केन्द्रीय प्रदूषण नियंत्रण बोर्ड
CENTRAL POLLUTION CONTROL BOARD
पर्यावरण, वन एवं जलवायु परिवर्तन मंत्रालय, भारत सरकार.
MINISTRY OF ENVIRONMENT, FOREST & CLIMATE CHANGE, GOVT. OF INDIA.

Speed Post/E-mail

CM-13011/44/2022-IPC-IV-HO-CPCB-HO

December 02, 2025

To

The Member Secretary
State Pollution Control Board/Pollution Control Committee
(As per list enclosed)

Subject: Implementation of "Environmental Guidelines for Charcoal Manufacturing Units" in the States/UTs - reg.

Sir/Madam,

Central Pollution Control Board (CPCB) has prepared "Environmental Guidelines for Charcoal Manufacturing Units" in compliance of the Hon'ble National Green Tribunal (NGT) order dated 28.11.2019 in the matter of OA No. 260/2019, Suman, Sarpanch, Village Panchayat Dhola Majra, Sahabad, Markanda Vs. State of Haryana. A copy of the Guidelines is enclosed for implementation in your State/UT and kind reference. The Guidelines are also uploaded on CPCB website and may be assessed through the following web-link:

https://cpcb.nic.in/openpdffile.php?id=UmVwb3J0RmlsZXMvMTc5NI8xNzY0NTg1NDg5X21IZGlhcGhvdG81MjE3LnBkZg==

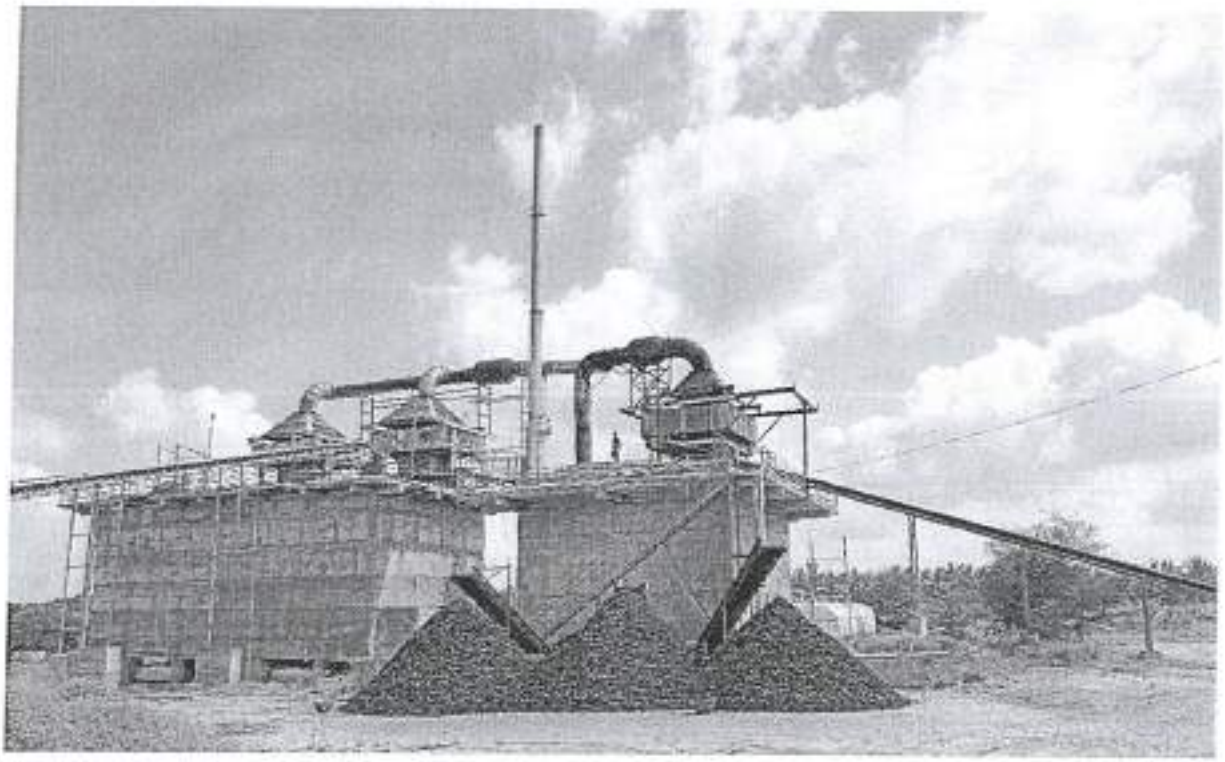
This issued with approval of Competent Authority, CPCB.

