Calorific Value

The following is adapted from the 298 page "Final Report of the Peat Committee."

The calorific value of peat from the various Canadian bogs as shown in the foregoing Tables II and III is determined on the absolutely dry sample. The heating value, however, of the absolutely dry sample is no index as to the effective heating value of the manufactured peat fuel, since the moisture content of the commercial fuel may be anything from a few percent up to 60%. It is usual, for power purposes, to deliver the peat to the power plant with a moisture content of from 25 to 30%, and all effective heating values are calculated on this moisture content. In all the calculations and the curves plotted from them, the calorific value of the absolutely dry sample of peat has been assumed to be 9,500 B.T.U. per pound. To determine the effective heating value when the moisture content and the calorific value of the absolutely dry peat are known, the following formula may be used:

$$A = \frac{1}{100}[100B - X(B + 1120)] \quad . \; . \; . \; . \; . \; . \; . \; . \; . \; . \quad (1)$$

Where A is the calorific value of the wet peat in B.T.U. per pound; B is the calorific value of the absolutely dry peat in B.T.U. per pound; X is the- percentage of moisture contained in the peat for which it is desired to determine the calorific value. The total quantity of heat required to raise one pound of water from 62°F to 212°F and evaporate it, is denoted by 1,120 B.T.U.

Terminology

Calorific: Capable of producing heat; causing heat; heating.

B.T.U. – British Thermal Unit: The amount of heat needed to raise one pound of water one degree Fahrenheit.

Pound (lb.) British Imperial weight measurement. One pound is approximately 454 grams; one kg is approximately 2.2 pounds.

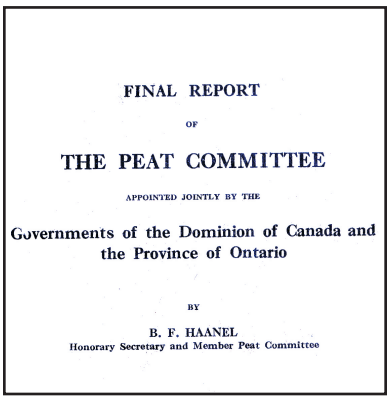
Fahrenheit: Temperature scale. One Fahrenheit degree is 5/9 of a Celsius degree, or one Celsius degree is 1.8 Fahrenheit degrees.

If it is desired to calculate the calorific value from the ultimate analysis, the following formula (an adaptation of that of Dulong) may be used:

$$Y = C \times 14600 + (H - \tfrac{1}{8}O)62100 - (9H + X)1120 \quad . \; . \quad (2)$$

C = weight of carbon; H = weight of hydrogen; O = weight of oxygen; X = weight of water

In this formula, the loss due to the water formed by the combination of the hydrogen and oxygen of the fuel is taken into consideration; whereas in formula (1) such loss is not taken into account. The following ultimate analysis of a sample of peat taken from the Alfred bog will be used as an illustration.


FINAL REPORT
OF
THE PEAT COMMITTEE
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Governments of the Dominion of Canada and the Province of Ontario
BY
B. F. HAANEL
Honorary Secretary and Member Peat Committee

Carbon	56.0%
Hydrogen	5.2%
Ash	6.0%
Oxygen, nitrogen and sulphur by difference .	32.8%

The nitrogen and sulphur may be taken as 2%, leaving 30.8% as oxygen.

If a moisture content of 25% is assumed, the percentages of carbon, hydrogen, ash, and oxygen will be:

Carbon	42.0%
Hydrogen	3.9%
Ash	4.5%
Oxygen	23.1%

and these values when substituted in formula (2) will give:-

$$Y = 0.42 \times 14600 + (0.39 - \frac{0.231}{8}) 62100 - (9 \times 0.039 + 0.25) \times 1120$$ or…

$Y = 0.42 \times 14600 + 621 - 673 = 6{,}080$ B.T.U. as the effective calorific value of the wet peat.

The calorific value as determined from formula (1) will be:-

$$A = \frac{1}{100}[100 \times 9460 - 25(9460 + 1120)] = 6815 \text{ B.T.U.}$$

Here, 9,460 B.T.U. is the actual calorific value of the absolutely dry peat as determined in the bomb calorimeter.

