CLEAN COAL OPPORTUNITIES

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CLEAN TECHNOLOGY

- CLEAN COAL
- MICROWAVE BASED COAL DRYING
- CONTINUOUS HYDRO THERMAL DEWATERING
- HYBRID COAL DRYING
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- ALLAM CYCLE
- CO2 CAPTURE AND REUSE

- DECENTRALIZED DISTRIBUTED GENERATION
- HYDRO KINETIC TURBINE
- SINGLE AXIS TRACKER
- FLOATING SOLAR
- BACK UP SUPPLY FOR TELECOM TOWER
- BIOMASS BASED GENERATION
MICROWAVE BASED COAL DRYING

STATUS:
• Evaluated microwave drying technology offered by a company known as Coaltek based in USA.
• Have a demonstration plant @ 15 TPH capacity reducing moisture level in coal from 40% to 28%. This plant is running in Calvert City, Kentucky, USA.
• Tata Power also conducted trials at a vendor in Navi Mumbai testing the suitability of microwave drying on Indonesian coal used in our Trombay power plant.

USP OF THE PROCESS:
• Moisture evaporated with surface temperature of coal not exceeding 90°C. Thus chances of ignition are minimized.
• Only sweep air needed to remove evaporated moisture thus level of air buildup in chamber is minimum
• Can use lower calorific value coal thereby cost of raw coal comes drastically down.

ANALYSIS RESULTS:
• Power consumption is higher compared to conventional coal drying processes.
• Our trials and technology analysis indicated a higher levelized cost of coal when low CV coal is subjected to drying through above method when compared with buying higher calorific value coal.

(Assumption is same CV of coal goes into the power plant in both cases. Drying is a means to enhance CV of low value coal by removing moisture)
**USP OF THE PROCESS:**

- CHTD known as continuous hydrothermal dewatering technology. Utilizes Earth’s heat potential and hydraulic pressure alter the structure of coal.
- Uses a vertically mounted autoclave which is 1 km below earth’s surface to create a pressure and temperature of 100 bar and 300°C, respectively.
- Removes up to 50% moisture.
- Hydrostatic head used to maintain pressure while decarboxylation reaction (exothermic) is used to maintain temperature. Hence, it is energy efficient.
- Patented by a company known as Exergen based in Australia.
- Proven at a capacity of 0.16 tph in Tasmania, Australia

**STATUS:**

- Tata Power is a strategic investor in Exergen.
- Currently in the process of identifying a suitable location for the demonstration plant (50TPH), which can be subsequently taken to commercial scale (350TPH)
HYBRID COAL DRYING

USP OF THE PROCESS:
• In House Design
• Makes use of LP steam and flue gas for coal drying and sweeping away moisture vapors.
• Recovers heat from flue gas and transfers it back to boiler feed water.
• Flue gas is used post ESP from the power plant while steam is used at 5 barg saturated condition.
• The outlet temperature of dried coal limited to 60°C so that no dust explosions occur.
• Trials conducted with moisture reduced from 30% to 18% and 1.34 kg steam/kg of moisture utilized.
• Flue gas required is only approximately 3% of the entire flue gas volume for a 500 MW sub critical power plant.

STATUS:
• The process can be incorporated into green field projects.
• Patented.
COAL BENEFICIATION

USP OF THE PROCESS:

- The process is based on gamma-ray identification of the non-coal particles on a belt conveyor.
- These non-coal particles are knocked off the conveyor using a high air jet stream.
- The inherent ash in the coal is not changed and mainly only the heavy particles (non-coal density) are eliminated by the jet stream.
- Based on the proximate and ultimate analysis of the coal, it was expected that input coal @ 45% would reduce to 37%, ash and inerts, at output at ~ 6% moisture content.

STATUS:

- This process is most suited at the mine mouth as the rejects can be dumped back into the mine.
- Does not make sense at the power plant site on account of economic non-viability of logistics with the inert in the raw coal.
USE OF SUPERCritical CO2 ALLAM CYCLE IN POWER PLANTS

USP OF THE ALLAM CYCLE PROCESS:

- Projected efficiency of 47.3% LHV when using Indonesian Coal in a 300 MW Allam Cycle power plant.
- Projected natural gas-fired efficiency of 58.9%+ LHV in commercial (300MW+ sized) units.
- A CO$_2$ sequestration-ready power cycle. Cycle operates with no air emissions: SOx & NOx produced as liquid acids; no particulates; secondary products (CO$_2$ and others) with commercial value are produced as a pipeline-ready byproduct.
- Substantially reduced foot print when compared with conventional coal power plants, and lower capex.
- No steam generation. Supercritical CO$_2$ is the working fluid for running the turbine. New technology turbine under development by a leading Japanese OEM – Toshiba.
- Demonstration plant based on natural gas to be commissioned shortly in Houston, TX, in 2016.
- Reduced water requirements.

STATUS:

- In discussion with Tata Power for FEED for a coal based plant in India.

CO2 CAPTURE AND REUSE

USP OF THE PROCESS:

• In House Design of CO2 Capture Process using third generation solvent characteristics of an upcoming Indian company.
• Steam requirement is 1.9 kg / kg of CO2 which is better than the commercial industry benchmark. This is 25% less steam than MEA based process.
• The Purity of CO2 is 99.99% which is then proposed to be used in situ for growth of algae in closed photo bio reactors.
• Easily retrofitted in existing power plants.
• Very less land required for the reuse plant.