Yours faithfully

(Anamika Sagar)
Additional Director &
Div. Head (IPC-IV&V)

Encl: As above

Environmental Guidelines for Charcoal Manufacturing Units



CPCB

Central Pollution Control Board
(Ministry of Environment, Forest and Climate Change, Govt. of India)
Parivesh Bhawan, East Arjun Nagar
Delhi-110032

(November, 2025)

ACKNOWLEDGEMENT

The Central Pollution Control Board (CPCB) extends its sincere gratitude to the Ministry of Environment, Forest and Climate Change (MoEF&CC) for the financial support in executing the R&D project on "Development of Environmental Guidelines for Charcoal Manufacturing Units"

We would also like to extend our sincere appreciation to the officials of the State Pollution Control Boards/Committees of various States and Union Territories (UTs) of India, as well as the Charcoal Manufacturing Units, for their cooperation during field visits and for providing invaluable information.

Furthermore, our thanks go to the members of the Technical Committee who were instrumental in finalizing the Environmental Guidelines. Their insightful contributions have greatly enriched this project.

CONTENT

SUMMARY

Charcoal production is the process of converting wood and agricultural waste into charcoal through thermal decomposition in a low-oxygen environment. This charcoal is used in various industries, including cooking, metal-working, air and water purification, and pharmaceuticals.

In India, charcoal production mostly uses traditional methods, such as earth kilns. The environmental issues associated with earth kilns are air and water pollution. However, in Tamil Nadu modern techniques, such as rotary kilns, are adopted which offer better efficiency and lower emissions.

The production process in charcoal manufacturing includes stages like feedstock loading, heating, carbonization, and cooling.

The Environmental challenges in manufacturing of charcoal include air pollution from incomplete combustion, water pollution from quenching, and solid waste. To address these environmental issues, guidelines suggests adopting cleaner technologies, recycling water, and better waste disposal practices.

1. BACKGROUND

The Hon'ble National Green Tribunal (NGT), Principal Bench, New Delhi, vide order dated 28.11.2019 disposed of the OA No. 260/2019; Suman, Sarpanch, Village Panchayat Dhola Majra, Sahabad, Markanda Vs. State of Haryana regarding air pollution caused by coal kilns in Village Dhol Majara, Tehsil Shahbad, District Kurushetra, Haryana and directed the following:

> *"...While environment norms are necessary and closure of activity causing air pollution cannot be avoided, it is necessary to explore availability of any option for continue such activities by using cleaner production techniques.*
> *Accordingly, we direct CPCB to explore availability of such technique and issue appropriate guidelines which may be placed in public domain for information of all concerned..."*

2. INTRODUCTION

Charcoal production involve conversion of wood and agricultural residues (ex. coconut shells, corn cobs, etc.) into charcoal by removing water and other volatile constituents by carbonizing or burning under a controlled environmental conditions (limited oxygen) in a confined space like a kiln through thermal decomposition (pyrolysis). Charcoal is soft, brittle, lightweight, black and porous solid residue containing 85 % to 98 % carbon.

Charcoal made from wood and coconut shell has a wide range of uses. Here are some of the key applications:

a. In hotels / restaurants for cooking purpose
b. Used in furnaces for forging and metal-working
c. In textile industry, to make carbon disulphide (CS_2)
d. In horticulture, to improve soil carbon content
e. Used in air and water purification systems to remove pollutants and odours, such as in charcoal filters in gas mask to remove poisonous gases from inhaled air and to remove colouring material from solutions.
f. In pharmaceutical industry, to produce charcoal biscuits as dietary supplement for gastric problems.
g. Used in teeth whitening, treatment of alcohol poisoning, anti-aging and to reduce high cholesterol

As per the inventory received from 07 State Pollution Control Boards (SPCBs), namely Himachal Pradesh (69), Chhattisgarh (19), Punjab (10), West Bengal (2), Karnataka (2), Assam (1) and Uttarakhand (1) are having charcoal manufacturing units. Most of the units are based on traditional earth kiln i.e. earth mound or earth pit type kilns made up of bricks and clay /

mud, without air pollution control system. While, in Tamil Nadu two modified process kilns based on coconut shell as a feedstock, an above-ground charcoal manufacturing kiln and a rotary kiln for continuous charcoal production (an integrated plant for activated charcoal manufacturing), with adequate pollution control devices, have been set up. Also, there are no charcoal kilns in 18 states/UTs as informed by SPCBs/PCCs.

