# An overview on biomass gasification technologies

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- Gasification introduction
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### Broad area of research activities at CGPL

- The broad areas include laminar premixed and diffusion flames, heterogeneous combustion, nozzle flows and combustion flow interaction in practical systems.
  Lifted diffusion flames, sandwich composite propellant burning,
- combustion of liquid droplets; propagation of premixed flames with complex chemistry and diffusion; reacting flows in nozzles and air inlets in aircraft and missiles;
- Experiments and modeling of wood combustion in gasifiers and in stoves
- Hydrogen and liquid fuel from biomass
- Modeling of in-cylinder processes in internal combustion engines

#### **Biomass gasification**

- Converts solid fuel to gaseous fuel
- Gaseous fuel can be used in an internal combustion engine to generate mechanical or electrical power
  - Diesel engine on dual fuel mode to replace about 80 % of the diesel
  - Gas engines on single fuel mode to operate on producer gas no fossil fuel

#### **Gasification technology**



#### Challenges in using producer gas

#### Properties differ from the conventional fossil fuel

Fuel	Fuel LCV,	Air/Fuel	Mixture,	Φ, L	imit	S <sub>L</sub> (Lim	it), cm/s	S <sub>L</sub>	Peak	Product/
+ Air	MJ/kg	@ (Φ=1)	MJ/kg	Lean	Rich	Lean	Rich	Φ =1, cm/s	Flame Temp, K	Reactant Mole Ratio
Natural gas	50.2	17.2	2.76	0.54	1.69	2.5	14	35	2210	1.00
Producer	5.00	1.35	2.12	0.47	1.60	10.3	12	50	1800	0.87

Quality and consistency of gas for engine application

- •Contamination
- •Gas composition and calorific value

Some field installations .....

Grid connected 100 kWe biomass gasification power plant in Karnataka

- 0.8 MWe of gasification power plant connected to the grid in Karnataka as a part of Biomass Energy for Rural India a program under GoK/UNDP/MNRE
  - The project is being implemented in five village clusters with a total of 26 villages in the state of Karnataka, India
  - The project had six gasifier based power plants composed of two 100 kWe and one 200 kWe in Kabbigere and one each of 240 kWe capacity in Borigunte and Sebinayanapalya.

#### **Performance details**





#### Performance details (2000 hours)



#### Some photographs – after 1000 hours









### Beach Mineral Corporation – Tamil Nadu 1.5 MW









## Performance



In the last 12 months the system has operated for 14500 hours (~ 7250 each) of operation generating about 4.0 million units of electricity using about 5500 tons of biomass.

#### **Overall engine performance**

- The turbo charged engines was closely monitored in the field,
  - During the initial phase joint inspection every 1000 hours
  - Checking of oil at regular intervals
- Over **200,000 hours** of operational experience in the field
- No major issue on the engine wear (based on studies by CIL)
  - Engine capable of handling varying loads
    - 30 40 % block loading was possible
- SFC ~ 1.1 ± 0.1 kg/kWh
  - Efficiency (Wood to electricity) > 26 %
  - Efficiency (Gas to electricity) > 32 %
- CIL has accepted Producer gas as a fuel and provides performance guarantee along with the warranty for the equipment.

#### Heat treatment – Tahafet, Hosur

- Eight furnaces and temperatures vary from 600 C to 1000 C
- Each furnace is fitted with two burners having air to fuel ratio control and also a PID controller to oversee the operations. The industry operates on three shifts for about 6 days in a week
- Typical LDO consumption per day = 1500-2000

### Heat treatment .. contd

#### 300-kg/hr capacity installed

- All the eight furnaces are connected to the gasifier using WESMAN make dualfuel burner with ratiotrol based A/F control and PID monitor servo controller. The temperatures in the individual furnaces are maintained independently.
- With 8 furnaces connected presently to gasifier saving is about 2000 litres/day.
- Average fuel consumed per day 5.2 T of coconut shells, wood chips
- Total operating hours ~ 35000



#### Kandaswamy Metals, Palakad

- An Aluminium industry involved in the melting and making vessels
- Located in Pallakad and using Furnace oil for the melting purpose
- System designed to use hot gas directly for the burner
  - 100 kg/hr
  - Specially designed burner



#### Kandaswamy Metals, Pallakad



Hours of operation per day,

hrs

#### Performance

Total running hours of the gasifier June	2007	: <b>780</b> hrs
Average running hours per day		: 14.00 hrs.
Average biomass consumption per day	: 1350 Kgs.	
Average melting of the Aluminum per	day	: 1600 Kgs.
Replacement of the Furnace oil per day	y : 400 Ltrs.	
Total biomass consumption		: 61 Tons
Total Aluminum melting	: 70 Tons.	
Saving		: Rs. 10 Lakhs



### 5 MW th for heat application

- Gasification system at M/S Tanfac industries, Cuddalore
- Total hours of operation ~ 30,000

#### Last 5 months summary

		Biomass	FO
	Hours of	Consumed	replaced,
	operation	Tonnes	kL
May-06	702	651	165
Jun-06	660	621	158
Jul-06	509	476	121
Aug-06	642	640	163
Sep-06	640	640	163

Hours of operation	3153	hrs
Biomass used	3028	Tons
Oil replaced	770	k Ltrs
Savings	4.5	M Rs.





# Performance using different fuels

- Agro residue briquettes tested at 20 % ash
  - Same gasification system can handle 1 to 20 % ash
  - Gas quality acceptable for engine
  - SFC consumption similar on ash free basis
- Fuel quality requirement
  - Thermal stability of the briquette important
  - Density and binding an important property

#### IISc's experience

- System reliability at industrial level
- System packaging as IPP
  - Continuous non stop operation > 2500 hrs
- Both thermal and power generation system saving over 30000 Its of fossil fuel daily.
- Increasing demand for gasification systems to meet various energy demands

......Thank you