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DEPARTMENT OF REGISTRATION AND EDUCATION

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STATE GEOLOGICAL SURVEY
FRANK W. DE WOLF, Chief

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THE MANUFACTURE OF RETORT COAL-GAS IN THE CENTRAL STATES USING LOW-SULPHUR COAL FROM ILLINOIS, INDIANA AND WESTERN KENTUCKY

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and
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ILLINOIS MINING INVESTIGATIONS

Prepared under a cooperative agreement between the Illinois State Geological Survey Division, the Engineering Experiment Station of the University of Illinois, and the U. S. Bureau of Mines.

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STATE GEOLOGICAL SURVEY

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FIG. 1.—Bituminous coal zone C, established by the U. S. Fuel and the U. S. Railroad Administrations, April 1, 1918, and corrected to July 1, 1918. Includes low-sulphur coal areas in southern Illinois.

During the period from October 1, 1918 to March 31, 1919, producing districts of Illinois, shown in black, are restricted in their shipments of coal to markets within and along the solid boundary line.

During the period from April 1, 1918, to September 30, 1918, these same districts are restricted in their shipments to markets within and along the heavy dashed boundary line and its solid continuation south from Albia, Iowa, and Milwaukee, Wisconsin.

During the entire year the producing districts of Vermilion County, Illinois, along the Wabash Railway may in addition ship coal to points of delivery along the Wabash Railway

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WAR ADJUSTMENT OF GAS-COAL DISTRIBUTION

Eastern gas coals, because of their high yield of gas and of excellent coke, have hitherto been used almost exclusively for retort coal-gas manufacture in the central west as well as in the east. However, the necessity of avoiding long freight hauls wherever possible, and of conserving the supply of eastern coals for the manufacture of metallurgical coke and for eastern gas requirements makes it a patriotic duty to utilize as far as possible the great but comparatively undeveloped resources of low-sulphur coal in the central states.

Gas plants in zones C, D, and E of the U. S. Fuel Administration (figs. 1, 2, and 3 and explanations of subsequent changes) should naturally use coal mined within the zones if possible, rather than request coal under permit from distant sources. The term "central district" coal as used in this paper includes that from Illinois, Indiana, and western Kentucky.

Although both commercial and technical problems must be solved before these coals are generally used in gas manufacture, reliable data already collected warrant further effort and promise success.

PRESENT USE OF CENTRAL DISTRICT COAL

The use of central district coals in gas making is by no means new. These coals have been used in a majority of the 20 representative plants recently inspected in Illinois, Iowa, and Wisconsin. Depending upon local conditions, the results obtained vary considerably and are in general agreement with those reported

within Indiana. Similarly, producing districts of Sangamon County may ship to stations along the Cincinnati, Indianapolis, and Western Railroad, as far east as Indianapolis, and including points of delivery within switching limits on connecting lines.

A modification affecting the distribution of Jackson and Randolph county coals is as follows: All producers located along the Mobile and Ohio Railroad and short-line connections in Illinois may ship coal to points of delivery on the Mobile and Ohio Railroad within Tennessee and Mississippi, as far south as Meridian, Mississippi, including stations within switching limits on connecting railway lines.

Consult the District Representative of the U. S. Fuel Administration, 2017 Fisher Building, Chicago, to learn decisions on suggested changes still pending. Of these changes, the one affecting particularly the coal-gas industry relates to the addition of the Lower Peninsula of Michigan to Zone C.

by F. K. Ovitz[1] of the U. S. Bureau of Mines. Mr. Ovitz's work had to do almost exclusively with the manufacture of coal gas from Illinois coals and mixtures of these with other coals. Since the publication of his results, much creditable work has been done by individual companies on the use of Illinois coals in water-gas generators. A separate paper by the authors of this report has been prepared, dealing with that work.

