Carbonizing and Briquetting of Lignites

Economic Possibilities

Commission of Conservation
Canada

COMMISSION OF CONSERVATION
CANADA

Carbonizing and Briquetting of Lignite

Economic Possibilities

BY

W. J. DICK, M.Sc.

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OTTAWA—1917

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May it Please Your Excellency:

The undersigned has the honour to lay before you a report on the possibilities of establishing a carbonizing and briquetting plant for the treatment of lignites in Saskatchewan.

Respectfully submitted

CLIFFORD SIFTON

Chairman

Ottawa, Oct. 25, 1917

Ottawa, Canada,

Oct. 24, 1917

Sir:

I beg to transmit herewith a report on the possibilities of establishing a carbonizing and briquetting plant for the treatment of lignites in Saskatchewan. The report has been prepared as a result of a visit made by Mr. W. J. Dick, M.Sc., Mining Engineer to the Commission of Conservation, to the lignite fields of Western Canada, and a thorough investigation of the problem.

Respectfully submitted

JAMES WHITE

Deputy Head and Assistant to Chairman

Sir Clifford Sifton, K.C.M.G.
Chairman
Commission of Conservation

Note

The information contained in this pamphlet was prepared by Mr. W. J. Dick, M. Sc., Mining Engineer, Commission of Conservation. The numerous enquiries respecting this important question—the economic use of our Lignites—received by the Commission of Conservation and by the Advisory Council for Research demonstrate that it should receive the widest possible distribution.

Carbonizing and Briquetting of Lignites in Saskatchewan

Foreword

EVER since the organisation of the Commission of Conservation in 1910, the utilization of the lignites of the Prairie Provinces has received attention. The Commission early realized that the solution of this problem would overcome the fuel difficulty of these provinces, and also promote the industrial development of those portions which are without water-power resources.

At the annual meeting of the Commission in 1912,* the Committee on Minerals recommended that:—

"Owing to the necessity of obtaining a suitable domestic fuel and cheap power for the Prairie Provinces, it is desirable that investigations be carried on with a view to utilizing the lignites which underlie the greater portion of these provinces."

The recommendation also pointed out that the United States Bureau of Mines had demonstrated that low-grade lignites could be briquetted, and adverted to the fact that Germany utilized her brown-coal or lignite deposits by briquetting, producing in 1910 some 21,575,000 short tons of briquettes, of which 77% was made from lignites.

In harmony with this recommendation, Mr. W. J. Dick, as Mining Engineer of the Commission, visited the lignite fields of western Canada in 1912 and 1913, and investigated the problem. The report † discussed in detail the supply, quality, and method of treatment of the western lignites necessary to render them serviceable as a fuel both for domestic and power purposes.

It was probably these early investigations of the Commission of Conservation that prompted the Advisory Council for Scientific and Industrial Research, when it took up the fuel problem of western Canada immediately after its formation in 1916, to apply to the Commission for information on the subject. The report which follows is the result. It deals mostly with the economic side of the problem, and is largely a summary of portions of the information gathered in 1912 and 1913 brought up to date after Mr. Dick had again visited the Prairie Provinces in 1917 for further investigation of the fuel situation. Because of the present importance of the subject, it has been thought advisable to publish the report in this brief and readily available form.

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* *Report of the Third Annual Meeting.* Commission of Conservation, 1912, page 27.

† *Conservation of Coal in Canada, with Notes on the Principal Coal Mines.* By W. J. Dick, Commission of Conservation, 1914.

Carbonizing and Briquetting of Lignites in Saskatchewan

THE GENERAL FUEL SITUATION

THE producing coal-fields of Canada are situated in the eastern and western portions of the Dominion. Owing to economic conditions, the interior portion, from Cornwall on the east to Swift Current on the west, is supplied by coal from the United States, central and eastern Ontario being supplied *via* St. Lawrence, Lake Ontario and Niagara River ports, while that for the west is shipped by rail to Buffalo and other Lake Erie ports, whence it is carried by water and rail to its destination. Bituminous coal is used principally for railway purposes and anthracite for domestic use.

Solution of Fuel Problem in Manitoba and Saskatchewan

In so far as supplies of fuel are concerned, the eastern portion of Saskatchewan forms the competitive area between supplies of United States coal on the one hand and of the high-grade bituminous coal of the Rocky mountains on the other. Owing to this fact, the cost of fuel in this portion of the province is high. The southern half of Saskatchewan has been considerably developed, and forms today the most important portion; but there are no water-powers within this area, that could be utilized as a source of cheap power for the most important cities. The central and southern portions of the province receive little precipitation, and consequently have no large rivers; such creeks and lakes as are found do not even provide water suitable for domestic purposes. This area, however, is situated in proximity to large deposits of lignite coal.

