Proceedings of the Iowa Academy of Science

Volume 54 | Annual Issue Article 24

1947

Abstract of Paper on Iowa Coals

S. W. Hockett
Iowa Wesleyan College

Abstract of Paper on Iowa Coals

S. W. HOCKETT

The chemistry department of Iowa Wesleyan College first began a preliminary chemical analysis on some South-Eastern Iowa coals, along the conventional lines of "proximate analyses."

Samples in the exhibit shown at the Academy meeting included coals from some of the earliest coals mined west of the Mississippi river, coming from mines in Van Buren county near Bonaparte and Farmington.

Analysis of these specimens showed that they ran fairly true to the pattern set forth in the Iowa state mine inspectors' reports, such as that for the two-year period ending Dec. 31, 1945.

Analysis of composite samples from these mines showed roughly on a dry basis:

40%	volatile-combustible
50%	fixed carbon
10%	ash.

Thermal values varied between 10,500 and 12,000 b.t.u per pound. Various samples showed 45% or more of volatiles, and one as low as 35% fixed carbon (determined as coke.)

After these preliminary analyses, the work of dry distillation at atmospheric pressure was begun, and the study of the quantity, character and utility of the products entered upon. Samples were also solicited from mines from all parts of the state.

After various tests with several types of retorts in various positions, distillation was carried out in a cylindrical iron retort with iron lead-pipes, and a temperature slightly above 650°C was decided upon within the retort, as the nearest approach to the "standard." At this temperature, owing to the great speed of distillation, which was over 90% completed in an hour with this type of set-up, less pyrolysis was believed evidenced. More of the original volatile products, unaltered by cracking, or hydrogenation or other secondary reactions, resulted. From the retort the volatiles were conducted through a series of washing towers, and condensing vessels equipped with temperature regulating devices.

At first, attempts were made to secure fractions as follows:

1st condensate—above 270°C.
2d condensate—above 225°C.
3d condensate—above 170°c.
4th condensate—all below 170°C.

Shortage of time for re-distillation and purification of products from each of the several portions, however, and the number of runs required to secure sufficiently large samples of all portions, eventually compelled combination of the several condensates into one distilling retort, and re-distilling in the usual manner. Re-distillation was found necessary several times before some of the samples in the exhibit were obtained sufficiently pure. The impurities in the residues shown in the exhibit have not been analyzed, nor their proportions determined. It is obvious that they are numerous and of complex nature.

The results showed that the higher-boiling condensates contained chiefly the heavier oils and anthracene, phenanthrene and carbazols; the second-highest boiling fraction was comprised in the main of creosote; the third fraction to condense contained phenolic constituents with naphthalene and pyridine; while the lower boiling portion contained benzene, toluene, xylene and other light oils adulterated with noticeable amounts of both naphthalene and pyridine that had escaped being caught previously.

Hydrogen and methane were the chief constituents of the blue-burning gas, but traces of vapors of light oils, particularly benzene, were observed. Little noticeable distinction could be observed in the time required to bring to boil a given amount of pure water by the flame from this gas or the flame from the city gas. Observers could not tell which was the city gas, without tracing the lead-tubing. The liquors contained most of the benzene or motor-spirits, however, and ammonium compounds were plentiful in the aqueous liquids from the washing towers. Culorific tests on the gas are being made, pointing to superiority over water gas.

Until absolutely uniformly standardized procedures be established, particularly in regard to time and temperature of carbonization, percentages of "yield" may not mean anything. Rough approximate averages of the final products showed per unit weight of dry coal appreciably MORE than—2.0% naphthalene
0.1% of toluene
0.5% benzene
0.05% xylenes, and lesser proportions of other ingredients like phenol, anthrocene, carbazole and fluorene.

The volume of illuminating gas—a pure-blue gas rich in hydrogen—varied from 2½ to 5 cubic feet per pound of dry coal distilled. This would mean from 5,000 to 10,000 cubic feet per ton of dry coal. It would also show yields of over 2½ gallons of benzene or motor-spirits per ton, and other useful crudes containing phenol and toluol, 2 to 5 lbs. per ton.

The coke averaged 800 to 850 lbs. per ton, on these samples. Every fraction tested invariably showed the presence of an abundance of unsaturated complexes, analyses of which have not as yet been completed. Bromine water and permanganate solutions were of course immediately decolorized, and odors characteristic of the products mentioned above were obvious.

As noted from the exhibits, the cokes obtained from these Iowa coals are obviously not sufficiently strong, hard, or heavy to make them adaptable to the steel and metallurgical industries as now carried on. However, for manufacturing blue-gas or water-gas they exhibit properties that should make them superior; and if used in powdered form as fuel in various modern types of fuel-burners, there is good reason to believe they would prove highly desirable, because of their facility in handling and pulverizing and burning, particularly when the dust residues are carried off properly. As to calorific values, these Iowa cokes themselves compare quite favorably pound per pound with other cokes.

These Iowa cokes appear to lend themselves remarkably to activation. The sample of activated coke in the exhibit was prepared by a student assistant in the I.W.C. laboratory and when tested proved more efficient than activated samples of coke from any other source obtainable. More collaboration is needed on this point, however.

Conclusions

The relatively high hydrocarbon yield from these Iowa coals, including the favorable yield of light and heavy oils, as well as the great variety and complexity of unsaturated hydrocarbons found, suggest possibilities for greater utilization of Iowa coals in the future.

Valuable by-products are proved obtainable from these high-volatile coals, and many others could readily be produced from the volatile products by such processes as cracking, hydrogenation, hydrolysis, oxygenating, and high-temperature distillation.

IOWA WESLEYAN COLLEGE,
DEPARTMENT OF CHEMISTRY.