3. CHARCOAL MANUFACTURING PROCESS

Charcoal manufacturing process based on traditional earth kilns involves several key steps as shown below:

i. **Loading of Feedstock**: Dried feedstock, such as hardwood logs, branches, sawdust, or agricultural residues (e.g., coconut shells, corn cobs, etc.), is cut and arranged inside the kiln. The arrangement aims to optimize airflow and heat distribution throughout the carbonization process. Larger pieces are placed at the bottom to provide structural stability and allow better air circulation, while smaller pieces and fines are layered on top to fill voids and ensure even heating. Packing density is critical as it affects the rate of pyrolysis and the quality of the charcoal produced.

ii. **Igniting:** Ignition is typically started from the top of the feedstock pile using easily combustible material such as dry leaves, small branches, etc. The objective is to start the pyrolysis process, where the feedstock undergoes thermal decomposition in the absence of oxygen. As the temperature in the kiln rises the organic materials break down into charcoal, gases and liquids.

iii. **Heating (Dry and Pre-carbonization stages):**

a. **Dry Stage:** The drying process begins at ambient temperature (typically between 20°C to 30°C) and continues until the moisture content of the feedstock is significantly reduced. This stage is crucial for preparing the raw material for carbonization. Drying can be carried out either in open air or inside a kiln, depending on the scale of production and available resources. In open-air drying, the feedstock is exposed to sunlight and ambient conditions, where moisture is gradually evaporated over several hours. In kiln drying, the feedstock is placed in a controlled environment with elevated temperatures, ensuring consistent moisture reduction regardless of external conditions. The duration of the drying process generally ranges from 6 to 12 hours, depending on factors such as initial moisture content, ambient weather and the type of drying method used. Proper moisture reduction during this stage is critical to ensure efficient carbonization and the production of high-quality charcoal.

b. **Pre-carbonization Stage:** Following the dry stage, the pre-carbonization process begins, during which Volatile Organic Compounds (VOCs) are released due to thermal decomposition of the wood's chemical components, such as cellulose, hemicellulose and lignin. As the temperature increases, these wood components break down, releasing gases and vapours. The temperature during this stage typically ranges from 150°C to 280°C. This process lasts between 6 to 12 hours, depending on factors like the feedstock composition, kiln design and temperature control. Proper management of pre-carbonization process is essential to ensure the efficient removal of volatile materials and to prepare the feedstock for the final carbonization stage.

iv. **Carbonization:** The process progresses from pre-carbonization to carbonization, where temperatures typically rise between 280°C and 500°C, or even higher. During this stage, air supply is deliberately limited to prevent combustion, as the process is a form of pyrolysis. As the temperature increases, the decomposition of cellulose and hemicellulose accelerates, resulting in the formation of charcoal, a solid carbonaceous residue with a carbon content ranging from 70% to 90%, depending on process conditions and feedstock type. Along with the formation of charcoal, various gases are released, including water vapour (H_2O), carbon dioxide (CO_2), carbon monoxide (CO), methane (CH_4), hydrogen (H_2), volatile organic compounds (VOCs) and tar. These gaseous emissions are by-products of the thermal decomposition of organic materials and careful management of these gases is essential for energy recovery and environmental control during the carbonization process.

The time required for the carbonization process generally ranges from 12 to 36 hours or longer, depending on factors such as kiln design, feedstock composition and the desired quality of charcoal. Longer carbonization durations typically result in higher-quality charcoal, characterized by lower volatile content and higher carbonization efficiency. During the initial phase, dense white smoke is emitted due to the release of water vapour (H_2O) and volatile organic compounds (VOCs). As the process progresses, the smoke becomes lighter and may take on a bluish-grey colour, indicating the presence of combustion products such as carbon dioxide (CO_2) and particulates. Additionally, an odour is initially noticeable due to the release of tar and VOCs, but this odour diminishes as the pyrolysis process completes.

v. **Sealing for Cooling and Unloading:** After the carbonization phase, it is crucial to properly cool the charcoal to prevent combustion. This step known as quenching, involves rapidly cooling the hot charcoal, typically by pouring water over it. However, careful control of the water used is essential to avoid excessive steam and prevent cracking of the charcoal. To allow for gradual cooling and minimize the risk of spontaneous combustion, the kiln is sealed with clay or mud. This gradual cooling process usually takes between 24 to 48 hours, effectively controlling temperature and limiting air exposure. Once cooled, the charcoal is then sorted, graded by size and quality and finally packaged for distribution.

In batch kilns, the heating and carbonization stages progress in a layer-wise manner. As the feedstock is loaded into the kiln, the material at the bottom layers begins to heat up and undergo carbonization first, while the upper layers heat gradually over time. This sequential, layer-by-layer process ensures that the entire batch of feedstock undergoes uniform thermal decomposition. Each layer undergoes heating, pre-carbonization, and carbonization in succession, leading to more efficient use of time and energy during the process.

