International Journal of Engineering Inventions
e-ISSN: 2278-7461, p-ISSN: 2319-6491
Volume 11, Issue 12 [December. 2022] PP: 233-241

Brief Review on Hot air oven

Ms. DaminiRathod , Ms. Tai Yele,Ms. JyotiJawale, Ms. KomalNaikude
Institute of Pharmaceutical Science and Research (For Girls)
(College code- 6914)
Gat.No. 541/2 off Pune – Solapur Highway,
Swami – Chincholi (Bhigwan),Tal-Daund ,Dist -Pune-413130
Corresponding Author: Damini Vishwanath Rathod

ABSTRACT

A Hot air oven is electrical device which is used for dry heat sterilization in laboratoryindustries. It is used to kill bacteria, remove moisture content present in the substanceand sterilization of glassware's in the laboratory. Drying is the process of removing water orany other solvent from a solid, semi-solid, or liquid substance through evaporation. Many components that make up a hot air oven they are divided into two categories: outside and inside components.
Additionally, it is employed in the chemical, pharmaceutical, food, beverage, and textilesectors. In contrast to autoclaves, hot air ovens don't need water and don't build up much pressure inside, making them safer to use. Also, because of this, they are better suited for usein laboratories.

Keywords: Hot air oven , Sterilization, Dry heat , ovens, equipment sterilize.

Date of Submission: 15-12-2022 Date of acceptance: 30-12-2022

---

1. INTRODUCTION

Electric appliances called as Hot air oven use dry heat to disinfect. Louis Pasteur was the person who first creates them. Typically a thermostat is used to regulate the temperature. Because their twin walls are metallic on the outside, they insulate the well and save energy. A hot air oven is thermostatically controlled, electrically heated appliances used for heating applications including drying and Sterilizing dental and surgical instruments.(1) Equipment that kind cannot be submerged in water and material want's melt, catch fare or otherwise changes when subjected to high temperature sterilized using dry heat. Microorganisms and bacterial spores destroyed in hot air ovens review using extremely high temperatures maintained for several hours. The ovens employ condition to sterilize objects by heating their exterior surface, which then absorb the heat and transfer the object via the conduction process. Drying is the conservation method that involves getting rid of a lot of water that is present. A food by applying heat under regulated circumstances with the goal of reducing the chemical, enzymatic and microbiological activities that leads to food deterioration. Hot air Sterilization usage has increased as result of the introduction of syringe services. The manager of Gina now clarifies the several hot air oven kinds. By employing the hot air oven we may sterilize a variety of objects including glassware's (such as Petri dishes, pipettes, flasks and test tubes), powders (such as starch, zinc oxide, and sulphadiazine), Material containing oils, tools (such as scalpel, scissors, and bleads). Drying is typically done for two main purpose: first to decrease water activity which extend the self life of food. And second to lighten the weight and bulk of food for less expensive transportation. Drying process can be broadly divided in to mechanical and sun drying, convicting drying, contact drying, cabinet drying, fluidized bed drying, pneumatic drying, somatic drying, freez drying, radiation drying, super heated steam drying etc. are some of the fundamental and often used drying techniques. Drying is the process of removing water and other solvent from a solid, semi-solid or liquid substance through evaporation.(2) it is thermo-physical and physicochemical process and both inside and outside laws of the mass and heat transmission regulate it's dynamic principles. In the majority of situations a gas stream like an air stream transfer heat through convection and removes the vapor as humidity. Being a simultaneous heat and mass transfer phenomenon, the temperature within the food rises as the heat is transfered through it. This rises the water vapor pressure of the moisture present in the food matrix. Hot air which is employed in convective drying has allow water vapor content and is the medium used to dry the food. When using hot air sterilizer the most typical time temperatures of 170°c (340 F) for 30.minutes, 160°c (320 F) for 60.minutes, 150°c (300 F) for 150 minutes or more. Because of the spores of Bacillus atrophies is more

resistant to dry heat than those of Geobacillus stearothermophilus they should be employed to monitor the sterilizing process for dry heat. The oxidation of cell components is thought to be the main delay mechanism. Remove all inner components and clean the oven completely every six months. Cleaning supplies including soaps, water, clothes and paper towels.

