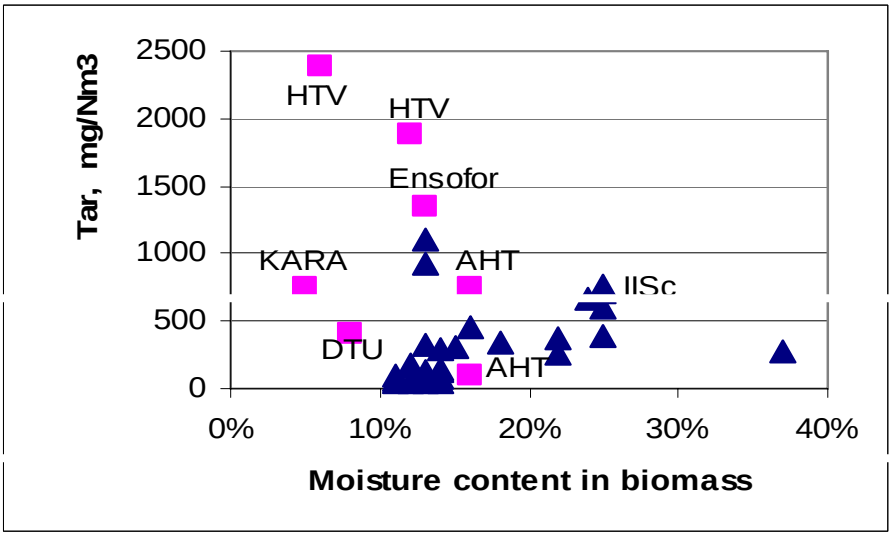
Uniqueness of IISc Biomass Gasification Technology

1. It is a modern fuel –flex system that includes urban solid waste.
2. It has an open top as against closed top of most designs
3. It has staged air injection that is not adopted by any other gasification technology in the World
4. Its reactor design with a ceramic inner shell – diameter and stages of air injection and associated details are tuned to provide a thermal and chemical environment to convert most tar molecules to simpler compounds.
5. The quality of the gas from the gasification system in terms of gas composition, hot and cold tar are established in rigorous tests in India and overseas as per the European test requirements through third party inspection and independent laboratory tests. The results are compared with those of several European designs (see Tables 1 to 5 and Figures 1 to 3).



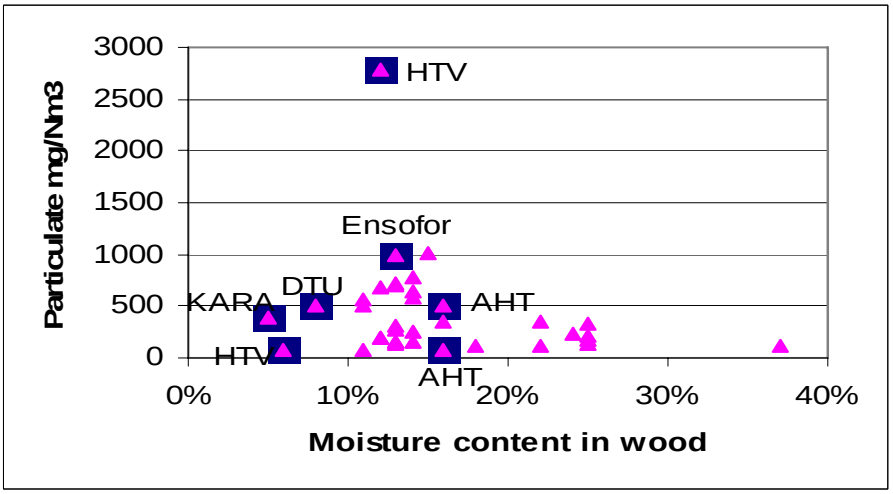
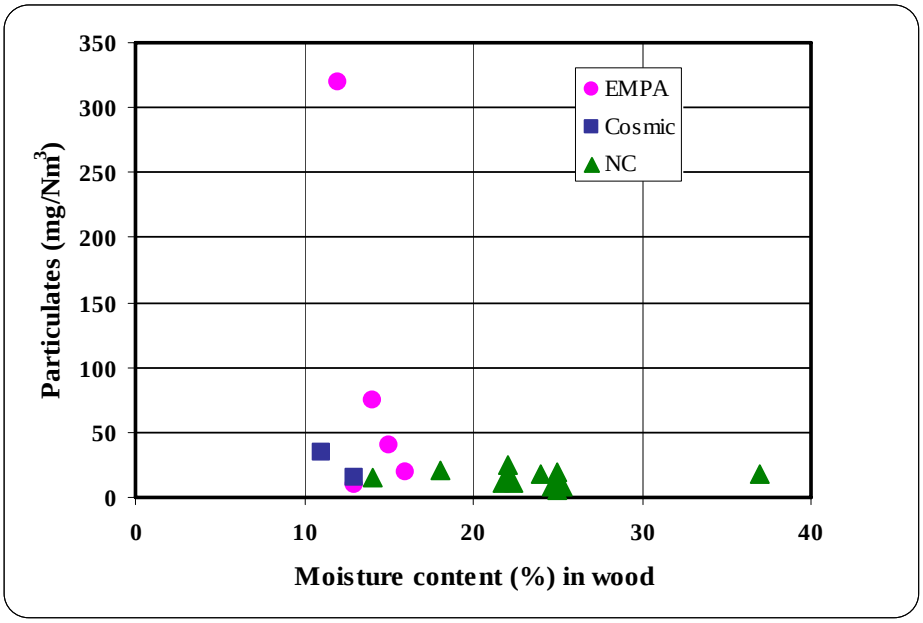


