

The ultimate
Green energy for
The planet



Radhe
GASIFIERS



GROWTH TREE OF RADHE

STILL GROWING STRONGLY GASIFIERS STILL GROWING STRONGLY
STILL GROWING STRONGLY STILL GROWING STRONGLY



GREEN
JOURNEY BEGINS
2 DECADES AGO

TEAM WORK

PLANNING

PASSION

VISION

ATTITUDE

RESEARCH

CREATIVITY

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Radhe at a Glance

Renewable Energy as a dream vision in mind of our chairman Dr. Shailesh Makadia has founded “Radhe Renewable Energy Development Pvt. Ltd.”, two decades ago, since then “RREDPL” is constantly thriving on effort to develop environment friendly technology which will be helpful to the society and in long terms for the sustainable growth.

The present economical revolution in the world to survive every industry has to improve their old style manufacturing process or has to adopt new efficient technology.

Today for every industry “Fuel” is the lifeline, to survive in rocketing cost of fuel Renewable & non-conventional energy technology is the one and only solution.

In this run of constant improving and survivals “RREDPL” brings ideal technology in non-conventional & renewable energy, not only for survival of struggling industries but with the promise of high financial returns within the shortest span of time, replacing the costlier fuel and protect the precious environment.

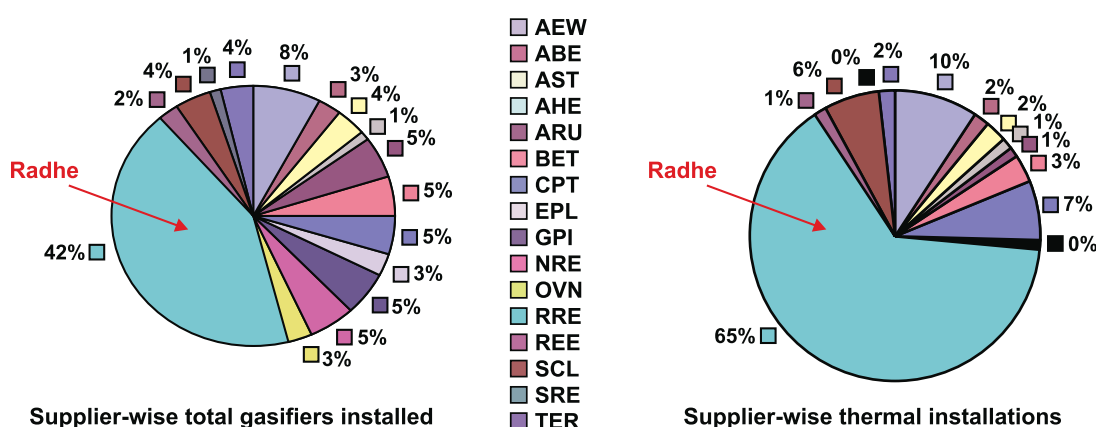
RREDPL is the core company of Radhe Group of Companies located at Rajkot, Gujarat, India. The Group's main line activities are research, development, manufacturing & marketing of non-conventional and renewable energy equipments likes Biomass/coal gasifiers (Gasification plant), Biomass power generation plants, Bio-mass briquetting plants, Hot-air generators (direct/indirect), waste heat recovery systems.

RREDPL has more than 700+ satisfied clients with successful track records in India and abroad.



Awards & Achievements

Radhe stands apart with 65% of total installations of gasification technology from the rest in India, as per the survey made by Karnataka state council of science & technology and DSIR (Department of Scientific and Industrial Research)



