United States
Department of
Agriculture

Forest Service

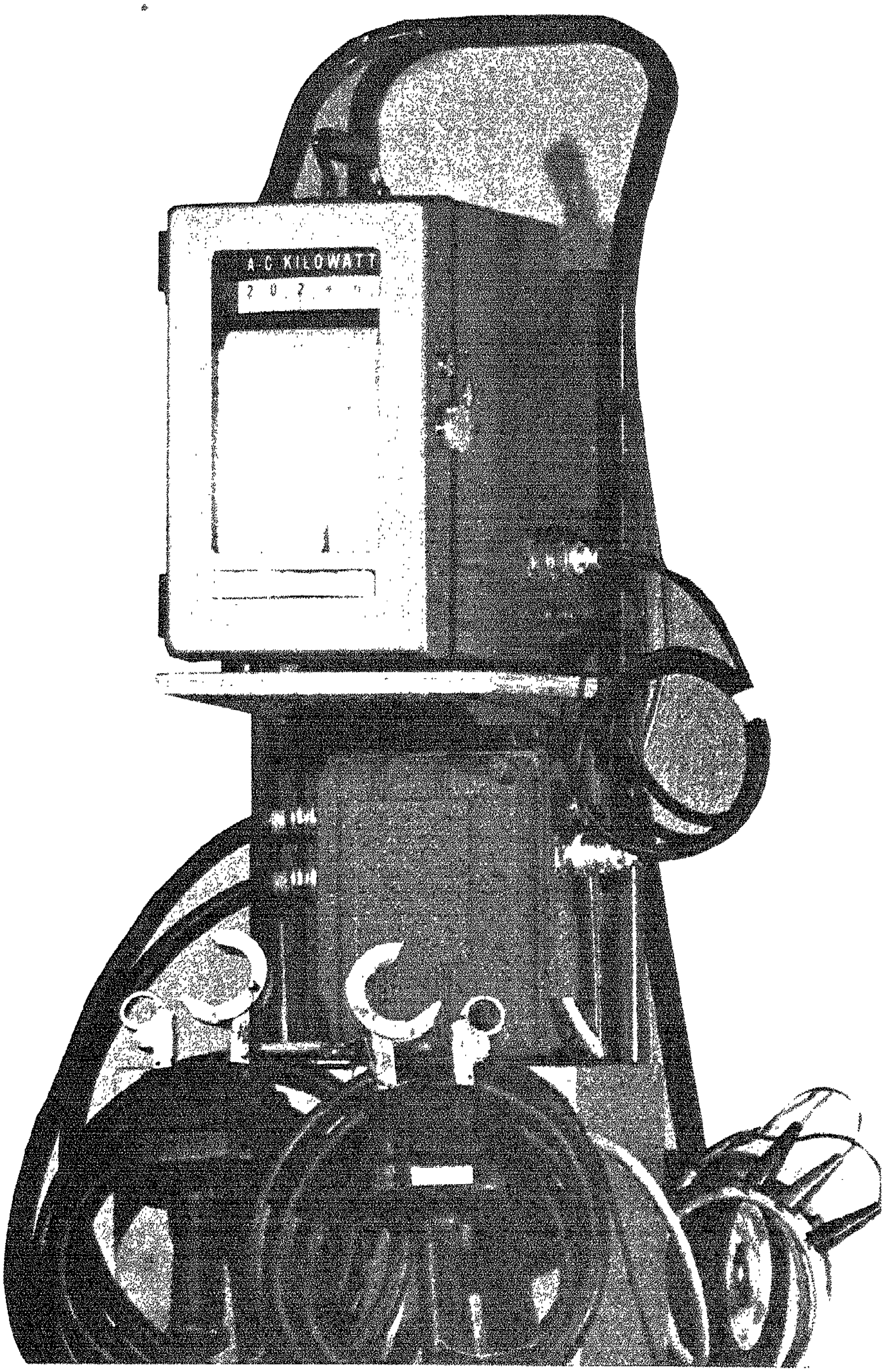
Northeastern Forest Experiment Station

General Technical
Report NE-79

1983

Use of Recording Watt/Varmeter to Evaluate the Electrical Power Requirements of a Combination Edger

Edward L. Adams



The Author

Edward L. Adams is a forest products technologist with the Northeastern Forest Experiment Station's Forestry Sciences Laboratory at Princeton, West Virginia. He received a B.S. degree in forest management and an M.S. degree in forest mensuration at West Virginia University. He worked for the USDA Forest Service in Oregon from 1960 to 1963 and joined the Northeastern Station in 1968.

Manuscript received for publication 12 July 1982

Abstract

A variety of uses can be made of the data provided by a recording watt/varmeter. One was used to measure power consumed by a combination edger processing red oak material—cants gang-sawed on one side of the edger and boards edged on the other. Log sizes processed through the headrig and sizes of material processed through the edger were also recorded.