Fig. 1 Comparison of IISc gasifier with European gasifiers - Particulate and Tar content in the Hot Gas [Results from tests conducted in Europe, Ref: Hasler Philipp, 1997]



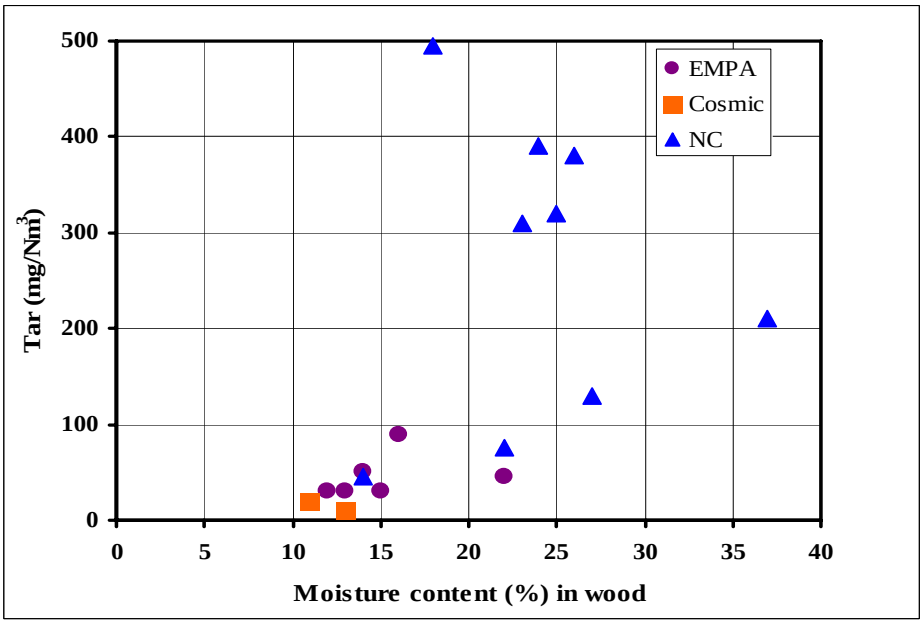
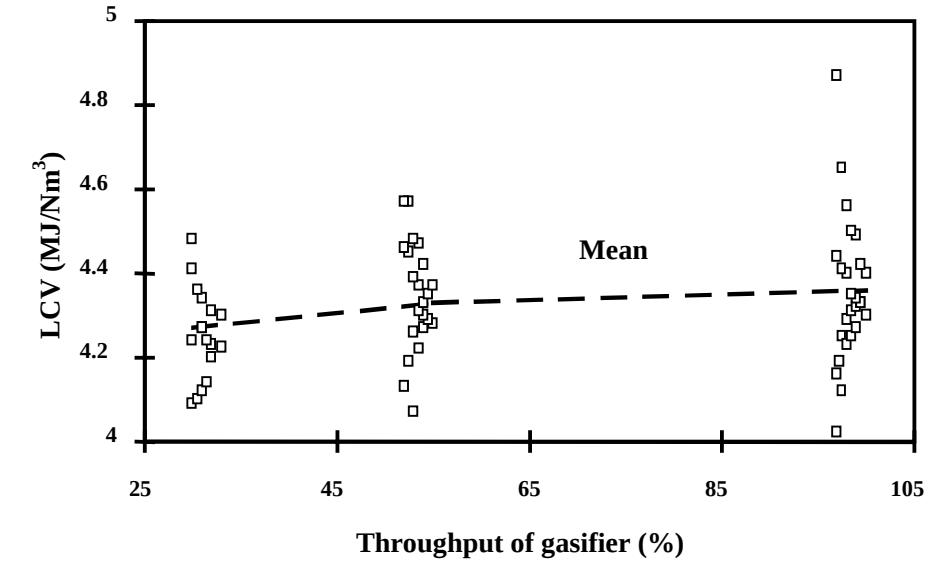