TEMPERATURE LEVEL OF HOT AIR OVEN. (3)

Name	**Hot air Sterilizer**
British Pharmaceutical Codex(1949)	150°c for 1 hr
Bigger, J. W. (1949)	169°c for 1 hr
Burrows, W. (1949)	170°c for 2 hr
American Public Health Association (1950)	160°c - 180°c for 2 hr
Dubos, R. J. (1948)	160°c for 90 min.
Fairbrother R. W. (1953)	160°c for 1 hr
Gerhards, G. A. (1952)	140°c for 1 hr (electric fan oven)
Gerhards, G. A. (1952)	170°c for 2 hr (gas oven)
McCulloch, E. C. (1945	160°c for 1 hr
Underwood Weedon, B. (1941)	320F. for 1 hour (electric oven without fan) (160°c)
Walter, C. W. (1948)	160°c for 1 hr if instrument are clean

PRINCIPLE OF HOT AIR OVEN

The hot air oven is based on the dry heat Sterilization principle. due to the fact that dry heat Sterilizations rely on conduction. the temperature of the object to be sterilized initially contacts it's surface before progressively descending to it's inside. Dry heat Sterilization ensure that the entire material sterilized as a result. the material then receives an even distribution of heat and if this heat is used for a predetermined period of time. it aids in the Sterilization of all types of microorganisms. including bacteria, viruses, fungus and even resistant end spores . which resist the majority of Sterilization method. dry heat Sterilization the material by causing the particles inside it to oxidize and damage their primary components. ultimately causing the organism to die. for effective Sterilization the temperature is typically set for an hour or so. since hot air is lighter than cold air, thus increasing the temperature inside the chamber results in the flow of hot air up to the roof of the chamber while cold air comes down. Thus, it facilitates the circulation of hot air inside the chamber.(4)

Fig. No 1 Hot air oven

WORKING OF HOT AIR OVEN

●A lot air oven is a steel, double-walled chamber that is filled with asbestos glass fibre insulation between the two walls to prevent heat loss. The door has a gasket on the inside of its double-walled interior.
●The oven's bottom accommodates the heating element. Electric fans evenly circulate the hot air.
●The oven is provided with 2 to 3 perforated shelves to place materials. Place the ingredients inside the oven after wrapping them in a fresh piece of cloth or filter paper.
● The material is placed on the oven's perforated shelves.
●Electrical heating elements have an impact on heating, and a thermostat automatically regulates temperature (subs. which is formed due to continuous heating)
● Different heat transfer techniques are used to transmit heat from the source to the substance.
● The items in the oven stay there until the temperature drops to 40 degrees Celsius after being heated for 2 hours at 160 degrees Celsius.(5)

CONSTRUCTION OF HOT AIR OVEN

Equipment used for dry heat Sterilizing is a hot air oven with this technique, the equipment is heated to a certain temperature within the oven to destroy the bacteria. The supplies used in the laboratories are excellent heat conductors making them perfect for dry heat Sterilization. The many components that make up a hot air oven can be thoroughly divided into two categories: outside components and inside components.

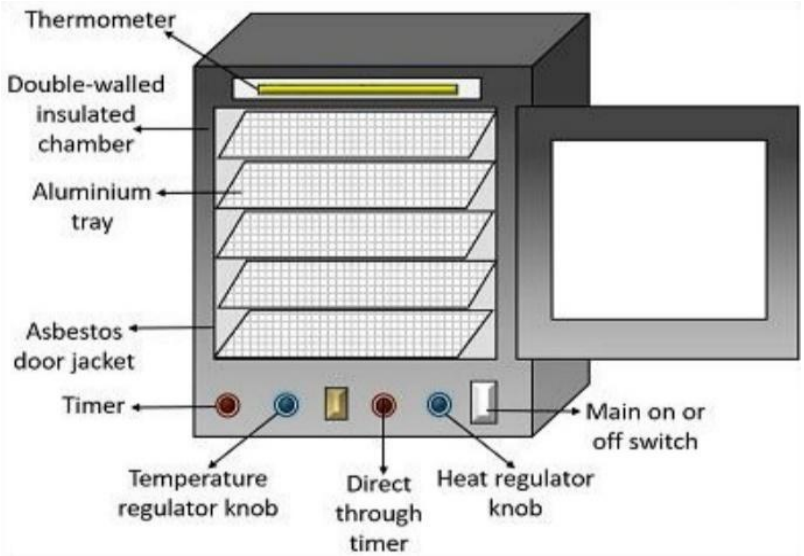

Fig. No 2 Construction of Hot air oven

Component of Hot Air Oven

01) Main Switch
02) Temperature Regulator
03) Thermostat
04) Asbestos Door jacket
05) Stainless Steel Interior
06) Temperature Sensor
07) Air Vents
08) Aluminium Trays
09) Circulating Fans
10) Heating Elements

