

# Design and Fabrication of a Halotherapeutic Generating Unit for Curing Pulmonary Diseases

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**Abstract-** This paper include the description of a treatment for respiratory problems called as halotherapy. Halotherapy is recognized as a better solution for many of the respiratory illness such as asthma, COPD, smoker's cough etc. The design consist of preparation of smaller particles of dry sodium chloride. The dry sodium chloride is being grinded to size of 1-5 micron and is effectively distributed in a room condition of 18- 24°C and the concentration to be maintained is about 1- 16 mg/m<sup>3</sup>.

**Index Terms-** Halotherapy, Speleotherapy, Halogenerator, Dry Sodium Chloride aerosol,

## 1 INTRODUCTION

With the increase in respiratory problems many researches were going on in the field of respiratory diseases and the most modern technique is the derivative of Speleotherapy called as halotherapy.

*Speleotherapy* is an underground respiratory treatment used mostly in Russia and East Europe for around half century before. It uses dry saline aerosol inhalation for the relief from respiratory problems like chronic obstructive pulmonary disease (COPD), asthma etc.[1] It can also improve sinus and lung function as a result of which have a relief from sinusitis. The penetration power of dry saline aerosol is much higher due to its negative charge and smaller size .It is

comfortable for patients who exposed to hypertonic saline aerosol solution. Its effects also include immunomodulating, antibacterial, mucolytic and anti-inflammatory.

In ancient times salt caves were natural salt therapy room. The people working for mining and other underground activities tend to show relief from respiratory problems as they work near salt mines. This lead to a finding that salt mines has an effect in the disease curing. The salt mine had an advantage of stable temperature, humidity and pollutants were lesser.

Exposure to hypertonic salt water aerosol was found to have relief from cystic fibrosis. This was identified from the regular sea surfers in Australia.

*Halotherapy* can be performed in a chamber commonly known as halochamber with walls, floors and roofs covered with sea salt. It is a drug-free treatment and requires a controlled air medium which is anonymous to a natural salt cave climate. The salt coverings absorb air moisture and maintain environmental conditions.

For this therapy the particle of dry sodium chloride is in the range of 1-5 $\mu$ m as the human lungs only inhale particle up to 5 $\mu$ m and these particles can be released in to the chamber using special techniques. Also it requires a special room conditions of controlled temperature and humidity.

The ideal concentration of aerosol particles of sodium chloride in the chamber is about 16mg/m<sup>3</sup>. Many studies reported that this treatment is much benefit for the patients with bronchial asthma, chronic obstructive and non-obstructive, cystic fibrosis, bronchiectasis etc. During the treatment it was observed that a severe improvement in body plethysmography, bronchial resistance, flow-volume loop parameters. And thereby Halotherapy was approved as a medical device in 1995 by the Russian Ministry of Health. The curative effect of sodium chloride – salt was found as soothing effect in inflammations and eliminating the bacterial actions.

## 1.1 Principle

The mechanism lies in the curative breathing environment which has favorable conditions of temperature and humidity with mass concentration of 1-16mg/m<sup>3</sup> and particle size of 1-5 $\mu$ m of dry sodium chloride aerosol. Here the dry sodium chloride aerosol have a slight positive charge of 6-10nK/m<sup>3</sup> and is much effective than the neutralized particles. Since the inner surfaces of respiratory tract has a positive charge, the oppositely charged salt particles penetrate much better and settles and thus it is much efficient than conventional hypertonic saline aerosol.

The environment should have a temperature range of 18 – 24°C. The smaller the particle size easier is to act through the alveolar tissues in lungs. So an ideal range of concentration is chosen.

The salt has an antimicrobial property which explains that it resist the microbes. It do have an antimycotic capacity that is destroying the fungi attack. The salt was as salt water gargling which ensured healing of throat and mouth irritation.

Salt therapy is usually done in a salt room: the walls and floor is covered with salt. The smaller sized particles are easier to be absorbed to the alveolar walls. The antimycotic property of salt will react to the surface of the tissues and removes the bacterial and fungi content.