- Dr. Shailesh Makadia has marked his name in the power in The power 100-The Eminent Personalities of Gujarat by Divya Bhaskar.
- Dr. Shailesh Makadia featured in Young Turks of Gujarat by Divya Bhaskar.
- Recognized as the jewel of Saurashtra as a Energy Entrepreneur by Divya Bhaskar.
- Award for Saving Oil & Fuel from Petroleum Conservation Research Association.
- Business Leadership Award for Industrial Development by Indian Economic Development & Research Association.
- Energy Conservation in Ceramic Industries from S.S.I Dept. Ministry of Industry, Govt. of India – Ahmedabad.
- Certified by American Society of Agricultural and Biological Engineers.
- Rashtriya sanmaan puraskar with medal from Economic Growth Society of India – New Delhi.
- Indian Achievers Award for Quality Excellence.
- Rashtriya udyog Ratan Award by Indian Organization for Business Research & Development.
- Certified by DUN and Bradstreet Global Database.
- Saving of 60 to 70 Million liters per day imported fossil fuel by RREDPL 's Technology which is worth around US \$175 Million.
- Radhe 's Green Revolution generated employment around 1,50,000 directly or indirectly.
- Radhe has recently applied nos of patents in gasification technology.



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Chairman's Vision Statement



We know very well ,where to reach, and most importantly: How to reach.

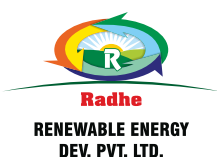
“A magnificent journey to the well-defined goal, with every step on chartered path”

RREDPL with best infrastructure and central government approved R&D center to support every need of industries in all thermal and power sectors with possible solution. Under the visionary guidance of our chairman Dr. S. V. Makadia and their expert team, brought the establishment of unique procedures of manufacturing, which involves the sourcing of finest raw-materials and components for specific functions as well as defining various processes of different parts.

OUR CORE STRENGTH

- Well established infrastructure
- An ultra modern tool room
- Well established R&D center (Approved by Department of Scientific & Industrial Research-DSIR)
- Fully equipped laboratory to support every testing analysis of coal, solid and liquid fuels, and gases.
- Highly experienced and enthusiastic staff.
- Capable of Turn key project execution.
- Best “after sales service” in the industry

Radhe Group Of Energy



What Is Gasification ?

Gasification Technology

Gasification is mainly a thermo-chemical process that converts organic/fossil fuel, agro solid waste and bio-solid waste based carbonaceous material in to carbon monoxide, Hydrogen and methane as a useful clean and combustible gaseous fuel called PRODUCER GAS or SYNGAS.

This is achieved by reacting these types of material at high temperature without combustion, with a controlled amount of oxygen and steam. The advantage of gasification technology is having more energy efficient than direct combustion of fuel.

In early days of gasification technology coal was gasified and was piped to customers for illumination, heating and cooking named was COAL GAS. High prices of fossil fuel like oil and natural gas leaded keen interest in gasification process.

Now this technology is widely accepted all over the world and supported and approved by some organizations like UNO, UNDP, DEO USA, FAO, MNRE... many more.

Main reactions in gasification process,

- COMBUSTION : $C + O_2 = CO_2 + \text{HEAT}$
- WATER GAS : $C + H_2O + \text{HEAT} = CO + H_2$
- WATER SHIFT REACTION : $CO + H_2O = CO_2 + H_2 + \text{HEAT}$
- BOUDOUARD REACTION : $C + CO_2 + \text{HEAT} = 2CO$
- METHANE REACTION : $C + 2H_2 = CH_4 + \text{HEAT}$

The gasifier can convert any types of solid biomass/coal in to producer gas, the chemical composition of producer gas is as under (the gas composition may slightly differ depending upon the fuels).

- CO(CARBON MONOXIDE) : $20 \pm 2 \%$
- CH₄(METHANE) : $03 \pm 1 \%$
- H₂(HYDROGEN) : $18 \pm 2 \%$
- CO₂(CARBON DIOXIDE) : $06 \pm 2 \%$
- N₂(NITROGEN) : REST ($50 \pm 5 \%$)
- CV OF PRODUCER GAS : 1000 TO 1300 KCAL/NM³



Features And Advantages Of Gasification Technology

To replace the costly fossil fuels like oil and natural gas with available locally biomass / coal, gasification technology is the best way to produce heat and power.