Outside Components
1.Main witch : It is used to turn the instrument on or off. When the gadget is turned on, a green indicator illuminates.
2. Temperature Regulator : It is used to adjust the temperature based on individual needs.
When the knob is turned to the right, the temperature rises; when turned to the left, the temperature falls.

3. Thermostat : It is up top, with one end of it inside the oven. Its job is to monitor and keep the hot air oven at the proper temperature.
4. Asbestos Door Jacket : This outer, double-walled jacket is constructed from glass-wool fibre. Its main job is to keep the heat produced inside the chamber, which saves energy.
Maximum thermal efficiency is provided, and the instrument surfaces are protected from heat damage .(7)
Inside Components
1.Inner Chamber/Stainless steel interior : It is built of stainless steel, which offers usage that is both corrosion-resistant and supports long-term operation. There are tray slots on both sides, which the tray shelves can slide into or out of depending on the height and volume of the items to be sterilised. The stainless steel wire mesh cable used to make the tray holder.
2. Temperature Sensor : It detects changes in oven temperature both up and down.
3. Air vents : It is near the top of the chamber, allowing hot gases and a lot of heat to escape from the oven.
4. Aluminium trays : The hot air oven's aluminium trays are used to store items like glassware, metals, and other materials. The trays are typically perforated to help the items stored inside get an even distribution of heat.
5. Circulating fans : It plays a crucial part in the improved temperature distribution and the uniform heat flow inside the hot air oven.
6. Heating elements : The instrument's bottom is covered with electrical coils, allowing heat to move upward. (7)

ADVANTAGES OF HOT AIR OVEN

1) for the moist heat Sterilization of things that are readily spoiled.
2) Because of the lengthy exposure to heat in this method, constructed Equipment like all glass syringes can be sterilized.
3) It doesn't harm glass and metal equipment as much as wet heat does.
4) The tools and needles never rust or corrode in the dry heat.
5)for the highest level of thermal efficiency, a balance between the inner and outside walls must be carefully maintained.
6) It is constructed with two walls, which keeps the heat in and saves energy.
7) The stainless steel polish inside the chambers prevents corrosion and guarantees the long-term functionality of the device.
8) It manages the heat well with a digitally controlled interface.
9) The device employs dry heat to sterilise commercial and laboratory goods.
10)It has a thermostat-based heat management system.(8)

DISADVANTAGES OF HOT AIR OVEN

1) Approach that takes a long time since heat penetration and germ death happen slowly.
2) Most material cannot be with stand high temperature for example, plastic and rubber products cannot be dry heated Sterilized because the temperatures employed (160°-170°c) are to high for them.
3) Different substances will required different amount of time and heat and some substances may become ruined by excessive exposure.
4.Sterilizes only the thermostable items.
5.In a hot air oven, rubber and plastic items cannot be sterilised because they will melt at a higher temperature.
6. The oven needed a constant supply of electricity.

TYPES OF HOT AIR OVEN
They are two types of hot air oven
1) Forced air hot air oven
2) Static air hot air oven
Hot air ovens come in two different varieties. Forced air and static air hot air ovens are the first two. Compared to a static air hot air oven, the forced air hot air oven is more efficient. In contrast to the forced hot air oven, which circulates the hot air by heating the oven, A heating coil at the bottom of the oven is how a static air hot air oven operates. It takes longer for the heat to reach the required temperature inside oven because it rises throughout.(9)

Temperature	Exposure time
150°c	For 150 minutes
160°c	For 60 minutes
270°c	For 30 minutes

Table No.2 Normal Temperature and exposure time.