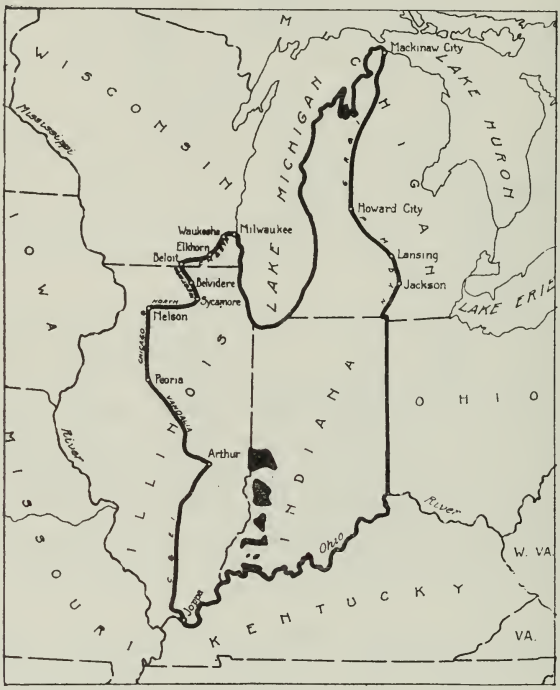

FIG. 2.—Bituminous coal zone D, established by the U. S. Fuel and the U. S. Railroad Administrations, April 1, 1918. Includes low-sulphur coal areas in southwestern Indiana.

All producing districts of Indiana, shown in black, are restricted in their shipments of coal to markets within or along the heavy boundary line.

Consult the District Representative of the U. S. Fuel Administration, 2017 Fisher Building, Chicago, to learn decisions on a number of suggested changes still pending at the time this was printed.

This report is the result of an inspection made by W. A. Dunkley, gas engineer of the Illinois Geological Survey, and W. W. Odell, gas engineer of the U. S. Bureau of Mines, working

[1]Ovitz, F. K., Coking of Illinois coals, U. S. Bureau of Mines Bull. 138, 1917.
———————., Carbonization of Illinois coals in inclined gas retorts: Ill. State Geol. Survey, Cooperative Series Bull. 20, 1918.

under the cooperative agreement[2], in order to determine and report at once the experiences of various coal-gas manufacturers with central district coals. The differences in present practice form the basis of a program of further experimentation.

PROBLEMS IN THE USE OF CENTRAL DISTRICT COALS IN COAL-GAS MANUFACTURE

The operator who has been accustomed to use eastern gas coals and whose plant and operating conditions are laid out especially for these coals is confronted by new problems when the use of central district coals is contemplated. These problems include relative prices and availability of coal supplies, plant capacity, labor supply, disposal of coke, purification of the gas, and changes in operating methods. These problems will be discussed separately.

1. Price and Availability of Coals

The prices of both eastern and central district gas coals are continually changing. Owing, however, to the considerably longer haul in the former case, there is usually about $2.00 per ton margin between the delivered price of eastern and of central district coals, in favor of the latter. For example, some plants in Illinois report that eastern coals are now costing them about $6.00 per ton and central district coals from the southern Illinois fields, about $4.00 per ton. A difference in price at least equal to this seems likely to be maintained for plants in Illinois and the states to the west.

The length of haul from the southern Illinois mines to gas plants in the northern part of the State varies from 250 to 350 miles. On the other hand, the rail haul from the eastern gas-coal fields to the same region averages probably at least twice as long and in at least one case is 720 miles. Taking into consideration the immense freight traffic for other purposes on the east and west lines, especially through the Pittsburgh district, it seems reasonable to expect that the supply of central district coals to local plants would be more certain during freight congestion than would the supply of eastern coals. Since the yearly gas-coal requirement of Zone C alone is nearly 2,000,000 tons, an extensive substitution of central district coals for eastern coals would release many cars on the east and west roads for other purposes.

[2]An extensive investigation of coal and coal mining has been in progress since 1911 under a cooperative agreement between the U. S. Bureau of Mines, the Illinois State Geological Survey and the Engineering Experiment Station of the University of Illinois.