Fig. 2: The Effect of variation of moisture content in biomass on Particulate and Tar content in the Cold Gas of IISc gasifier - measurements made by various agencies in India and Switzerland



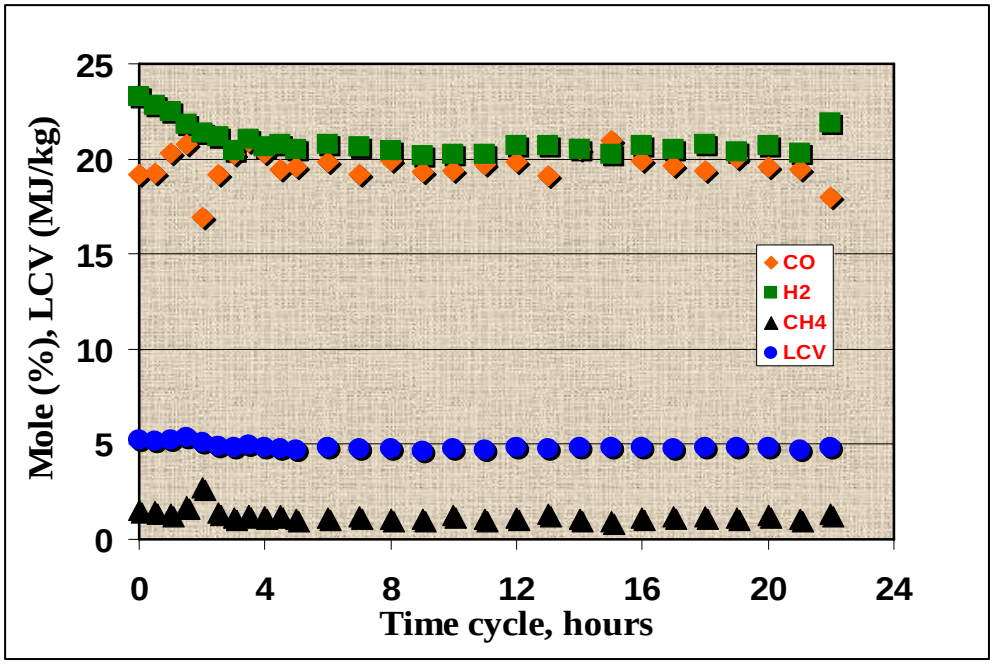


Fig. 3 Long duration measurement of Producer gas composition and lower calorific value variation against the Gasifier throughput

Table 1: Variation of Gas Composition with Fuel Moisture Content

Type of biomass	Moisture content, %	H_2 (V %)	CO (V %)	CH_4 (V %)	CO_2 (V %)	Cal Value MJ/N m^3
Standard Wood	13	18.8	16.1	2.3	15.0	4.87
Standard Wood	14	17.4	16.7	2.0	14.4	4.7
Standard Wood	11	17.6	17.6	2.1	13.6	4.9
Standard Wood	13	17.1	16.3	2.3	14.5	4.7
Standard Wood	14	18.6	17.4	2.1	14.1	5.0
Pine	15	17.5	17.3	1.6	13.3	4.6
Pine	18	16.5	16.3	1.5	13.2	4.4
Pine	16	16	15.7	1.6	14.4	4.3
Pine	24	15	14.8	1.5	14.7	4.0
Pine	25	16.3	14.6	1.4	15.0	4.1
Branches	25	16.5	13.9	1.1	14.4	3.9
Branches	25	15.3	14.7	1.3	13.0	4.0
Pine	22	15.5	14.3	1.4	13.6	4.0
Pine	25	14.3	13.5	1.3	14.3	3.7
Green Wood 37	14	11.2	1.3	15.3	3.4	
Pine + charcoal	25	12.9	13.4	1.5	14.0	3.6

