Introduction to Gasification

The manufacture of combustible gases from solid fuels is an ancient art, but by no means a forgotten one. In its widest sense, the term *gasification* covers the conversion of any carbonaceous fuel to a gaseous product with a useable heating value. This definition excludes combustion, because the product flue gas has no residual heating value. It does include the technologies of pyrolysis, partial oxidation, and hydrogenation. Early technologies depended heavily on pyrolysis (i.e. the application of heat to the feedstock in the absence of oxygen), but this is of less importance in gas production today. The dominant technology is partial oxidation, which produces synthesis gas (otherwise known as syngas) consisting of hydrogen and carbon monoxide in varying ratios, whereby the oxidant may be pure oxygen, air and/or steam. Partial oxidation can be applied to solid, liquid and gaseous feedstocks such as coals, residual oils, and natural gas and, despite the tautology involved in "gas gasification", the latter also finds an important place currently.

The meaning of gasification should not be extended to include catalytic processes such as steam reforming or catalytic partial oxidation. These technologies are a specialist field in their own right. Although it is recognized that pyrolysis does take place as a fast-intermediate step in most modern processes, the word *gasification* includes the sense of partial oxidation, and the two terms might be used interchangeably. Hydrogenation has only found an intermittent interest in the development of gasification technologies, and where it is discussed the specific terms *hydro-gasification* or *hydrogenating gasification* might be used.

1. **Introduction**
   - 1.1 Historical development of gasification
   - 1.2 Gasification today
2. **The thermodynamics of gasification**
   - 2.1 Reactions (reactions, thermodynamic equilibrium, other compounds)
   - 2.2 Thermodynamic modelling of gasification (basic data, feedstocks, coal, moderator, equations, variables)
   - 2.3 Deductions from the thermodynamic model (effect of pressure, effect of temperature, fuel footprint, unexpected issues)
   - 2.4 Optimizing process conditions (process indicators, optimum operating point – efficiencies, IGCC applications, syngas and hydrogen applications)
3. **The kinetics of gasification and reactor theory**
   - 3.1 Kinetics (devolatilization, volatiles combustion, char gasification, rate of reaction, comparison of different types of solid feedstocks, effective reactivities)
   - 3.2 Reactor theory
   - 3.3 Applications to reactor design
4. **Gasification and the future**
5. **Conclusions**

References