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High Pressure Experiments,
Leuna, 1.

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To the Theory of the Liquid Phase

Summary.

Regularities in the behavior of the liquid phase are illustrated with a few examples, and a method of testing of hydrogenation behavior of coals is outlined.

The table contains examples of the behavior of different coals in the liquid phase for the purpose of production of oils of different composition. All tests have been run at 600 atm with iron catalysts, a normal gas throughput and with about a 50% paste. The only remaining independent variables were the temperature, the trough-put, and the composition of the fuge oil (pasting oils). When these three requirements are fixed, the conversion of a given coal, yield, composition of the oils produced, gasification and asphalt production will be perfectly definite for a fixed method of the working up of the residue. Results will vary from coal to coal, and the converse is also true, that for different coals the three above mentioned requirements must differ when the same results are desired.

Should a definite oil composition be required, e.g., a process intended for the production of middle oil and gasoline, i.e. with the production of no heavy oil, or e.g., for the production of 50% heavy oil, the number of independent variables will be reduced by setting these requirements.

Should we make the stipulation, that the thinning oil in the process for 100% gasoline and middle oil be 100% heavy oil, and the temperature be likewise fixed, there will be but a single throughput for a given coal to operate the converters with the production of oil of this fixed composition. All results, such as conversion, throughput, gasification and asphalt are fixed.

Should an additional requirement be made in the above case, such as a definite asphalt content, or a definite amount of gasification, then with a fixed composition of the thinning oil, there can be but a single throughput and temperature.

Different methods for the production for gasoline, middle oil or heavy oil could be similarly outlined.

It may, for instance, be possible for these reasons, to obtain from a given coal the same distribution of the oil composition with respect to the proportion of gasoline + middle oil to heavy oil by different procedures, which will differ from each other by different temperatures, throughput and composition of the thinning oil on the one hand, on the other by different throughputs, gasification, asphalts and conversion.

There are certain limitations to these conclusions, in that small temperature changes will not have equally great results upon all the factors (say upon the percent of conversion, of the solids, or the asphalt), and on the other hand by the composition of the coal which will affect the definite proportion of gas, middle oil, heavy oil and asphalt simultaneously produced in the destructive hydrogenation. Any strong deviation from these simultaneously predetermined proportions may cause, e.g., a larger gasification, etc. In the process for the production of gasoline and middle oil, the process may be imagined to consist in a simultaneous formation of part of the liquid phase gasoline and middle oil (together with gas, heavy oil and asphalt) directly from coal, while the rest is produced by varying gasification from the heavy oil and asphalt produced at the same time, which enter the return cycle. This may explain why in, say the process for gasoline + middle oil + 25 or 50% heavy oil, in spite of shortened time of contact, the same high pressure reaction volume and temperature will produce considerable amounts of heavy oil in addition to the gasoline and middle oil, compared with the process for gasoline and middle oil. The explanation would lead to the requirement, that each coal be operated for a certain kind of production, best suited to it. One may see in the second line, representing the Heinitz coal hydrogenation, that a process for gasoline and middle oil could hardly be considered suited because of the 27% gasification by this process against the low losses through gasification in the process for the production of heavy oil. Conditions for the production of heavy oil as used with the Zweckel coal do not seem to be the proper ones for this coal because of no advantages against the gasoline + middle oil process produced by the modification.

The observation has already been recorded, that Ruhr and Upper Silesian coals have about the same carbon content but have very different hydrogenation characteristics, when hydrogenated for gasoline and middle oil, and the same applies also to a process for gasoline + fuel oil. With the same proportion of oil, Upper Silesian coals showed no increased throughput even at a higher temperature.

As a general rule, the Ruhr coal seems to be better suited to gasoline + middle oil production than the Upper Silesian coal.

The recycling of oils in a closed cycle may not be the best means to determine the particular method best suited to a given coal, because of the possibility of superimposed effects, which will obscure the issue. The use of B bombs with a standard pasting oil is basically more correct, in spite of the disadvantages of using a non-continuous process with errors resulting from it.

It may well be that a continuous test in a 1 to 2 liter converter, using some standard pasting oil and a standard procedure would produce the best foundation for the evaluation of coal and for finding the relationship between oil production and gasification.

/s/ Rank

W.M. Sternberg

11/21/46

Conversion of Different Coals into Gasoline + Middle Oil, or Gasoline+Heavy Oil

Fuel Oil Experiments in 10 Li. Converters, at 600 Atm, with Iron Cat.

	Temper.	Pure coal throughput	Centrifuge thinning oil	% conversion	total yield	Gasoli + m.o. yield	% gasific in oil prod.	%Asphalt in Liquid
)	480	0.45	100% heavy oil	97.0	0.26	0.25	22.6	13.5
+ oil	481	0.61	50% heavy oil 50% midd. oil	96.6	0.38	0.25	20.5	16.4
+ il	481	0.65	7.5% h. oil 92.5% m. oil	96.2	0.41	0.19	19.0 27.1	15.1 7.7
m.o. 25%	472	0.57	100% heavy oil	95.0	0.32	0.32	21.9	7.3
	475	0.72	50% heavy oil 50% midd. oil	95.3	0.48	0.35	21.6	8.6
50%	476	0.76	100% midd. oil	94.8	0.50	0.30		
m.o. 50%	480	0.47	100% heavy oil	94.6	0.30	0.30	18.5	11.5
	476	0.61	80% midd. oil 20% heavy oil	96.3	0.41	0.21	18.5	11.7
m.o. 50%	468	0.44	100% heavy oil	96.1	0.27	0.27		
	477	0.81	100% midd. oil	96.4	0.55		24.7 20.5	7.4 11.5

[illegible]

From Fuel Oil Experiments in 10 li. [illegible]

	Coal	% C in pure coal	Process	Temper.	Pure coal throughput	Content [illegible] thinning oil	% con-version	Total yield	[illegible] + m.o. yield	% [illegible] in oil prod.	[illegible] in Liquid
1	Beuthen - Heinitz, 1 : 1 (production test)	81.96	Gasol+m.o	480	0.45	100% heavy oil	97.0	0.26	0.25	22.6	13.5
			gasoline + 35% s. oil	481	0.61	50% heavy oil 50% midd. oil	96.6	0.38	0.25	20.5	16.4
			gasoline + 50% s. oil	481	0.65	7.5% h. oil, 92.5% m. oil	96.2	0.41	0.19	19.0 27.1	15.1 7.7
2	Heinitz coal	81.0	gasol.+ m.o.	472	0.57	100% heavy oil	95.0	0.32	0.32	21.9	7.3
			Gasol.+ 25% s.oil	475	0.72	50% heavy oil 50% midd. oil	95.3	0.48	0.35	21.6	8.6
			Gasol. + 50% s.oil	476	0.76	100% midd. oil	94.8	0.50	0.30		
3	Zweckel coal Scholven (10 li.conv.)	82.5	Gasol. + m.o.	480	0.47	100% heavy oil	94.6	0.30	0.30	18.5	11.5
			Gasol. + 50% f. oil	476	0.61	80% midd. oil 20% heavy oil	96.3	0.41	0.21	18.5	11.7
4	Gelsenberg coal (young) (10 li. conv.)	83.9	Gasol. + m.o.	468	0.44	100% heavy oil	96.1	0.27	0.27	24.7	7.4
			Gasol. + 50% h. oil	477	0.81	100% midd. oil	96.4	0.55		20.5	11.5