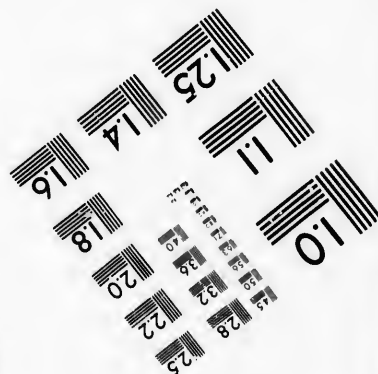
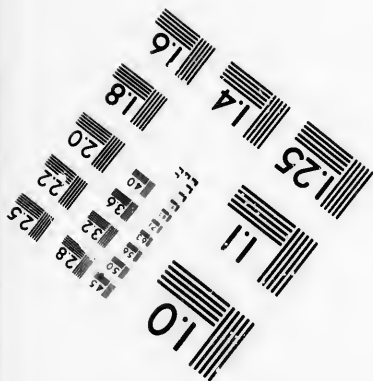
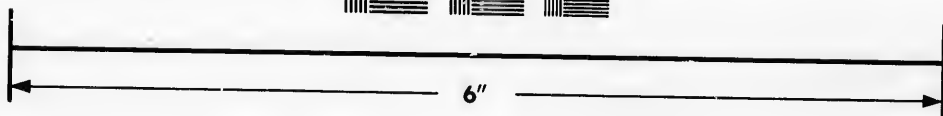
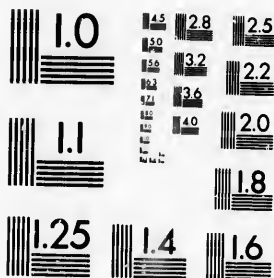


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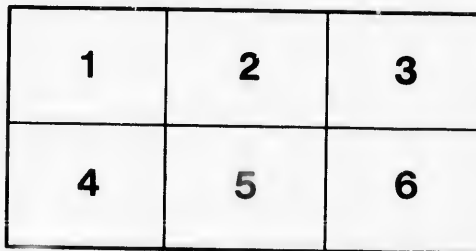
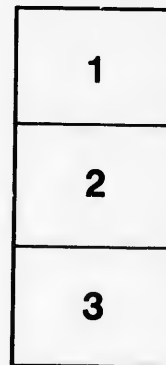
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Canadian Society of Civil Engineers.

ESTABLISHED 1887.

TRANSACTIONS.

N.B.—This Society, as a body, does not hold itself responsible for the facts and opinion stated in any of its publications.

Mr. Clement's paper will be read on Thursday, Nov. 3.

Mr. F. N. Gisborne's paper on the Telephone will be read on Thursday, Nov. 17, and will be practically illustrated.

NOTES ON PETROLEUM AS FUEL.

By L. M. CLEMENT, M. CAN. Soc. C. E.

Among the first trials in California of petroleum as fuel, was that on the ferry steamer "Thoroughfare," used for transferring freight cars across the Bay of San Francisco.

Results of the trial on this steamer were chronicled in the newspapers and fully quoted by railroad and engineering journals and works on fuel.

No mention was made of the quality of the Lone coal, with which the petroleum was compared, nor of the theoretical value of either fuel. Lone coal is a brown lignite of very inferior quality, too poor a fuel for general use, and compared with the ordinary commercial coal of this coast is about as three (3) tons to one (1).

Such a coal compared with petroleum, and not making known its quality would create false impressions among those who have not given fuel values any thought. They, of course, would assume that the coal was at least equal to the coals ordinarily used.

The analysis below of the Lone coal will be sufficient to establish its theoretical (comparative) value with other coals.

ANALYSIS OF LONE COAL.

Water.....	36.30 per cent.
Volatile carbonaceous matter.....	35.10 "
Fixed carbon.....	16.15 "
Ash.....	12.45 "

100.00

Adding the water and ash, and deducting we have,

Water.....	36.30
Ash.....	12.45

51.25 per cent.