The typical particle size that could enter the respiratory tract is below 10 micron. Rest of the Particle size will be struck in the pathway like the nostrils and throat. It is because higher particle size will not be able to penetrate through the lower tissues of lungs tract.

The adaptable ideal concentration condition for halochamber is such that for fractions of dry sodium chloride aerosol

- 35.4±2.1 % particle size is 1-2 µm
- 61.8±3.3% particle size is 2-5 µm
- 2.8±0.4% particle size is 5-10 µm
- 0.003% particle size is greater than 10µm.

## 1.2 Effectiveness

Sodium and Chloride ions are present in our body cells and they are helping in hydration. It's effective against bacterial action. Usually spray nebulizers are used for asthma and respiratory problems but aerosol form of sodium chloride helps in rapid action with the positive ions inside the alveolar region.

The mucus membrane present inside the respiratory tract will produce mucus. The inflammation created in the site is being eliminated by this treatment. [2]

The effectiveness would be maximum only when the concentration of aerosol as well as the particle size is optimum. Many benefits are being observed from the use of halotherapy. Some people treated with this

therapy assured that intensity of asthma attacks were reduced.

As of the ancient use of salt water for gargling improvement in mucociliary clearance is achievable. Reduction in bronchial hyperresponsiveness is yet another remarkable property of halotherapy. Pathogenic microorganism can be eliminated by the antimicrobial action of salt and its smaller size enable the elimination the bronchial tract and even at the lower respiratory regions.

Halotherapy has shown curative effect to various diseases like Bronchiectatic diseases, Breathlessness, chest tightness, Chronic bronchitis, Cough with viscous sputum, Colds and influenza, Dry rales changing its localization during auscultation, Eczema, psoriasis, Pneumonia after acute stage, Wheezing, Smokers' cough, Sinusitis, Tonsillitis, Respiratory infections, Rhinitis and rhinosinusopathy, Bronchial Hyperresponsiveness. [3]

Halotherapy method is more preferable as it is a drug free treatment and thus it will have lesser side effects. Rather than any other medicinal treatments salt therapy has proved to benefit for about one year. The halotherapy treatment is stress releasing method as the patients can engage in their work or relax by listening to music. The viral diseases can be prevented from attacking while we are exposed to a salt environment because of its antibacterial property.

There isn't any sort of pressure upon the patient and the microclimate conditions are continuously monitored by health care professionals and even it could be controlled automatically. There are no additional costs such as for supplements etc. Treatment has a lesser cost and frequent treatments may improve the health conditions. Speleotherapy was found to have a direct immunological reaction like the t-lymphocytes actions and its increment. [4]

Halotherapy may have rare side effects. Skin rashes with some irritations may appear after the first session but this are usually disappearing after 4 or 5 sessions. Tickling in throat section can be avoided simply by gargling boiled water. Patients are recommended to keep their eyes closed during the halotherapeutic sessions as there is a chance of inflammation. Eye drops like sulfacetamide solution is recommended for about a week in order to eliminate inflammation. Conjunctivitis may occur in some patients when exposed to dry sodium chloride.

## 2 EXPERIMENTATION

Halogenerator unit was built on the conclusions made from different theories and papers. The basic design of which consist of a salt tank, dispenser, blower, mesh and a grinder.

### 2.1 Salt Tank

Salt tank or hopper is a storage container used

to dispense the salt to the halogenerator body. The hopper can be made of a wide shape at its inlet end and a narrow hollow pipe at its other end to channel the fine-grained salt into the halogenerator body. We are mainly using this type of design to avoid the spillage. Hopper can be made either of a stainless steel or cast iron. The funnel of the hopper can be made so that it is capable to withstand the required amount of salt for grinding. The material used in its construction should be sturdy enough to withstand the weight of the salt being transferred, and it should not react with salt.

