REPORT ON UTILIZATION OF ALASKAN COALS WITH PARTICULAR REFERENCE TO LOW-TEMPERATURE CARBONIZATION

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INTRODUCTION

At the request of Dr. L. C. McCabe, Chief, Fuels and Explosives Division, U. S. Bureau of Mines, a survey and appraisal of the coal situation in Alaska was undertaken. The objective of this survey was to investigate possible methods of increasing the utilization of Alaskan coals, particularly by the process of low-temperature carbonization. Such a survey included (1) an evaluation of the possible markets for the products of low-temperature carbonization and (2) estimates of the cost of these products to ascertain their competitive status. Additionally, any possible new or expanded uses to which coal could be put were investigated. Accordingly, this report includes, in addition to an evaluation of the feasibility of low-temperature carbonization, a brief estimate of the present competitive status of Alaskan coal in the overall fuel picture and suggestions for possible increased use of coal in thermal power generation and synthetic ammonia.

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LOW-TEMPERATURE CARBONIZATION

Products

In any process of low-temperature carbonization of low-rank coal, the principal products are: Char, tar, and gas of high carbon dioxide content. The possibilities of utilizing the char from subbituminous coal for the production of either a premium-grade or power-plant fuel were investigated carefully. The possible utilization of the tar and gas within the territory and for the export market was also considered. A discussion of the pertinent facts as applied to the markets for these products follows.

Char

Domestic

If the process is to be successful economically, it is highly desirable that markets be available in which the char can command a premium price. Possible markets would be as a briquette for domestic use and as a stable, storable fuel for export.

The best estimate of the possible domestic markets for briquettes is the present consumption of lump-nut size coal now hand fired. In the Fairbanks area the consumption of this size coal was 10,277 tons in 1950, which declined to 8,188 in 1952. The consumption in the Anchorage area is about 14,000 tons. Scarcely any coal

is burned in Juneau by hand firing or other means. Approximately double the hand fired tonnage is burned satisfactorily in domestic stokers. There appear to be no special problems in either the storage or use of these small amounts of domestic coal, hence, it is doubtful if a premium-priced char briquette could compete in this market.

In 1952, the average price of all domestic fuel at the wholesale fuel yard in Fairbanks was $11.91 per ton for subbituminous coal from the Healy River mines; the delivered price is $14.41. In Anchorage, the comparable delivered price is about $26.35 for Matanuska Valley bituminous coal.

Industrial

Another possible outlet for the char would be as a safe, storable fuel for industrial use either as char itself or briquettes. The major industrial market for coal in Alaska is at military establishments. In the Anchorage area, 25 million B. t. u. (the so-called standard ton) from coal now costs $17.58 and from fuel oil, $20.52. Considering this narrow spread, the opinion was expressed by a mechanical engineer, concerned with coal procurement and burning, that coal was pricing itself out of the market. It is thus apparent that a premium price cannot be obtained for char and any

economic evaluation of a low-temperature carbonization process must assume that the value of the char per B. t. u. cannot be greater than that of coal.

Also, this survey indicates that char has only a slight advantage over coal in providing a safe and storable fuel. For example, no difficulty has been encountered in a 1,000-ton, 20-foot pile of Healy River subbituminous coal which has been in storage for 25 years at Fairbanks. Examination showed that the top 6 to 12-inch layer had disintegrated to a fine size but immediately below this layer the coal had retained its apparent initial size and showed no visual evidence of deterioration. However, it is not uncommon for coal from the Healy River area to develop "hot spots" in storage which are removed mechanically; such difficulties are minimized by covering the initial storage pile with fine slack. Most of the industrial users of subbituminous coal do not consider storage a serious problem. Evidence of the ability of coal users to stockpile Alaskan coals is furnished by the following tabulation of coal in storage as of September 1953:

	Tons
Eielson (Fairbanks)	98,500
Ladd (Fairbanks)	175,000
Elmendorff (Anchorage)	86,000
Fort Richardson (Anchorage)	45,000
Total	404,500

Moreover, even in the Fairbanks area, where extremely low temperatures prevail in the winter months, no difficulty has been encountered in removing coal from storage in winter. Usually the frozen crust on the pile of coal is only a foot or two thick.

Foreign.

It was suggested that the char from low-temperature carbonization could be shipped to Japan for use in the manufacture of metallurgical coke. This proposal did not appear reasonable because of (1) the high cost of Alaskan coal, (2) the large reserves of Japanese low-rank bituminous coals, and (3) the advanced technological development in Japan. At the first opportunity, therefore, discussions were held with a representative of the Japanese coking industry to evaluate the possible market in Japan for char.