51 1/4 per cent. of combustible material remains, and of this fully 20 per cent. will be used in the evaporation of the hygroscopic water contained in the coal; of the remaining 31 per cent., not over 80 per cent. will be the equivalent of a good British bituminous coal. $31 \times .8 = 24.8$

It is probable that one ton of average British bituminous coal is equal in evaporative power to four tons of the Lone coal. Therefore

one lb of oil ^{should} have an evaporative power equal to 11.6 lbs of Lone coal. But Lone coal is only 2.88 carbon cell coal apparently equal to British is only 2.88 instead of 4.55 times the value (as fuel) of Lone.

Calorific value of any fuel cannot be approximated from any the information given by chemical analysis alone.

PROXIMATE ANALYSIS OF PETROLEUM

[Crude mineral oil?]

Heavy Naptha distilling between 170 and 250 degrees	
Fah	3.76 per cent.
Light illuminating distilling between 250 and 400 degrees Fah	31.70 "
Lubricating oil distilling between 400 and 520 degrees	
Fah	39.10 "
Asphaltum Maltha and loss	25.44 "
	100.00 "

ULTIMATE ANALYSIS OF PETROLEUM.

Carbon	84.00 per cent. - 87 is very highest
Hydrogen	12.50 - 10 to 14 is average. Then
Nitrogen and Oxygen	2.40 - 5 to 8.0 price variations
Water, ash and loss	1.10 - usually ignored
	100.00 "

The consumption of upwards of six thousand (6,000) tons of low coal, and thirteen thousand six hundred (13,600) barrels of petroleum on the steamer "Thoroughfare," showed the cost per mile for coal and fireman to be \$128.73, and for the petroleum and fireman, \$62.09, or \$66.64 per mile in favor of the petroleum, or 51.77 per cent.

Price of Iowa coal per 2,000 pounds..... \$3.90
 " petroleum per barrel..... 1.69

Five hundred and fifty two and one half (552½) pounds of Iowa coal per mile, and fourteen and five hundredths (14.0625) gallons of petroleum. *Practical 100 lbs with oil being a eq. per of .85 or 5½ coal = 1 lb oil*
 When a fair quality of coal is compared with petroleum, we find a very different showing: instead of a consumption of 552½ pounds per mile, only 191.3½ pounds of the Carbon Hill coal. *or 2.88 to 1 in coal*

ANALYSIS OF CARBON HILL COAL.

Water	1.50 p. cent.	1.56 p. cent.	1.70 p. cent.
Volatile carbonaceous matter	34.00	35.00	36.68
Fixed carbon	53.75	54.35	50.45
Ash	10.75	9.15	11.70
	100.00	100.00	100.00

say average 88 percent which is a good average coal

Name of Steamer.	Tonnage.	Number, kind and size of engines.			Remarks.
		No.	Kind.	In. dia Ft. stroke.	
Thoroughfare	1912	2	High Pressure	22 7	Boilers Plate I. Do do IA & IB
Piedmont.	1854	1	Low Pr. sater Horizontal.	37 11	

Much better have given size of boiler & type of furnace

TRIALS ON STEAMER "THOROUGHFARE" OF PETROLEUM AND CARBON HILL COAL.

- 13,708 miles with petroleum four months.
- \$7,329.97 cost of petroleum " "
- \$53.47 cts. = 7,329.97 cost per mile with petroleum, including firemen.
- 13,708 miles.
- 191.3043 pounds of Carbon Hill coal per mile.
- 2½ mills per pound, 85 per 2,000 lbs.
- \$47.83 cts. = 191.3043 x 2½ mills, cost of Carbon Hill coal per mile.
- \$6.13 cts. = cost per ton of extra firemen firing Carbon Hill coal.
- \$53.96 cts. = cost per mile of Carbon Hill coal, including extra firemen over those needed firing petroleum.
- \$0.38 cts. = less cost of water per mile.
- \$53.58 cts. = cost per mile of Carbon Hill coal.
- 53.47
- \$ 0.11 cts. = in favor of petroleum per mile.