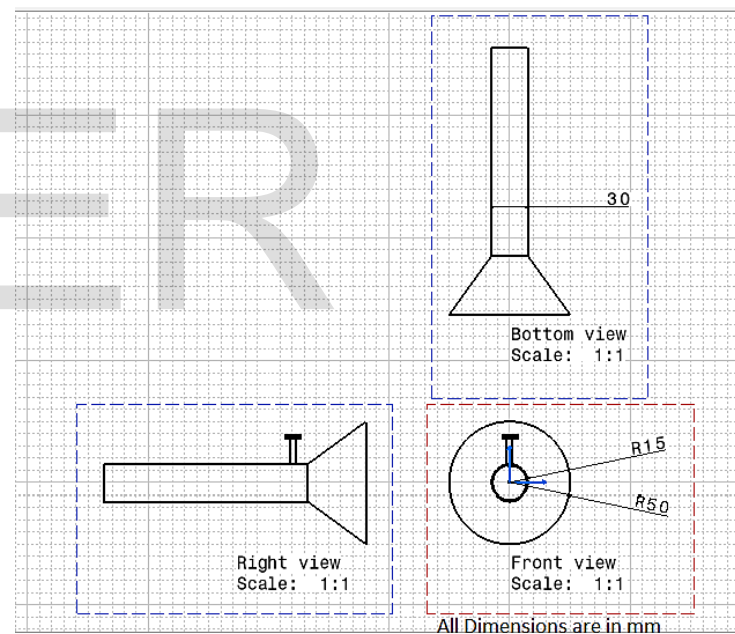


Fig 1. Hopper Design

### 2.2 Dispenser

The dispenser is a box like container or device for holding and dispensing the salt in small amount. Since the amount of salt given to the halotherapy grinder unit is of small, a dispenser unit is essential. This dispenser is controlled by external unit. The dispenser is

also made of cast iron or stainless steel so as to reduce the salt corrosion. It can be placed at the end of frustum of the hopper. Here the dispenser has the mechanism same as a butterfly valve and its motion is controlled by a servomotor attached to it.

The dispenser is placed near to the inlet so as to control the flow of salt particles. It is the primary method to control the salt flow rate. There are various additional methods accompanying this.

### 2.3 Blower

The halotherapeutic unit consist of a ducted centrifugal fan or a blower to blow out the salt in to the therapic room. The speed of blower used in this system is 16000rpm. When the rpm increases the salt flow rate also increases. Thus it requires higher rpm fan. Also it is required to reduce the diameter of the hopper at the flow region for the smooth movement of salt particles.

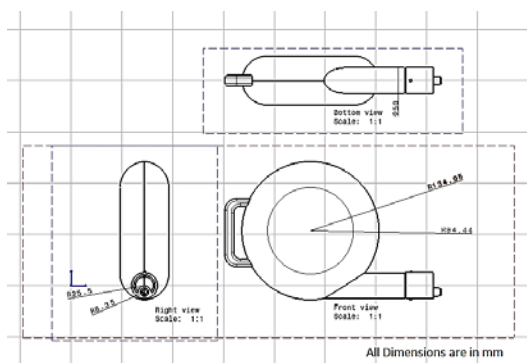


Fig 2. Blower used

The blower outlet can be made special so that the 1/3<sup>rd</sup> of the air can be given to the grinder so that the salt can be move upward in

addition to the centrifugal force developed due to grinding. Only 2/3<sup>rd</sup> of the air is given to the room for the blowing of salt.

### Specification Of Blower

Input Supply	220V, 50 Hz, 1.5 A
Power	500W
Speed	16000 rpm
Flow Rate	2.8m <sup>3</sup> /min

### 2.4 Mesh

Since halotherapy requires the particles in the range of 1- 5µm we are using a mesh of 100 microns. Here the large particles get settled down and required particles get accumulated in the halochamber.

### 2.5 Grinder

The main purpose of grinder is to break the higher grain salt particle in to lesser size particles as for the halotherapy treatment around 1-15µm particles only can be used. Thus special grinders should be used for this purpose. Also the grinder required for this purpose is of continuous type as it is required to introduce the salt continuously.



Fig 3 Grinder used

Specification Of Grinder

Motor	1.5Hz, 2800rpm, 1Φ, 230V
Capacity of Grinder	5 Kg

2.6 Halogenerator Body

The halogenerator body is a box like structure in which the generating unit can be kept. It has two holes axial to each other.

