



Torrefaction of biomass to produce biofuel

Biomass can be torrefied for heat and electricity generation applications.

Torrefaction of biomass can be described as a mild form of pyrolysis at temperatures typically ranging between 200 and 300°C in an inert and reduced environment. Common biomass reactions during torrefaction include devolatilization, depolymerization, and carbonization of hemicellulose, lignin, and cellulose. The torrefaction process produces a brown to black uniform solid product, as well as condensable (water, organics, and lipids) and noncondensable gases (CO₂, CO, and CH₄). Typically during torrefaction, 70% of the mass is retained as a solid product, containing 90% of the initial energy content, while 30% of the lost mass is converted into condensable and noncondensable products. The system's energy efficiency can be improved by reintroducing the material lost during torrefaction as a source of heat. Torrefaction of biomass improves its physical properties like grindability; particle shape, size, and distribution; pelletability; and proximate and ultimate composition like moisture, carbon and hydrogen content, and calorific value.

Compared to raw biomass, the carbon content and calorific value of torrefied biomass increases by 15–25% wt, while the moisture content decreases to <3% (w.b.). Torrefaction decreases the grinding energy by about 70%, and the ground torrefied biomass has improved sphericity, particle surface area, and particle size distribution. Torrefied biomass pelletization at temperatures of 225°C decreases the specific energy consumption and increases the capacity of the mill by a factor of 2. The loss of the OH functional group during torrefaction makes the material hydrophobic (i.e., loses the ability to attract water molecules) and more stable against chemical oxidation and microbial degradation. These improved properties make torrefied biomass particularly suitable for cofiring in power plants and as an upgraded feedstock for gasification.¹

Application of torrefied biomass

Biomass torrefaction has gained widespread attention due to its benefits as a standalone process to improve biomass properties to be at par or similar to those for coal in electricity generation or as a pretreatment step before pyrolysis and gasification processes. It has also found application in other processes like steel production where it is aiming to replace coal or work alongside coal by co-firing the coal with biomass at certain proportions.

¹ Extracted from [A review on biomass torrefaction process and product properties for energy applications](#), Tumuluru, Sokhansanj, Hess, Wright, and Boardman. Idaho National Laboratory, 2011