Biomass Gasification Status in India
and
initiatives of
Indian Oil Corporation Ltd.

Biomass gasification in India

- **Biomass feedstock availability**
  - ✓ Agro residues - 683 million tonnes (MT)/yr from eleven major crops and about 178 MT is surplus quantity
  - ✓ Agro industrial wastes - Large quantity of agro industrial wastes like rice husk, bagasse etc. are generated
  - ✓ MSW (Municipal Solid Waste) – about 110 million tonnes per year is generated
- **Gasification technology**
  - ✓ Indigenous technology based on fixed bed gasification technology
  - ✓ Deployed for heat and power applications
  - ✓ Exports to over 40 countries in all continents
  - ✓ Wide range of outputs from a few kilowatts to a few megawatts
- **Key drivers**
  - ✓ To reduce dependence on energy imports
  - ✓ To achieve goal of low carbon clean energy pathways
  - ✓ Policies and incentive system

Ref : Biomass gasification in India – TERI presentation, 2021 & TIFAC report on estimation of crop residues, 2018

Brief history of biomass gasification in India

- Research on biomass gasification in India commenced in 1980's
- Leading academic institutes (IISc and IITs) and R&D institutes (TERI, Ankur etc.) extensively worked on design and development of biomass gasification technology
- Initial years, emphasis was on replace diesel based agriculture pump sets and small scale systems for rural electrification needs
- Expanded the technology for sub-MW scale capacity for grid application and industrial thermal applications
- Gasifier system to process biomass fuels such as rice husk, arhar stalks, cotton stalks, wood chips etc. to producer gas successfully developed indigenously
- More than 15 leading manufacturers in India
- Power range 10 – 2000 kWe and thermal gasifier with 25 kW_{th}-5MW_{th} successfully deployed
- Developed indigenous engines for producer gas operation

Ref : Biomass gasification in India – TERI presentation, 2021

Financial assistance for Biomass gasifier and Co-generation

- Ministry of New and Renewable Energy(MNRE) is promoting biomass gasifier based power plants for producing electricity using locally available biomass resources
- The main components of the biomass gasifier programmes are:
  - ✓ Distributed / Off-grid power for Rural Areas
  - ✓ Captive power generation applications in Rice Mills and other industries
  - ✓ Tail end grid connected power projects up to 2 MW capacities
- Focus of the biomass gasifier programme is to meet captive electrical and thermal needs of rice mills and other industries
- Prevailing financial assistance for biomass gasifier systems:
  - ✓ Rs. 2,500 per kWe with duel fuel engines for electrical application
  - ✓ Rs. 15,000 per kWe with 100% gas engines for electrical application
  - ✓ Rs. 2 lakh per 300 kWth for thermal applications

Source : https://mnre.gov.in/waste-to-energy/schemes

Recent major development other than CHP

- Mangalore Refinery and Petrochemicals Limited (MRPL) has awarded LanzaTech the contract to commence the basic engineering for an integrated processing facility to convert locally available agricultural residues to approximately 16 ktons/year (5.3 MGal/year) of fuel grade ethanol

- To convert the solid biomass wastes to gases, LanzaTech will deploy commercially proven gasification technology from Ankur Scientific, a waste to energy company that specializes in distributed production
- The resulting carbon rich gas will then be converted to ethanol using LanzaTech's gas fermentation platform
- The integrated technology will have the flexibility to process a wide range of biomass feed stocks enabling rapid replication at other locations.

Ref : https://www.lanzatech.com/2020/09/15/advanced-biofuel-facility-gets-green-light-in-india/