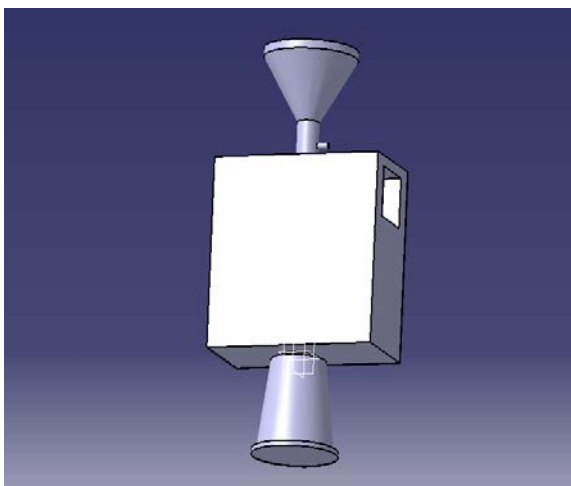


Fig4 Design Outlook in Catia V5 R18

The fan is kept at one hole and through the second hole the salt aerosols can be introduced in to the hole. The halogenerator body is basically made of stainless steel as it is cheaper and easily available and also due to its high inertness it has higher resistance to corrosion.

The Halogenerator unit was initially designed as the figure given below. The cover plate was designed with minimum considerations. Here the hopper was placed exactly at the center of the grinder and the slits were given around it.

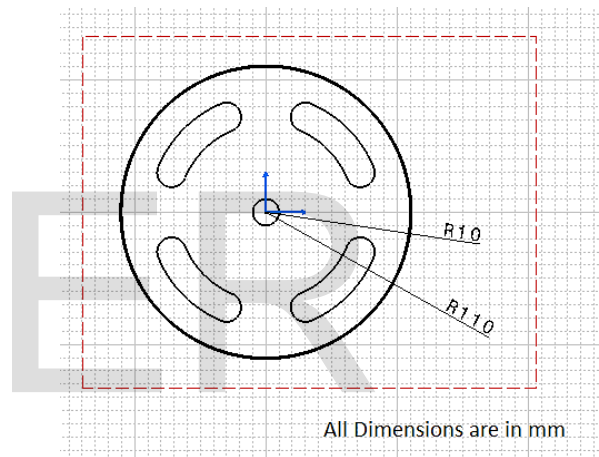


Fig5 Sample Cover Design

The design was not perfect as the hopper pipe was in the middle of the grinder and the outflow of salt was lesser. The slits with meshes didn't allow enough salt aerosol particle to come out as there wasnot enough blowing inside the grinder. So the cover design was put into consideration and futher modifications made is as shown below.

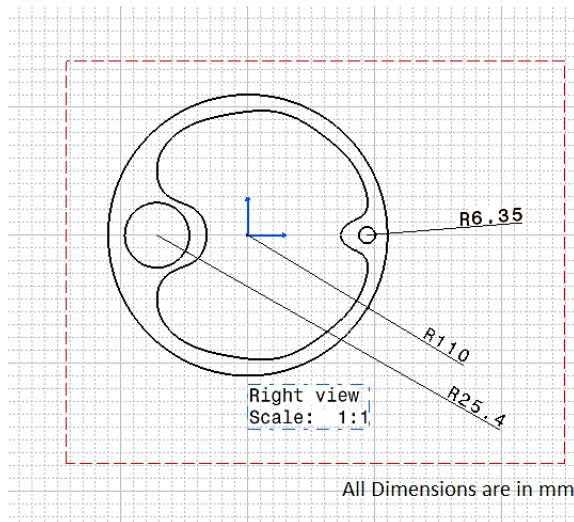


Fig 6 Final Cover Design

Here the 1/3<sup>rd</sup> of blower outlet is fed into the grinder for enough particle circulation and efficient outflow of

aerosols. The hopper pipe is placed near a corner. slits were placed in the remaining parts.

### 3 FABRICATION

The halotherapeutic generating unit was made with a blower and grinder assembly along with mesh of 150 micron. The material used was stainless steel as it can withstand salt associated corrosion. A box casing was created using sheet metal covering the grinding vessel, blower and the hopper pipe.