Introduction

General Technical Report NE-71 (Adams 1982) provides information on assembling and using a watt/varmeter system to measure the electric power consumption of sawmill machinery. This followup report illustrates its use to answer the following questions about the operation of a combination edger:

1. What is the total power cost for 8 hours of edger operation?
2. What is the power cost per hour when the edger idles?
3. Would it pay to turn off the edger motor when other equipment is down for maintenance or repair?
4. To what extent is the edger being utilized?
5. Is the edger motor large enough to handle the material being processed efficiently?
6. Would installing capacitors lower electric cost and improve the electrical efficiency of the motor?

The Study

For this case study, 116 red oak logs were sawed around for grade lumber on a circular headrig, with material needing additional processing being sent to a combination edger. So that the results from this study can be related to combination edgers in other hardwood sawmills, Table 3 (in the Appendix) shows the frequency distributions by both diameter class and length class for the input logs; Table 4 (in the Appendix) shows (1) the thickness and width of boards and cants that did not go to the edger, (2) the thickness and resulting width of boards processed through the edger, and (3) the thickness and width of cants sent to the edger. Mills processing similar logs into similar material can expect the results presented in this paper to approximate those for their own combination edgers.

A Corley combination edger powered by a 200-horsepower Brook motor was used in the study.[1] On one side the edger has movable saws for edging individual boards; the other side has a bank of six stationary saws for gang-sawing cants into 2-inch boards. The biggest cant that can be processed is 8.5 inches thick and 12 inches wide. Although the edger has two sides, only at high volumes are two men used to feed the machine. During the study one man did the feeding.

The watt/varmeter was connected to the edger; kilowatts of power used and occasional kilovar measurements were recorded for 4 operating hours. To assure that data were collected during actual operating time, the recording meter was turned off during downtimes caused by employee breaks, equipment repairs, and maintenance. Only normal delays associated with the processing of material through the mill were included in the recorded data. The chart speed for the meter was set at 3 inches per minute. At this speed 1/2-inch on the horizontal axis of the strip chart represented 10 seconds of time. The multiplying switch of the meter was set so that one major graduation on the vertical axis of the chart represented 20 kilowatts or 20 kilovars, whichever was being measured at the time.

[1] The use of trade, firm, or corporation names in this publication is for the information and convenience of the reader. Such use does not constitute an official endorsement or approval by the U.S. Department of Agriculture or the Forest Service of any product or service to the exclusion of others which may be suitable.

Figure 1 shows an example of the strip chart and recorded data. The data at location "A" in the figure show that approximately 10 kilowatts of power are required to run the edger at idle. Location "B" shows that the peak power required to edge a particular board is 37 kilowatts with an average power of approximately 24 kilowatts required for 10 seconds. Location "C" shows the peak power required to process a particular cant to be 57 kilowatts with an average power of approximately 32 kilowatts required for 24 seconds. And location "D" shows a kilovar reading of 34 when the machine is idling.

Kilovars are used only to determine the power factor for the motor circuit. I will not attempt to define or explain either kilovars or power factor except to state that power factor is a ratio for expressing the part of apparent power flowing in an alternating current (AC) circuit that is true power. The equation for calculating power factor is:

$$\text{Power factor } (\%) = \text{Cos } [\text{Tan}^{-1} (\text{Kilovars/kilowatts})]$$

The kilovars and kilowatts needed in this equation are read from the recorder strip chart. To illustrate this, note location "D" in Figure 1; it shows a recorded power of 10 kilowatts. It also shows recorded kilovars of 34. These values entered in the above equation yield a power factor of 28 percent.

The information from the strip chart was divided into four sections, each representing 1 hour of operating time. The number of boards processed, the number of cants processed, the average kilowatts used per hour (kilowatt hours), and the total processing time in minutes were determined for each hour.

Other information obtained from the chart included the highest peak power required to process a cant, the highest peak power required to process a board, kilovar reading for several different load situations, the average kilowatt load required to run the edger at idle, and the power required to start the edger motor. All of this information plus the support information will be discussed in the next section.