FEATURES OF GASIFICATION PLANT

- Acceptability of range of carbonaceous materials.
- Online facility to switch over the fuel.
- Auto ash removal system.
- Higher turndown ratio.
- User friendly operations of gasifier and robust constructions.
- Low pressure and temperature during operation.
- Stable operation to maintain stability in end process.
- High standard safety precaution facilities and automation.
- Emergency shutdown facilities.
- Follows all environment protection norms.

TECHNICAL, ENVIRONMENT AND SOCIO - ECONOMIC BENEFITS

- World wide environment friendly accepted renewable technology.
- Reduce greenhouse gas emission.
- Replaces fossil fuels and reduce oil import bills.
- Generate employment.
- Fast payback periods.
- Low NO_x formation due to low flame temperature .
- Negligible SO_x formation.
- After combustion of producer gas ash and smoke emissions are very negligible compare to solid and liquid fuel combustion.
- Close to Zero discharge.
- Controlled air pollution.
- Drastically reduce production cost.

MAINLY KNOWN TYPES OF GASIFICATION TECHNOLOGY ARE AS UNDER

- UP-DRAFT GASIFICATION TECHNOLOGY
- DOWN -DRAFT GASIFICATION TECHNOLOGY
- FLUIDISED BED GASIFICATION TECHNOLOGY

Radhe is mainly involved in manufacturing and supply of UP-DRAFT GASIFICATION TECHNOLOGY and newly developed HOT GAS FILTRATION TECHNOLOGY(patent pending) with the best team in industry and gives ultimate solutions to customers as required.



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Research & Development

Nothing is ultimate as the next one will be better



R & D is the heart of our Organization. The key to our success till today is mainly based on passionate approach towards R & D. In our Central Government Approved in-house R&D Center we develop and carry on innovations in process development, process implementations, process controls, cost reduction, quality improvement and investigate potential growth areas for Radhe with the help of....

- Advanced fuel testing laboratory
- Ultimate and Proximate analysis facility
- Physical, Chemical & Biological testing facility
- All-metal testing facility
- State of the art laboratory equipped with spectrometer, Gas Chromatograph, Bomb Calorimeter & other latest and hi-tech equipments.

Our R & D team of qualified scientists, networks with the global scientific community including companies, universities, government organizations and scientists with similar interest areas.

Dedicated and Experienced team of scientist engaged in research activities for biomass and related green energy technology.

**Radhe is committed not only to providing next-generation solutions to our clients,
but to helping in providing tomorrow's products today.**



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Various Green Technology Offered by Radhe

With Two decades of expertise in gasification technology Radhe Renewable Energy Development Pvt Ltd. is offering wide range of various green technologies and systems as per customers requirement.

- **UP DRAFT GASIFICATION TECHNOLOGY**
Mainly used for thermal applications to replace liquid fuels and natural gas.
- **FLUDIZED BED HOT AIR GENERATOR(HAG) DIRECT / INDIRECT**
Mainly used to generate hot or drying air for purpose of process industry.
- **WASTE HEAT RECOVERY HEAT PIPE BASED TECHNOLOGY**
Used to recover low grade waste heat indirectly from dirty exhaust of furnaces and kilns with latest technology of heat pipe .
- **WASTE TYRE / WASTE PLASTIC CONTINUOUS PYROLYSIS TECHNOLOGY**
Continuous process to recover value added oil and high grade carbon with fully control process.
- **CONTINUOUS (CARBON DIOXIDE) GENERATION TECHNOLOGY**
Purest form of high pressurized CO around 99.5 % can be achieved with synmaxx technology using CPC. coal.
- **POWER PLANT (GASIFICATION - DG ROUTE)**
this technology generates clean producer gas to run modified D.G. for electricity production from very lower capacity to bigger one.
- **Drying Technology**
To reduce high moisture from biomass, minerals or any other materials, different dryers are designed as per raw materials size, density and moisture content.