2. Plant Capacity

The experiences of those who have used central district coals show that under usual operating conditions, these coals do not yield more than 80 per cent of the amount of gas yielded by an equal weight of good eastern gas coal. The question of plant capacity is therefore one of first importance. If, as is the case at some plants, hardly enough generating apparatus is provided to meet the demand for gas when the highest yields are obtained from eastern coals, then an immediate change to central district coals is impracticable. On the other hand, if a plant has at least 20 per cent spare capacity, this obstacle of decreased capacity is overcome. At many plants where there is a rated surplus capacity, the spare benches are down for repairs and may not be repaired until actually needed for use. In many cases if this surplus capacity could be quickly made available there would be no obstacle to the use of central district coals until other benches were let down for repairs.

In some plants it was observed that all the coal-gas apparatus is worked constantly to maximum capacity, and the additional gas required is supplied by water-gas apparatus. In such cases the substitution of central district for eastern coals in the coal-gas plant would necessitate the making of more water gas. The question would have to be decided whether the saving in cost of gas manufacture by the use of central district coals would be offset by the additional cost of making the extra volume of water gas needed, since the cost of water-gas manufacture is usually higher than coal gas. In such cases, if ample water-gas apparatus is available, the use of central district coals as generator fuel might permit a substantial saving in this part of the plant. Under favorable conditions, therefore, the use of central district coals throughout the plant might be found quite profitable. This leaves out of account the desirability, especially at the present time, of conserving the transportation facilities of the country, which should be seriously considered by every gas man.

Several plants were visited in which the use of eastern gas coals is not absolutely necessary but is continued either because no financial advantage is seen from making a change, or because the troubles anticipated from the use of central district coals are magnified. Where the total capacity of the plant would permit the use of central district coals, alone or in mixtures, this matter should have the earnest consideration of the manager, especially since their use may become necessary in a few months on account of freight congestion.

