

## **Master thesis: Waste gasification - a techno-economic study**

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### **Comments to reviewer's report**

#### **1) Why is the thermochemical process better than biochemical one? What kinds of biomass properties should be characterised for gasification process?**

Biochemical processing of biomass needs longer processing time and stable biomass composition without any toxic components. The open question is an environmental impact (waste processing generates solid/liquid/gaseous wastes), product's demand and compatibility in the industry.

Biomass should be characterised by its species, particle size and shape, moisture, total solids, volatile solids, elementary and chemical composition, lower heating value, and also by local availability and its purity. Moisture content, purity and particle size are the crucial factors to decide whether gasification or fermentation.

#### **2) What types of gasifiers are recommended for biomass gasification and why?**

There are such configurations of gasifiers:

- Downdraft/updraft gasifier – fixed bed, conventional solution in the industry, easy to operate, reliable and proven for fuels, higher particulates in the product gas and moderate tar levels in the product gas.
- Bubbling fluid bed gasifier – reasonable temperature control & high reaction rates, higher particulates in the product gas and moderate tar levels in product gas, good temperature control tar cracking catalyst can be added to the bed.
- Circulating fluid bed gasifier - all the features of bubbling beds, large minimum size for viability, high cost at low capacity.

- My literature survey of gasifier manufacturers found that 75% of gasifiers offered commercially were downdraft, 20% were fluid beds (including circulating fluid beds), 2.5% were updraft and 2.5% were other types.

### **3) Which factor will have an influence on the heat of reaction?**

The heat of reaction is primarily influenced by biomass composition, process temperature and pressure.

### **4) Why is the production of H<sub>2</sub> and CO higher during steam gasification than air gasification?**

The reason is gasification agent and its composition (air, oxygen, steam, carbon dioxide, steam-oxygen mixture). If air is used, main products CO, CO<sub>2</sub>, H<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>, tar and this gives a low heating value gas of ~5 MJ.Nm<sup>-3</sup>. Production gas is diluted by nitrogen. If steam is used, main products are CO, CO<sub>2</sub>, H<sub>2</sub>, CH<sub>4</sub>, tar, so higher production H<sub>2</sub> and CO. This gives a medium heating value gas of ~15–20 MJ/m<sup>3</sup>.

### **5) What is the most important factor for the development of gasification unit in Czech Republic?**

My personal opinion is that the primary driven force to develop gasification units is still increasing energy price and limits to reduce fossil fuels, decrease landfilling and waste combustion, i.e. strategy waste to X. Waste to energy or waste to chemicals through waste gasification. The higher energy price, the more accessible and profitable the gasification units will become. I would also like to point out the second most crucial factor. This is the EU's influence with the 2050 climate neutrality directive, Paris declaration/Katowicze declaration/Madrid declaration/Green Deal EU, which is intended to close down fossil fuel power plants.

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