In 1916, 533,642 tons of anthracite coal and 2,376,934 tons of bituminous coal were imported *via* Port Arthur, Fort William and Manitoba ports of entry. At least four-fifths of the anthracite was used as a domestic fuel in Manitoba and Saskatchewan. United States anthracite is used because of its non-smoky nature and because it burns in a heater for a long time without replenishment. The imports of anthracite have been increasing, notwithstanding its increase in price. If mined at the present rate of production, the anthracite coal reserves of the United States will be exhausted in about 100 years. It must, therefore, be expected that the price will gradually increase until only the wealthy can afford it. Coincidently, with the rising price, production will decrease, thus prolonging the life of the mines. This decrease in production is already manifest, as during the four-year period, 1913-16, production decreased from 91,524,922 tons in 1913 to 88,312,000 tons in 1916, or rather more than 1 per cent per annum.

This situation is unique, and the high price paid for anthracite coal has not a parallel elsewhere. In other countries, even where coal is cheaper than in Canada, substitutes have been developed. In 1917, the price of anthracite coal in the west varies from $12 per ton at Winnipeg to $14.50 in Moose Jaw. It is desirable, both from mining and national standpoints, that these conditions be changed. It is inconceivable what would happen if the exportation of hard and soft coal from the United States were prohibited. We had, in the spring of 1917, a slight indication of what it would mean, when a freight blockade caused a temporary shortage in some localities.

It is thus evident that, before many years, Western Canada will not be able to procure supplies of anthracite from the United States. As there are no supplies of this class of coal suitably situated in Canada, some kind of a substitute must be found. Briquetted lignite is the one most easily available.

The problems to be dealt with in the provinces of Manitoba and Saskatchewan are those of domestic fuel and cheap power. These may be solved by the proper utilization of the low-grade fuels which underlie a portion of Saskatchewan. In order to make this coal transportable and suitable for domestic and power purposes, it would be necessary:

1. That it be of sufficient value to bear the cost of transportation.
2. That it withstand handling and a certain amount of weathering.
3. That it be a suitable fuel for domestic and power purposes.

Coal or lignite briquettes and carbonized lignite briquettes fulfil these conditions.

Manufacture of Carbonized Lignite Briquettes

Raw lignite is heated in closed retorts, somewhat similar to by-product coke ovens. The volatile matter and moisture is driven off in the form of gas, a portion of which may be used for heating the retort and the remainder recovered as a by-product. The carbonized material, unlike bituminous coke, is hard, dense and incoherent, consisting chiefly of slack. When briquetted, it produces a fuel similar in many respects to anthracite coal.

It is not the object of this report to deal with the actual briquetting problem, but to set forth the economic situation which justifies the erection of a briquetting plant in Saskatchewan.

Coal Available for a Briquetting Plant in the Souris District

On account of the nature of the coal, and its proximity and transportation facilities to suitable markets, the best location in Saskatchewan for such a plant would, no doubt, be in the Estevan district.

A plant with a capacity for briquetting 10 tons per hour is proposed, but it is the intention to operate the briquetting division half-time only, until the plant is proven. Although the plant is capable of producing double this tonnage, the estimated cost of producing briquettes, as outlined further in this report, is based on half the capacity of the briquetting plant only. It will operate on carbonized lignite, and, as two tons of raw lignite are required to produce one ton of briquettes, the amount of coal required annually is 60,000 tons. The principal producing mines in the Estevan district are:

	Production in 1916
Western Dominion Collieries	91,843 tons
Manitoba and Saskatchewan Coal Co	67,809 "
Bienfait mine (Hosmer mine)	36,452 "
Saskatchewan Coal, Brick and Power Co. (Shand mine)	23,755 "

As there is, practically, no market for lignite slack, the coal is loaded into cars in the mine by means of forks, the fine coal being left behind. On account of the rapid disintegration of lignite, the product from the mine is screened on the surface and the slack wasted. In this way from 15 to 20 per cent, or more, of that mined is wasted. This waste in mines of the Bienfait district amounts to from 30,000 to 35,000 tons per annum.

Cost of Mining

If the demand for coal were such that the mines could work up to capacity throughout the year, the cost of production would be less than at present, but there would be other disadvantages.

The cost of producing one ton of saleable lignite is estimated at from $1.25 to $1.50, depending on the mine, plant equipment, etc. If all the coal mined were saleable, it is estimated that the cost of production would vary from $1.14 to $1.41 per ton. The slack coal now wasted could be obtained at from 50 cents to 75 cents per ton.

Summary—1. The requirements of the proposed carbonizing plant are 60,000 tons per year.

2. From 30,000 to 35,000 tons of slack coal could be obtained annually at Bienfait at a cost of 75c per ton; 5,000 tons at Shand

station at about 60c per ton, whilst 20,000 tons could be obtained under certain conditions from Estevan at 50c per ton.

30,000 tons at 75c per ton.....	$22,500
5,000 tons at 60c per ton*.....	3,000
20,000 tons at 50c per ton†.....	10,000
55,000 tons at a total cost of.....	$35,000

Average cost per ton of slack at mines = 65c.

In this district there is sufficient slack made in mining operations to supply a plant of the size proposed. On account of the slack being produced principally in the autumn and winter months, and, as it cannot be stored, there would not be a steady supply of this material to keep the plant in continuous operation. On the other hand, there would be a large enough supply for about half of the time, and at a period when the mines would be glad to sell it; for the remainder, run-of-mine ‡ coal could be obtained at a price of $1.50 per ton.

