, moths, etc. whereas low humidity results loss of flexibility in leather items and can also result in cracks in wooden item due to dimensional changes. To overcome these problems, active and passive methods of humidity generation have been devised. In case of active methods, scientifically developed humidity generators and controller machines are installed which help in ensuring a particular level of humidity as per the requirement whereas in case of passive methods, an approximate level of humidity is tried to be developed with the help of saturated salt solutions. This study determines the level of humidity generated using various salt solutions at a given temperature.

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## II. Background Of The Study

The use of saturated salt solution is a very simple and convenient method of producing known relative humidity for testing and calibrating hygrometers and hygrographs at temperatures above 0°C. The saturated solutions provided theoretically ideal relative humidity buffer. The saturated salt solution is made up as a slushy mixture with distilled water and chemically pure salt in a glass or suitable metal tray or in a glass or sealed metal chamber. A constant relative humidity is obtained in the chamber when equilibrium conditions are attained.

The relative humidity in equilibrium with the saturated salt solution is given by the equation

$r_{h.} = \{ es / et \} \times 100$

where

es is the saturated vapour pressure of pure water at dew point temperature, and

et is the saturated vapour pressure of pure water at the ambient temperature.

## III. Experimental Set Up Of The Study

In order to conduct the study, the following items were used:

- A transparent plastic container box with tight lid.
- Salts – Magnesium Chloride, Mangnisium Nitrate,

Sodium Chloride and Potassium Nitrate.

- Laboratory China Dishes
- Distilled water
- Hygrometer
- Thermometer
- Stop watch

Step I: Find the room temperature and relative humidity using thermometer and hygrometer respectively.

Step II: Take specified quantity of salt in the dish and prepare its saturated solution using distilled water.

Step III: Place the dish containing saturated salt solution and hygrometer in the tight box.

Step IV: Observe the reading of the hygrometer at specified interval of time and record the same to assess the behavior of the salt in changing the relative humidity of the closed chamber (box)

Step V: Repeat the process with different salts and observe the change in humidity in each case.

In this study also, the process was conducted with saturated solution of following salts:

- Magnesium Chloride
- Magnesium Nitrate
- Sodium Chloride
- Potassium Nitrate.

In each case, ten grams of salt was taken and its saturated solution was prepared. The reading was taken using stop watch and the hygrometer at constant intervals of time.

### *3.1 Observations and Readings*

For each salt, the process was conducted three times and relative humidity values were recorded at fixed interval of time. Thereafter, average value of the three observations is calculated, as shown below in table 1, 2, 3 and 4.

The room temperature recorded and relative humidity recorded at the time of each experiment has also been recorded and mentioned along with the readings.

Table.1. Relative Humidity generated using Magnesium Chloride salt

| | Relative Humidity (using Hygrometer) | | | |
|---|---|---|---|---|
| Temperature | $27^0$ C | $28^0$ C | $28^0$ C | |
| Relative Humidity | 47 | 48 | 48 | |
| Time | Reading1 | Reading 2 | Reading 3 | Average of the readings |
| 20 | 45 | 46 | 43 | 44.67 |
| 40 | 41 | 42 | 41 | 41.33 |
| 60 | 39 | 41 | 40 | 40.00 |
| 80 | 37 | 39 | 38 | 38.00 |
| 100 | 34 | 36 | 37 | 35.67 |
| 120 | 33 | 34 | 33 | 33.33 |
| 150 | 33 | 35 | 34 | 34.00 |

Table.2. Relative Humidity generated using Magnesium Nitrate salt

| | Relative Humidity ( using Hygrometer) | | | |
|---|---|---|---|---|
| Temperature | $26^0$ C | $27^0$ C | $28^0$ C | |
| Relative Humidity | 46 | 47 | 48 | |
| Time | Reading1 | Reading 2 | Reading 3 | Average of the readings |
| 20 | 49 | 48 | 50 | 49.00 |
| 40 | 52 | 51 | 51 | 51.33 |
| 60 | 53 | 52 | 53 | 52.67 |
| 80 | 53 | 53 | 53 | 53.00 |
| 100 | 55 | 54 | 54 | 54.33 |
| 120 | 54 | 54 | 55 | 54.33 |
| 150 | 54 | 54 | 55 | 54.33 |