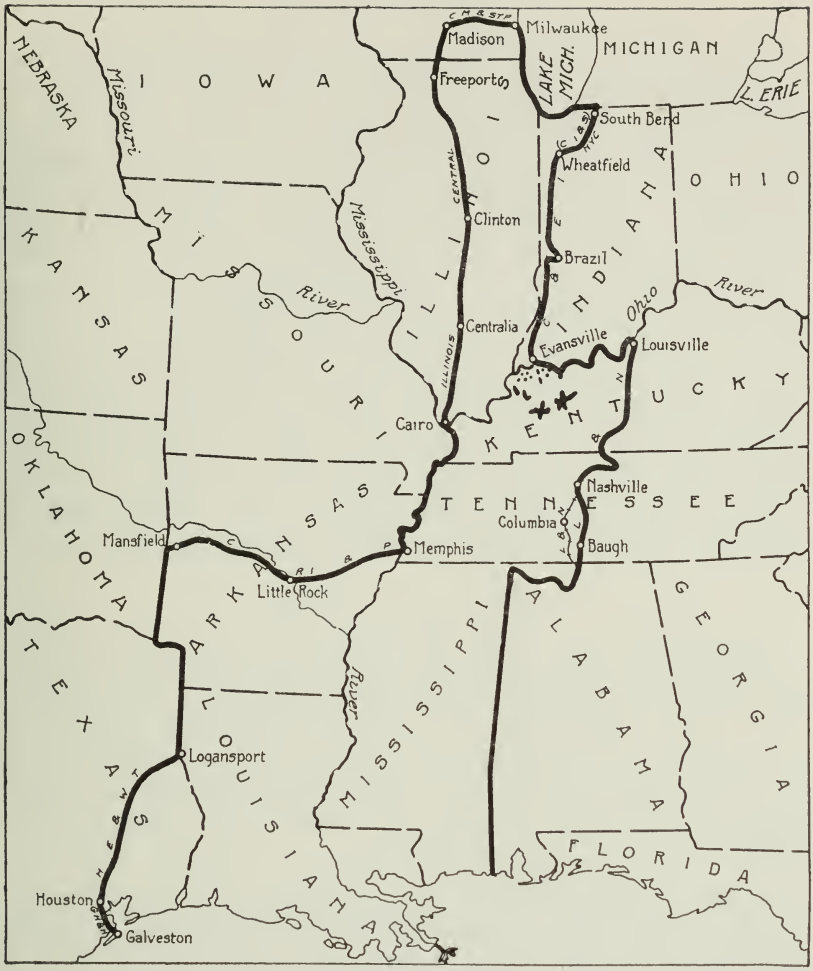

FIG. 3.—Bituminous coal zone E, established by the U. S. Fuel and the U. S. Railroad Administration, April 1, 1918, and corrected to July 1, 1918. Includes low-sulphur coal in western Kentucky.

Producing districts in western Kentucky, shown in black, are restricted in their shipments of coal to markets within or along the heavy boundary line.

Modifications of the original zoning made prior to July 1, 1918, have been incorporated in the map. Later modifications affecting the gas-coal markets are as follows:

Producers in the western Kentucky districts may in addition distribute their coal (1) along the Louisville, Cincinnati and Lexington Division of the Louisville and Nashville Railway between Louisville and Newport, Kentucky, inclusive, and (2) in Cincinnati, Ohio, and points of delivery located within the Cincinnati switching district.

Producers in this district may not ship coal without permit into those parts of Illinois, Wisconsin, and Indiana, included originally in zone E as shown by the heavy boundary line. A provision is made, however, which should be noted by the coal-gas manufacturer: Any western Kentucky producer may ship coal of special quality for special uses to delivery points within the prohibited territory under permit which may be obtained from the Fuel Administration on application of the consumer.

3. Operating Labor

An occasional plant was inspected in which there is apparently ample generating capacity in good condition to handle central district coals, but the management is not using them because of the difficulty of securing the additional retort house labor to operate the necessary additional equipment. In these cases it is impossible to judge from casual inspection whether the labor situation is really as serious as reported, or whether the policy of the particular company in dealing with its employees is responsible for the difficulty. In one plant visited the labor shortage is so serious that in an effort to maintain the gas supply without starting another bench, heavy charges are made and pulled so "green" that the gas obtained is not more than 80 per cent of the yield which could be reasonably expected from the eastern coal in use. It is evident that the money being lost would far more than offset the readjustment of wage which might be necessary to put the plant on an efficient operating basis.

4. Disposal of Coke

Nearly all the gas operators interviewed stated that the central district coals produce coke which is inferior to that obtained from the best eastern coals; yet it is quite generally agreed that they can sell at the present time all the coke which they can produce from either kind of coal. Some plants could dispose of several times their present production from central district coal at a profit.

With the return to normal conditions of demand and supply, the quality and yield of coke from central district coals will be of renewed importance; and therefore a study of the conditions affecting these will be made as soon as possible.

In the use of these cokes as water-gas generator fuel the experiences of various operators differ. Some operators have much trouble with the clinker formed from these cokes, while others handle the clinkers without particular difficulty. Further study of clinker formation is needed and will be made in the near future. Operators who are using central district coals as generator fuel in water-gas machines usually report less clinker difficulty than where the coke made from the same coals is used. This indicates that the operating conditions in the generator are of at least as great importance as the composition of the fuel and ash.

5. Purification

Many operators beginning the use of central district coals anticipate that a much larger amount of sulphur will be yielded in the gas from these coals than from eastern coals. One operator who has never used central district coals states that there is not enough purifying material in the United States to purify the gas from one carload of Illinois coal! While it is true that many coals of this district can not be used under present conditions because of their high-sulphur content, yet there are many coals produced in the central district which are nearly as low in sulphur content as eastern coals. A subsequent publication will present a description of the low-sulphur coals mined in the central district. Few companies who have used these coals report any serious difficulty from excess sulphur in the gas. Where sulphur has caused trouble, it is usually impossible to learn definitely whether the sulphur in the gas has been excessive or whether the purifying material in use at that time was inefficient. In most of the plants inspected there are no facilities for making quantitative tests of sulphur in the gas. The more general use of the Tutweiler hydrogen sulphide apparatus among the various gas companies would seem to be advantageous. In most of the plants visited, the purifying capacity is ample to purify the gas produced from any of the better coals of this district.