Indian Oil Corporation Ltd. initiatives on biomass gasification

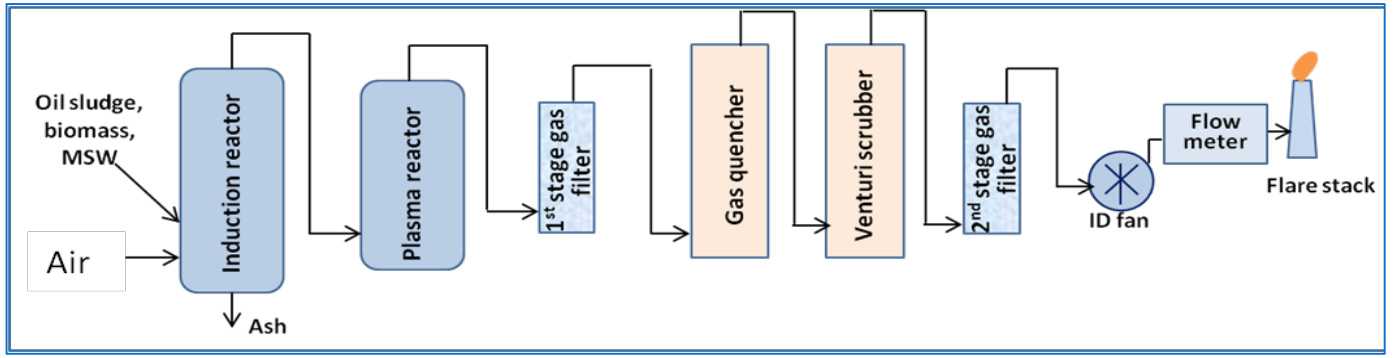
Biomass gasification pilot plant

- IndianOil set up 10 kg/hr fixed bed downdraft biomass gasification pilot plant to study gasification characteristics of different biomass feedstocks
- Gasification plant operated with both wood chips and biomass briquettes(generated from agro residue) using air as oxidant
- Experiments conducted at different equivalence ratios from 0.28 to 0.34
- CO/ H2 ratio of generated syngas / producer gas : 1.2 – 1.35
- Gas yield : 1.9-2.2 Nm^3/kg biomass

10 kg/h fixed bed gasifier

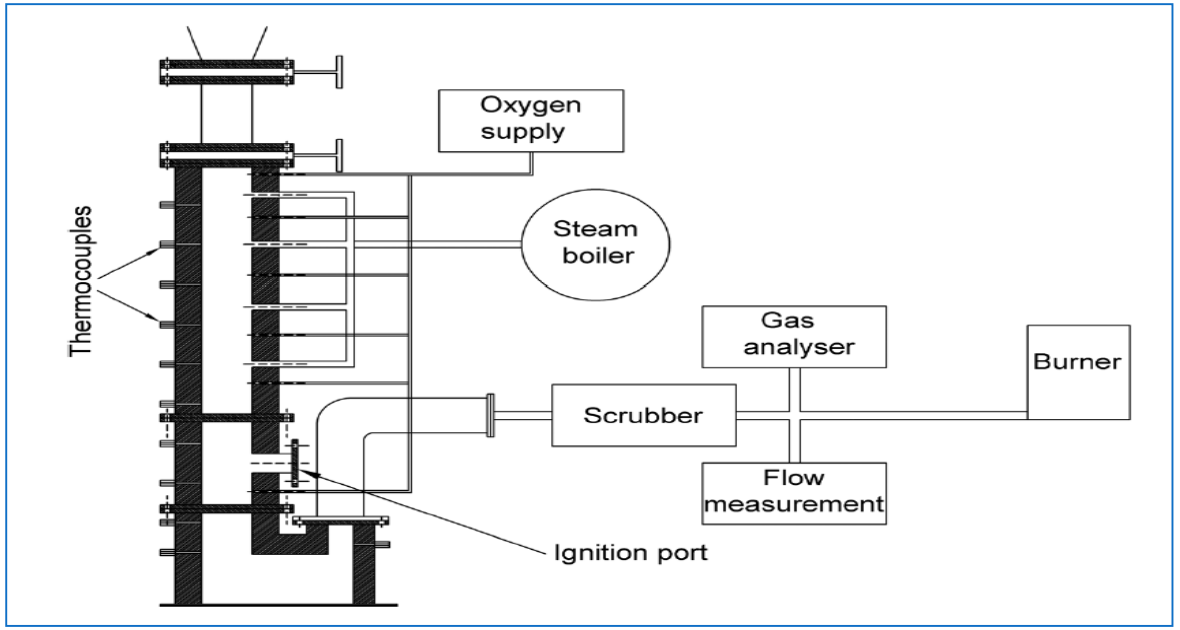
Feasibility of gasification of biomass, MSW and oil sludge in two stage gasification system

- Biomass, MSW and oil sludge gasification experiments conducted in two stage reactor
  - ✓ First stage – induction based fixed bed batch reactor
  - ✓ Second stage – plasma reactor for cracking of tars
- Syngas samples collected and analyzed using offline GC
- CO/ H2 ratio of generated syngas / producer gas : 1.36-2.31
- Heavier hydro carbons (vol%) :1.4-4.0
- Generated syngas has significant quantities of heavier hydro carbons (HHC)