STATUS:

• Feasibility and FEED of a 10 TPD CO2 Capture and Reuse plant at Trombay has been completed.
• Since there is no regulation to impose penalty on CO2 emission in India, hence the project is on hold and shall be considered in greenfield projects wherever regulations are needed to be complied.
HYDRO KINETIC TURBINE

OBJECTIVE:
Cost effective generation from water streams having velocities between 0.75 m/s and 3.2 m/s.

STATUS:
a) Technology scan for techno commercial feasibility and indigenization
b) 8 KW hydro kinetic turbine (2 numbers) tested successfully at Bhira for more than a year [M/S Casmir / University of Southampton]
c) In house development – Generator stator winding including lamination punching and power conditioning unit (10 KW Variable AC-DC-50 hz, 415 V, 3 phase AC). This is Version 1 with 85% efficiency.
d) In house development of power evacuation system
e) Meanwhile the first commercial matrix inverter has hit the market. Adopting the product for this application by developing appropriate settings with OEM. In process of installing 2 inverters and synchronizing with installed turbines.

POTENTIAL:
a) Product is ready for market deployment as a DDG solution
b) Provides electricity to areas / settlements along river streams.
c) Can be deployed in last mile of canals, as well as from ocean currents (blades being bi directional and can handle harsher sea conditions)
d) Series of turbines can be installed thus scalable.
HYDRO KINETIC TURBINE

POWER EVACUATION SYSTEM:

a) The above system is already functional for the past 18 months and was fabricated locally and is 85% efficient.

b) Further, the commercially available Matrix inverters are being tuned to evacuate power from the turbines with voltage ranging from 0 to 280 V and frequency varying from 0 to 40 Hz. With this installation we can achieve efficiency of 93%.
SINGLE AXIS TRACKER

OBJECTIVE:
Demonstrate working of a cost effective DDG Based solar Plant with tracking technology

STATUS:
a) Commissioned a 69.12 KWp capacity solar plant in Lonavala on opex model.
b) The Plant utilizes 288 PV modules of 240 W each and makes use of single axis east west tracking system.
c) At average irradiance of 625 W/m², a plant load factor (PLF) of 17% achieved. With tracker, the PLF increased by 15%.
d) Tracking feature tilts angle of solar panel by 1° every 4 minutes.
e) The system is helping the institute save on its electricity bills. (~ Rs. 3/KWh is the saving for the institute).

POTENTIAL:
a) Solar prices have fallen. Hence tariffs have become more attractive over the life cycle (20 years and above).
b) Replicable on rooftop as well as scalable to higher capacities.
c) Benefits are higher for high irradiance areas. Solution ready for commercial deployment.
FLOATING SOLAR

- 13.5 KW pilot at Walvhan (Sunengy)
- Commissioned on 8th Jan 2014.
- Various technical challenges.

- 3.36 KW pilot at Walvhan (in house)
- Commissioned on 18th Oct 2014.
- Raft design in house
- FEA done in house

- Can withstand wind speeds upto 150 kmph
- Cables are floated on water (developed in house)
- String inverter placed on raft
- Earth leakage and graded surge protection provided
- No effect on local flora and fauna [certified by NEERI]
- Terminal box of solar module conforming to IP67
FLOATING SOLAR

BENEFITS

- Expected increase in yield due to passive cooling when compared with land based systems
- Entire system scalable to MW capacity.
- Replicable on lakes, canals, water bodies, as well as land.
- Ready for deployment as a DDG solution as well as on a MW scale. Entire engineering in house
- At 1000 KW capacity and at a location with an irradiance of 1600 units /kw/year, the tariff is comparable to land based system.
BACK UP SUPPLY FOR TELECOM TOWER

**Objective:**
Designed as an alternative power option for telecom towers with respect to diesel gen sets

**USP of the System:**
- a) In house design of the structure placed on top of the porta cabin. Does not therefore compete for land
- b) Solar modules are thin film type. Thus can generate even in shadows and dim light.
- c) Cheaper power than DG based power
- d) In house optimization of the power management system of the BTS site leading to enhanced battery life.
- e) The power conditioning unit is capable of performing the role of SMPS in telecom sites thereby eliminating its need.
- f) Efficiency of 95% from generation till final delivery to BTS.

**Current Status:**
Commissioned in Bhira on 30/3/2015.

**BENEFITS:**
- a) Scalable to double, triple and 4G sites.
- b) Replicable at other telecom tower locations and can be easily retrofitted in existing sites.
- c) Easily replace diesel generated power as it is cheaper.
- d) Ready for deployment as a DDG solution
- e) Will give more benefits in high irradiance areas.
BIOMASS BASED SOLUTION

OBJECTIVE:
Develop cost effective biomass based power generating solution in the DDG space

STATUS:
a) Commissioned a 14 KW biomass based gasification system in Trombay Colony.
b) In collaboration with Tata Motors and IISc, have developed a 8 to 14 KW gas engine
c) Takes in biomass (twigs, coconut shells and leaves and produces producer gas which is burnt in the gas engine producing electricity and catering to the street light requirements in the colony.

WAY FORWARD:
a) Developing in house a multi fuel gasifier which can accept multiple types of biomass thus becoming independent of geography and fuel availability limitations.
b) The system shall be scalable and replicable
c) Shall be a demo in one of our hydro areas
ASH PRODUCTS & TECHNOLOGY EVALUATION

Ash – a by-product of thermal power generation is being viewed as a resource, rather than a waste.

Developed various products for utilization of ash as a resource and further working with academic institutions to enhance the value for thermal power plants by making ash as a product for commercialization.

Continuous evaluation of technologies in the energy & Storage space for decentralized distributed generation and MW scale generation

Improvement in Operational Efficiency of Existing Power Plants

Develop new business models for commercial viability
“Journey Continues..
We value your inputs, suggestions and critique.”

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