6. It has the highest gasification efficiency for any of the tested systems (78 to 82 % cold gasification efficiency at as low as 75 kg/h capacity).
7. It is the only system where the deviation in performance due to incorrect choice of biomass – moisture content in particular has been fully characterized (see Fig. 4)

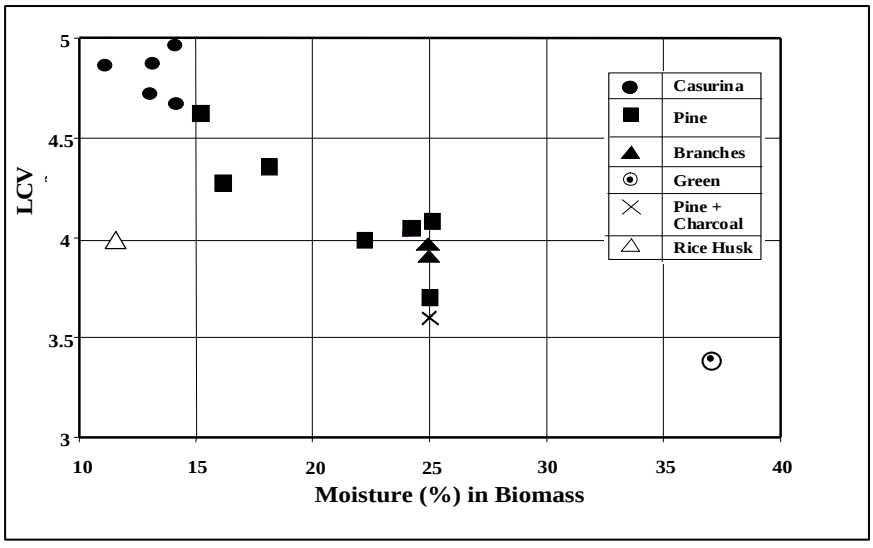


Fig. 4: Effect on variation of moisture content on the lower calorific value of the producer gas with different types of biomass

8. It is the only design where rigorous tests have been performed over a wide range of fuels (see the description and performance data in Table 2 to 4) and on systems for as large as 300 kg/h (see results in Table 2 to 4).

Table 2: Test Run Details:

Test No	Date	Biomass	Load (kg/hr)	Run Time (hrs)*
1.	23/3/99	Causurina Rounds	180	6.5
2.	25/3/99	Mulberry Stalks	144	9.25
3.	12/5/99	Mulberry Stalks	210	7.5
4.	21/5/99	Causurina Rounds	210	7.5

*After Igniting the Gas in the Flare

Table 3: Average Gas Composition

Test No	H_2	CO	CH_4	CO_2	O_2
1.	11 ± 1	26 ± 1	1.5 ± 0.2	7 ± 1	0
2.	14 ± 1	28 ± 1	3 ± 1	12 ± 1	0
3.	14.5 ± 0.5	22 ± 1	1.2 ± 0.4	12 ± 0.5	0.3
4.	17.5 ± 0.5	15.5 ± 1	1.8 ± 0.2	13.5 ± 0.5	0.3

Table 4: Particulate and Tar content in the Gas

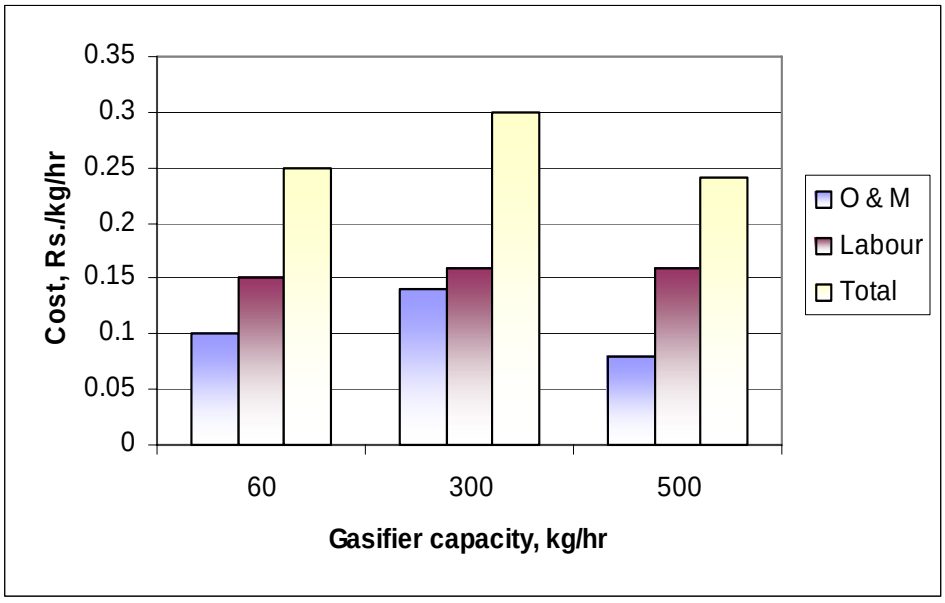
Test No	Particulate, mg/ m^3		Tar, mg/m^3	
	Hot	Cold	Hot	Cold
1.	186	46	172	17
2.	161	28.5	127.6	13.7
3.	189	12.6	156	15.2
4.	269	6	116	15