6. Operating Methods with Central District Coals

So far as can be learned from various operators, the use of central district coals in retort gas practice at present is in general no different than the use of eastern coals. Practice varies considerably in different plants, but these variations are due to personal views of different operators as to what heats, coking times, weights of charge, etc., give the best results in their particular cases, rather than to any generally recognized "best way" of using these coals. With the considerable differences in practice which exist, there are no very marked variations in the results obtained.

In carbonizing coals in retort practice several variable conditions influence the quantity and quality of the products. Among these, the conditions which are most easily changed and most likely to be varied by different operators are: retort temperature, length of coking time, size of charge, and size of coal. One operator favors a certain combination of these conditions for a given coal, while another operator selects a different combination. The results obtained may be almost identical.

Some operators favor high retort temperature for central district coals, claiming that the rate of heat penetration into the charge is slower than with eastern coals, and that high temperature is necessary to obtain complete fusion of the coal and consequent strong coke structure. They point to the granular structure of the coke from some of these coals as evidence of incomplete coking due to insufficient temperature. On the other hand, other operators say that the heat penetration is more rapid with these coals and that a poor, weak, fingery coke structure is more liable to result from over-coking the charge, and consequently they favor lower retort temperatures for these coals.

Long coking periods are preferred to short periods by some operators. They often claim that a higher yield of good quality gas and a higher yield of ammonia are obtained with a long period of coking at a moderate temperature than with a short coking period at a high temperature. On the other hand, some operators say that a long coking period over-cokes the charge, weakens the structure of the coke, and makes it more liable to break into small fingery pieces.

Evidently the same results are frequently attributed to long coking as to high temperatures. There is usually no way of determining what the temperature of a retort actually is. Gas plants are not generally equipped with pyrometers, and the degree of temperature carried is merely a matter of judgment, into which the personal opinion enters very largely. The study of these variables would give much-needed information, and it is hoped that such a study may be undertaken soon.

There is no uniformity in the weight of coal charge in different plants having retorts of the same size. Usually the charges are as large as can be properly coked in the chosen coking period and vary from 325 to 400 pounds. The weight of charge seems to be the means of heat control in many plants. If the retort temperatures drops, the weight of charge is decreased, or vice versa. The weight of charge is also varied to diminish standpipe stoppage and to prevent naphthalene deposits. So far as could be learned no difference in the size of charge is required with central district coals and with eastern gas coals.

Size of coal is another varying condition about which great difference of opinion is expressed. Fine crushing of the coal would undoubtedly result in a more intimate mixture of all the components of the coal and result in a more uniform and stronger coke. However, there is considerable difference of opinion among

gas men as to the feasibility of crushing coal. Only a very few plants are equipped with crushers. Some operators claim that whereas the quality of coke from crushed coal would be better, the heat penetration into crushed central district coal is so slow that the usual yield of gas is not obtained from the coal during the short coking period which the retort gas maker can allow. However, at least one inclined-retort plant was inspected which is coking crushed coal and obtaining, not only a very good coke from southern Illinois coal, but a yield of gas greater than is produced by most plants using uncrushed coal. From appearances, the coal is thoroughly coked in 6 hours. Some operators expressed novel opinions and theories upon the coking of various coals, and though these ideas have no place in this report, they suggested problems for further study.

