EFFECT OF COKE-SIZING ON PUFFING CHARACTERISTICS OF BAKED STOCK

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Puffing characteristics determined by a dynamic puffing test were utilized to evaluate coke sizing-puffing relationships. Four types of baked stock, ranging from all-flour mixes to coarse particle electrode type mixes were formulated with both high puffing coke C* (sulfur content 1.2%) and low-puffing coke B (sulfur content 0.8%). Each mix type with each coke type was evaluated without inhibitor and with 1 pph Fe_2O_3 between 1200° and 2900°C. Puffing tests at both 5°C/min. and 14°C/min. were conducted on each of the samples. The puffing test procedure, and sample puffing curves are described briefly in the reference cited below*.

The following is a general description of the four mix types evaluated in this study:

- Mix #1 stock - all flour (largest particle size <0.21mm)
- Mix #2 stock - medium fine-grain, largest particle size 1.6mm
- Mix #3 stock - medium-grain, largest particle size 6.7mm
- Mix #4 stock - medium coarse-grain, largest particle size 12.7mm

Table I summarizes the results of this study. Total puffing values, defined as $\%\Delta L$ from minimum length to maximum length, are designated as $\%\Delta L_1$ or $\%\Delta L_0$ for inhibited and uninhibited stock, respectively. Results are much as expected with degree of puffing, in general, increasing with both increasing upheat rate and increasing mix coarseness. Puffing in low-puffing and non-puffing coke stock is less affected by mix type and upheat rate than in puffing coke stock but both follow the same general trends in their puffing behavior.

Uninhibited mix #2 baked stock made with coke B (low puffer) puffs 0.24% and 0.62% at 5°C/min. and 14°C/min. upheat, respectively, while mix #4 baked stock made from the same coke, also uninhibited, puffs 1.27% and 2.07% under the same graphitization conditions.

Uninhibited mix #2 baked stock formulated with high puffing coke C puffs 0.69% and 2.01% at 5°C/min. and 14°C/min. upheat rates, respectively, while uninhibited mix #4 baked stock made from the same coke puffs 2.09% and 5.28% under the same graphitization conditions.

The same trends noted in the above examples, except at lower total puffing levels, are followed by baked stock inhibited with 1 pph Fe_2O_3. Baked stock intermediate in particle sizing between mixes #2 and #4 have intermediate total puffing levels.

It is apparent from the examples cited above that fine-grain stock is more easily inhibited than coarse-grain stock fabricated from the same coke. Figures I and II depict the relationships among mix type, total puffing and puffing inhibition (1 pph Fe_2O_3 vs. none) for baked stock prepared from cokes B and C, respectively. Placement of the mix type on the graph's horizontal axis was assigned on the basis of the size in mm of the largest coke particles within that mix. Good correlations exist between total puffing and mix coarseness as discussed in the above examples.

In addition to determining puffing characteristics on all the baked stock shown in Table I, apparent densities and coefficients of linear thermal expansion (CTE) were obtained on the 1"ø x 1" long puffing plugs after the puffing test. All of these plugs were well-graphitized since all were tested to 2900°C.

In some instances densities show the expected decrease with increased total puffing, particularly at high heating rates. Processing conditions and the small sample size tend to "wash out" correlations when slow heating rates are involved. Considering the small sample size of the puffing plugs a fair correlation exists between CTE and total puffing. Figure III illustrates this relationship.

In summary, the degree of puffing ($\%\Delta L_0$ or $\%\Delta L_1$) increases significantly with increasing mix coarseness. Also, puffing increases as the heating rate is increased. Stock formulated with cokes C and B follow generally the same trends although coke C is obviously a higher puffer.

As puffing increases due to larger particle size in the stock, density of the stock tends to decrease. CTE's follow an inverse correlation with $\%\Delta L_0$ or $\%\Delta L_1$.

*For coke description see abstract "Puffing of Electrode Stock As Influenced by Sulfur Content and Heating Rate" by K. W. Tucker, et. al., 13th Biennial Carbon Conference