Location of Carbonizing and Briquetting Plant

The economic selection of a location in Saskatchewan, for the carbonizing and briquetting plant is determined by the following:

(1) Suitable supply of cheap coal near plant
(2) Transportation facilities by which the briquetted material may be delivered to the most profitable markets at a minimum cost due to freight charges
(3) A consideration of markets for by-products, such as gas, resulting from carbonization of the lignite.

Supply of Coal—The only developed mines which could deliver adequate supplies of coal are the Western Dominion collieries, Manitoba and Saskatchewan Coal Co., Bienfait mine, Shand mine, Estevan Coal and Brick Co. All these mines are in the vicinity of the town of Estevan.

Transportation Facilities—Either Estevan or Bienfait presents exceptional advantages for serving the larger markets of Saskatchewan and Manitoba.

Markets for By-products—The most important by-product recovered during carbonization is gas. From every ton of lignite

* If the plant were constructed at Bienfait, this cost would be increased to $1.16 by the freight and switching charges from Shand to Bienfait.

† If the plant were constructed at Bienfait, this cost would be increased to 96 cents by the freight and switching charges from Estevan to Bienfait.

‡ Includes all coal mined.

carbonized there is a surplus of 4,000 cubic feet of gas with a heat value of 400 to 450 B.T.U. per cubic foot. In the carbonization of 60,000 tons of coal, 240 million cubic feet of gas would be produced as a by-product.

This gas is valuable as a source of power for brick burning, domestic heating and for all purposes requiring heat or fuel. The candle-power is below the standard for lighting, but it could be used to generate electricity for lighting purposes.

In brick burning, gas fuel is very desirable, as it permits an even and uniform burn throughout the kiln, and requires less labour for firing and attendance than coal firing. A potential market exists in the brick plants of the Estevan Coal and Brick Company, and Saskatchewan Coal, Brick and Power, Limited.

The Estevan electric light plant is too small for present requirements and the city would be pleased to take gas to increase its capacity. This plant would require gas of at least the equivalent of 4,000 tons of lignite at $2.10 (pre-war price). There is no city gas plant in operation and the city still holds the franchise. There is, therefore, a potential market at Estevan for some 10 million cubic feet per annum for heating and cooking purposes, provided the city undertook the distribution.

Summary—

Value of by-product gas which would replace coal at Estevan electric power plant	$ 8,400 per year
Domestic heating and cooking, 10,000 M. at 10c per M	1,000 " "
Estevan Coal and Brick Co. at 10c per M	7,500 " "
Total	$16,900 " "

After meeting the above requirements there would still be a surplus of about 70 million cubic feet per year. There is no demand for this surplus, at present, but it would be available for extension of the Estevan power plant and for encouraging the development of manufacturing enterprises.

While the following shows the estimated cost of 60,000 tons of slack and run-of-mine coal at the most economic locations for the

carbonizing and briquetting plant, the factor of *quality of coal* would also have to be considered:

Cost of Coal at Bienfait—	
30,000 tons of slack at 75c per ton	$22,500
30,000 tons run-of-mine at $1.50 per ton	45,000
Total	$67,500
Average cost per ton	$1.12½
Market for gas	None
Cost of Coal at Estevan—	
20,000* tons of slack at 50c per ton (10c freight)	$12,000
10,000 tons of slack (from Shand) at 60c per ton (freight Shand to Estevan 40c)	10,000
30,000† tons of run-of-mine at $1.50 (switching charge 6c per ton)	46,800
Total	$68,800
Average cost per ton	$ 1.15
Market for gas, per year	$16,900
Cost of Coal at Shand—	
5,000 tons of slack at 60c	$ 3,000
25,000 tons of slack from Bienfait at 75c per ton (freight and switching charges, 60c per ton)	33,750
30,000 tons of run-of-mine at $1.50 per ton	45,000
Total	$81,750
Average cost per ton	$1.36
Market for gas, per year	$3,000

The distances from Estevan to Bienfait and Shand are about 8 miles and 6½ miles, respectively, and, as the soil is sand and gravel, without rock exposures, it would not be a very costly undertaking to pipe gas from one place to the other.

Estimated Cost of Carbonizing and Briquetting

According to estimates prepared by R. A. Ross, chairman of the Lignite Committee, Honorary Advisory Council for Scientific

* This slack could be obtained provided gas was supplied at a reasonable price for fuel for brick burning.

† It is assumed that the Estevan Coal and Brick Co. could supply this quantity of coal.

Research, the cost for carbonizing and briquetting, at a plant producing 30,000 tons per annum, would be as follows:

Total cost of plant, etc.	$366,534
Fixed charges—	
Interest, 6 per cent. Depreciation, 10 per cent. Repairs, 4 per cent.	73,307
Fixed charges per ton of output	2.45
Total operating expenses	4.55
Total cost of carbon briquettes, per ton	$7.00

This estimate is based on a cost of $1.00 per ton for coal, but if a market for gas be not considered, and, assuming that the plant were constructed at Bienfait, the requisite amount of coal is estimated to cost $1.12½ per ton. As two tons of coal are required in the production of one ton of briquettes this would increase the cost of briquettes 25c per ton over Mr. Ross' estimate, or a total cost for producing one ton of carbonized briquettes of $7.25.

