

Soil Sterilization using Induction Heating

¹N M Mali¹, ²Suryakant F Rathod, ³Sunil A More, ⁴C. Shriramshastrri

^{1,2,3}Assistant Professor Mechanical Engineering Department, DY Patil College of Engineering, Ambi Pune.

⁴Professor Mechanical Engineering Department, DY Patil College of Engineering, Ambi Pune.

(*nitin.mali@dyptc.edu.in)

1. INTRODUCTION

The idea to generate heat using the principle of electromagnetism has been used in many areas from a long time. This is referred to as induction. It doesn't generate harmful effects on the environment and is very economical to assemble. This makes it a very reliable alternative to many other methods of heating. Induction heating is the production of an electric or magnetic state by the proximity (without contact) of an electrified or magnetized body. A very distinct concept is to use induction heating to generate steam. This is being tested and used in wide range of areas from factories and refineries using pressured steam to steam driven turbines. The combination of using induction heating for generating steam gives it a distinct power as the heating from induction benefits the process to create hot steam which can be converted to high power by simply pressurizing the steam during the process, an unconventional method but with a good developmental area to innovate. Steam generated with the help of induction boiler, at first may seem pretty limited to explore but there is an unceasing demand in the area of sterilization, more specifically the area of soil sterilization that actually demands hot steam.

The concept to relieve soil from its pests and weeds is what soil sterilization means to a layman. Although, the statement in itself is not false but it alone cannot be termed as completely accurate. A key factor often ignored is the concept of steam involved in the process. "It is a farming technique that sterilizes the soil with steam in open fields of greenhouses. Pests of plant cultures such as weeds, bacteria, fungi, and viruses are killed through induced hot steam which causes vital cellular proteins to unfold." Conventionally, induction heating is regarded as a better alternative to many other solutions to generate heat since it has the benefit of no harmful by-product but as previously mentioned, the cause of the induction method not being popular is its own non recognition. By linking it with soil sterilization process, the usage of induction as a process will gain momentum in general minds and slowly but surely more and more such linkage will innovate, thus widening the reach of induction process and induction heating.

2. PRINCIPLE OF ELECTROMAGNETIC INDUCTION

Experimental setup has been developed with the objective to study the induction phenomenon for increasing the fertilization capacity of the soil. Conventional way of generating steam has been replaced by electromagnetic induction way of generating steam with improved efficiency. The working principle of induction heating has also been dealt in this paper.

The energy transfers to object to be heated occur by means of electromagnetic induction. It is known that in a loop of conductive material an alternating current is induced, when this loop is placed in an alternating magnetic field. When loop is short circuited; the induced voltage will cause a current to flow that opposes its cause, the alternating magnetic field which refers to Faraday Lenz's law. It a massive conductor (e.g. a cylinder) is placed in the alternating magnetic field loop, then eddy currents (Foucault currents) will be induced in here. The eddy currents heat up the conductor according to the Joule effect.

