TOWARD THE DEVELOPMENT OF A SUPERIOR BINDER FOR CARBON MATERIALS

S.C. Martin, A.N. Adams, H.H. Schobert, F.R. Rusniko, Jr.
Carbon Research Center
Energy and Fuels Research Center
The Pennsylvania State University, University Park, PA 16802

Introduction

Anodes produced from petroleum pitches are inferior in baked density, strength and air permeability to those produced from traditional coal tar pitches. This is related to the fact that petroleum pitches contain no quinoline insoluble material. Moreover, with the increase in sourcing and blending of coal tar pitch, it has become prudent to evaluate novel possibilities for pitch revenues for use as binders in anode manufacture. Therefore, the development of a superior binder for carbon materials is an area of future utilization for industrial pitches.

This project is concerned with investigating the feasibility of altering the reactivity of petroleum pitches to emulate the desirable properties of their coal tar counterparts. Indeed, the possibility exists to modify petroleum pitch, either physically or chemically, to approach the behavior of its coal tar counterpart, whilst retaining initial its properties.

Experimental

Samples were a commercial and three unknown coal tar pitches and a petroleum pitch for comparison. Sample characteristics are provided in Table 1.

Sample	Softening Point (°C)	β resin (wt %)	QI (wt%)
Petroleum Pitch	122	7	0
Coal Tar Pitch	113	14	14
A2	89	12	13
A4	108	11	18
A9	126	18	21

<u>Table 1. Characteristics of Industrial Pitches.</u>

<u>HPLC</u> HPLC analysis of the quinoline soluble fraction of the samples were performed as described previously [1].

<u>TGA</u> Thermogravimetric analyses of selected fractions were performed in a Mettler TG50 with *ca* 10 mg sample operated under a temperature program of 30 °C to 950 °C at 20 °C/min under an N_2 flowrate of 100cm^3/min. Weight loss as a function of temperature were recorded and the derived curve allowed determination of T_{max} (temperature of maximum weight loss).

Results

Figure 1 and Table 2 summarise the thermal behavior of the relevent samples.

Sample	Temperature (°C)	Weight Loss (% w/w)
Petroleum Pitch	435	68
Coal Tar Pitch	375	58
A2	350	62
A4	400	58
A9	400 500	29

<u>Table 2. Thermal Results from TGA Analyses.</u>

In practice, pitches with higher softening points (*ca* 125-130 °C) possess desirable anode properties such as high coking yields. Moreover, low material losses upon carbonization result in more control over environmentally insidious PAHs, an area of universal concern. β-resin and QI contents are known to increase with extent of heat treatment during manufacture. Moreover, a more severe distillation gives rise to an increased degree of condensation of the complex aromatic structures present in those pitches. These observations are confirmed in the general composition and reactivities of the coal tar pitches examined in this study and reported elsewhere [2,3]. Table 2 and Figure 1 summarise the thermal behaviour of the pitches in the temperature range 30 to 950 °C. Table 1 indicates a significant decrease in mass loss on progression to sample A9. T_{max} for this sample is similarly passed to a higher temperature than for the other coal tar samples (Figure 2), with an unresolved peak at *ca* 500 °C. Molecular characterization of pitch A9 demonstrates higher concentrations of large condensed aromatics (>7-ring units) in comparison to its commercial coal tar counterpart and, as such, is expected to show significantly smaller mass loss. Similarly, the molecular composition of petroleum pitch is refelcted in it's relatively large volatile loss.

A relationship btween thermal behavior and industrial is attempted in Figures 2 and 3. Similar to the results reported by Martin et al. [4] a general correlation can be applied between softening point and solvent insoluble content and T_{max}, however it cannot be condensed into one definitive term due to the extreme complexity of the materials. Moreover, petroleum samples are interpreted separately due to their unique molecular make-up.

Conclusions

The ability to adequately define the behavior of inknown pitches by reference to minimal empirical expressions is an attractive concept in the development of a superior binder for carbon materials. It is hoped that with the ability to fingerprint both petroleum pitches and the quinoline soluble material of their coal tar counerparts by HPLC, without lengthy sample preparations, a quantitative method can be developed to asceratin any corelation between molecular composition and reactivity.

Acknowledgements

The authors would like to acknowledge the financial support of the members of the Pennsylvania State University Carbon Research Center.

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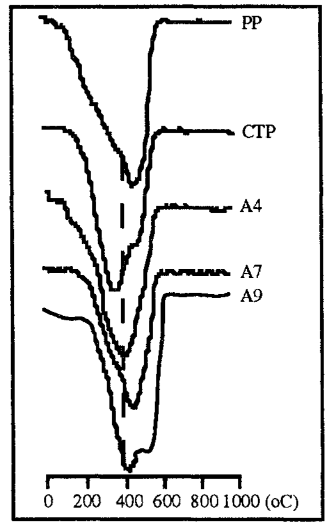

Figure 1. DTA Curves of Pitches.

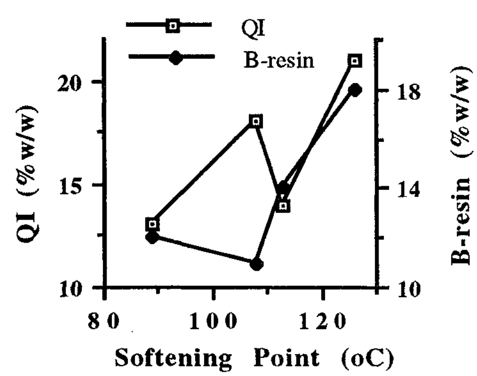

Figure 2. Variation of Pitch Insoluble Content with Softening Point.

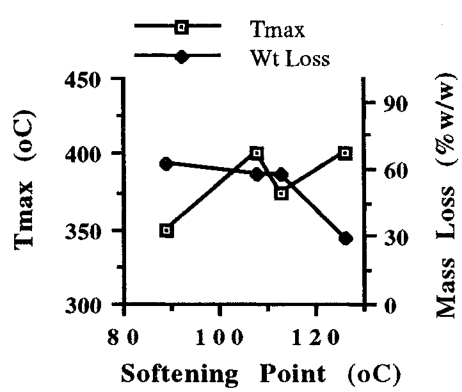

Figure 3. Relationship Between Softening Point and Thermal Reactivity Data.