EFFECT OF MOISTURE ON THE CALORIFIC VALUE OF PEAT

The presence of moisture in peat fuel lowers its effective heating value since a portion of the heat of combustion is utilized in evaporating the contained moisture, and the heat of the steam formed passes off with the flue gases unused. It is highly desirable, therefore, that the moisture content, except for certain purposes, be kept as low as possible when consistent with economy.

The following tables show the effect which the quantity of moisture present in the fuel has upon its calorific value. The column showing the quantity of heat required to evaporate the moisture is calculated: first, assuming that the heat required is only that which overcomes the latent heat of the water, or 970.4 B.T.U. per pound; second, the calculation assumes conditions that prevail in a gas producer or steam boiler in which it is assumed that the water enters at the temperature of the charged peat – about 60°F – and leaves at the temperature of the hot gases-about 600°F. Under these latter conditions, the total heat required to evaporate the water and then superheat it to 600°F will be, per pound, as follows: –

To raise the temperature of the water from 60° to 212°F, 212–60	152.0 B.T.U.
Latent heat of water per pound	970.4
Heat required to superheat the steam, assuming the specific heat of superheated steam to be 0.48, is 0.48 × (600-212)	186.0
Total heat per pound of water	1,308.4 B.T.U.

or, in round numbers, 1,300 B.T.U. per pound.

The calorific value of 1 pound of absolutely dry peat is taken as. . . . . 9,500.0 B.T.U.

TABLE V*

Effect of Moisture on Calorific Value of Peat

% mois-ture in peat	Lbs. of moisture per lb. of dry peat	Lbs. of moisture removed from 1 lb. of peat containing 90% moisture	% of total moisture removed from 90% wet peat	Theoretical pounds of dry peat to evapo-rate and superheat the moisture content of 1 lb. peat for 7.3 lbs. water	% of dry peat present available for external use	Net calorific power of one pound of wet peat B.T.U.
90	9.00	0.000	0.0	1.230	0.0	-220
88	7.30	0.170	19.0	1.000	0.0	0
86	6.10	0.290	32.2	0.835	16.5	220
84	5.25	0.370	41.7	0.719	28.1	427
82	4.55	0.440	49.5	0.622	37.8	646
80	4.00	0.500	55.5	0.548	45.2	858
77	3.35	0.560	62.8	0.459	54.1	1182
75	3.00	0.600	66.7	0.410	59.0	1405
70	2.30	0.670	74.2	0.315	68.5	1950
66	1.90	0.710	78.5	0.260	74.0	2390
60	1.50	0.750	83.4	0.205	79.5	3022
55	1.20	0.780	86.6	0.165	83.5	3570
50	1.00	0.800	89.0	0.137	86.3	4100
45	0.82	0.820	91.0	0.122	88.8	4630
40	0.67	0.830	92.5	0.096	90.4	5180
35	0.54	0.846	94.0	0.074	92.6	5720
30	0.43	0.857	95.2	0.059	94.1	6260
25	0.33	0.867	96.3	0.045	95.5	6795
20	0.25	0.875	97.2	0.034	96.6	7240
16	0.19	0.881	97.8	0.026	97.4	7780
t 10	*u* 0.10	*v* 0.890	*w* 98.9	*x* 0.013	*y* 98.7	*z* 8430

Spill-Sorb Specification and our notations relating to Table V, and Figures 1, 2 & 3.

* Table and original graphs prepared by John Blizard

t As per horizontal axis in Figure 1, page 29 and Figure 2, page 30.

u As per line “A”, Figure 2, page 30.

v Relating, directly by subtraction, with category *u* above.

w As per line “C”, Figure 2, page 30, and horizontal axis, Figure 3, page 30.

x Line “A” minus line “C”, Figure 1, page 29.

y As per line “B”, Figure 2, page 30.

z Note line “C”, Figure 1, page 29 and vertical axis, Figure 3, page 30.

The curves shown in Figure 1 show graphically the results set forth in the table on page 28.