The following table shows the estimated cost of carbon briquettes compared with the price of United States anthracite coal in certain cities in Manitoba and Saskatchewan:

COMPARATIVE COST OF UNITED STATES ANTHRACITE COAL AND CARBON BRIQUETTES IN MANITOBA AND SASKATCHEWAN

City	U.S. anthracite used in 1916-17	Price of U.S. anthracite per ton, f.o.b.*	Carbon briquette		Difference in favour of carbon briquettes
			Freight and Switching	Estimated price, f.o.b. cars†	
	Tons				
Winnipeg	200,000	$ 9.50 to $10.00	$1.90	$10.15	
Portage la Prairie	4,000	10.00 " 10 50	1.80	10.05	. 0 to .45
Carberry	1,050	10.65 " 11.15	1.60	9.85	.80 " 1.30
Brandon	9,200	10.60 " 10.85	1.50	9.75	.85 " 1.10
Virden	2,280	10.80 " 12.15	1.60	9.85	.95 " 2.30
Moosomin	1,836	11.00 " 12.25	1.80	10.05	.95 " 2.20
Wolseley	1,012	11.50 " 11.75	1.80	10.05	1.45 " 1.70
Regina	45,300	11.60 " 12.25	1.60	9.85	1.75 " 2.40
Moose Jaw	3,845	11.45 " 12.35	1.50	9.75	1.70 " 2.50

The following is a comparison of the chemical analyses and

* Owing to the exhaustion of the anthracite resources of the United States, these prices will increase year by year.

† Including profit of $1.00 per ton.

calorific values of anthracite coal, lignite and carbonized lignite briquettes:*

	Moisture, per cent	Volatile matter, per cent	Fixed carbon, per cent	Ash, per cent	Heating value, B.T.U.
Lignite as mined...	35.01	25.01	34.67	5.21	7,000 to 7,800
Lignite briquettes carbonized.....	0 to 6	2 to 8	72 to 82	10 to 16	11,500 " 12,000
Anthracite.....	1 to 5	2 to 6	78 to 92	10 to 15	12,000 " 13,500

Analyses of the lignites (as mined) from the Estevan district show that lignite from this field is equally as high in value as the analyses given above. The analyses show that the heating values of carbonized lignite briquettes and anthracite coal are practically equal, and, in practice, the briquettes and anthracite will stand comparison very closely on the basis of cost. The briquettes should, however, be made from lignite low in ash, that the calorific value may be kept as high as possible.

From the table on page 13 it will be seen that Regina and Moose Jaw could consume the total output from the proposed plant and that, at these points, the minimum difference in favour of the briquettes over United States anthracite coal is $1.70 per ton. In the intervening country districts the saving would be greater. Assuming that, in order to give the consumer some benefit from the manufacture of these briquettes, the retail selling price be $1.70 below the price of anthracite coal, there would still be a profit of $1.00 per ton, or $30,000 on the 30,000 tons, equal to 7½ per cent on the investment. In addition to this profit, there would be kept in Canada, annually, some $200,000, or one-half the total money spent on the plant. There is a possible market for this class of fuel equal to at least nine times the capacity of the proposed plant.

Suggested Method for Marketing Briquettes

The present practice of marketing coal in western Canada is by means of local agencies. These, besides selling United States coal, have the exclusive right to handle coal from a mine or group of mines in a particular coal field. In a few cases, the right to handle coal from a group of mines for distribution within the province is granted to one agency, which, in turn, distributes the coal to local dealers.

The cost of distributing is, in general, as follows: To the f.o.b. cost of coal, from 15 to 20 cents must be added as the cost of unloading the coal from cars and reloading on delivery waggons.

* *Economic Methods of Utilizing Western Lignite*, Bulletin 89, U. S. Bureau of Mines.

The delivery cost varies from 50 to 60 cents per ton. The selling price to the consumer is in some cases represented by the total cost of the coal (plus delivery) to the dealer plus 10 per cent for profit and overhead charges, as follows:

Cost, f.o.b., say	$10.00	per ton
Unloading and loading	.20	" "
Delivery	.60	" "
	10.80	" "
Dealer's profit, from which overhead charges must be deducted—10 per cent of $10.80	$ 1.08	
Cost to consumer	11.88	

No difficulty should be experienced in getting coal dealers to handle carbon briquettes, provided there is a fair margin of profit. One of the largest mining companies in western Canada requires all dealers handling its coal to sign a contract, in which the selling price of coal is fixed and certain conditions are imposed with regard to the handling of its coal exclusively.

