

INTEROFFICE MEMORANDUM

SUBJECT: State of the Art
Preparation of PC-3
Fuel Source

DATE: October 9, 1984

TO: Mr. M. D. Shannon

FROM: J. L. Resce

Fuel sources for the PC-3 model are currently composed of a carbon material derived from cellulose and a binder of sodium carboxymethyl cellulose and are formed by extrusion. The carbon precursor is Grande Prairie Canadian Kraft, a softwood pulp paper supplied by Buckeye Cellulose Corporation, Memphis, Tennessee (see attached technical bulletin). This pulp is characterized as having relatively long fibers, $1.5 - 2.0 \times 10^6$ fibers per gram and is available at a cost of \$540 per ton. Also, available is a hardwood pulp paper, Grande Prairie Hardwood, at a cost of \$510 per ton but it is yet untested as a fuel source. These fibers are shorter and smaller, measuring $8-10 \times 10^6$ fibers per gram (see attached technical bulletin).

The carbonization process, performed by J. White, is carried out under nitrogen with 13.6 Kg (30 lbs.) batches of pulp. The oven temperature is steadily raised to 650°C over a two hour period and maintained at that temperature for another two hours before cooling. The sample is removed from the nitrogen atmosphere of the oven after about 20 hours and weighs approximately 2.8 Kg (6 pounds) with a total yield of 20 percent. The carbon is ground twice in the large Wiley mill (located in building 27-1) passing thru a 30 mesh screen. The particle size distribution and tap densities for three batches are shown in the table below.

Table 1. Particle Size Distribution and Tap Density for Carbonized Grande Prairie Cellulose.

Mesh Size	Weight Percent			Tap Density, g/cc
	Batch #1	Batch #2	Batch #3	
20-100	10	10	10	0.31
100-140	9	9	9	0.26
140-200	13	16	15	0.27
200-270	6	6	6	-
270-325	9	9	9	-
325-400	6	6	6	0.30
-400	45	44	44	0.45
Total				0.44, 0.44

The binder and carbon are mixed in a separate process prior to the preparation step for extrusion. A 10 percent (wt/wt) level of binder is required. The binder of choice is currently CMC-HF, a high molecular weight sodium carboxymethyl cellulose supplied by Hercules, Inc. of Norcross, Georgia. It is first dissolved in water (2% wt/wt) and then thoroughly mixed with the carbon. The material is then cast, dried and ground on a Wiley mill. A detailed description of this CMC and carbon mixing process is given as follows:

A 10 g portion of CMC-HF is dissolved in 500 ml distilled water in a jar on a roller mill overnight. The gel is poured into a 1.5 quart bowl and mixed with 90 g of carbon in a Sunbeam Mixmaster for 30 minutes on the maximum setting. The material is then transferred to a cookie sheet and dried overnight with the aid of a hair dryer and further dried in an oven for one hour at 80°C. It is then fed into a small Wiley mill first passing through a 10 mesh screen and then fed again into the Wiley mill passing through a 40 mesh screen.

The current extrusion process requires that about 20 g of powder be first mixed with water, about 50% (wt. by wt.), and worked by hand until a hard, yet pliable, ball is formed. This usually requires about 10 minutes. If the ball loses its shape and flows, when left alone for a few hours, it is possibly too wet for the extrusion. After a period of at least 3 to 4 hours the ball is again briefly worked and placed into the extruder.

In summary, the PC-3 fuel source is formulated from a mixture of 90 percent carbonized Grande Prairie Cellulose softwood pulp paper and 10 percent CMC-HF.



J. L. Resce

/mhc

Attachment

xc: Mr. Dick Haberkern
Ms. Rachelle Neuman
Mr. Ernie Farrier