In these curves A is the higher calorific value of wet peat per lb. B is the quantity of heat required to evaporate and superheat the contained moisture. C is the net or effective calorific value of the wet peat, and is obtained by subtracting the values represented by curve B from those of curve A. The abscissa represents the percentage of moisture in the wet peat and the ordinate the corresponding calorific value in B.T.U. The curves A, B, and C, Figure 2 (page 30), show the pounds of moisture contained in the peat substance per pound of dry peat for varying percentages of moisture, and the percentage of the total moisture contained in the wet peat substance which is removed when the moisture content of the dried peat varies from 0 to 90%.

As an example, suppose it is required to find from curve A how many pounds of moisture per pound of absolutely dry peat are contained in a mass of wet peat containing 50% moisture. The abscissa shows the quantity of moisture in the peat and the right hand ordinate the weight of water in pounds per pound of dry peat substance. Thus 50% on the abscissa will give one pound on the right hand ordinate as the weight of water contained in the 50% wet peat per pound of dry peat, 80% moisture corresponds to 4 pounds of water to 1 pound of dry peat, and 90% moisture to 9 pounds of water per pound of dry peat.

If the peat contains 87% water, by referring to curve B, it will be seen that no dry peat is available for power purposes. The percentage of moisture contained in the peat is shown on the abscissa, as in the previous case, and the percentage of dry peat available is shown on the left hand ordinate. If the peat contains 80% moisture the dry peat available for power purposes is about 44% ; for 60% moisture about 79.5% of the dry peat is available; if it contains, 40%, over 90% of the dry peat is available, and so on for any percent of moisture. Curve C is self-explanatory, the abscissa represents the percentage of moisture contained in the peat and the left hand ordinate the percentage of the total moisture content removed from peat with 90% water content, when the moisture content of the dried peat is between 0 and 90%.

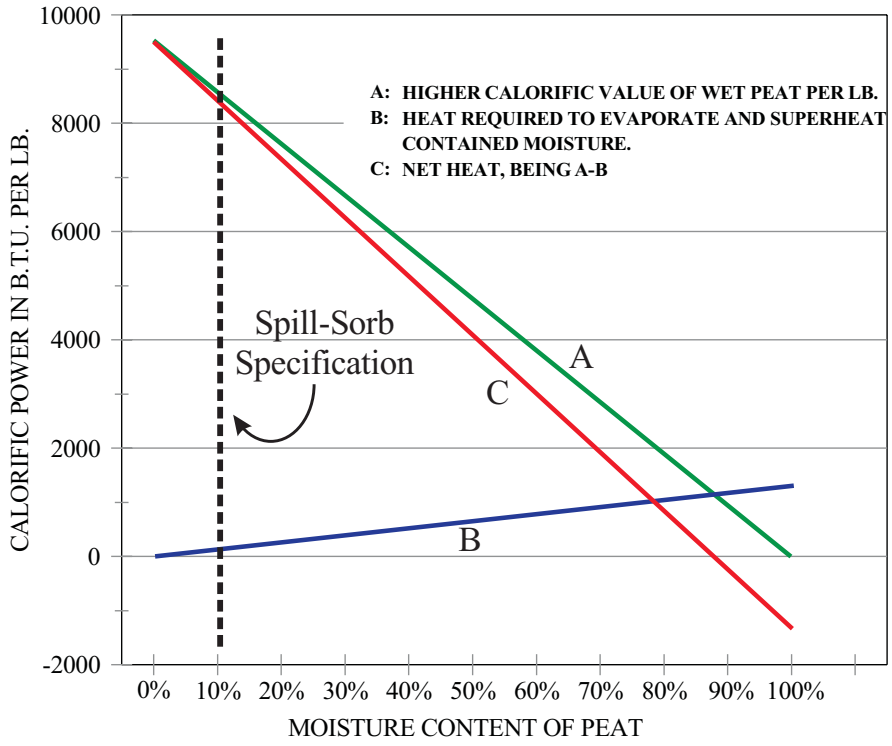

Figure 1. Curves showing the higher and lower calorific value of peat containing different percentages of moisture and the quantity of heat required to evaporate and superheat the moisture removed.

Thus to reduce the moisture content of the peat to 50%, 89% of the total water contained in the 90% wet peat substance must be removed, and so on for other moisture contents.