The sale of carbon briquettes should be available to all dealers, but, in order to protect the public, and, at the same time, encourage the demand for this product, each dealer should be required to sign a contract to the effect that briquettes will be sold to him on railway cars at a stated price per ton (price may be reduced during summer months depending on conditions of coal trade) subject to the following conditions:

1. In selling to the public in carload lots, not more than ..... per ton be added to the foregoing rates.
2. In selling to the public in small lots from shed, not more than ..... per ton to be added to the above rates.
3. A reasonable amount per ton for cartage to be charged in addition to the above rates when delivery is required.
4. Payment for the coal to be made on arrival at..... station, when that point is a regular billing station for freight traffic; otherwise, cash must accompany order.
5. All contracts for the delivery of coal, either upon his part or upon that of the briquetting plant to be subject to interruptions of coal supply from any cause whatever.
6. Railway weights at point of shipment to govern settlements in all cases.
7. The dealer to keep on hand, at all times during the winter months, a supply of not less than .....tons of carbon briquettes, and, during the summer months, of not less than ..... tons.
8. This arrangement to terminate in any event on ..... but to be subject to cancellation at any time by either party giving one month's notice in writing.

Imports of United States Coal into Prairie Provinces

The total imports of coal into Fort William, Port Arthur and Manitoba, Saskatchewan and Alberta points of entry for the years 1914, 1915 and 1916 were as follows:

Kind of coal	Amount, in tons			Value in 1916
	1914	1915	1916	
Anthracite	612,164	485,330	533,642	$3,008,489
Bituminous—				
Slack	145,960	222,769	258,836	326,326
Lump and run-of-mine	2,995,181	1,586,620	2,118,098	2,759,873
Totals	3,753,305	2,294,719	2,910,576	$6,094,688

The foregoing valuation of the coal imported in 1916 is based upon the price at the mines in the United States and does not include the freight charges on American lines nor the freight on that brought up the lakes. The total amount of money which annually leaves Canada to pay for these imports represents approximately $10,000,000.

Coal is, in general, taken up the Great lakes as return freight by ships engaged in the ore-carrying trade and, therefore, a low freight rate is secured. Owing to war conditions, the price of imported coal, in some cases, has increased nearly 100 per cent. The following table shows the estimated cost per ton (2,000 lbs.) of bituminous lump coal, f.o.b. steamship, Fort William:

	Old price (1915-16)	Present price (1917)
Coal at mine	$1.60	$4.00
Rail freight to lake ports	.83	.98
Freight up lakes	.30	.50
Duty	.53	.53
War-tax	.12	.30
Total	$3.38	$6.31

The price of anthracite, f.o.b. cars at dock, Fort William, in 1916, was $7.10; the price in May, 1917, was: Egg and stove, $7.60; nut, $7.85. This price is made up as follows: Rail freight to lake ports, $1.85; selling commission, loading, etc., $0.70; lake freight, $0.50; price at mine, $4.55 (estimated); total, $7.60. The price of anthracite coal at any point west of Fort William would be the price, f.o.b. cars Fort William, plus the freight rate on the railway to that point.

KIND OF FUEL, CONSUMPTION AND PRICES, IN PLACES OF 1,000 POPULATION OR OVER ON MAIN LINE OF CANADIAN PACIFIC RAILWAY IN MANITOBA AND SASKATCHEWAN*

	Anthracite		Bituminous		Sub-bituminous		Lignite		Remarks
	Tons	Price per ton f.o.b.	Tons	Price per ton f.o.b.	Tons	Price per ton f.o.b.	Tons	Price per ton f.o.b.	
Winnipeg..	200,000	$11.25*a*	150,000	$8.00—$8.50*a*		$9.00—$9.50*a*			Much lignite is also used
Portage la Prairie...	4,000	$11.00—$11.50*a*	10,000	10.00—12.50*a*		9.00—10.00*a*	6,500	$5.75*a*	
Carberry...	1,050	10.65— 11.15	100	10.05	458	7.45— 8.35	972	$3.35—$4.40	
Brandon...	9,200 305	10.60— 10.85 7.95	2,516	8.10— 9.60	5,241	7.50— 8.00	19,000	3.00— 4.00	Bituminous screenings $6.40 to $6.60.
Virden.....	2,280	10.80— 12.15	126	11.75—12.15	2,829	7.15— 7.90	100		
Moosomin .	1,870	11.00— 12.25	269	8.85	1,670	7.00— 7.50	140	3.60— 4.00	
Wolseley...	1,174*c*	11.50— 11.75			2,135	6.70— 7.05			
Regina*g*...	55,300*d*	11.60*a*	150,000*e*	6.40— 7.00*a*			20,000	5.05*a* (slack) 6.50 (lump)	
Moose Jaw*b*	3,845 (U.S.) 2,360 (Canada)	11.45— 11.70*a* 7.25— 11.25 (pea) (stove)	7,031	4.95— 6.15	39,374*f*	5.30— 6.65	565	3.40— 3.90	

* Does not include coal used on railways and certain power plants.
a Delivered.
b In addition, some 210,000 tons are used for railway purposes.
c Includes 162 tons of Canadian anthracite, price $7.50 to $8.00 per ton.
d Includes 10,000 tons of Canadian anthracite, price $9.50 to $10.00.
e Includes 10,000 tons of U. S. bituminous coal, also sub-bituminous coal.
f A small quantity of U. S. coal is sold, price $10.60 per ton.
g The Regina statistics were furnished by the Regina Board of Trade, and, unlike the data respecting other points, include consumption by manufacturing plants and by railways.