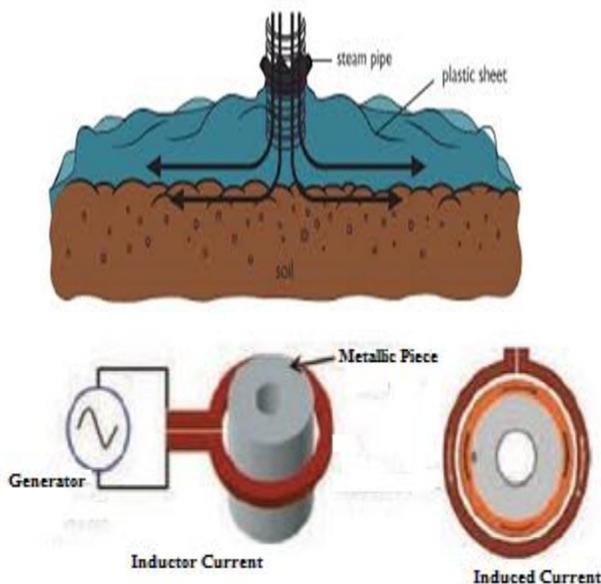


Fig: 1 Soil sterilization

3.EXPERIMENTAL SET-UP AND EXPERIMENTATION

Initially, inner tank is filled with water through inlet valves up to a certain limit which is determined using a buzzer into the tank to the limit. So, when the water is filled up to a limit buzzer activates and sends the signal so that the power supply of motor will be cut off automatically and then inlet valve closes so that water will not get wasted. When the water at ambient temperature is to be heated and desired to be in steam state. It will have to be filled in ferromagnetic container. The container will be wound with copper coil which has tendency to carry high current due to its own content property. The system will work on faraday Lenz's law of electromagnetic induction due to which when coil will carry low voltage, high current and high frequency it will develop electromagnetic field itself. The water to be heated will be filled in a container and it will be placed inside an air coil driven by the power supply, usually in combination with a resonant tank capacitor to increase the reactive power. The electromagnetic field will induce eddy currents in the container. The current will flow through the coil which leads the coil to produce electromagnetic induction in the field.

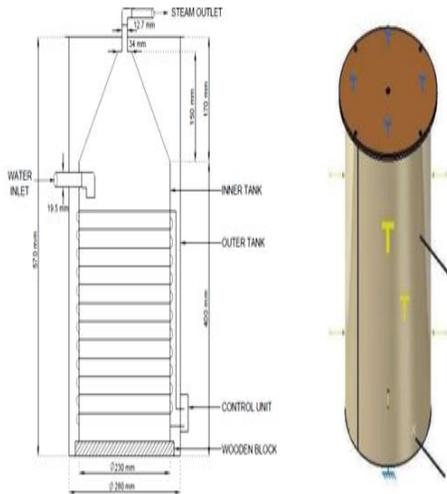


Fig. 2 Experimental-setup [Three dimensional model]

As the current flow will increase it will make the coil to produce more electromagnetic field in the container. This phenomenon helps to give heat to the container. The electromagnetic induction has the property of increasing temperature rapidly. Therefore, the water inside the container will start boiling in less duration of time. Due to continuous provision of high current and high frequency to the

copper coil which extends the duration of electromagnetic phenomenon will help to boil the water vigorously. After certain duration the water will start converting into the high temperature steam which is desired output from the corresponding setup. The steam which will be generated from the boiler will be passed through the outlet pipe situated at the top and will be passed towards the crops through the pipeline. The steam pipe outlet will be connected to thermo-pressure gauge which is there to measure the temperature and corresponding pressure of the steam from the outlet.

As the inner cylinder is the actual component which is in the radiation of electromagnetic waves generated by the copper coil provided with current it must be analyzed for various components like stresses, temperature etc. Therefore the inner tank is analyzed with the CAD software for the clarification of safety terms which may arise during the operating condition. That is why the CAD model of inner tank is analyzed for the above purpose and the results were witnessed the safe results. The analysis results are as follows,