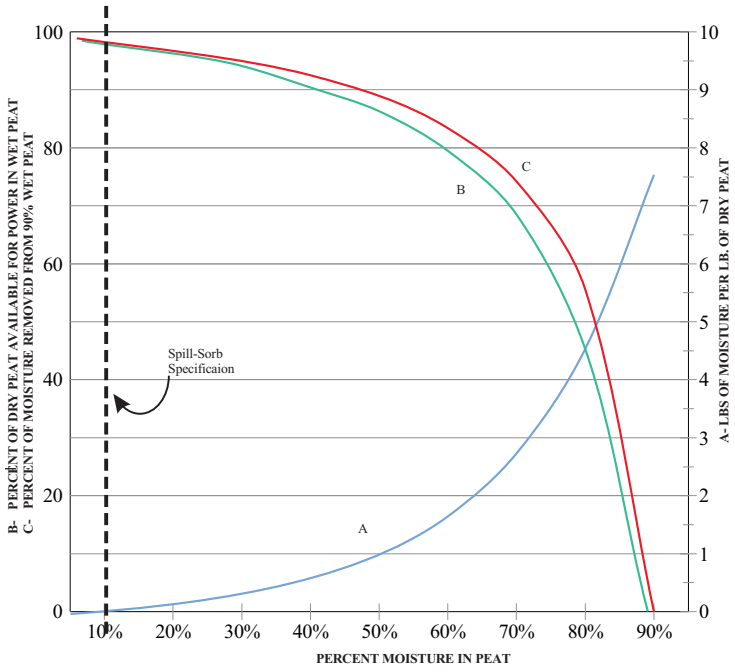

Figure 2. Curves showing pounds of moisture per pound of dry peat, for peat containing different percentages of moisture; percentage of dry peat available for power at different moisture contents, and percentage of total moisture removed from 90% moisture peat in order to obtain peat with different moisture contents.

The effect produced on the calorific value of wet peat by the removal of different percentages of the total moisture is graphically shown in Figure 3 (page 30). The raw peat is assumed to have a moisture content of 90%. If now 50% of the moisture content be removed the calorific value of the peat will be a little over 600 B.T.U. per pound. If 80% be removed the calorific value will be increased to about 2,500 B.T.U.

Spill-Sorb note:

The tables and B.T.U. ratings in this chapter relates only to sphagnum peat moss encapsulated with varying percentages of water. B.T.U. ratings will increase dramatically when ***Spill-Sorb*** is encapsulated with various hydrocarbons. As an example, ***Spill-Sorb*** encapsulated by Bow River Alberta crude oil to 95% saturation has a B.T.U. rating of approximately 17,400.

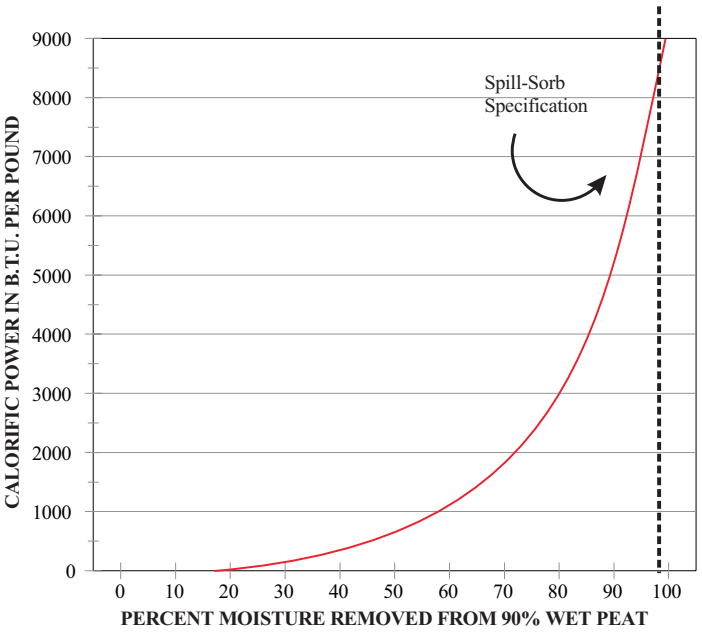

Figure 3. Curve showing the effect on the calorific value of wet peat by the removal of different percentages of the total moisture content.