RESULTS REPORTED FROM CENTRAL DISTRICT COALS

Several of the coal-gas plants in Illinois are using eastern gas coals this summer. Some of these plants used central district coals during the past winter or at some previous time, but the results of their experiences with these coals are available chiefly as more or less definite impressions. The following are typical results reported where definite figures are available; unfortunately none for Indiana or western Kentucky is included.

These results are in fair agreement with those reported by Mr. Ovitz and indicate that no radical developments in the use of these coals in ordinary retort practice have arisen recently. The central district coals now in use are from only a few mines, and it seems likely that much valuable information can be obtained by the testing of other coals and mixtures of coals from this district. A more intimate knowledge of such conditions as temperature, coking time, size of coal, rate of heat penetration, and other variables is also needed. This information can come only by experiment.

Some gas men believe that the most successful use of central district coals will come through new by-product oven or low-temperature processes, rather than by any modification of operating conditions in the present equipment. Certain investigators are working on such processes, and some attractive claims are made for them, but as yet no commercial plants built to use these processes are in regular operation with central district coals.

TABLE 1.—*Results of retort gas practice with central district coals from Illinois*

Source of coal	Perry Co.	Franklin Co.	Jackson Co.	Perry Co.
Weight of charge (*pounds*)	450	400	410	720
Retorts—				
Size (*feet*)	9	9	9	15
Type	Stop-end Hor.	Stop-end Hor.	Stop-end Hor.	Inclined
Kind	Silica	Silica	Silica	Silica
Coking time (*hours*)	6	4	6	6
Heats	Good	Good	Good	Good
Gas yield (*cu. ft. per lb.*)	4.2	4.1	4.5	4.5
Heating value of gas (*B.t.u.*)	585	600	570	550
Coke (*per cent*)	60	65	68	65
Breeze (*per cent of coke*)	Not estimated	10	7.3	Not estimated
Quality of coke	Fair	Fair	Very good	Good
Tar recovered per ton (*gals.*)	10	Not determined	12	13
Ammonia recovered per ton (*lbs.*)	Not determined	Not recovered	Not recovered	4.9
Sulphur in gas	No trouble	No trouble	No trouble	No trouble
Bench fuel per ton (*lbs.*)	400	Not determined	Not determined	280

Meanwhile, the type of gas retort now in general use is an active unit whose characteristics are understood by the operators. It has been in use for years, and doubtless will continue to be used in the smaller plants for years to come. It represents the investment of large sums of money. For these reasons the effect of the many varying conditions upon its operations should be thoroughly understood as a basis for further work which may be done from time to time.

THE ECONOMICAL ADVANTAGE OF CENTRAL DISTRICT COALS FOR COAL-GAS MANUFACTURE

Aside from the difficulty of obtaining eastern gas coals under present conditions, and the conservation of freight traffic to be gained by the use of coals of the central district for gas making, the question of the choice of coals is a financial one: whether it is actually cheaper for the gas manufacturer to use central district coals.

To determine what if any saving can be realized from the use of these coals in a given case, local conditions must be considered and certain assumptions based upon the results which have been obtained by others, must be made. It is the purpose of this section to apply the average operating results reported by several plants to a case in which certain fuel, labor, and miscellaneous costs and returns from the sale of residuals are assumed, and to point out how the various conditions affect the cost of manufacture. The costs assumed do not represent the conditions existing in any particular plant, but are taken merely for illustration. It is believed that any operator can substitute his own figures and arrive at a conclusion as to whether the use of central district coal would pay in his own case.

In changing from eastern to central district coal, several factors are to be considered in determining the effect of the change on the final cost of manufacture. These factors include, for each coal, the following items:

1. Cost of the amounts of materials required to produce a given volume (say 1,000 cu. ft.) of gas of the required quality.
2. Cost of operating labor.
3. Cost of repairs.
4. Overhead and miscellaneous expense.
5. Income to be realized from the sale of residuals.

It is very difficult except after long operating experience to assign definite values to all of these items, and in some cases the difference would be so slight as to have little weight in the comparison. In assuming values for the different items the unit costs selected do not apply to the operating conditions in any particular plant. The amounts of materials used, however, are fairly representative of the present practice in several plants.