Below are the different types of drying technology:

- A.Rotary Dryer: Co-current & Counter current
- B.Paddle Dryer
- C.Flash Dryer
- D.Fluidized Bed Dryer
- E.Flat & Wave Bed Paddle Dryer



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Up Draft Gasification Technology

In this types of fixed bed gasification technology a carbonaceous fuel like coal or biomass is fed from the top and gasification agent steam, oxygen and/or air flows from bottom to top (counter current flow) and producer gas leaves from upper stage of system. Combustion reaction occurs near the grate which are followed by reduction, reaction towards upper side in gasifier. Drying and pyrolysis of the feed stocks occur at top most part of gasifier. The tar and volatile matter produced during the process will be carried in the gas stream. Ashes are removed from bottom as slag form. Thermal efficiency are high as the temperature in the gas exit are relatively low. As per application demands RREDPL offers below systems in UP-DRAFT GASIFICATION TECHNOLOGY

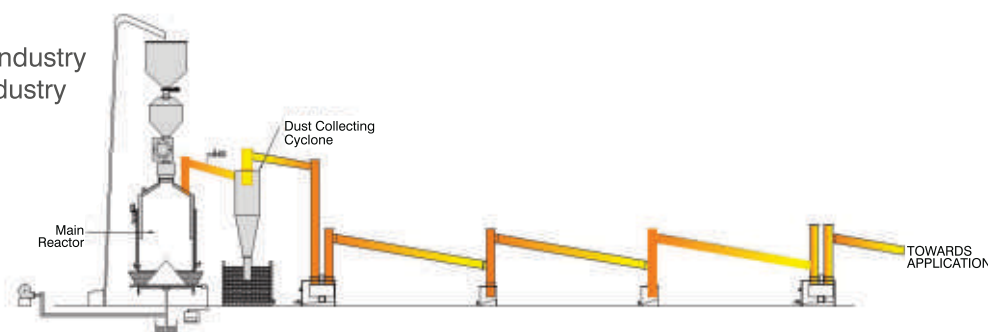


• Up Draft Gasification Technology-Applications **Hot Gas Application**

In this types of gasification mode the hot gas is leaves from the top of gasifier, heavy dust particles are being removed with cyclone dust collectors & special arrangements, then fed to the applications and generates heat through the hot gas burner.

HOT GAS APPLICATIONS

- DRI - Rotary Kilns of Sponge Iron Industry
- Hot Re-Rolling Furnaces of Iron Industry
- Rotary Kiln of Mineral Industry
- Driers And Kilns of Iron Pallets
- Chemical Industry
- Wire Industry

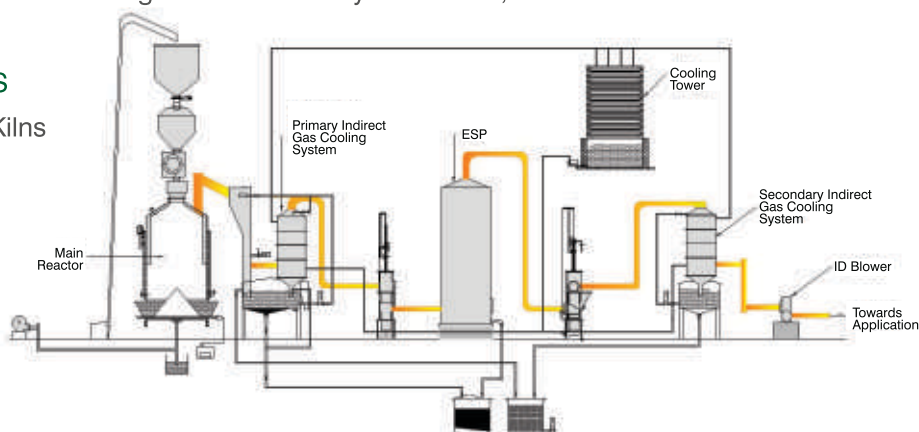


• Clean And **Cool** Gas Application

In this type of gasification mode hot gas leaves from the top of gasifier, then clean gas passes through various stages like water scrubbing, indirect cleaning and cooling and followed by wet E.S.P., which removes TAR and carbon particulate with moisture.