Wood Fuel

The southern portions of Manitoba, Saskatchewan and Alberta have no large supplies of wood available as a source of cheap fuel. Up to a few years ago, wood, cut locally, was used to some extent but, with the gradual exhaustion of these supplies, the demand for coal is increasing yearly. The cordwood used in the Prairie Provinces comes from the following localities: Rainy River district of Ontario, southeastern Manitoba, districts west of lake Winnipeg and lake Manitoba, Riding mountains, vicinity of Prince Albert, Kootenay district of British Columbia, and from Minnesota.

These sources of supply are at a considerable distance from the centres of population of the Prairie Provinces, and the long freight haul largely increases the price. Even in certain of the areas above-mentioned supplies are becoming exhausted, and, under present conditions of transportation, there is no likelihood of its being used to any greater extent than at present.

Tamarack, poplar and birch constitute the principal fuel-woods. Prices in certain municipalities in Manitoba and Saskatchewan are as follows:

Portage la Prairie—Cordwood, f.o.b. Portage la Prairie, $5.50 to $6.00 per cord. The pre-war price was $1.75 per cord at the point of shipment, while the present price is $4.25.

Virden—Cordwood, f.o.b. Virden, $8.00 per cord; price at point of shipment, $5.00; freight charge to Virden, $3.00. The pre-war price was $6.85 f.o.b. Virden.

Moosomin—Price, per cord, f.o.b. point of shipment, $5.00 to $6.00.

Moose Jaw—Price, per cord, f.o.b. Rainy River district, $3.00; freight to Moose Jaw, $3.00; price per cord, f.o.b. Moose Jaw, $6.00. Price per cord, f.o.b. East Kootenay district, B.C., $4.00 to $4.50; freight to Moose Jaw, $3.00; price per cord, f.o.b., Moose Jaw, $7.00 to $7.50. The price to the consumer in Moose Jaw is $3.50 per one-quarter cord.

Oil

The refining and distribution of kerosene and gasolene in the Prairie Provinces is in the hands of three companies, viz., Imperial Oil Co., Continental Oil Co., and the Canadian Oil Co. The oil refineries are situated at Winnipeg and Regina, and the bulk of the crude oil comes from the oil-fields of Oklahoma and Wyoming. The quantity of oil sold in these provinces is estimated at about

500,000 gallons and distributed in approximately the following proportions: Alberta, 33⅓ per cent; Saskatchewan, 50 per cent; and Manitoba, 16⅔ per cent.

Prices—In Manitoba, with very few exceptions, there is a flat price for each grade of oil throughout the province. In Winnipeg, the price to dealers or large consumers is: Kerosene 19 cents per gallon (pre-war price 17 cents per gallon); gasolene, 35 cents per gallon. Elsewhere the price is 20 cents per gallon for kerosene and 35 cents per gallon for gasolene. In Saskatchewan and Alberta, with few exceptions, a flat price prevails for each grade of oil. Kerosene is 22 cents and gasolene 38 cents per gallon. Crude oil, f.o.b. Estevan, is 15.87 cents per gallon.

Lignite Deposits of Souris District

Two coal-bearing formations are exposed in Saskatchewan. The lower formation is the Belly River, which is exposed in the Saskatchewan valley, in the western portion of the province. In this area the coal is, in general, not well consolidated and is of poor quality; several mines have been opened up, but have since been abandoned. When in operation, the coal mine at Brock was working on a five-foot seam, which was considered the best showing in this area.

The operating mines in the Souris district are in the higher formation, which is, probably, Tertiary. The Tertiary beds are widely distributed in the southern portion of the province, where they form the lower portions of the Cypress hills, the greater portion of Wood Mountain plateau and the belt of elevated land extending north-west of Moose Jaw. Eastward, they form a shallow, synclinal basin in the Souris River valley and occupy some of the higher country to the north. On the south, they cross the international boundary at the second meridian and west of the third meridian.

There are a number of producing mines in the southern area, particularly in the vicinity of Estevan. There is also a developed mine situated on the lake of Rivers, about 35 miles due south of Moose Jaw, but it is understood that this mine is not working at present. The southern field is the most important in the province, and the lignite seams are thick and of good quality; the conditions also are such as to make mining operations safe and relatively cheap. The seams vary in thickness up to 15 feet. The following are analyses of mine samples from the Souris coal-field:

Locality	Moisture (freshly-mined coal) per cent	Proximate analyses of dry coal			
		Volatile, per cent	Fixed carbon, per cent	Ash, per cent	B. T. U.
*Taylorton	28.6	42.9	49.0	8.1	
*Estevan	30.9	40.0	43 2	16 8	
Bienfait Mine	29.25	29.05	35.90	5.90	7,605
Estevan Coal & Brick Co.—					
Upper portion, 3 ft. 6 in.	25.67	28.94	38.59	6.80	8,073
Lower portion, 3 ft.	26.20	26.70	35.95	11.15	
Willow Bunch Lake	20.15	28.47	34.18	17.20	6,388
Bienfait—					
Lower seam	22.40	29.73	37.97	9.90	
†Carbonized lignite	2.55	9.10	74.55	13.80	10,987

Channel samples of coal from the principal mines were taken by the writer and submitted to the Mines Branch, Department of Mines, for analyses. These samples weigh approximately 60 pounds each, and, as it is the intention to carry on tests with them, they have not yet been analyzed. The following are the results of proximate analyses* of the moisture samples, which are of importance only as indicating the moisture content of the coal when freshly mined. (The analyses were made on the fuel air dried and other results calculated therefrom):

LIGNITE COAL (MOISTURE SAMPLES) FROM WESTERN DOMINION COLLIERY, TAYLORTON, SASK.

Laboratory sample number	1,075			1,076		
Moisture condition of sample	Fuel as received	Fuel air dried	Fuel dried at 105° C.	Fuel as received	Fuel air dried	Fuel dried at 105° C.
Loss of air drying, per cent	13.7			12.9		
Proximate analysis:						
Moisture, per cent	34.3	23.9		33.8	24.0	
Ash, per cent	6.8	7.8	10.3	6.5	7.5	9.9
Volatile matter, per cent	26.3	30.5	40.1	26.0	29.8	39.3
Fixed carbon (by difference), per cent	32.6	37.8	49.6	33.7	38.7	50.8
Fuel ratio, $\frac{\text{fixed carbon}}{\text{volatile matter}}$	1.25	1.25	1.25	1.30	1.30	1.30

Coking properties: Non-coking.

Remarks: No. 1,075, straight north entry, 8 feet coal; No. 1,076, No. 4 west entry.

* Analyses by the Mines Branch, Department of Mines.
† Analysis by Darling.

LIGNITE COAL (MOISTURE SAMPLE) FROM BIENFAIT MINE, BIENFAIT, SASK.

Sample mark	No. 2			No. 1		
Laboratory sample number	1,077			1,078		
Moisture condition of sample	Fuel as received	Fuel air dried	Fuel dried 105° C.	Fuel as received	Fuel as dried	Fuel dried at 105°C.
Loss on air drying, per cent	14.0			13.4		
Proximate analysis:						
Moisture, per cent	34.3	23.6		34.2	24.0	
Ash, per cent	5.5	6.4	8.4	6.1	7.1	9.3
Volatile matter, per cent	27.0	31.4	41.1	30.0	34.6	45.6
Fixed carbon (by difference), per cent	33.2	38.6	50.5	29.7	34.3	45.1
Fuel ratio, $\frac{\text{fixed carbon}}{\text{volatile matter}}$	1.25	1.25	1.25	0.99	0.99	0.99

Coking properties: Non-coking.

Remarks: No. 1,077, No. 1 west level; No. 1,078, No. 5 east entry.

LIGNITE COAL (MOISTURE SAMPLE) FROM ESTEVAN COAL & BRICK CO., ESTEVAN, SASK.

Laboratory sample number	1,079			1,080		
Moisture condition of sample	Fuel as received	Fuel air dried	Fuel dried at 105° C.	Fuel as received	Fuel air dried	Fuel dried at 105°C.
Loss on air drying, per cent	10.0			9.0		
Proximate analysis:						
Moisture, per cent	35.9	28.8		34.9	28.4	
Ash, per cent	9.7	10.7	15.1	9.9	10.9	15.2
Volatile matter, per cent	26.4	29.4	41.3	24.7	27.1	37.9
Fixed carbon (by difference), per cent	28.0	31.1	43.6	30.5	33.6	46.9
Fuel ratio, $\frac{\text{fixed carbon}}{\text{volatile matter}}$	1.05	1.05	1.05	1.25	1.25	1.25

Coking properties: Non-coking.

Remarks: No. 1,079—Stripping; surface coal; 8 feet. No. 1,080—Mine sample from second room west; 8 ft. coal.

LIGNITE COAL (MOISTURE SAMPLE) FROM SHAND MINE, SASKATCHEWAN

Laboratory sample number	1,081		
Moisture condition of sample	Fuel as received	Fuel air dried	Fuel dried at 105° C.
Loss on air drying, per cent	8.6		
Proximate analysis:			
Moisture, per cent	34.8	28.6	
Ash, per cent	10.0	10.9	15.3
Volatile matter, per cent	24.5	26.9	37.6
Fixed carbon (by difference), per cent	30.7	33.6	47.1
Fuel ratio, $\frac{\text{fixed carbon}}{\text{volatile matter}}$	1.25	1.25	1.25

Coking properties: non-coking.

Remarks: From entry off main south entry, 9 feet coal.

LIGNITE COAL (MOISTURE SAMPLE) MANITOBA & SASKATCHEWAN COAL CO., BIENFAIT, SASK.