Table I
Effect of Coke Sizing on Puffing of Baked Stock

Coke	Mix Type	Inh.	Total Puffing ($\%\Delta L_0$ or $\%\Delta L_1$) at Heating Rate (°C/Min.) 5°	14°	A.D. After Graph. Heating Rate (°C/Min.) 5°	14°	CTE (cm/cm °Cx10^{-7}) After Graph. Heating Rate (°C/Min.) 5°	14°
B	1	No	0.11	0.23	1.41	1.42	19.1	15.4
B	2	No	0.24	0.62	1.41	1.45	8.2	12.9
B	3	No	0.80	1.06	1.46	1.40	8.1	9.5
B	4	No	1.27	2.07	1.44	1.39	11.0	11.0
B	1	1F	0.05	0.05	1.42	-	14.7	-
B	2	1F	0.07	0.26	1.54	1.48	14.7	15.4
B	3	1F	0.26	0.49	1.49	1.46	10.8	10.8
B	4	1F	0.50	1.30	1.50	1.41	9.9	6.8
C	1	No	1.33	2.24	1.28	1.21	10.2	10.8
C	2	No	1.29	3.01	1.48	1.35	13.9	7.9
C	3	No	1.52	4.92	1.46	1.26	7.0	7.0
C	4	No	2.09	5.28	1.37	1.25	7.2	3.3
C	1	1F	0.03	0.16	1.40	1.41	14.7	12.7
C	2	1F	0.14	1.32	1.51	1.44	14.9	11.8
C	3	1F	0.59	3.13	1.49	1.32	8.5	6.8
C	4	1F	0.92	4.39	1.52	1.24	-	3.3

1F = 1 pph Fe_2O_3

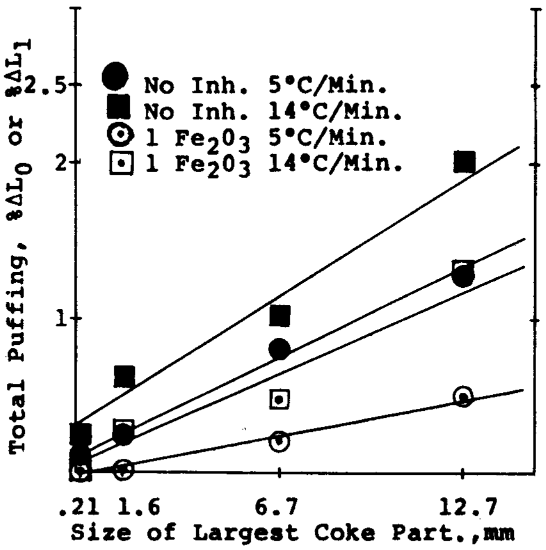

Fig. I. Puffing Vs. Mix Type-Coke B

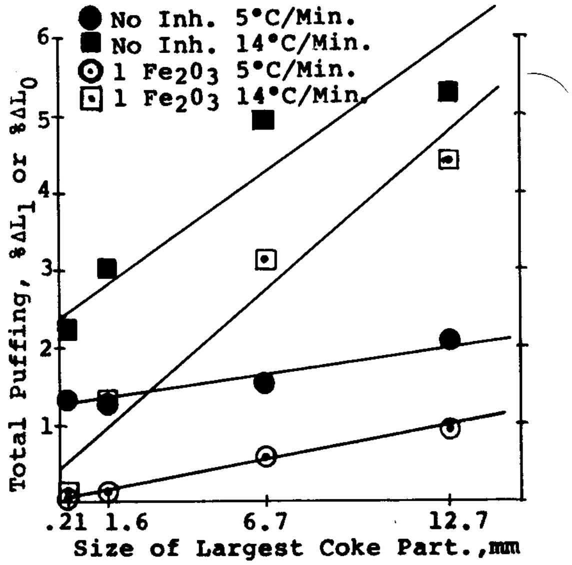

Fig. II. Puffing Vs. Mix Type-Coke C

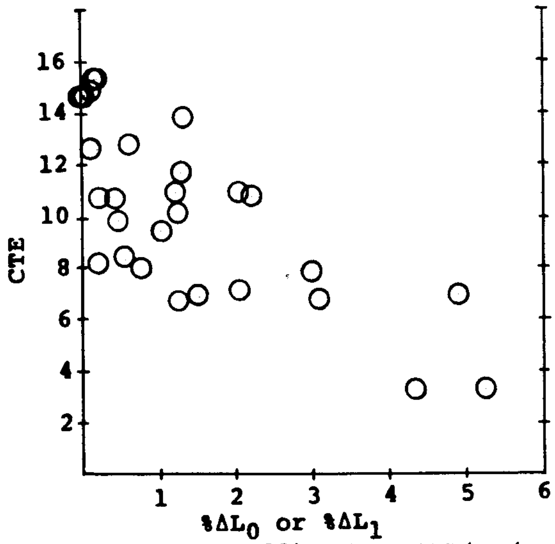

Fig. III. Total Puffing Vs. CTE(cm/cm °Cx10^{-7}