4. TYPES OF KILNS USED FOR CHARCOAL PRODUCTION

Charcoal manufacturing units can be classified based on factors such as the feedstock used, rational use of heat, and the recovery of energy from the smoke during the carbonization process. However, all these units operate on the same basic principle of carbonization. In India, traditional earthen kilns, including mound and pit types, are widely used, with the exception of a few rotary kilns.

i. **Earth Pit Kilns:** Earth pit kilns are one of the most traditional and simplest methods for charcoal manufacturing. A small or large earth pit is stacked with wood or coconut shells, etc., sealed with grass and soil, and ignited at one end to initiate the carbonization process. These kilns require minimal investment, making them a popular choice for small-scale operations. However, efficient resource management and controlling air and groundwater pollution pose significant challenges.
In compliance with the Hon'ble NGT (SZ) order in Original Application No. 24/2013 (Ozone Care Public Welfare Association Vs. The Chairman Tamil Nadu Pollution Control Board), the Hon'ble NGT directed charcoal units based on earth pit kilns operating in Tamil Nadu and other southern states to transition to above-ground level technologies. As a result, all earth pit kilns in Tamil Nadu have either been closed or have transitioned to alternative processes, such as retort kilns, elevated / above-ground kilns, or rotary kilns.

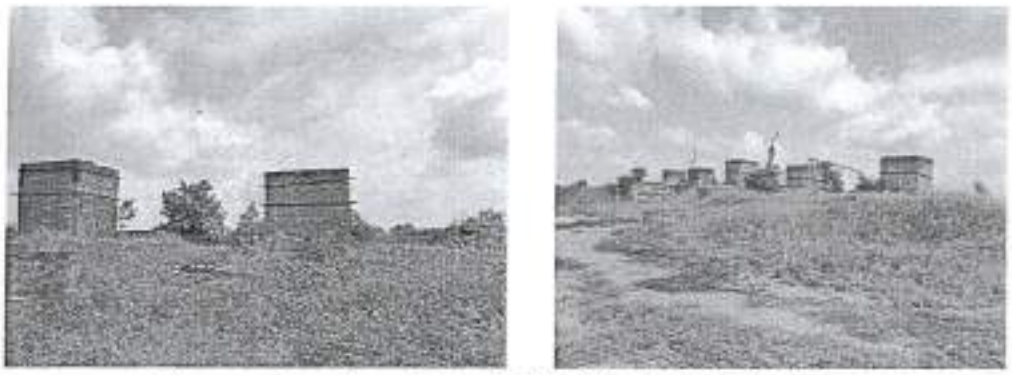


Figure: Abondoned Earth Pit Kilns in Tamil Nadu

ii. **Traditional method:** The traditional method of charcoal production involves using Juli flora wood, a common firewood in Tamil Nadu. The wood is stacked and covered first with a layer of fibre material, followed by a layer of soil. A fire is initiated at the top of the pile, and the burning continues for several days. During this phase, water is

lightly sprayed over the soil layer to regulate the burning process and prevent excessive combustion.

Once the controlled combustion is complete, the pile is quenched with water to cool the charcoal. After cooling, the soil covering is removed, and the quenched charcoal is screened to segregate usable charcoal from debris and ash. From 35 tons of Juli flora wood, approximately 10 tons of charcoal is produced. The images illustrate various stages of this process, including the initial stacking of wood, the soil-covered pile emitting smoke during combustion, and the screening of the finished charcoal.

Figure: Traditional Method of Charcoal Production

While this traditional method has been in practice for years, it presents significant environmental challenges, such as air pollution from smoke emissions and soil degradation. Given these drawbacks, it is recommended that such traditional methods of charcoal production should no longer be permitted to operate due to their negative environmental impact.

iii. **Earth Mound Kiln**: The earth mound kiln is a widely used method for charcoal manufacturing, particularly where wood is the primary feedstock. These kilns are typically constructed using local materials such as bricks, sand and clay, and require minimal investment.

The process begins by stacking the wood inside the kiln, which is then sealed with clay or mud. Small holes are strategically left at different levels along the periphery of the mound to control the carbonization process. Initially, the holes at the top periphery are closed after a period of time, causing the fire to shift to the lower layer. Similarly, the holes at the lower periphery are closed after some time, allowing the fire to gradually shift to the next lower layer. This controlled process continues until the firing is completed, at which point the kiln is left to cool.

The entire carbonization process typically takes between 3 to 6 days, depending on the size of the kiln. Once the cooling period is complete, the charcoal can be unloaded. However, earth mound kilns are associated with significant smoke emissions and the release of harmful gases, posing environmental and health risks.