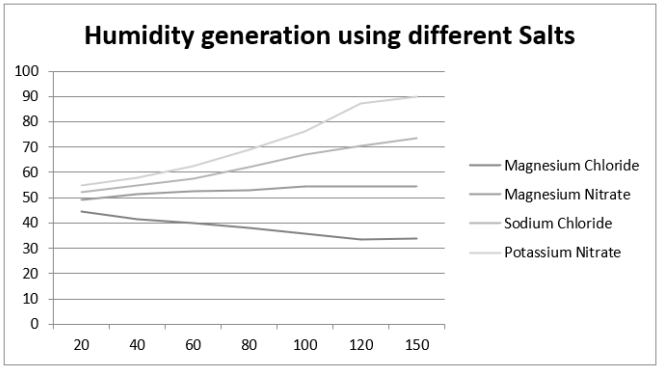
Table.3. Relative Humidity generated using Sodium Chloride salt

| | Relative Humidity ( using Hygrometer) | | | |
|---|---|---|---|---|
| Temperature | $27^0$ C | $26^0$ C | $28^0$ C | |
| Relative Humidity | 46 | 45 | 49 | |
| Time | Reading1 | Reading 2 | Reading 3 | Average of the readings |
| 20 | 53 | 52 | 52 | 52.33 |
| 40 | 56 | 54 | 55 | 55.00 |
| 60 | 58 | 57 | 58 | 57.67 |
| 80 | 63 | 61 | 62 | 62.00 |
| 100 | 68 | 66 | 67 | 67.00 |
| 120 | 71 | 71 | 70 | 70.67 |
| 150 | 74 | 73 | 74 | 73.67 |

Table.4. Relative Humidity generated using Potassium Nitrate salt

| | Relative Humidity ( using Hygrometer) | | | |
|---|---|---|---|---|
| Temperature | $27^0$C | $26^0$C | $28^0$C | |
| Relative Humidity | 46 | 45 | 49 | |
| Time | Reading1 | Reading 2 | Reading 3 | Average of the readings |
| 20 | 56 | 54 | 55 | 55.00 |
| 40 | 59 | 57 | 58 | 58.00 |
| 60 | 64 | 61 | 62 | 62.33 |
| 80 | 69 | 67 | 71 | 69.00 |
| 100 | 78 | 75 | 76 | 76.33 |
| 120 | 86 | 87 | 89 | 87.33 |
| 150 | 90 | 90 | 90 | 90.00 |

It can be observed from the values arrived for different salt that each salt has tendency to generate a specific level of humidity. The chart shown below in figure 1 clearly indicates the levels of the humidity generated by different salts.




Following important observations were made:

- The saturated salt solutions have tendency to affect level of relative humidity.
- Different salts have different tendency of generating humidity. Relative humidity in the range of 33 percent to 90 percent can be generated using saturated solutions among these salts.
- At a room temperature of approximately $26^0$ C , Magnesium Chloride has generated humidity of 34%, Magnesium Nitrate generated humidity of 73%, Sodium Chloride generated humidity of 75% approximately and Potassium Nitrate generated humidity level of 90%.
- Despite of relative humidity in the range of 45 to 48%, salts like Magnesium Chloride have reduced it whereas Potassium Nitrate has increased it significantly.
- After a given time period, saturation level of relative humidity is achieved and thereafter further change is insignificant.
- As per the required level of humidity, the quantity and nature of salt can be used.

### *3.2 Limitations of the method of generating humidity using saturated salt solutions*

When salt solution buffers are used for fixed relative humidity control, many stringent conditions which are described below should be satisfied, and the precautions given below are to be observed in order that the theoretical values may be used without the need of actual measurement.

- Saturated salt solution should be enclosed in a sealed chamber. This is necessary to avoid breathing effects which result from the development of differences of pressure between the inside and outside of the enclosures.
- The chamber in which the desired humidity is to be produced and the fixtures therein must be made of non-hygroscopic materials, preferably metal or glass. In particular, when screw-top jars are used, any water-absorbent linings in the lids must be replaced by unabsorbent material, otherwise the time required for humidity equilibrium to be achieved may be very great, sometimes of the order of days.
- The chamber, salt solution, and ambient air should be brought to temperature equilibrium. This is best satisfied by putting the enclosure bodily into a temperature-controlled cabinet.
- It is desirable for the salt solution to occupy as large a surface area as possible. As ideal conditions are rarely obtained in practice, it is probable that the theoretical values of relative humidity are seldom reached.

## IV. CONCLUSION

Humidity generation using saturated salt solution can prove effective in creating a specific range of humidity level but accurate value of humidity is rarely possible. Although, the method suffers from number of limitations but on account of its cost effective and usage in the absence of electricity make it advantageous against scientifically designed humidity generator. It can prove effective in areas where range of humidity is required and not a particular specified level. The specific range of humidity can be established with the type and quantity of salt depending upon the requirement of

humidity level and dimensions of room in which the objects are stored.

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