Synthetic Oil

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Background

- Synthetic oil is a lubricant consisting of chemical compounds which are artificially made (synthesized) from compounds other than crude oil (petroleum).

- Synthetic oil fuel or synfuel is a liquid fuel obtained from coal, natural gas, or biomass.

- South Africa meets 30 percent of transportation fuel needs by means of synthetic fuel. (SASOL)

Syngas

- Syngas is a mixture of hydrogen and carbon monoxide gases (H_2 + CO).
- Syngas may be produced from coal, petroleum coke and or anyother carbonaceous material (as well as biomass).
- Its a important fuel as well as a basic building block for many hydrocarbons and chemicals.

Syngas production

- Gasification (Thermal Treatment)
  - High temperature (>1200°C)
  - Low Temperature (<1000°C)
  - Gasification products contains a large number gases, volatiles and dust. Needs gas cleaning.

- Steam reforming (also for H_2 production)

  $CH_4 + H_2O \rightarrow CO + 3H_2 + 206$ kJ/mol

Syngas as feedstock

- Gas cleaning
- Shift reaction

$$CO + H_20 \xrightarrow{\text{Catalyst}} CO_2 + H_2 - 41kJ/mol$$

Feedstock Preparation

Products

  - Hydrogen production
  - Diesel production using FT (Fischer-Tropsch) synthesis
  - Fertilizer production through ammonia
  - Methanol production for chemical Industries
  - Electricity generation through combustion

Bio-Oil

- Bio-oil is a highly oxygenated free-flowing dark brown organic liquid produced from biomass.
- Contains water, lignin fragments, aldehydes, organic acids & alcohols.
- Heating value 18 – 20 MJ/kg
- Low viscocity, heavier than water (ρ=1.2)

Bio-Oil Production

- The Fischer-Tropsch process was developed by Franz Fischer and Hans Tropsch in 1923 in Germany.

$$nCO + 2nH_2 \xrightarrow{\text{Catalyst}} (CH_2)_n + nH_2O + \text{Heat}$$

- This reactions produce a wide spectrum of oxygenated compounds including alcohols and aliphatic hydrocarbons ranging from C_1-C_3 (gases) to C_{35+}(solid waxes)

- Germany and Japan used this technology during World War II. In 1944, Germany alone produced 6.5 million tons (124,000 barrels) a day.

Syngas to Alcohols/Chemicals

- Alcohol (methanol)
  - Methanol is in itself an important feedstock for the production of transportation fuel as well as other chemicals

    $CO + 2H_2 \xrightarrow{\text{Catalyst}} CH_3OH - 91kJ/mol$ (FT synthesis)
  - Production of gasoline from methanol is an established commercial process.

Syngas to Alcohols/Chemicals

- Ammonia
  - Used in fertilizers, nitric acid, refrigerant etc

$$N_2 + H_2 \overset{\text{catalyst}}{\longleftrightarrow} 2NH_3$$

(high pressure, low temperature)

- Glycerol
  - By product of trans-esterification of fatty acids

Biochemical route

- Ethanol
  - Fermentation of starch and sugars
  - Milling, liquefying, hydrolysis, fermentation, Distillation, Dehydration.
  - Net energy production is meagre. (pg11)
- Diesel
  - Trans-esterification of any vegetable or animal oil .

Triglyceride+ Sodium Methoxide → Biodiesel + Glycerol

Key Information

- Production of oil from non-food source is recommended.
- Made comparison of fuel to wheel energy ratio of the oil to electric vehicle.
- Energy loss in methanol production
  - Biomass to methanol 30 – 47 %
  - Coal to methanol 41 – 75 %

Recommendation

- This chapter has given overall introduction of bio-fuel production from all possible sources.
- I would like to suggest a detail introduction to any of the technology that is in accordance with the objective of the book.
- Flow arrangement of the information.

Conclusion

- Synfuel is the wonderful technology that converts low quality of fuel into high quality.
- Products and bi-products can be used to produce plastic, resin, fertilizer etc.
- However it must be bear in mind that, source of synfuel must be renewable i.e. biomass.