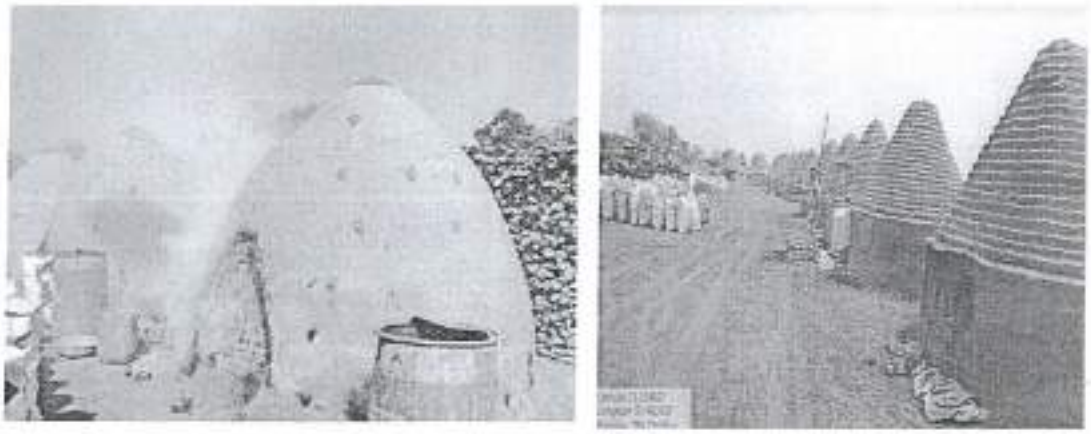


Figure: Earth Mound Kilns

iv. **Improvised Technology- Retort System:** Retort kilns offer a significant improvement over traditional methods by providing better control of the pyrolysis process. These kilns use an airtight chamber to heat the cellulosic material, which helps in maintaining a controlled environment during carbonization. This design not only improves the efficiency of the process but also allows for the capture and recycling of heat, leading to more complete combustion. As a result, emissions of harmful gases such as carbon monoxide (CO) and methane (CH_4) are significantly reduced.

Retort kilns can be equipped with chimneys to facilitate better airflow, promoting more efficient combustion. The inclusion of adjustable air vents helps regulate the oxygen supply, further optimizing the combustion process and reducing emissions. Additionally, insulation can be added to the kilns to maintain consistently high temperatures, which supports better combustion and ultimately increases the charcoal yield.

Compared to traditional methods, retort kilns are more efficient, reduce energy consumption and are significantly more environmentally friendly. These improvements make retort systems a more sustainable and cost-effective option for charcoal production

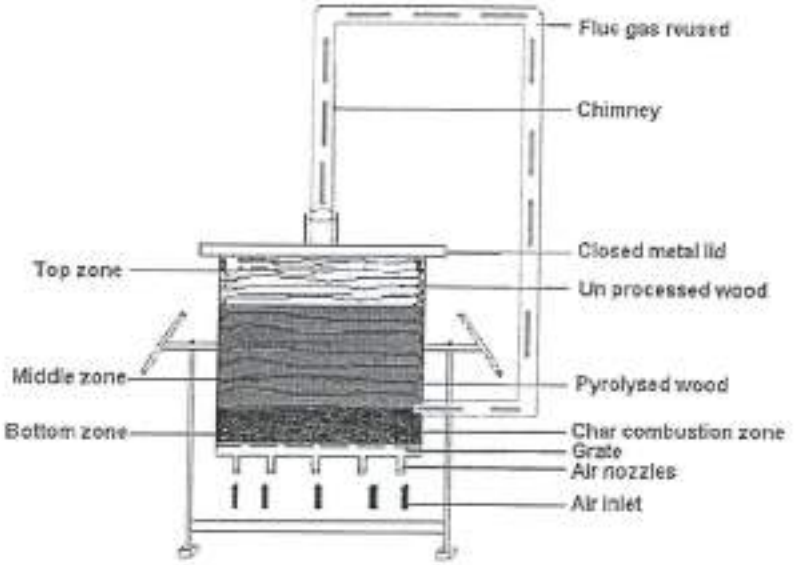


Figure: Retort Type Kilns

(Source: A novel performance study of kiln using long stick wood pyrolytic conversion for charcoal production - Scientific Figure on ResearchGate. Available from: https://www.researchgate.net/figure/Pilot-model-for-charcoal-kiln_fig1_260989710 [accessed 6 Jan 2025]

Although traditional small kilns are widely used across India, there are also notable examples of the adoption of improved kilns, such as the Elevated /Above-ground Kiln and Rotary Kiln. These modern technologies offer better control over the carbonization process, increased efficiency, and reduced environmental impact compared to traditional methods.

v. **Elevated / Above-ground Kiln:** The elevated / above-ground kiln method for charcoal production, particularly using coconut shells, has been adopted in Tamil Nadu. This method is carried out in a controlled manner, ensuring efficient charcoal production while minimizing emissions and preventing groundwater contamination. The entire production cycle typically spans around 72 hours, from the initial input of raw material to the final charcoal output.