Such a discussion was held recently in Pittsburgh with Mr. Tojiro Oka, Manager of the Coke Department, Kurosaki Factory, Mitsubishi Chemical Industries Limited, who stated that the price of char delivered to the coke ovens of the above company was $14.00 per metric ton (2,200 lbs.) for a 15% ash char. Further, he stated that within the past year the company manufacturing the char, using the Lurgi carbonization system, was unable to operate profitably at this figure and had ceased operations. The competitive fuels that forced abandonment of the plant were (1) low-volatile

Pocahontas coal of less than 7% ash, which is delivered at the above plant for $19.50 per metric ton (this price includes $10.00 per ton freight and $9.50 coal at Newport News), and (2) Indo-China Anthracite (6% ash, 9% volatile matter, 0.4% sulfur) at $22.00 per metric ton. The low ash, volatile matter, and competitive prices were determining factors in the overall economic picture that forced the shut down of the low-temperature carbonization plant. Mr. Oka stated that if the Japanese coke industry would pay more than $14.00 per ton for the char, this plant would be reopened. It is thus reasonable in an economic evaluation of char to assume that any imported char must be sold for $14.00 or less per metric ton in Japan.

It is shown on page 10 of this report that from 2,000 lbs. of Healy River coal ($8.95 per ton as mined) 1,090 lbs. of char (16.5% ash) is obtained in low-temperature carbonization. If this char is sold simply for its fuel value--same price per B.t.u. as from original coal--the value would be $\frac{\$6.35 \times 2200}{1090} = \$12.80$ per metric ton at the mine. The present freight rate from the Healy River mines to Anchorage is $4.15 per ton (2,000 lbs.). If it is assumed that the same freight rate is applicable per ton of char (in the U. S. the freight rate per ton of coke is higher than per ton of coal), then the freight from Healy to Anchorage would be $\frac{\$4.15 \times 2200}{2000} = \$4.55$ per metric ton, and the value of the char at

Anchorage would be $17.35 per metric ton for a 16.5% ash char. The price in Japan would be increased by the shipping cost from Anchorage to Japan.

It is thus apparent that such char is completely non-competitive with local Japanese char ($14.00 per ton--only 15% ash), and no market in Japan can be anticipated. The situation in the United States is even less favorable.

Tar

As the demand for char appears limited in all markets and it further appears that a premium price for char cannot be obtained, any sound economic evaluation of a low-temperature carbonization plant must assign to the char only a value proportional to its heat content so that the cost per B. t. u. is the same from char as from coal. Consequently, the entire processing costs must be borne by the tar and gaseous products.

For orientation purposes, the following considerations are made, using a representative coal from the Healy River field which, as mined, shows: Moisture, 21%; ash, 9%; and heating value, 8,840 B. t. u. per lb. The cost at the mine is $8.95 per ton. Using the data on the low-temperature carbonisation yields for Suntrana coal given in the monthly progress report for December 1950 from

the Coal Branch, Region IV, it can be shown that the following relations hold:

Raw Coal	Carbonization Products
2,000 lb. - Value = $8.95	Char - 1,090 lb. - Value = $6.35 Tar - 21.5 gallons Gas - 170 lbs.

If it is assumed (1) that the gas has no value other than to supply all the heat needed for carbonization; (2) the cost of processing the coal is $1.50 per ton, which figure would include plant operation, maintenance, amortization, labor charges, etc.; then the tar at the mine must sell for $\frac{\$8.95 + \$1.50 - \$6.35}{21.5} = \$0.19$ per gallon to break even. This figure should be compared to $0.10 per gallon as the value of tar at the coke oven in the United States. Further, Mr. Oka, to whom reference has already been made, states that his company buys gas house tar in Japan at 9800 yen per metric ton, which is roughly equivalent to tar at 10.3 cents per gallon. It is thus apparent that the tar resulting from the proposed low-temperature carbonization plant must sell for roughly twice the price of either coke oven tar in the states or local tar in Japan. It should be recognized that the figure of $1.50 per ton for processing is quite low, and it is doubtful if the coal could be processed for this amount with the high labor costs prevailing in the Alaska territory.

In order to compare the cost of tar from low-temperature carbonization with that of imported fuel oil and asphalt, a survey was made of various possible uses in which the latter find application--the uses investigated were:

Road Material.