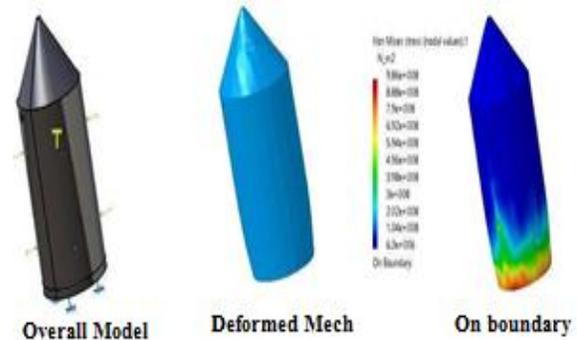


Fig. 3 FEA-Analyzed Model

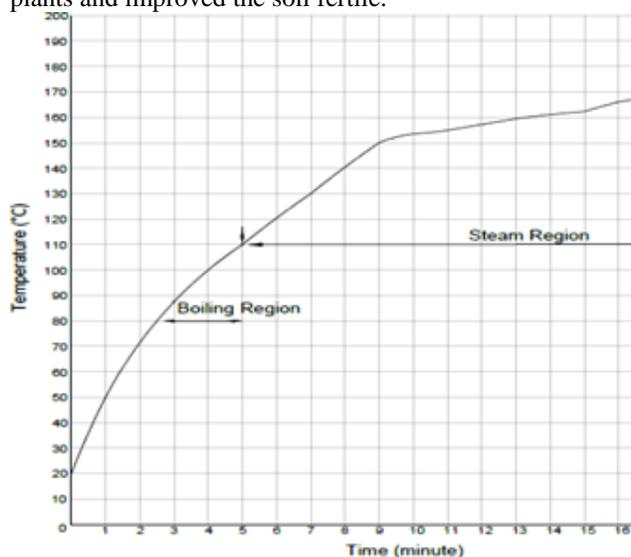
Criterion	Good	Poor	Bad	Worst	Average
Stretch	2430 (73.44%)	643 (19.43%)	236 (7.13%)	0.013	0.080
Aspect Ratio	2568 (77.61%)	415 (12.54%)	326 (9.85%)	78.521	22.873

Material	Steel
Young's modulus	2×10^{11} N/m ²
Poisson's ratio	0.266
Density	7860 kg/m ³
Coefficient of thermal expansion	1.17×10^{-5} mm/K
Yield strength	2.5×10^8 N/m ²
Energy	1477.309 J

4. RESULT

The efficiency of the Induction of the boiler is stable

throughout the operational period. Induction pot belongs to the class of energy saving equipment. Cost is ensured high power factor, which is characterized by the frequency of the current used. As a result, the operating costs are reduced by 30%. Growth of plants is at faster rate than before. Through steam the harmful organisms, fungal spores, weed seeds, etc. is killed providing a “clean” growing environment which encourages strong, healthy growth of the plants and improved the soil fertile.



The graph given above shows the temperature rising with respect to time while working on induction. As we can see in above figure when the boiler unit is in ON condition, initially the temperature rises slowly and gradually. As the temperature increases the graph goes on showing the expected temperature condition in the inner tank of boiler. At the interval of 5 to 7 min the speed in rising of temperature of water increases. The temperature goes on increasing leading to conversion of water in steam in around 20 min.

5. FUTURE SCOPE

In the upcoming years, the percentage of the induction phenomena will be greater than that of the other fossil fuels. The demand for the applications operated by using this phenomenon is certainly increasing day by day. That is because induction equipment continues to evolve and systems are available that have been optimized to achieve client requirements. So, there are many applications where the steam from the boiler is considered priority for the operations to be carried out.

Some of the applications are as follows:

1. Process Heating in Industries: Technique of applying heat to the raw goods, to achieve final product.
2. Atomization: The spray nozzle commonly utilizes steam to heat the liquid and mechanically cause the droplets to easily travel in the hot gases to locate oxygen molecule for the combustion. Better atomization results in better combustion.
3. Humidification: - Heating your home with a heat pump is energy efficient and cost-effective. When dry indoor air becomes a problem in winter, however, we are likely to find that the central humidifiers that just work fine with fossil fuel fired furnace aren't as effective when used in conjunction with heat pump. Fortunately, a steam humidifier may be the solution to the problem.
4. Drying Purpose: - Steam effectively sanitizes clothes, which helps to eliminate nasty smells.
5. Soil Sterilization: - In this process, pressurized steam is used to heat the land which kills all microbes, spores and viruses affecting the plant growth.
6. Hospitals: - To reduce the risk of causing infection in the patient. The medical devices are sterilized to eliminate human pathogen-organisms that are known to cause human disease.
7. Power generation in Industries: - Steam is used as a source for production of electricity in many power plants across the world.

CONCLUSION

The versatile nature and unique properties of induction phenomena enables both the designers and engineers in many areas of specialty to use induction as a secure and reliable method of heating. With its much-needed advantages it proves to be a very good solution to a long running problem. We get a high level of environmental safety.

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