

Study on the Forming Process of High-Density Carbon Blocks

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INTRODUCTION

Carbon materials are generally manufactured from filler coke and binder pitch by kneeding, forming, baking and graphitizing¹. It is also known that high-density carbon blocks can be made, without using binder pitch, from the carbonaceous powder (green coke and specially treated pitch) which contains an adequate amounts of volatile matters². We studied the use of carbonaceous powder prepared from a bulk mesophase for producing carbon blocks.

This paper presents the characteristics of carbon blocks prepared from a bulk mesophase powder by three different processes, cold isostatic press (CIP), hot press (HTP) and hot isostatic press (HIP) methods.

EXPERIMENTAL

Preparation of carbonaceous powder

The bulk mesophase obtained from decant oil was heat-treated and was pulverised then to produce a carbonaceous powder. The properties of this powder are shown in Table 1.

Table 1 Properties of Carbonaceous Powder

Volatile Matter	Quinoline Insoluble	Average Particle Diameter
8.1 wt %	99.8 wt %	2.2 μm

CIP

Green blocks were formed at a pressure of 2,000kg/cm² using a CIP. The green blocks were conventionally baked at 1,000°C under normal pressure, and graphitized at 2,000°C.

HTP

HTP-1: The carbonaceous powder packed into a hot press mold was applied a pressure of 200kg/cm² while heating the mold from room temperature to 300°C or 400°C. The blocks thus formed were baked

at 2,000°C under normal pressure. HTP-2: The green blocks formed by CIP method were pre-baked at temperature between 500°C and 1,000°C under normal pressure. Then, the pre-baked blocks were set in a hot press mold and heated from room temperature to 2,000°C under a pressure of 200kg/cm². HTP-3: The carbonaceous powder packed in a hot press mold was heated to 400°C or 500°C without application of pressure.

After reaching the above temperature, the powder was pressed at 200kg/cm². The blocks obtained this hot press procedure were baked at 2,000°C under normal pressure.

HIP

The carbon blocks formed in CIP system were pre-baked at temperatures of 800~1,500°C under normal pressure, and then processed in a HIP system at 2,000°C under a pressure of 2,000kg/cm².

RESULTS AND DISCUSSION

The properties of the carbon blocks obtained from the hot press, method HTP-1, are shown in Fig. 1. The bulk density and bending strength of blocks pressed at 400°C were higher than those pressed at 300°C, but the hot pressing at temperature above 500°C caused cracks in hot pressed blocks. Fig. 2 shows the properties of carbon blocks obtained from method HTP-2.

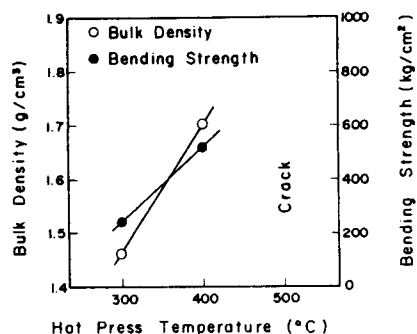


Fig. 1 Changes of the Properties of Carbon Blocks with Hot Press Temperature at HTP-1.

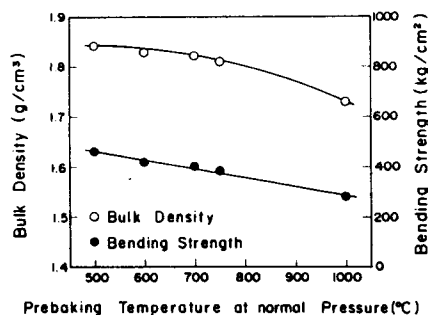


Fig. 2 Effect of Pre-baking Temperature at normal Pressure on the Properties of Carbon Blocks obtained by HTP-2.

The bulk density and bending strength decreased with raising the pre-baking temperature. Fig. 3 shows the properties of carbon blocks obtained from method HTP-3. The bending strength of blocks obtained by hot pressing at 500°C were higher than those obtained from methods HTP-1 and HTP-2.

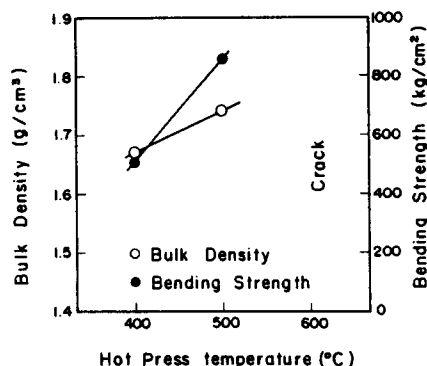


Fig. 3 Changes of the Properties of Carbon Blocks with Hot Press Temperature at HTP-3.

Fig. 4 shows the relationship between the properties of blocks obtained by HIP processing and pre-baking temperature. The bulk density of the blocks increased as pre-baking temperature was raised, especially the bulk density that have been pre-baked at 1,500°C showed extremely high value (2.14g/cm³).

Table 2 lists the characteristics of carbon blocks which formed using CIP, HTP and HIP process. These were representative in each processes having the highest bending strength. The block, produced using HTP process (HTP-3) showed higher bending strength than CIP and HIP process. This result suggests that the application of pressure at a desirable temperature such as 500°C to cause plasticity in the binder component of the carbonaceous powder have an effective to improve binding strength between particles, consequently improving the strength of the blocks.

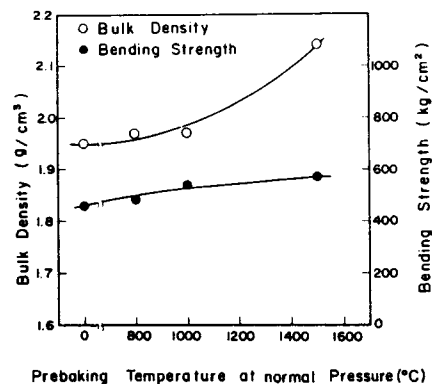


Fig. 4 Effect of Pre-baking Temperature at normal Pressure on the Properties of Carbon Blocks obtained by HIP.

Table 2 Properties of Carbon Blocks obtained by CIP, HTP and HIP.

Process	CIP	HTP	HIP
Bulk Density (g/cm³)	1.88	1.74	2.14
Electrical Resistivity (x10 ⁻³ Ω·cm)	2.2	2.7	2.3
Bending Strength (kg/cm²)	410	840	535
Pore Volume (x10 ⁻² cc/g)	8.5	12.9	1.7
Remarks	CIP 2000 ^{kg/cm²} Baked at 2000°C	Pressed at 500°C Baked at 2000°C	CIP 1000 ^{kg/cm²} Baked at 1500°C HIP 2000°C 2000 ^{kg/cm²}

On the other hand, the application of continual pressure until 2,000°C such as in the case of HIP processing was effective to increase bulk density, but it would probably cause microcracks, thereby reducing mechanical strength.

CONCLUSION

The characteristics of blocks obtained using the CIP, HTP and HIP processes were studied. With forming process that involved the pressurized baking as HIP and HTP, the timing of pressurizing was found to have a major influence on the properties of the blocks produced. The application of pressing at a temperature such as 500°C, causing plasticity in the carbonaceous powder was an effective means of improving the mechanical strength of carbon blocks.

REFERENCES

- 1.C.L. Mantell, "Carbon and Graphite Handbook", Pl56, Interscience Publishers (1968).
- 2.Y. Yamada et al, Tanso, No. 88 P2 (1977).