Cost of Materials

In the following comparison it is assumed that central district coal can be delivered at the gas plant for $4.00 per ton, and that eastern coal at the same place costs $6.00 per ton. From the results obtained in several plants, yields of 4.2 cubic feet of gas per pound from central district coals, and 5.25 cubic feet of gas from eastern coals seem to be typical figures. The gas coal cost on this basis would be $0.476 per 1,000 cubic feet with central district and $0.571 per 1,000 cubic feet with eastern coal.

The cost of bench fuel in each case will of course depend upon the kind of fuel used. Most of the plants of this district are now using for bench fuel a portion of the coke which they produce. A few, however, are using coal. It will be assumed in this case that coke is used and that 85 per cent of the coke from central district coal is worth $9.00 per ton and the remainder is breeze worth $2.00 per ton, whereas 92 per cent of the eastern coke is worth $9.00 per ton and the remaining 8 per cent is worth $2.00 per ton. On this basis, assuming that 300 pounds of bench fuel are required per ton of coal carbonized, the cost in the case of the central district coal will be $0.142 per 1,000 cubic feet of gas, and in the case of eastern coal $0.120 per 1,000 cubic feet.

No present prices of purifying material are available, and since this item is usually a relatively small one in making up the total manufacturing cost, it will be assumed that the total purifyig cost, including labor and material, is $0.009 per 1,000 cubic feet for gas made from eastern coal, and 50 per cent greater or $0.0135 for gas from central district coal.

Other materials such as steam, water, lubricating oils, gas and electric current enter into the cost of manufacture, but except in special cases where coal or coke is handled mechanically, it does not seem likely that the cost would be materially different for one kind of coal than for the other. In this case it will be assumed that these materials are handled by hand and the difference will be considered under operating labor.

Operating Labor Costs

The operating labor will be assumed to include coal and coke handling, both in the yard and in the retort house; and miscellaneous works-labor, purifying labor and work-superintendence. Of these items, the only ones which appear to need consideration in a comparison of this kind are fuel-handling labor and purifying labor. The latter has already been taken up.

In using central district coals more coal must be handled to produce 1,000 cubic feet of gas than when eastern coal is used. On the basis of the yields of gas assumed, namely, 4.2 cubic feet of gas per pound from the former coal and 5.25 cubic feet of gas from the latter, the amount of central district coal to be handled would be 25 per cent greater. The cost of handling coal, both in the yard and in the retort house, will vary according to the prevailing scale of labor. For this comparison a cost of 20 cents per ton for handling in the yard is assumed, which would give a cost of $0.019 per 1,000 cubic feet of gas from eastern coal and $0.024 per thousand cubic feet of gas from central district coals. For retort-house labor, which includes the care of the benches, charging and discharging the retorts, caring for the standpipes and hydraulic main, quenching and stocking coke, etc., a cost of $1.50 per ton is assumed which would amount to a retort-house labor cost of $0.178 for central district coal and $0.142 for eastern coal.

Repair Costs

So far as can be ascertained, the wear and tear on benches and gas-handling equipment is no greater per ton of coal carbonized with one kind of coal than with the other. But about 25 per cent more generating equipment is required to produce a given amount of gas from central district coal than from eastern coal. It is assumed that the cost of bench repairs is $0.045 per 1,000 cubic feet of gas with eastern coal and that the repair cost is proportional to the amount of equipment in use. On this basis the cost of repairs with central district coals will be $0.056 per 1,000 cubic feet. It is assumed that all other repair costs remain unchanged, although it is evident that in a plant equipped with much coal-handling equipment the handling of 25 per cent more coal would necessarily increase the cost of repairs per 1,000 cubic feet of gas by an appreciable amount.