The kiln is structured with a rectangular design, featuring a centrally positioned cylindrical pit and earthen soil flanking both sides. Designed to be situated above ground level, this kiln has a capacity to process 45 tons of coconut shells, yielding approximately 15 tons of charcoal per batch.

A firing chamber is incorporated to destruct the gases emitted during the carbonization process. To efficiently manage the exhaust (flue) gases, a duct system channels the exhaust to a scrubber, followed by an ID fan and a stack. This system significantly helps in reducing gaseous emissions, such as methane (CH_4), carbon monoxide (CO) and volatile organic compounds (VOCs).

The quenching process requires around 3 kiloliters (KL) of water, with only 200-300 liters remaining post-quenching, which is then recycled. Additionally, the wastewater

generated from both the quenching process and the scrubber is recycled, ensuring a zero-discharge operation.

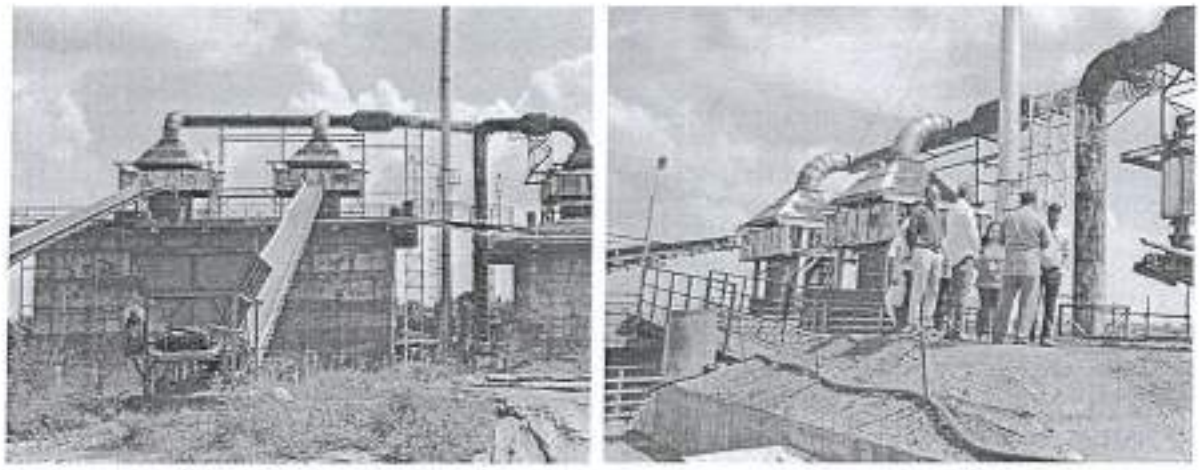


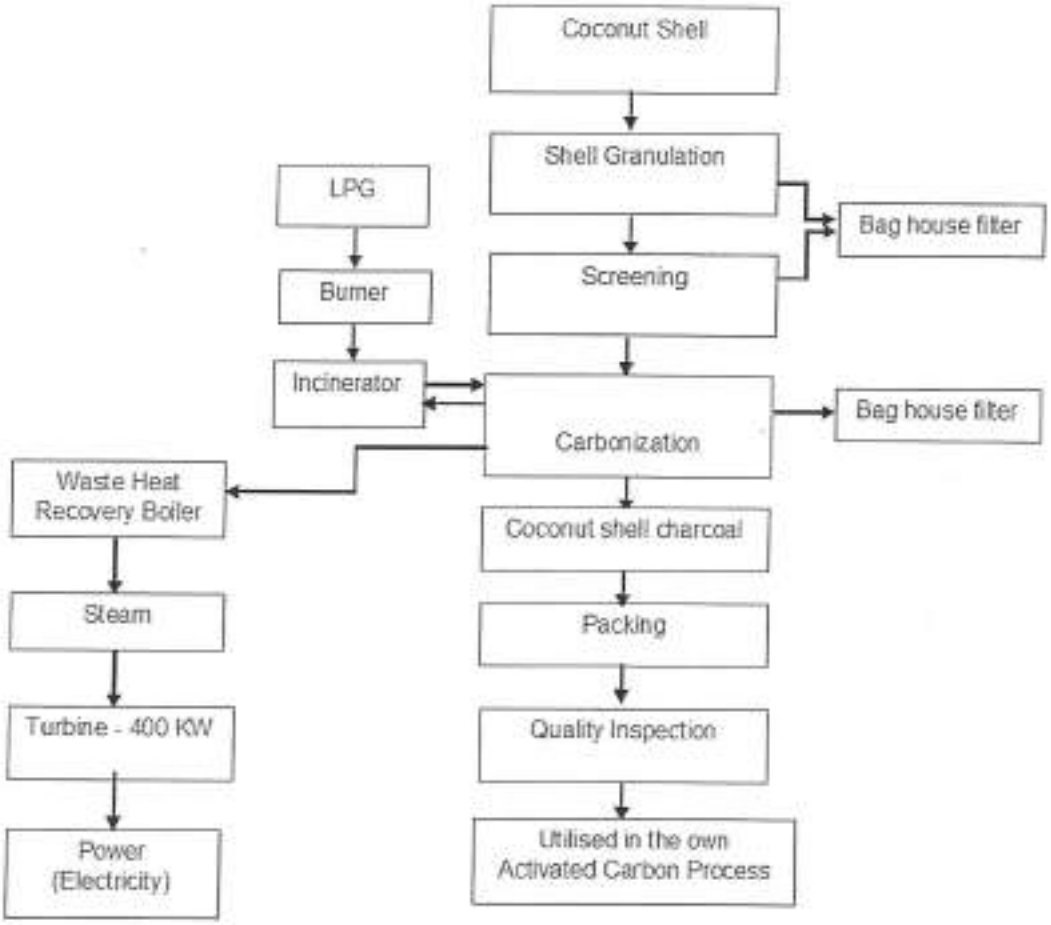
Figure: Elevated Charcoal Production using Coconut Shell in Tamil Nadu