Forced air hot air oven

work with the conduction principle. These sterilisers operate by preheating the oven and circulating hot air with a fan. With this sterilising technique, the cooler air is kept at the bottom of the oven and the hot air is kept from rising to the top. The fan ensures that the oven's hot air circulates throughout at a constant temperature. The item that needs to be sterilised is exposed to pressurised hot air. By sending energy through it, this destroys the bacteria that are present on the object. Because it evenly distributes the heat load on the item you are sterilising, this method of dry heat sterilization is frequently favoured. Static air hot air ovens are generally thought to be less effective than the forced air hot air oven.

Fig. No 2 forced air Hot air oven

Static air hot air oven work on the convention governing the law of gravity. The air inside the chamber is heated by hot air produced by a heating coil at the chamber's base. The air then drifts downward on whatever you are sterilising after rising to the top of the chamber. Static air sterilisers take longer to sanitise objects because the chamber needs time to heat up before the procedure can start. Additionally, it takes more time to get to the correct temperature. The temperature is not uniform throughout the oven because heat is not circulated as it is in forced-air ovens.(10)

Fig.4 Static air hot air oven.

PECIFICATIONS OF HOT AIR OVEN
- 250-litter capacity.
- Temperature range: 5 to 200 C.
- Control precision: 0.5C.
- At 100.0 C, uniformity is 2.0.
- A minimum of three shelves that can be raised in 25mm increments.
- Glass pane incorporated inside the door for convenient sample viewing.
- When the door opens, the heater and blower automatically shut off.
- With a timer, alarms, and auto tuning, a digital PID temperature controller.
- Internal aerodynamic design for horizontal air circulation.
- A solid, unadorned, and unwired bottom.
- G.I. epoxy-coated outer body; stainless steel inner body; clear bottom; CE-certified.
- Mentioned warranty period (minimum 1 year).
- AMC fees will be disclosed.(11)

HANDLING PROCEDURE OF HOT AIR OVEN

1. Place the device on a sturdy, level surface.
2. Place the hot air oven in a room that is open. There should be enough room for air to flow around the machine from all directions. The machine will function better if it is placed at least 2 feet away from a wall and other objects of interest.
3. Keep the machine away from any windows. Otherwise, the hot air the machine releases could lead to droplets forming in the windows.
4. Take a second mercury thermometer and check the oven's temperature if you believe the equipment isn't operating properly. then contrast that value with the display's default value.
5. You can put your hand inside the device as well. To determine if the coils are heating or not, touch the side walls.(12)

SIGNIFICANCE OF HOT AIR OVEN IN DIFFERENT INDUSTRIES

USE OF HOT AIR OVEN IN MICROBIOLOGY INDUSTRY

Hot air ovens are used to test food, pharmaceutical, and other consumable products for temperature stability over the course of use. A hot air oven, commonly referred to as a steriliser, is important in the sterilisation process. When working with pathogenic germs in the lab, it will help you maintain the sterility of your workspace. The calibration certificate is included with this testing device from Presto. (13)

INDUSTRIAL APPLICATIONS OF HOT AIR OVEN

Ovens are typically used for heating and drying. However, it is utilised differently in certain businesses. The pre-treatment of the sample prior to testing for tension, compression, deformation, etc. is frequently utilised.
A hot air oven's other main applications include.
1 Testing of electronics
2 solder strength testing
3 Accelerated heat testing
4 Altering the chemical nature of polymers.(14)

HOT AIR OVEN FOR ACCELERATED AGEING TEST ON PLASTICS

industrial oven is a frequently used testing tool for analysing the effects of ageing on products and materials. The material to be tested is warmed in the sightseeing oven by being placed in the broiler chamber. The manufacturers can concentrate the accelerated effects of maturation on the example in a short amount of time by warming the materials. The qualities of the example are taken into account when developing the testing methodology for theoptimal evaluation of the example. The Hot Air Oven from Presto is equipped with a double-walled chamber. The outside divider is made of mild steel that has been appropriately powder coated, while the interior mass of the chamber is constructed with massively tempered steel. The interior partitions are reinforced with fair mineral glass fleece protection, which ensures that the office is well-protected.