CLEAN AND COOL GAS APPLICATIONS

- Ceramic Industry - Roller And Tunnel Kilns
- Ceramic Industry - Spray Dryers
- Food Processing Industry
- Cement and Lime Industry
- Rubber Industry
- Pharmaceuticals Industry
- Textile Industry



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Up-draft - **Hot** filtration & clean gasification technology

It is Newly developed Modified Up-draft hot clean gasification technology, has more advantages rather than old traditional gasification technology. It Is Totally TAR and phenolic water free process. This technology gives both unique features of COLD and HOT gasification technologies, will give precise automation and more energy efficient producer gas.

Waste TAR is now used as TAR vapor (AS A FUEL) in kiln or furnace will give extra energy, causes less fuel consumption and high production ratio.

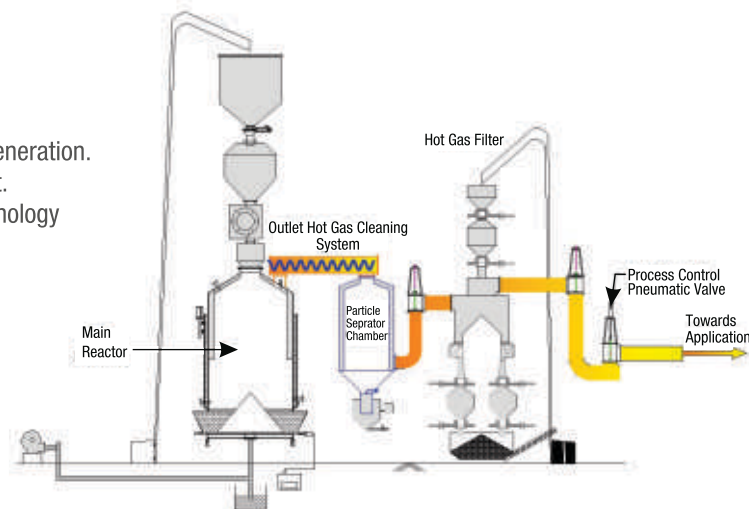
About **Hot** gas filtration & cleaning technology

- Aim to utilize direct clean and Hot gas.
- Tar is remain in gaseous form and utilize in furnace as fuel with producer gas (coal gas).
- Outlet temperature of gas up to 300 - 450°C.
- Utilization of hard coal for cleaning of hot gas. This contaminated hard coal will be re-utilized back to Gasifier with fresh feed coal.



Features and advantages of Hot filtration and clean technology

- Tar and phenolic water free producer gas will ease the process and no handling of waste water and Tar.
- No gas scrubbing so no fresh water required hence no waste water generation.
- No waste water so no extra evaporation required, will reduce fuel cost.
- Less space, less equipment, less electricity high energy efficient technology
- Hot gas and tar in vapor form increase the gasifier efficiency (it reduces 20 -25 % fuel consumption) ultimately reduces the green house emission.
- No by product generation and no residue left out (zero discharge)
- Completely environmental friendly technology
- Process control with fully automatic scada control system, totally user friendly process.
- Low capital investment
- Potential saving of huge natural resources.



Merits and comparisons of Hot gas filtration system & cleaning gasification technology with updraft wet cleaning gasification technology