Laboratory sample number	1,082		
Moisture condition of sample	Fuel as received	Fuel air dried	Fuel dried at 105° C.
Loss on air drying, per cent	9.0		
Proximate analysis:			
Moisture, per cent	34.1	27.6	
Ash, per cent	7.6	8.3	11.5
Volatile matter, per cent	25.6	28.2	38.9
Fixed carbon (by difference), per cent	32.7	35.9	49.6
Fuel ratio, $\frac{\text{fixed carbon}}{\text{volatile matter}}$	1.25	1.25	1.25

Coking properties: Non-coking.

Remarks: Marked 'Main South.'

Coal Resources of Saskatchewan*

Group 1.—Including Seams of 1 Foot or Over, to a Depth of 4,000 Feet

District	Coal seams		Actual reserve (calculation based on actual thickness and extent)		Probable reserves (approximate estimate)	
	No.	Thickness	Area, in square miles	Metric tons (2,204 lbs.)	Area, in square miles	Metric tons (2,204 lbs.)
Belly River coal.....	1	Maximum, 8 ft.	18	108,000,000	1,500	11,000,000,000
	2	4 ft. and 7 ft....	...	.....	5,700	22,800,000,000
Tertiary coal..		Maximum, 18 ft.	288	2,304,000,000	5,900	23,600,000,000

Coal Mining in Souris Coal-field

Coal mining in this field does not require a large outlay of capital. The seam either outcrops on the surface, or is overlain by comparatively shallow deposits of clay, sand and gravel and a few feet of soft strata; consequently, the mines are developed by inexpensive tunnels, although one of the largest producers is operated by means of a two-compartment vertical shaft. The condition of the coal-mining industry is determined by (a) nature of the coal, (b) market, and (c) labour.

Nature of the Coal—The raw lignite contains a high percentage of moisture and, if exposed to the air for a short length of time, it slacks and disintegrates. It also ignites readily through spontaneous combustion. These defects, together with the cost of freight on an inferior coal, preclude its shipment for any great distance and prevent its storage for winter supply.

Market—The lignite may be successfully used with mechanical stokers for the generation of steam in boiler plants. It is also of special value as a source of power in producer-gas plants. The present market for this coal, however, is for heating and power purposes during the winter months, when, owing to freight conditions or severe weather, coal cannot be had from Alberta or the United States.

Labour—As the mines are practically idle during the summer months, labour is not employed continously. From the operator's

* *The Coal Fields and Coal Resources of Canada*, by D. B. Dowling, Geological Survey, Department of Mines.
Coal Resources of the World, International Geological Congress.

standpoint this has the advantage of permitting a certain selection of labour during the winter, when employment on farms is not obtainable.

The disadvantages are the higher cost of production, due to the overhead charges, and the necessity of keeping the mine in condition for operation in the autumn.

The following table shows the output from the mines:

OUTPUT OF SASKATCHEWAN MINES FOR THE CALENDAR YEAR 1916

Name of mine	Location Sec. Tp. Rge. Mer.	Output	Tonnage sold in Saskatchewan
Pierce Rock coal mine	29–1–2–2	50	50
Johnson mine	11–2–8–2	7,241	7,241
Estevan Coal & Brick Co	14–2–8–2	3,310	3,310
Munroe mine	14–2–8–2	277	277
Hosmer mine	19–2–6–2	54,678	36,452
Western Dominion Collieries	3–2–6–2	91,843	45,921
Superior Coal mine	25–1–7–2	35	35
Manitoba & Saskatchewan Coal Co.	10–2–6–2	67,809	33,905
Nicholson mine	2–2–8–2	680	612
Dawson mine	10–2–8–2	Not operated	
Riverside mine	34–1–6–2	2,826	2,826
Palmer mine	4–2–8–2	Not operated	
Lloyd mine	18–2–8–2	" "	
Shand mine	4–2–7–2	23,755	11,877
Excelsior mine	30–1–5–2	Not operated	
Big Chunk mine	10–2–8–2	1,350	1,350
Diamond mine	11–3–19–2	3,237	3,237
Wooloomooloo mine	14–2–8–2	1,401	1,401
Anderson mine	28–1–8–2	838	838
Roan mine	17–3–21–2	42	42
Heuval mine	11–7–27–2	1,030	1,030
Dee mine	22–4–16–2	185	185
Square Deal mine	32–3–26–2	670	670
Three Star mine	7–4–26–2	463	463
White Hope mine	18–2–8–2	700	700
Souris Valley mine	8–24–1–7	790	790
Commercial mine	23–2–7–2	Not operated	
Lake of Rivers mine	33–10–28–2	" "	
Frayne mine	22–1–6–2	206	206
Pure Lignite mine	25–1–6–2	400	200
Thistle mine	29–1–6–2	359	359
Halle mine	18–6–27–2	651	651
Readlyn mine	33–7–27–2	432	432
Ford mine	29–3–27–2	Not operated	
Lignite Power Co	24–2–8–2	In development	
How mine	3–5–23–2	650	650
		265,908	155,710