vi. **Rotary Kiln with Continuous Process**: The rotary kiln method provides efficient and controlled carbonization through indirect heating. The charcoal manufacturing process in a rotary kiln involves several key steps. First, dry cellulosic materials (such as coconut shells in Tamil Nadu) are granulated to the desired size before being fed into the rotary carbonizer kiln. Inside the kiln, the granulated material undergoes carbonization at temperatures exceeding 850°C through indirect heating.

Initially, LPG is used to heat the kiln, but once the temperature stabilizes, the kiln's gas is recirculated to maintain heat, eliminating the need for LPG. After the carbonization process, the carbonized cellulosic material (now charcoal) is passed through cooling systems, such as water-jacket rotary valves and coolers, before being collected. The final charcoal product is stored in bulk bags following quality checks. Throughout the entire process, emissions are carefully controlled, and energy recovery systems are employed to enhance sustainability. If a heat recovery plant is installed, it can recover around 400 kWh of energy in a 30 TPD (tons per day) charcoal plant using 90 TPD feedstock, improving energy efficiency and making the process more sustainable.

The wastewater generated during the process (approximately 2.5 KLD) is treated in an effluent treatment plant.

The process flow diagram of the manufacturing process of charcoal kiln using coconut shell is as follow:



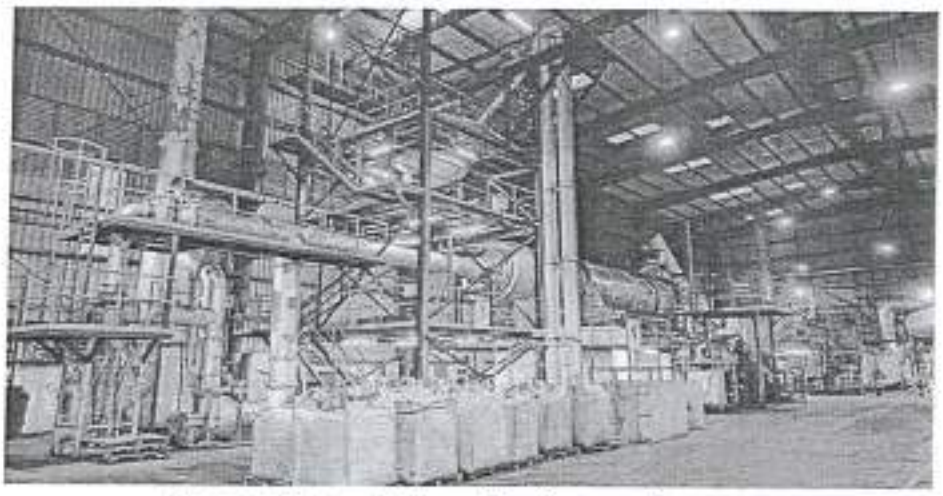


Figure: Rotary Kiln – Continuous Process

The rotary kiln is more capital-intensive, with higher initial investment costs due to its complex structure, automated systems and precise control over the carbonization process. However, it ensures consistent and uniform quality of charcoal, making it ideal for large-scale production, especially when high-quality activated carbon is required. The continuous operation of the rotary kiln enables higher throughput and better energy efficiency, making it a preferred choice for larger, more modern facilities.