Overhead and Miscellaneous Expense

No figures are available from which it is possible to compute what change in overhead expense would result from the change of coals here considered. If more equipment had to be installed to make the use of central district coals possible and the interest on the investment, depreciation, etc., were computed to the basis of 1,000 cubic feet of gas made, it is evident that there would be an increase in the cost per 1,000 cubic feet for gas from central district coal. On the other hand, if hitherto idle equipment were brought into use then the cost per 1,000 cubic feet due to the use of these coals might actually decrease, since there would be a return from the capital invested on account of increased coke production. In the present case the effect of this item upon the relative cost will not be considered.

Income from Residuals

In computing the credit from the sale of residuals in each case, it is assumed that the total coke yield is 60 per cent of the central district coal carbonized and 65 per cent of the eastern coal, and that 15 per cent of the coke in the former case and 8 per cent of the coke in the latter case is breeze. It is also assumed that the screened coke brings $9.00 per ton, and the breeze $2.00 per ton in the yard in each case. On this basis the income per 1,000 cubic feet of gas from the sale of coke and breeze would amount to $0.546 and $0.021 respectively for central district coal and $0.512 and $0.010 respectively from eastern coal.

It is assumed that the central district coal gives an ammonia recovery of 5.5 pounds per ton of coal, as compared with 5.0 pounds per ton from eastern coal, and that a net price of $0.09 per pound is realized. This would give an ammonia credit of $0.059 per 1,000 cubic feet of gas from central district coal and $0.043 per 1,000 cubic feet from eastern coal. In neither case is the cost of handling and concentrating considered, it being assumed that these charges will be proportional to the yield in each case.

The tar yield is assumed to be 10 gallons per ton from central district coal and 13.5 gallons per ton from eastern coal. A value of $0.035 per gallon for the tar produced gives a credit of $0.042 and $0.045 per 1,000 cubic feet of gas, respectively. Here as in the case of the ammonia the handling costs are neglected.

Summary of Costs

Using the values assumed in the foregoing, the following comparison for the two kinds of coal may be tabulated:

TABLE 2.—*A comparison of the approximate manufacturing costs of gas from central district and eastern gas-coals.*

	Central district coal *Cost per M cu. ft. of gas*	Eastern coal *Cost per M cu. ft. of gas*
Coal carbonized	$0.476	$0.571
Bench fuel	.142	.120
Purifying expense	.014	.009
Coal-handling labor	.024	.019
Retort-house labor	.178	.142
Bench and retort repairs	.056	.045
	$0.890	$0.906
Income from residuals		
Coke	$0.546	$0.512
Breeze	.021	.010
Ammonia	.059	.043
Tar	.042	.045
	$0.668	$0.610
Cost less residuals credit	.222	.296

This table does not take into account all of the elements of cost, which include plant, mains, et cetera, but only those which would seem to be affected by the kind of coal used, it being assumed that the same amount of gas is produced in each case. Therefore these figures are *not presented to show the actual cost* of gas to the holder but merely to indicate the approximate saving in manufacturing cost which might be effected by the use of central district coals under the conditions assumed. The actual saving will vary, and some operators will be unable to substitute central district coal completely because of inadequate equipment. Operators are urged to substitute their own costs in the foregoing tabulation and ascertain whether their own conditions will not permit them to make a substantial saving. The assumed difference in cost of eastern and central district coals is the chief item underlying the calculations.

SUMMARY

A majority of the coal-gas plants in Illinois and neighboring states have used central district coals. While the gas yield is smaller and the coke made under present conditions is somewhat

inferior to that from eastern coals, many plants are finding the use of central district coals profitable. Since the use of these coals would do much to release railroad cars needed for war purposes, it is a patriotic duty to use them; furthermore, their use will serve to protect gas companies because the supply will be more certain during periods of freight congestion. Experiences of many gas companies indicate that there are no insurmountable difficulties preventing the use of these coals for gas making. A more exhaustive study of the conditions affecting the use of these coals is needed and will be undertaken in the near future. All gas operators who are not now using central district coals should carefully consider the practicability of doing so.