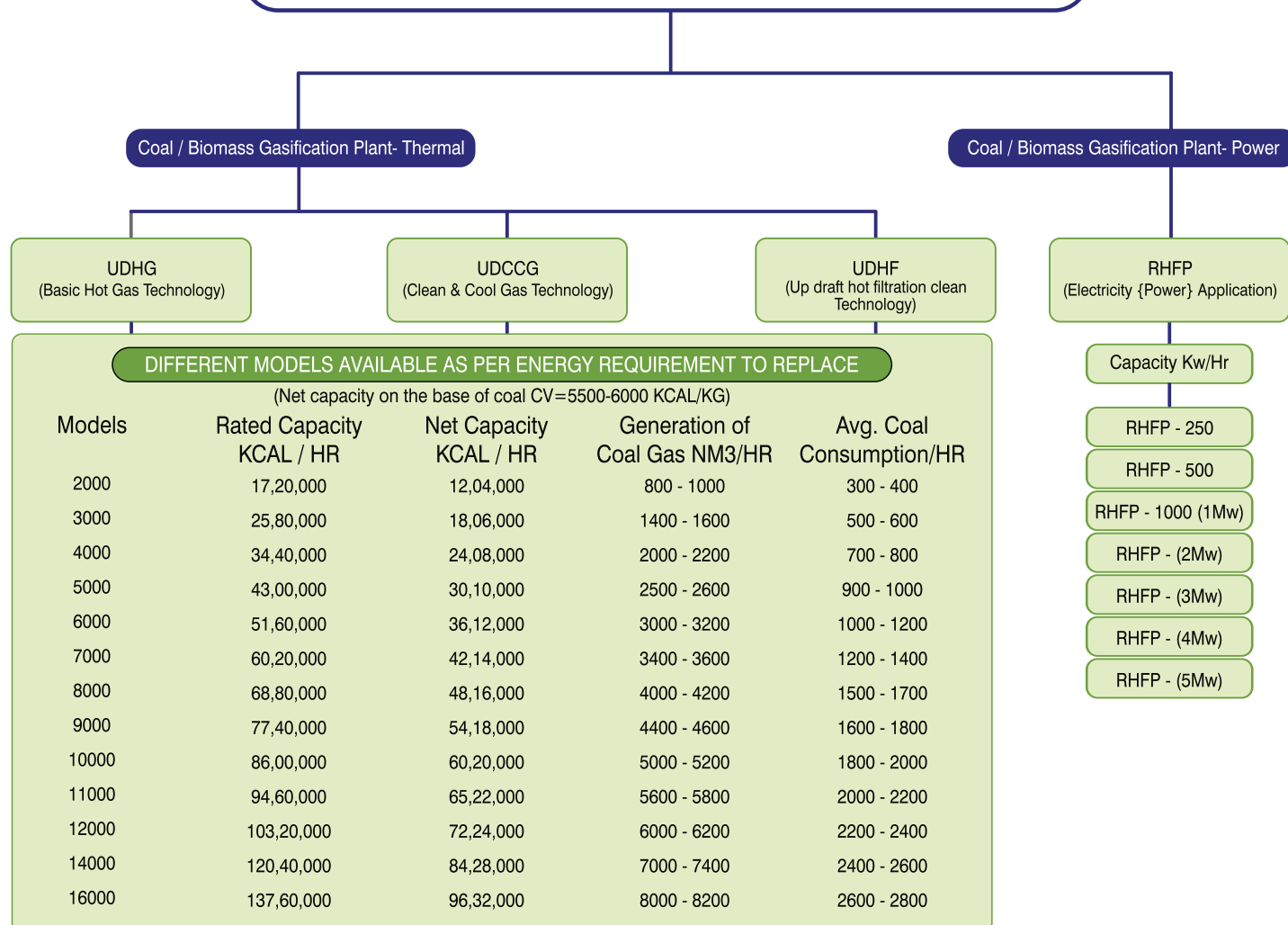
| Sr. No. | Features | Updraft Wet Cleaning Technology | Newly Hot Gas Filtration and Cleaning System Gasification Technology |
|---------|---|--|--|
| 1. | Additional Energy Require | ✓ | X |
| 2. | Risk of Explosion | ✓ | X |
| 3. | Residue Generation (Waste Water, Coal Tar) | ✓ | X |
| 4. | Need to Disposal of Residue | ✓ | X |
| 5. | Require Complex Additional Equipment (Waste Water Evaporator, Cooling Tower & Tar Disposal) | ✓ | X |
| 6. | Skill Manpower for Operation | ✓ | X |
| 7. | Energy Efficiency | LOW | VERY HIGH |
| 8. | Equipment, Maintenance and Operation Cost | HIGH | VERY LOW |
| 9. | Environment Friendly, Complete Zero Discharge | No but need precise attention for residue disposal | ALMOST ZERO DISCHARGE |



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Radhe Renewable Energy Development Pvt. Ltd. Application Wise Model Chart



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Fluidized bed direct **Hot** air generator

Technology

The development of fluidized bed combustion technology over the past 25 years has significantly increased the use of various biomass and waste products in power and heat generation. It converts agriculture and biomass waste fuels & any type of coal (powdery coal) into highly efficient energy.