5. ENVIRONMENTAL ISSUES ASSOCIATED WITH CHARCOAL MANUFACTURING

The environmental issues associated with charcoal productions are:

Air Pollution: During the carbonization process in kilns used for charcoal manufacturing, the incomplete combustion of organic materials leads to the release of various emissions. These include particulate matter (PM) and gases such as carbon monoxide (CO), methane (CH_4) and volatile organic compounds (VOCs). In earthen kilns, fugitive emissions contribute to local air pollution, which poses significant health risks to workers and nearby communities. Particulate matter can cause a variety of respiratory and cardiovascular problems, particularly for those exposed to it for prolonged periods. The release of harmful gases like CO and CH_4 further exacerbates air quality concerns and contributes to broader environmental issues, such as climate change.

Water Pollution: In charcoal production, water is primarily used for quenching—cooling down the hot charcoal after the carbonization process. This is done by spraying water over the hot charcoal in the kiln or pit. Additionally, water is also used in some cases for flue gas scrubbing to manage emissions. However, the use of water for quenching raises environmental concerns, especially due to the leaching of contaminants from the quench water, which often contains high levels of organic materials. The wastewater generated during the quenching process of red-hot charcoal tends to have high organic content, potentially contaminating surrounding environments.

Furthermore, small quantities of water are used in the mortar (a mixture of sand, soil, cow dung and water) to construct the earth mound kiln and for cooling the kiln after use. This water usage may also contribute to pollution if not properly managed.

Solid Waste: During the pyrolysis process in charcoal manufacturing, the cellulosic material is converted into charcoal, but not all of the material is fully carbonized. A portion of the material is converted into ash, which settles at the bottom of the kiln. Additionally, some wood chips and other residue remain after the process.

The amount of bottom ash and chips is generally around 1% to 2% of the total cellulosic material processed. These by-products, if not properly disposed of or utilized, may contribute to solid waste accumulation, potentially leading to environmental challenges such as land degradation or contamination.

6. ENVIRONMENTAL GUIDELINES FOR CHARCOAL MANUFACTURING UNITS

Kiln specific guidelines

a) Earth Mound Kilns:

This method for charcoal manufacturing should adopt following modification and measures, or cleaner method for charcoal manufacturing:

i. A well-ventilated cover shed should be provided for multiple kilns, restricted to a maximum of seven kilns. A well-designed suction hood system must be installed to effectively capture the air emissions, ensuring minimal leakage and optimal extraction efficiency. The emission should be vented out at a minimum height of 12 meters, subject to site-specific conditions and local air quality regulations, to facilitate proper dispersion of emissions. The overall design should prioritize environmental compliance, worker safety and adequate ventilation.

ii. An inter-se distance of at least 500 meters should be maintained between two charcoal units to prevent clustering and ensure effective dispersion of air emissions.

iii. Water used for cooling the kiln should be stored in an impervious storage tank and reused for the same purpose. The tank should be designed to prevent any percolation of water into the soil, ensuring efficient water conservation and minimal environmental impact.

b) Elevated / Above-ground Kilns or Rotary Kilns

The following measures should be adopted in elevated/above-ground kilns or rotary kilns:

i. The unit should be equipped with an adequate hood and suction system to collect emissions, a water scrubber for emission control and a stack with a minimum height of 30 meters from ground level to ensure proper dispersion of air emissions.

ii. The emissions may be utilized for heat energy recovery wherever feasible. If a heat recovery system is not installed, the emissions from the kiln should be directed to the firing chamber for incineration before being discharged through the stack connected to the scrubber.

iii. Permanent emission monitoring facilities, such as a port hole, platform and ladder, should be provided in accordance with the CPCB guidelines.

iv. The unit should install an adequate collection and treatment system for the reuse of quenching water.

v. A dust collector should be installed at key points such as the crushing, screening and granulation areas of rotary kilns.

Common guidelines

i. Good housekeeping practices should be followed within the premises to maintain cleanliness and safety.

ii. Personal protective equipment, such as masks, safety shoes and other necessary gear, should be provided to workers.

iii. Raw materials, such as wood for charcoal production, should be sourced from agroforestry or agricultural residues.

iv. Ash and dust collected should be stored in enclosed containers and utilized as a soil conditioner, for filling low-lying areas, or in brick kilns for making bricks.

7. REGULATORY / MONITORING MECHANISM FOR CHARCOAL MANUFACTURING UNITS

i. The charcoal unit shall obtain consents to Establish / Operate under the Water (Prevention and Control of Pollution) Act, 1974 and the Air (Prevention and Control of Pollution) Act, 1981 from the respective State Pollution Control Boards (SPCBs) / Pollution Control Committees (PCCs).

ii. Unit shall comply with the emission standards specified by the SPCBs/PCCs in their consent conditions.