Discussion with representatives of the Alaska Road Commission disclosed that at the present time they are using in the road paving program 8,000 to 10,000 tons per year of asphalt, which is purchased at $25.00 per ton. Taking the specific gravity of asphalt as 1.2, this is equivalent to $0.125 per gallon, or approximately 65% of the cost of tar at the mine. It is thus seen that a premium price must be obtained for the tar acid fraction of the tar if the pitch is to compete in this market.

Binder for Briquettes.

Here again the pitch fraction would be competing with 12-cent per gallon asphalt. Further, the very small potential market for both domestic and industrial briquettes makes this market unattractive.

Fuel Oil.

It has been suggested that some of the tar distillates could be used as a fuel oil for use in the territory. Discussion with a representative of the Armed Services at Fort Richardson disclosed

that the cost of fuel oil in tanker lots at Anchorage is of the order of 10 cents per gallon. Here again the cost is about half that of tar.

Creosote Oil.

Discussion with a member of the Forest Service indicated that the use of this oil for creosoting wood in Alaska is limited. It was stated that the most abundant timber in the territory are spruce and hemlock, and that these woods were not nearly as amenable to creosoting as those from Washington and Oregon. It does not appear, therefore, that the present or anticipated demands for creosote oil justifies a low-temperature carbonizing plant.

Gas

In addition to the char and tar, the third principal product of carbonization is gas. The gas from low-temperature carbonization of the low-rank coals of the Healy River area contains considerable amounts of carbon dioxide, of the order of 30 to 40%, which contributes nothing to the heating value of the gas. There is considerable doubt that such gas can be used for purposes other than supplying the heat necessary for carbonization, particularly if the carbonization unit is located near the mine. In the case where the low-temperature carbonization plant is operated in conjunction with a thermal power plant, the excess gas can be used as fuel. In this case, however, either new thermal plants must be built at the mine

or the coal must be shipped to existing plants, which will add to the cost of the coal some $3.00 per ton.

The possibility of using the gas for domestic purposes was considered, but the expected presence of petroleum and natural gas in the territory makes it extremely doubtful that a plant would be built for gas generation.

General Observations

The high cost of Alaskan coal makes it unlikely that any low-temperature carbonization process can compete successfully with other countries or the United States at the present time. The cost per ton of low-grade coal in Alaska is substantially higher at the mine than the good-grade coking coals in other areas of the United States. It appears that the major problem in Alaska, if a chemical industry based on coal is to be developed, is to reduce coal cost substantially below the present value. If the cost of coal could be reduced to $3.00 per ton, then the price of the tar could be reduced to the order of 11 cents per gallon, which brings it into at least a competitive range with tar from other sources.

Even if such a reduction in price were possible, however, major problems in disposal of the pitch resulting from the refining of such tar would arise. It has not been shown, for example, that pitch from low-temperature tar is a suitable material for road construction, tar roofing, pitch paints, etc., and considerable

development work on refining a low-temperature tar and development of suitable markets would be necessary. The chemical industry has geared itself to high-temperature tar from coke ovens, and the market for low-temperature tar is not developed. It may be that in the near future such markets will be developed, using the tar from the Texas Power and Light Process, but there is no definite assurance that this tar will be competitive on a dollar per gallon basis with high-temperature coke oven tar.

Conclusions

1. The high price of Alaskan coal makes it extremely doubtful that a low-temperature carbonization plant can be justified.

2. The selling price of char and of Pocahontas low-volatile coal in Japan is such that Alaskan low-temperature char is non-competitive. Any char resulting from carbonization would find use only as a power-plant fuel at the same value per B. t. u. as the original coal.

3. There is only slight difficulty in storing Alaskan coals if modern storage practices are followed. It will not be possible to obtain a premium price for char in the Alaskan territory.

4. The cost of tar from low-temperature carbonization will be substantially greater than coke oven tar in the United States or water gas tar in Japan, so it does not appear that the tar can be marketed economically at the present time.

COMPETITIVE STATUS OF ALASKAN COAL

In the discussion of the feasibility of installing a plant for the low-temperature carbonization of coal, one fact stands out, namely, that Alaskan coal costs are too high to be competitive either in the United States or in Japan. At the present time in the Anchorage and Fairbanks area it appears that coal is pricing itself out of the market, even for heating purposes. Discussion with representatives of the Army base at Fort Richardson disclosed that at this base the cost of 25 million B. t. u. of heat is $17.58 from coal and $20.52 from oil, and this differential has been steadily narrowing. If mining costs continue to rise, it appears rather doubtful that coal can retain even its present markets unless the government is willing to subsidize production or to forbid the Armed Services from using oil.