Oxy-steam biomass gasification for hydrogen production

- IndianOil is curretnly working with Indian Institute of Science (IISc) for development and demonstration of oxy-steam biomass gasification based hydrogen generation
- IISc developed an efficient technology for conversion of biomass to hydrogen
- Developed technology demonstrated at 2 kg/h hydrogen production
- Oxy-steam biomass gasification system adapted
- Vacuum Pressure Swing Adsorption (VPSA) considered for production of fuel cell grade hydrogen
- Currently optimization of operating conditions and generation of scale up data is under progress
- 240-250 kg/d hydrogen production demonstration plant will be set up based on developed technology



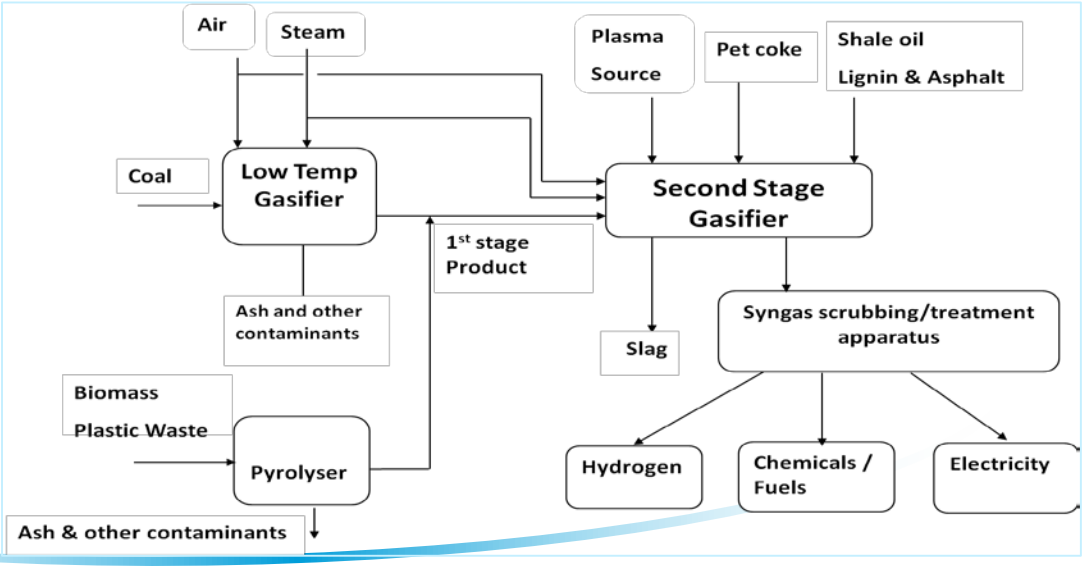
SBR	0.75	1	1.4	1.5	1.8	2.4	2.7
ER	0.21	0.18	0.21	0.23	0.27	0.28	0.3
H_2 yield (g/kg biomass)	66	68	71	73	94	99	104
H_2 yield (vol %)	41.8	45.2	43.1	45.2	49.6	51.6	50.5
CO yield (vol %)	27.6	24.9	26.5	24.9	17	12.4	13
H_2/CO ratio	1.5	1.8	1.6	1.8	2.9	3.8	3.9
LHV (MJ Nm^{-3})	8.9	8.6	8.8	8.7	8	7.4	7.4
Gasification efficiency (%)	85.8	76.8	80.8	77	79.5	70.5	71.5

Ref : K. Sandeep and S. Dasappa, Int. J. Energy Res. 2014; 38:174–188

Other gasification related initiatives by IOCL

- IndianOil extensively worked on gasification of high ash Indian coals, petcoke etc.
- Multi-feed fluidized bed gasifier of 1-2 kg/h set up to undertake gasification research activities
- Extensively worked on :
  - ✓ Gasification of different feed stocks such as coal, petcoke etc.
  - ✓ Developed Indian coals characterization data
  - ✓ Gasification kinetics of Indian coals
- Developed a novel concept on integrated gasification for optimal use of available gasifier designs by segregation of feedstock according to reactivity and ash content
  - ✓ Energy efficient
  - ✓ Clean up and treatment of syngas minimized
  - ✓ Simplified new gasifier designs resulting in cost reduction & reliability improvement

Multi-feed fluidized bed gasifier



Integrated gasification concept

Ref : Rajesh M Badhe et al. (2013) US patent No. 8617424

Thank You