USING HOT AIR OVEN TO STERILISE PHARMACEUTICAL PRODUCT

Applications for laboratory ovens can be found in a wide range of industries, including biotech, pharmaceuticals, and material manufacture. The methods of baking, annealing, curing, and drying materials with various physical and chemical compositions form the foundation of these businesses. The majority of

laboratory ovens' typical uses involve sterilizing lab materials by autoclaving them or heating and drying glassware. To determine the tensile strength, resilience, and deformation of various produced goods, these ovens are used for material testing. In forensic, biological, and environmental laboratories, lab ovens are employed specifically. To make something, the testing laboratories need only the purest of substances and components. The thermal sterilization process is one of the best ways to sterilise tools, including plates and tubes used in the production of pharmaceuticals. In order to properly sterilise the substances, the procedure applies dry heat sterilisation to them. Approximately 80% of pathogenic microorganisms are adept at using this technique.(15)

SOPs FOR HOT AIR OVEN

1) Objective
To establish the process for operating, calibrating, and cleaning a hot air oven.
2) Scope
The cleaning, use, and calibration of the hot air oven in the microbiology lab shall be subject to this SOP.
3) Responsibility
1) The creation and implementation of this SOP shall be the responsibility of microbiologists and above.
2) The Head of Quality Control & Quality Assurance is in charge of reviewing and approving this SOP.
4) Accountability
Head of Quality control
5) Procedure
5.1 Cleaning :
5.1.1 Before cleaning, make sure the hot air oven's power is turned "OFF" and that the plug is taken out of the socket.
5.1.2 Every day, wipe off the oven's surface, walls, top, bottom, and trays using a dry, lint-free cloth to ensure that there are no dust particles present.
5.1.3 Every week, the entire oven, including the exterior, must be cleaned using a damp, lint-free cloth dipped in purified water.
5.2 Operation
5.2.1 Ensure the cleanliness of the instrument.
5.2.2 Make sure there is airflow. knob must be clearly provided on the oven's top.
5.2.3 Make sure the power supply switch is turned ON
5.2.4 Ensure for the electronic temperature controller displays the chamber temperature.
5.2.5 The "PUSH" switch must be depressed to establish the desired temperature, and then the coarse potentiometer knob must be turned either clockwise or counter clockwise until the desired temperature is reached.
5.2.6 The use of a fine potentiometer knob is required to adjust the temperature.
5.2.7 Make sure the heater's indicator bulb glows to indicate that the power is "ON."
5.2.8 For airflow, the hot air oven fan must be turned "ON."
5.2.9 As soon as the temperature reaches the predetermined point, note it and begin the cycle at the designated time.
5.2.10 Make sure the cycle is complete and turn "OFF" the main power switch and the power supply to the oven.
5.2.11 Fill out the daily usage log book with the period's cycle information.
5.3. Calibration process
5.3.1 For the calibration of the hot air oven, a standard thermometer with a temperature range of up to 300°c must be used.
5.3.2 After the oven has been running for an hour, the calibration procedure must begin.
5.3.3 Make sure the oven is set to the appropriate temperature.
5.3.4 For 30 minutes, the Standard thermometer must be placed on the oven's upper shelf with the oven door closed.
5.3.5 After 30 minutes, the oven door must be opened so that the temperature standard thermometer can be read and compared to the oven's observed temperature.
5.3.6 By placing the thermometer in the lower shelf for 30 minutes, the aforementioned procedure must be repeated.
5.3.7 The hot air oven calibration record must contain a note about the observed temperature.
5.3.8 Make sure that the temperature on both shelves is within a tolerance of 2.0 degrees of the predetermined temperature.
5.3.9 Periodically: once per month.
5.3.10 Calibration from Without

The external party must calibrate the hot air oven on an annual basis.
5.4 precautions
5.4.1 To take an item from the oven, asbestos gloves must be worn.
5.4.2 When the oven is in use, the door must not be left open.(16)

VALIDATION OF HOT AIR OVEN
The following tools are utilised while assessing an oven's validity.
1. Detector of resistance temperature.
2. Thermocouple
3. Data logger
4. Constant temperature bath
5. Stopwatch
6. Voltmeter
7. Optical tachometer

Basic Validation Approach
DQ - Design Qualification
IQ - Installation Qualification
OP - Operational Qualification
PQ - Performance Qualification

Design Qualification
1) The DQ lists the essential components of the system that are intended to fulfil user needs, legal compliance, and supplier selection criteria.
2) The following are the main factors for a DQ:
● Dimensions of the apparatus and accessories.
● The instrument's ideal environment for operation.
● necessity for health and safety.