Another interesting point for consideration is that the Armed Services are building a 622-mile, 8-inch pipeline from Haines to Fairbanks with a capacity of the order of 500 bbls. of fuel oil per hour. Using the conversion factors of 4.285 bbls. of oil, equivalent to 25 million B. t. u., and 1.41 tons of Healy River coal, equivalent to 25 million B. t. u., it can be shown that this pipeline has a yearly capacity equivalent to 1,185,000 tons of Healy River coal. Such a tonnage is of the same order as the total Alaskan coal production,

and the implications are self evident. Adequate capacity, competitive prices, and ease of operation with oil will be powerful arguments for the replacement of coal by oil at the military establishments. It thus appears that if coal is to hold its own markets in the territory, prices must be reduced. It is our opinion that the greatest opportunity for coal research in Alaska is in the development of better mining methods to produce lower cost coal.

POSSIBLE USES TO INCREASE THE UTILIZATION OF ALASKAN COAL

As it did not appear that low-temperature carbonisation would be feasible, some time was spent in considering other possible uses for coal. These were: (1) For thermal power generation and (2) for manufacture of synthetic ammonia.

Thermal Power Generation

At the present time the electric power supplied to the Anchorage and Fairbanks area is generated in relatively small thermal plants located in these cities. The high cost of coal and the relatively low capacity of these stations result in high cost power of the order of 22 mills per KW hour. Representatives of the Rural Electrification Administration suggested that this cost can be greatly reduced by building large, modern thermal plants at the mine site and transmitting at 230,000 volts to both the Anchorage and Fairbanks

area. It seems reasonable to expect a large growth in the consumption of electricity in the area. It further appears that thermal generating stations can take their fair share of this market if sufficient quantities of coal at a reasonable price are available. If the price of coal at the mine can be reduced to about $4.00 to $5.00 per ton and large modern thermal plants built, a greatly increased market for Alaskan coals will develop.

One possible deterrent to the construction of thermal power plants is the hydroelectric development program of the Bureau of Reclamation. One site is already being developed at Eklutna, with a capacity of 30,000 KW. The best estimate of the cost of power from this project is 11 mills, although doubt was expressed in some quarters that power will be available at this low value when the actual operation is begun. There is considerable discussion of a 1,000,000 KW hydroelectric plant at Susitna with power available at 5 to 6 mills. If this development takes place, it is doubtful that a thermal power plant would be built. However, it is by no means certain that this plant will be built or, if built, that it can supply power at the price stated.

Even for 6 mill power, the coal situation would be hopeful and attractive if the cost of coal could be reduced to about $4.00 per ton at the mine. With coal at this price, and using modern thermal

power plants at the mine site, coal could be competitive with hydroelectric power, so that the incentives for lowering the price of coal per ton are great.

Synthetic Ammonia

Casual observation of the area in and around the Matanuska Valley showed that only a small amount of farming is done. Discussion with residents in Anchorage and Fairbanks indicated that the soil is rather impoverished and not suitable for farming without extensive fertilization. We have neither the background nor knowledge to comment factually on the need for fertilizer in the area or whether climatic conditions are responsible for the small number of farms. However, if an impoverished soil is the real reason for lack of agriculture, then there might be a future use for Alaskan coal in the manufacture of synthetic ammonia for fertilizer. This could represent a fairly large industry and one which would greatly aid in the development of the territory if successful. We mention this here merely for consideration and possible reference to the U. S. Department of Agriculture for a factual analysis of the situation.

RECOMMENDATIONS

1. Prime research effort in Alaska should be directed toward development of improved mining methods to reduce coal costs.

2. A research program on the characterization and utilization of low-temperature tar should be initiated in order to develop products and markets for the chemicals obtained in low-temperature carbonization. Such a program assumes that the price of Alaskan coal can be sufficiently reduced so that the cost of tar per gallon is competitive with that in the United States and Japan.

3. A research and development program for evaluating the suitability of pitch from low-temperature carbonization for use in road materials, tar roofing, etc. should be undertaken. Here again it is assumed that coal costs can be materially reduced from the present level.

4. A thorough survey of the fertilizer needs of the territory should be made to see if a synthetic ammonia plant can be justified.