The blower outlet was designed to have flow for blowing out the salt aerosol particles as well as to have a blow inside the grinder for an efficient out flow of the fumes. The blower outlet was fabricated using 3D printer.

The blower outlet had its 1/3<sup>rd</sup> part guided towards the grinder and the remaining for the blowing out process.

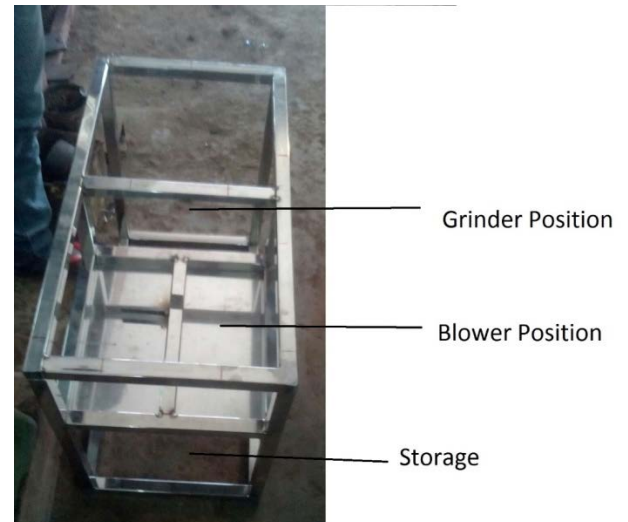


Fig7 Casing

Cover plate was first of all designed with simple concept that is with a hopper hole in the middle and surrounded by slits. The redesigning of cover plate was done to have a blower flow inside the grinder, a hopper pipe inlet hole and holes attached with 150 micron size mesh.

The blower flow is placed perpendicular to the grinder outlet and the medicated exhaust is directed in the opposite side of the blower through the grill prepared. The blower is placed upright to the grinder and it's given cooling and filtered air input that satisfies the room conditions.



Fig8 Arrangement of blower in halogenerator.

There was a perfect outcome of required particle sized salt aerosol. The particle size was obtained below 50 microns and greater particles were settling within the mesh and near the grills.



Fig9 . Aerosol fume formation just above the grinder with 150 micron mesh

#### 4 RESULT AND DISCUSSIONS

This project was done to create a halotherapy generating unit with certain conditions satisfied. Halotherapeutic generating unit was fabricated with along with a grinder of 2800 rpm, a blower of 16000 rpm. The grinder was loaded with heated salt (removal of moisture) and 1/3<sup>rd</sup> of blower flow was arranged to the grinder.

The cover plate of grinder was given a half inch hole for guiding the blower flow inside the grinder and a hopper or 2 inch size is guided inside through another hole. The remaining part was given mesh of 150 micron so as to get a specific range of salt particles out. The out coming fumes or aerosol particles of salt is directed towards outside with help of blower flow.

The halotherapeutic unit prepared was nearly satisfying all the required conditions specified. The output aerosol particles was between 1- 50 micron size. But the size of particulate matter that can enter the bronchial tract is 1-5 micron size. The larger particle size aerosols like about 50 microns or higher won't be able to suspend in the air so that they might settle down. Thus in effect smaller particles will be entering the patient's respiratory system.

The corrosion is another factor that should be considered in case of this system. The room, walls, other equipment are being covered with rock salt so that settlement of higher sized particle will not add up the corrosion. The artificial microclimate is being created with temperature range of 18-24°C and humidity 40-60 % and concentration of 10 mg/m<sup>3</sup>



## 5 CONCLUSION

The fabricated design produced aerosol particles of sodium chloride, with size suitable for effective penetration into the lumen of the respiratory tract. The fabricated design requires a startup time to obtain the required concentration in the test room. The startup time depends on the specifications of the test room.

The halogenerator was made to create an atmosphere with sodium chloride aerosol particles of size less than 50 micron and with a concentration of 1- 16 mg/m<sup>3</sup>.

A system of halotherapy generating unit was created with an output of aerosols of sodium chloride within the required range. The system is calculated to create a medicated environment of 10 mg/m<sup>3</sup> within 13 minutes of working.

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