Installation Qualification
1) It is done in conjunction with or immediately following the equipment's installation at the user's location.
2) The objective is to offer written confirmation that the appropriate equipment was used. Has arrived and been set up in accordance with the plan and process.
3) Documents relating to intelligence should be examined and authorised by those assigned to be responsible
4) It contains information on-
● Structural- Verify dimensions and seal presence.
● The correct identification, type, size, air capacity, and flow rate of filters.
● Electricals: Correct labelling and safety cut-off.
● The necessary temperature and pressure differential is provided by the HVAC-System.
● Air supply: Determine the source and the duct size.
● Check that the source and kind of supply, whether it be air or natural gas, are in line with the manufacturer's instructions.
● Record the manufacturer's model number and the number of heating elements for heaters.
● Blowers: Verify that the correct fan belt is being used and that it is in good shape.
Operational Qualification
1) The system or component's performance within the designated operating range has been verified in writing.
2) The required parties should read and sign the OQ paper. representative of the department.
3) The system's components must comply with the operating parameters specified in the purchase order.
4) The following process elements must each be recognised, and the determined operating performance and range.
● **Temperature Monitors**
● **Cycle timers :** The timer's precision must be established in order to guarantee cycle time.
● **Door interlocks :** If a unit has twin doors, the interlocks must function in such a way that if the door to the non-aseptic area is opened, the door leading to the aseptic area cannot be opened.
●**Heaters :** The heating components must all be operational.
● **Blowers :** The blower motor speed and air velocity should be recorded in the OQ records.
● **Cooling coils :** If coils are present, it is important to note their type, size, and the temperature of the cooling medium at the input and exit of the coils.

● **Chamber leaks :** For batch sterilisers, the perimeter of the doors should be examined for leakage of air while operating.
● **Particulates count :** To quantify the particle load added to the product by the sterilisation process, the particle count inside the containers should be examined before and after sterilisation.

Performance Qualification
1) Demonstrates that, under typical production conditions, the equipment operates in a dependable, reproducible way in accordance with design specifications and user-defined requirements.
2) **physical :**
● Research on heat transfer in an empty space.
● A study of heat distribution in a loaded chamber.
● Study of heat transfer in a loaded chamber.
3) **Microbiological :**
● studies on the bio- and pyro-challenges.(17)

REFERENCE

[1]. Articlein SSRN Electronic Journal · January 2018 DOI: 10.2139/ssrn.334032. SaifAldeenSaadObayes MIEEE Saifaldeen.Saad@ieee.org
[2]. Greensmith M (1998) Practical Dehydration.WoodheadPublishing.
[3]. E. M. DARMADYAND R. BARRINGTON BROCK From the Portsmouth and Isle ofWightArea Pathological Service (RECEIVED FOR PUBLICATION OCTOBER 14, 1954)
[4]. https://thebiologynotes. com › hot-air oven.
[5]. https://articlezings.gonevis.com/hot-air-oven-working-types-and-advantages
[6]. https://tempoinstruments.com/blog/hot-air-oven-construction
[7]. upward.https://biologyreader.com/hot-air-oven-sterilization.html.
[8]. Article Source: http://EzineArticles.com/9567478
[9]. SECOND YEAR B. PHARM., SEMESTER III Dr.Kuntal Das Professor Dept. of Pharmacognosy and Natural Product chemistry
[10]. Krupanidhi College of Pharmacy,#12/1, ChikkaBellandur, Varthur, Hobli, Bangalore-35, Karnataka (Niraliprakashan)
[11]. https://www.despatch.com/blog/dry-heat-sterilization-static-air-vs-forced-air/
[12]. https://www.cmfri.org.in/uploads/tender/38-32-2016.pdf
[13]. https://www.tec2med.com/hot-air-oven-uses-operation-price.
[14]. https://www.prestogroup.com/articles/what-is-the-use-of-hot-air-ovens-in-the-microbiology-industry.
[15]. https://www.testing-instruments.com/blog/importance-of-lab-hot-air-oven-in-different-industries
[16]. https://www.testing-instruments.com/blog/using-hot-air-oven-to-sterilise-pharmaceutical-products
[17]. Researchsop.comhttps://www.researchsop.com/2021/01/SOP-FOR-HOT-AIR-OVEN-CLEANING-OPERATION-CALIBRATION-HOT-AIR-OVEN.html?m=1.
[18]. EQUIPMENT VALIDATION : HOT AIR OVEN