Inside the fluidized bed, fuels mixed with inert solids such as ash or sand media is combusted. Specific velocity air is passed into the bed, creating strong turbulence inside the bed and causing the solid particles to behave like a fluid and mix uniformly. Fluidized bed reactors are capable of combusting solid fuels at 95 % efficiency or higher, generating heat/gas at a high rate, which can in turn be used to produce steam and electricity for industrial factories.

Radhe renewable energy development pvt .ltd. is pioneered in designing & developing this system. We have successful nos. of such installations in various industrial segments for dryer applications.

This technology utilize the input in powdery foam of solid fuels to get final temperature control within $\pm 2^{\circ}\text{C}$ by utilizing a highly sophisticated PLC base controlling system. The final temperature of 700°C is achievable with this system.



System Aspects

The system comprises of fluidized bed furnaces, nozzles, chambers for ash settling, ash removal mechanisms, cyclones, fuel feeding blower, instrumentation & control equipments, operation panel board, motors & electrical components.

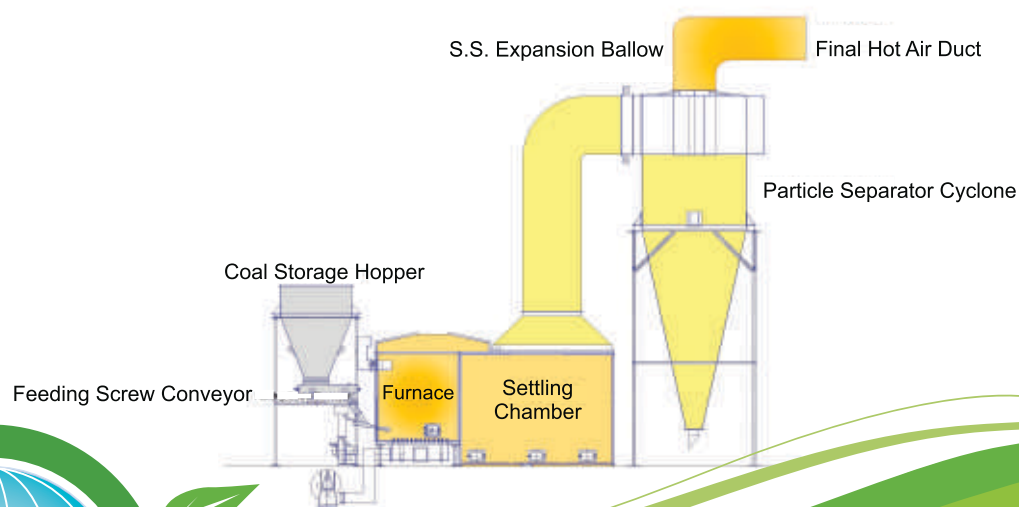
Applicable Fuels (0-6 mm size, < 15 % Moisture Contain, Ash upto 30 %)

- Wood wastes (Bar, Chips, Saw Dust etc).
- Agriculture wastes (Husks, Ground Nut Shell, Cotton Stacks).
- Lignite/Coal/Solid waste.

Features and advantages of fluidized bed **Hot air** generator

- Multiple waste fuels can usable (Agriculture Waste , Wood Waste)
- Cheap fuel like powdery coal (lignite, Imported Coal, Indian Coal) can be utilized easily and efficiently.
- Very much low maintenance cost rather than other Hot air generators.
- Favorable ash properties.
- Low NOx formation.
- Low operating cost.
- High combustion efficiency (Almost 95-98 %).
- Fast start-up and shut down.
- Low emission.

Schematic diagram of fluidized bed direct **Hot air** generator



RADHE'S CONTRIBUTION TOWARDS SUSTAINABLE GROWTH





LIVE GREEN
LOVE GREEN
LEAVE GREEN



RADHE RENEWABLE ENERGY DEVELOPMENT PVT. LTD.

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