Price of Carbon Hill coal, 85 per 2,000 pounds. = 25 of a cent per lb.
 Price of petroleum, \$1.65 per barrel of 42 gallons. = 397.36 lbs or cost per lb. = .55 cent
 8.33 x .85 = 7.08 lbs per gal
 7.3
 During the trials on the steamer "Thoroughfare," with both fuels, gauge pressure, throttle and revolutions of the engine were the same.
 Trials were also made of petroleum and Carbon Hill coal on the steamer "Piedmont" by the writer. Prices of both fuels the same as on the "Thoroughfare."

$\frac{.25}{.55} = 2.20$; or per Unit night, oil cost 2.20 as much as coal, but the calorific value is 9.91 in addition to the saving in labour.

and oil?

	317,500 pounds Carbon Hill coal consumed on the trial.
	276.67 pounds per mile.
69,167 cts.	= 276.67 × 2½ miles = cost of coal per mile.
17,557 "	= Cost per mile of firing coal.
86,724 "	= Cost of coal and firing per mile.
	20,124 barrels of petroleum consumed in steam in 944,307 miles, costing \$33,204.60.
74,940 cts.	= \$33,204.60 = cost per mile of petroleum.
	44,307 miles.
9,576 "	= Cost of firing petroleum.
84,516 "	= Cost of petroleum and firing.
2,208 "	= Difference in favor of petroleum.

With the coal the "Piedmont" made the trips in nineteen (19) minutes and with petroleum twenty (20) minutes, from the go-ahead to jingle bell.

Steam gauge pressure would fall in crossing, and while in the slips it was necessary to continue the burning of petroleum, or in other words, it was necessary to bottle the steam, while the steamer remained in the slips, otherwise the trip could not be made even in twenty (20) minutes.

Using Carbon Hill coal, steam pressure of fifty (50) pounds (highest allowed by law on this steamer) was easily maintained, and while lying in the slips, doors and dampers were closed.

Assuming that the consumption of fuel on the same steamer varies as the square of the speed multiplied by the distance, the ratio would be 1 to 1.109.

74,94 cts.	= Cost of petroleum for time of 20 minutes.
83,108 "	= 74,94 cts. × 1.109 = cost of petroleum for speed of nineteen (19) minutes.
9,576 "	= Cost of firing petroleum
92,684 "	= Cost of petroleum and firing to make time of nineteen (19) minutes.
86,724 "	Cost of coal and firing.
5,960 "	Difference in favour of coal at equal velocity, or time in crossing.

The result of the trials indicate that petroleum on the steamer "Thoroughfare" is slightly cheaper than Carbon Hill coal, with petroleum at \$1.65 per barrel and Carbon Hill coal at \$5 per 2,000 pounds.

On the "Piedmont," petroleum is the cheaper if no value is placed on the difference in time.

Since the above trials were made petroleum has been reduced to \$1.40 per barrel, a reduction of about 15 per cent.; the price of Carbon Hill coal remains the same. This reduction so far as the fuel value is concerned, places petroleum beyond comparison, although there may be some question as to its safety on passenger steamers.

The apparatus for supplying the petroleum to the furnace is substantially the same as those used in Russia, and is so constructed that a jet of steam meets the petroleum at the mouth of the burning pipe atomizes it into a finely decided vapour, burning with a loud roaring noise.

When the supply of petroleum is properly adjusted there is no smoke and the combustion appears complete.

There is 96.5 % combustible in oil
" " 88.0 " " " coal

Or $\frac{88.0 \times 96.5}{9 \times 88.0} = 1.09$; that is to say that with only

9 % additional combustible per lb of fuel the fuel

oil has 2.2 calorific value of coal absolutely realized

In brief (speaking roundly), per lb of combustible, oil

will do twice as much work as Carbon Hill coal

is very highest —
to 14 the average. The
10 price variations —
is ignored —

5½ cts coal = 1 lb oil
coals

average 88 percent
which is a good average
coal

much better
have given
size of boiler
& style of furnace

a cent per lb —
97.36 lbs on cost
per lb = .55 cent

2 as much as coal,
in view to the

or per unit weight. Oil cost 2.2 as much as coal.

