Gasification Study of a BPL® Activated Carbon Sample by High-Pressure TGA (TGA-HP)

ABSTRACT

This paper describes the use of high-pressure TGA (TGA-HP) to investigate gasification of BPL activated carbon.

INTRODUCTION

Gasification is a term most commonly used to refer to the process of conversion of solid or liquid carbonaceous materials into a gas, typically under conditions of high pressure and temperature, and possibly in the presence of another gas or steam.[1] For example, coal gasification is the conversion of coal into hydrogen and carbon monoxide (a product called synthesis gas or syngas) with the application of high temperature, pressure and steam. There is wide interest in gasification because it produces lower quantities of air pollutants and the syngas burns cleaner than the original material.[2]

Activated carbon is carbon that has been processed in a manner to create a pore-structure. Due to the large size and density of the pores, the pore-structure produces a very large surface area (typical ratio is 100 m^2/g) and makes activated carbon an excellent material for use as an adsorbant. For example, activated carbon may be used in water treatment for the purpose of removing particles and inorganics.[2] BPL activated carbon is a bituminous coal-based activated carbon material.

RESULTS & DISCUSSION

High-Pressure TGA is an excellent tool to investigate the gasification of materials such as coal and carbon. The TA Instruments TGA-HP Series products are specialty gravimetric analyzers designed to provide unique capabilities for High-Pressure, Ultra-High Vacuum, and High-Temperature under static or dynamic reactive atmospheres. These instruments are designed for sorption studies using water vapor, organic vapors, hydrogen, methane and carbon dioxide as well as permanent gases and corrosive gases.

Using the continuous flow method, the TGA-HP Analyzers provide isotherms, isobars and time course data for the study of processes such as:

- General gas/solid reactions
- Oxidation/reduction of metals
- Degradation of ceramics
- Catalysts, zeolites, activated carbons and other specialty materials
- CO_2 Sequestration techniques

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The TGA-HP 150s model is specially configured for gasification and related studies. It includes an integrated steam generator and a double-walled reaction chamber that allows for higher temperatures. Figure 1 illustrates the gasification of a BPL® activated carbon sample. The experiment is performed at a temperature of 800°C while

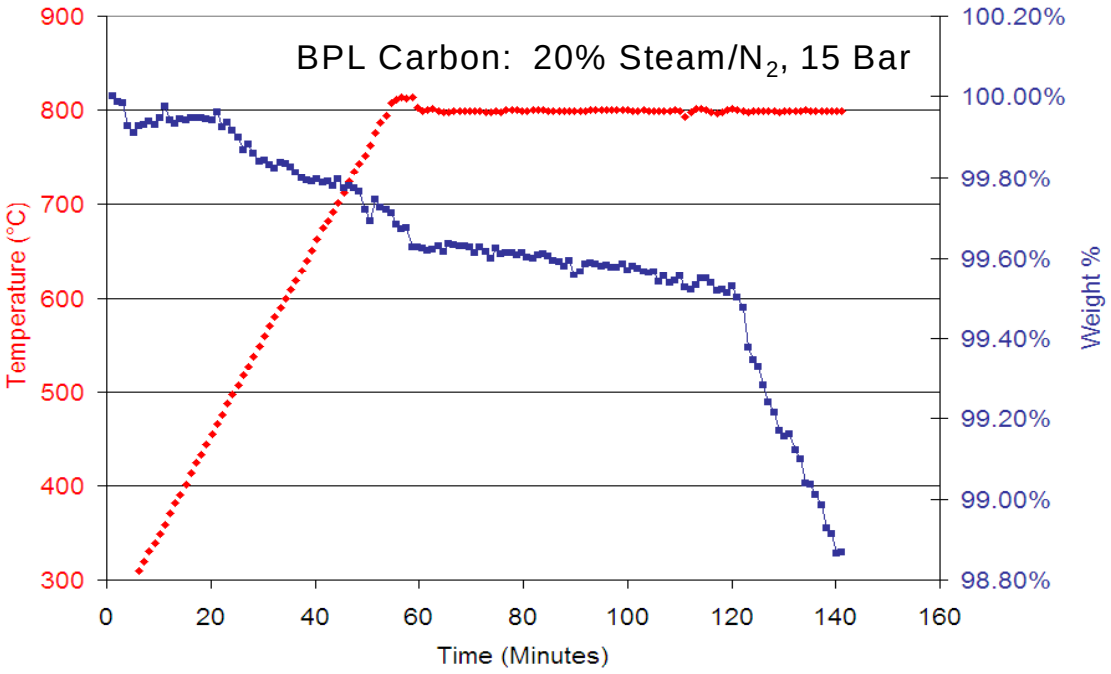

Figure 1: TGA-HP Gasification of a BPL Activated Carbon

the atmosphere is 15 bar (217.5 psi) nitrogen charged with 20% steam. The presence of water facilitates the following reaction for the production of syngas:

$$C + H_2O \longrightarrow CO + H_2$$

In the data above, at approximately 120 minutes the gasification of the carbon sample begins as indicated by the sudden and steady decrease in weight.

With the production of carbon monoxide, a supplementary reaction known as the water-gas shift reaction can occur. It is a slightly exothermic, equilibrium reaction that results in the further production of hydrogen and concomitant carbon dioxide. The reaction can be written thus:

$$CO + H_2O \longleftrightarrow CO_2 + H_2$$

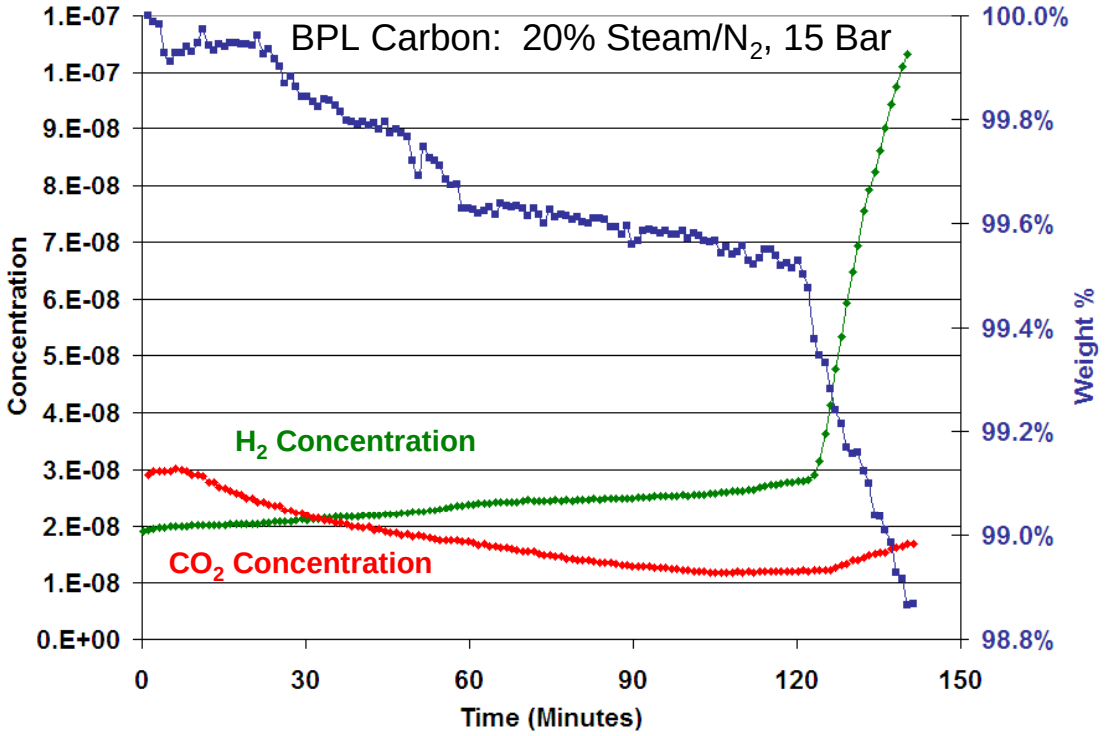

Figure 2: Production of Hydrogen Gas and Carbon Dioxide from Gasification of BPL® Carbon.

The TGA-HP 150s can also be interfaced with a mass spectrometer for the qualitative chemical analysis of off-gas components. Figure 2 overlays data from a mass spectrometer that follows the production of the primary syngas component hydrogen, as well as carbon dioxide from the associated water-gas shift reaction. Note the rapid production of hydrogen, the main syngas component.

SUMMARY

The TGA-HP150s provides an ideal platform for the study and quantification of carbon gasification. The system includes the necessary components (such as an integrated steam generator), is easily interfaced with an optional mass spectrometer, and readily achieves the appropriate experimental conditions for gasification research.

REFERENCES

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