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ABSTRACT

A notable way to reduce pollution for a friendly environment is to make use of clean fuels. Biomass has been identified as a potential alternative clean fuel and it will play a significant role providing energy in the years to come.

We will need efficient processes to convert biomass into fuel; therefore this study utilized a process synthesis approach i.e. a graphical targeting tool to determine the optimal operating conditions for biomass gasification. Gasification is the conversion of carbon based material into combustible gases by reacting the solid fuel at high temperatures with a controlled amount of oxygen, steam or air.

The technique of graphically representing gasification allows one to make simple assumptions and represent the mass balance, energy balances and the reaction equilibria around a gasifier graphically to determine a stoichiometric subspace (region) within which we can understand, operate and optimise biomass gasification. The approach allows one to easily screen the various options and thus determine processes that are efficient and environmentally friendly, before a large investment is made on equipment and expensive laboratory testing.

The graphical approach was used to maximise the conversion of biomass, to minimise the carbon dioxide production and to minimise as much energy consumption as possible simultaneously. The result of this approach shows that the best place to operate gasification process is in the region where heat and work are required to be added. This is because in this region when heat is added work can also be added to meet the energy requirement of the process and there is a point within the region where the process does not emit carbon dioxide.

Furthermore we illustrated the use of the thermodynamic regions in the Enthalpy- Gibbs free energy space to provide the heat and work that gasification requires. This method allows one to determine whether heat at an appropriate temperature is sufficient to meet the work requirement of a chemical process or other means should be considered. This is done with the goal to identify ways to make infeasible processes possible, or minimize or even nullify the work requirements of the combined process.

This work identifies the best operating point in the gasification region as the point where the work requirement of the process is zero, there is no carbon dioxide emission and heat is required to be added. This is the reason why studying biomass gasification process is always welcome, especially if the intention is to save energy. Today, because of increased fuel prices and environmental concern, there is renewed interest in this century old technology.