EFFECT OF ATMOSPHERE ON TORREFACTION: FOCUSING ON OXYGEN, CARBON DIOXIDE AND THEIR MIXTURE

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This chapter aims to review the torrefaction of biomass, specifically, the effect of torrefaction atmosphere on the behaviour of torrefaction. This subject is important for saving investment and running costs for the torrefaction process and clarifying the mechanism of torrefaction under a non-inert atmosphere. In this chapter, biomass means lignocellulosic biomass unless otherwise notified.

INTRODUCTION

Torrefaction is a low-temperature thermal treatment mainly for lignocellulosic biomass. When lignocellulosic biomass undergoes thermal treatment at temperatures between 200 and 300°C, light carbonisation of the biomass occurs and brings several features to the treated biomass. These are recognised as advantages when torrefied biomass is used as solid fuels. Thermal treatment of biomass causes a seamless change, as shown in Figure 2.1. The oldest literature on torrefaction of biomass that could be found so far is the one published by Pentananunt et al. in 1990 [1].

When alternative energy sources attracted societies' strong attention due to the Oil Crises in 1973 and 1979, attempts at biomass conversion into gas and liquid started. Figure 2.2 shows the chronological change in the number of research papers related to gasification + liquefaction and torrefaction of biomass from a certain representative database. Most likely, the motivation for gasification and liquefaction of biomass comes from convenient handling by converting solid biomass resources to fluids by gasification and liquefaction. Fortunately, gasification and liquefaction technologies for coal had already been developed at that time, and then the technologies were modified to change raw materials from coal to biomass. Even though research work for biomass gasification and liquefaction has been well-activated since then, commercial processes for biomass gasification and liquefaction have not been so successful due to logistics and economic obstacles. As summarised in Table 2.1, gasification and liquefaction of biomass require a huge amount of biomass as feedstock. In order to avoid this obstacle, eventually, the application of biomass as solid fuels attracted attention since solid product processes from biomass can be commercialised with a minimum amount of biomass feedstock among the three processes (Table 2.1). Therefore, in the middle of the 2000s, research studies on torrefaction, which can improve biomass quality as solid fuels, become activated, as shown in Figure 2.2.

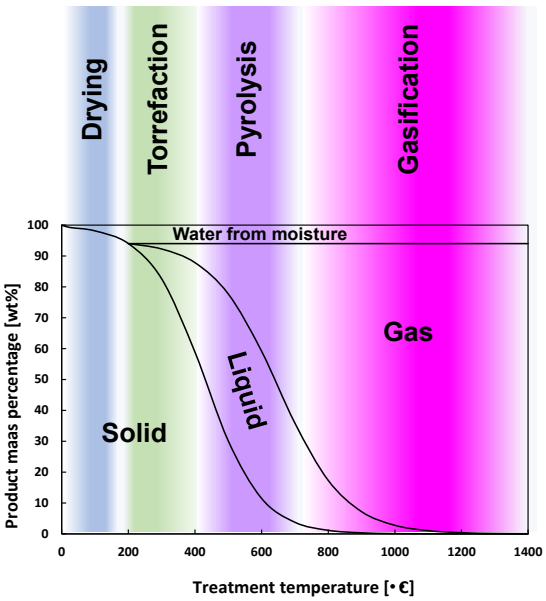

Figure 2.1 Thermophysical/chemical treatment of lignocellulosic biomass