GASIFICATION / PYROLYSIS (GP) R&D – SOME POSSIBILITIES

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Gasification / Pyrolysis (GP) process can produce low heating value (LHV) gas, liquid fuel and charcoal. The percentages of these products depend upon the heating rates, oxygen to fuel ratios and temperatures. However, producer gas and charcoal are at extreme ends of the spectrum. GP research should therefore focus on maximizing these products for certain end uses.

Below are given some areas of possible R&D in GP. The list is by no means exhaustive and is given so as to stir debate so that more points could be added to it and a comprehensive plan of action chalked out. Since GP is biomass based, R&D regarding biomass production should also form a part of the list.

I. BIOMASS

1. Adequate and proper quality of biomass has to be ensured for any GP process. For this R&D needs to be done in breeding fast growing species of trees.

2. R&D needs to be carried out in harvesting of woody biomass with emphasis on cutting and drying of small stem trees. Especially important is the fuel processing for wood gasification.

3. There is a need to do extensive R&D in usage of grasses as biomass source. They come in right size are easy to harvest and can be grown on almost any type of land. Besides providing biomass they will also help in land reclamation and reducing soil erosion.

4. For biomass residues, there is a need for R&D in handling, compacting and processing them in the form suitable for GP. Baling and compaction of loose biomass for transportation is essential.

5. There is a need to develop data base for Taluka level biomass and biomass residue availability.

II. GASIFICATION

1) Development of database to decide the niche for gasification i.e. the sector (100 kWe, transportation, 500 kWe, 1 Mwe or greater range) in which it will be most useful. Determination of this niche will ensure that the efforts are focussed on developing technology rapidly. Once the gasification program for a certain range is successful, then it can diffuse automatically into other sectors.

2) Hallmark of natural evolution is size reduction and increase in complexity. Generally technological evolution also follows this path. Work in India on technology for 5 HP gasification system seems to negate this principle. It will therefore be appropriate to do R&D on bigger systems (> 100 Kw) and then attempt size reduction.

3) R&D needs to be done in developing a systems approach to cooling/cleaning the gas. Large amount of information from communication theory can be used for this approach. Thus particulates and condensables can be modeled as noises of different frequencies and relevant filters from communication theory can be used.

4) The materials problems of both the gasifier and cooling/cleaning train have still to be solved. R&D needs to be done in using better and stronger materials so that they can last for at least 5-7 years. Experience from automobile industry may be beneficial regarding this.

5) All I.C. engines were designed for running on clean liquid fuel. Producer gas is a mixture of CO and H_2. Engine performance is not optimum with these gases. R&D should be undertaken in matching engine with producer gas. Problem is also compounded by the fact that the gas quality varies with time. Hence a better solution may be, to use liquid fuels in these engines (oils via pyrolysis route).

6) There is a need for development of a microprocessor based engine control system running on producer gas. "Smart" engines may be a possible solution for matching existing I.C. engine with producer gas. Again experience from automobile industry is required.

7) Turbocharging in diesel engines should be researched. This may allow hot gases to be fed into the engine thereby eliminating need for excessive gas cleaning.

8) More R&D should be undertaken in gasification of loose biomass. Different designs should be developed and evaluated.

9) Storage of producer gas for process industries, specially those industries which require instantaneous switching to gas when electricity is off; should be researched. This will also help in decoupling the gasifier from the prime mover.

10) There is a need to do R&D in development of new lube oil for producer gas engines.

11) More R&D is required in tar cracking technologies including use of catalyst.

12) For bigger output ranges (> 1 MW), there is a need for R&D in steam injected gas turbine (SIGT) technology. Present estimates are that gasifier powered SIGT may be a cheaper technology (Rs/kW) than the existing Rankine systems ones.

13) Fundamental studies with real time imaging of gasification process need to be undertaken.

14) Finally, gasification systems have to compete with existing fuel systems and hence their economic viability has to be evaluated. The major competition will be from natural gas. There is a need to completely evaluate the economics of producer gas powered systems vis-à-vis natural gas systems.

III. **LIQUID FUEL PRODUCTION**

1) Production of liquid fuel from biomass via fast pyrolysis offers the best strategy for conversion of biomass into liquid fuels. Massive R&D efforts should be directed towards this approach. The salient features of this technology are :

   - Conversion of 55-60% (w/w) of biomass into pyrolysis oil (equivalent to No. 6 oil) has been achieved.
   - Production of small amounts (10%) of char and gas takes place.
   - This pyrolysis oil can be directly fed into oil furnace as fuel.
   - Upgrading of this oil via catalyst route can produce aromatic gasoline [15-20% (w/w) on biomass basis).

2) Liquid fuel production by fast pyrolysis should be compared with ethanol production. Firstly ethanol can only be produced from sugar crops whereas pyrolysis oil can be produced from any biomass.

   - One ton sugar crop produces ~ 1100 MJ in terms of ethanol.
   - One ton of biomass produces ~ 11000 MJ in terms of pyrolysis oil.

   Hence an order of magnitude energy production difference is accrued via pyrolysis oil route.

3) Pyrolysis oil production is a very nascent technology. Only half a dozen organizations around the world are working in this area. Indications are that the future of biomass program in U.S. and Europe may be geared more towards pyrolysis oil. There is a need for developing this technology in India.

4) Besides production of fuel oil, pyrolysis oil can also be used as a feedstock for chemical industries. Hence a rural based pyrolysis oil industry will be a great step towards setting up of agro-based industries on sound footing.

IV. **CHAR PRODUCTION**

Char is normally a by-product of GP process. However in order to make char as an important by-product, R&D is required in the following areas :

a) Development of char/water slurry as a furnace fuel.

b) Development of technologies for making activated charcoal economically.

c) Mixing of char with suitable binder so as to make a briquetted fuel.

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