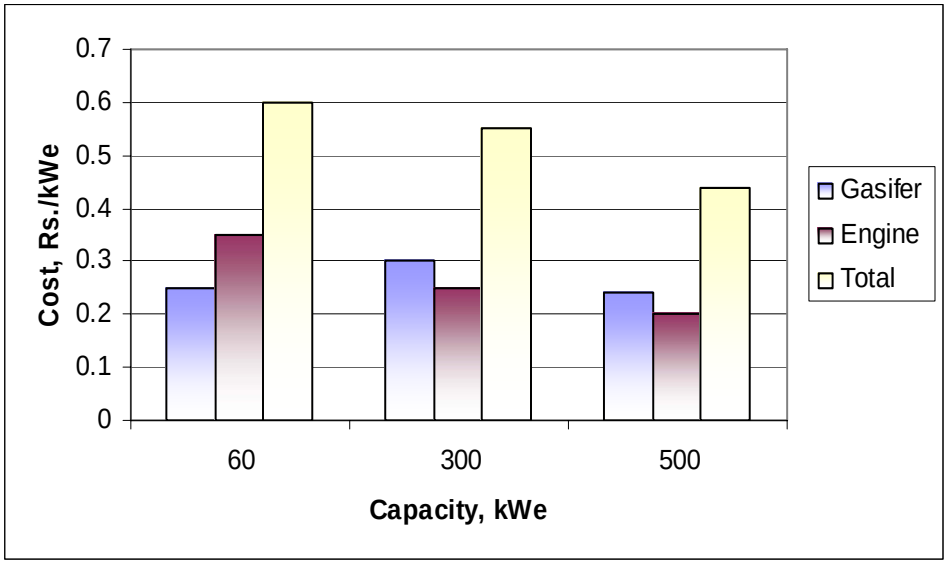
9. It is the only design where the long term field performance data of at least six large industrial systems has been tracked and set out. These data have given the most important user related information – long term operation and maintenance costs (see Table 5 and Figure 5)

Table 5:

SYSTEM	ESTBLD	CAPACITY	FUEL	HRS PER YEAR (OPERATD)	PLANT AVAI-LABILE?
ARASHI HI-TECH BIOPOWER	2002 (D-F) 2004 (GAS)	1 MWe	Julifora Prosopis, Coconut shell	6500	>85 %
HINDUSTAN PENCILS	2003 (D-F) 2005 (GAS)	200 kWe	Sawdust briquette	5500	> 95%
TANFAC	2003	1100 kg/hr	Juliflora Prosopis, Forest waste	15000	>95%
TAHAFET	2001	300 kg/hr	Juliflora Prosopis	7000	>95%
CRUMB RUBBER (1)	2002	80 kg/hr	Wood, Coconut shell	7000	>97%

Fig 5:





10. It is the only design that has partnered with one of the most leading engine manufacturer in the World (of small and large engines) – M/s Cummins and evaluated the field performance of engines (see the data on lubrication system performance for two engines).

Table 6: Lube Oil Analysis

Parameter	Fresh Oil	Used Oil (496 hrs)	Limit*
Kinematic Viscosity @ 40^0	114	95	Low – 85 High - 155
TBN, mg KOH/g	5.7	2.2	2.0

*as per Cummins

- Oil quality inspected after every 200 hours and well within the qualifying limits
- No water content in the oil
- Wear metals < 100 ppm
- Oil change recommended at 500 hours

11. It is the only design that has an institutional support for long term follow up and problem resolution.