Results

Evaluation of the recorder strip chart showed that the combination edger: (1) processed an average of 94.50 boards per hour, (2) processed an average of 15.75 cants per hour, (3) used an average of 15.52 kilowatts of power per hour, and (4) was productive an average of 16.60 minutes per hour. Table 1 shows the hourly values used to determine these averages plus other information provided by the chart. In deter-

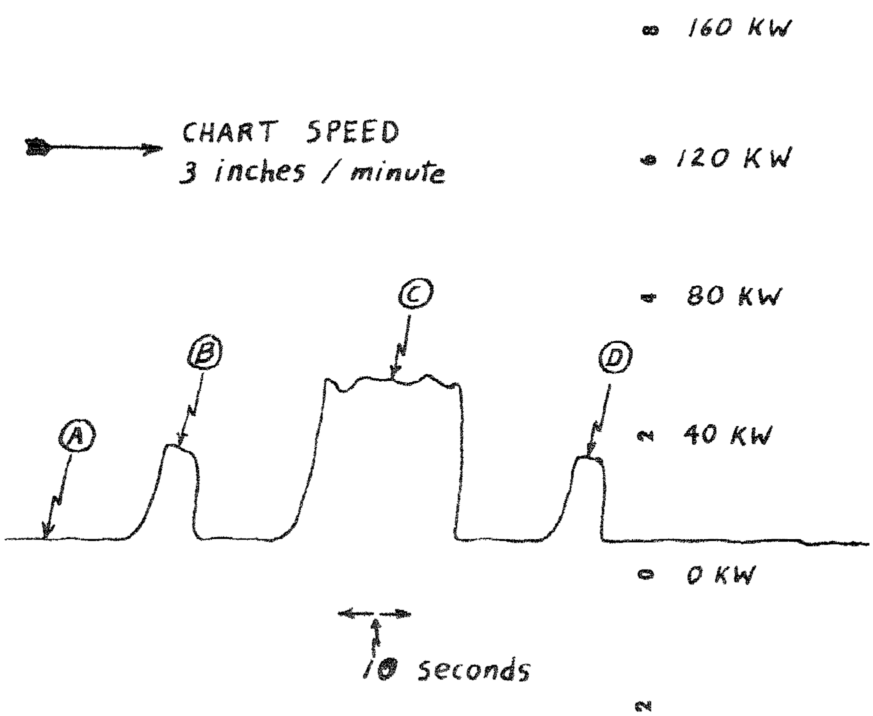


Figure 1. Example of recorder strip chart and data.

Table 1. Information obtained from the watt/varmeter chart

Summary of hourly information for edger:	1st hour	2nd hour	3rd hour	4th hour	Ave./hr.
Boards processed	83	107	94	94	94.50
Cants processed	19	14	16	14	15.75
Kilowatt hours used	17.48	14.92	15.92	13.75	15.52
Processing time (minutes/hour)	16.15	16.81	18.28	15.18	16.60

Power used by edger at idle	10 kilowatts
Highest peak power required to gang-saw a cant	109 kilowatts
Highest peak power required to edge a board	45 kilowatts
Average energy required to start edger motor	88 kilowatts for 5 seconds
Range of power factor (for measurements taken)	
10 kilowatt load with 34 kilovar reading	28 percent
68 kilowatt load with 40 kilovar reading	51 percent

mining the productive time, 3 seconds were added to the actual processing time for each piece; this was determined at the mill to be the average interval between one piece clearing the saws and the next piece entering the saws.

Discussion

Here I will use the study results to answer the questions presented in the introduction.

- What is the estimated total cost of electricity needed to run the edger for an 8-hour shift and how does this cost break down into idle cost and processing cost?

First, let us assume that the edger operates only 7 hours during an 8-hour shift (1 hour of downtime). The study results show the edger using an average of 15.52 kilowatts per hour. For 7 operating hours, an estimated 108.64 kilowatt hours of energy would be required. At $0.06 per kilowatt hour, it costs $6.52 per shift to idle the edger. The study also showed that the average productive time was only 16.60 minutes per hour. For 7 operating hours this would amount to only 1.94 hours of productive time. Subtracting the productive time from the operating time shows that the edger is running 5.06 hours at idle. Since it takes 10 kilowatts of power to idle the machine, 50.60 kilowatt hours are required to idle the edger for this period of time. At $0.06 per kilowatt hour, this amounts to $3.04 per shift. Now, subtracting the 50.60 kilowatt hours used during idle from the total 108.64 kilowatt hours provides an estimated 58.04 kilowatt hours used to process material. At $0.06 per kilowatt hour, it costs $3.48 per shift for the electricity required to process the material through the edger. Table 2 summarizes these values.

Table 2. Estimated amount and cost of electricity used by combination edger per shift (at $0.06/kwh)

	Kilowatt hours/ 8-hour shift	Dollar cost/ 8-hour shift
Processing	58.04	3.48
Idling	50.60	3.04
Totals	108.64	6.52

- What was the power cost for the combination edger when running but not processing material?

As shown in the results, the edger used 10 kilowatts of power when running at idle. At $0.06 per kilowatt hour, it costs $0.60 per hour ($0.01 per minute) to idle the edger. This cost is only a fraction of the idle labor cost.

- With this cost of $0.01 per minute to idle the edger, would it pay to turn the motor off when the other pieces of equipment are down for maintenance or repair?

Consider that it takes an average of 88 kilowatts for a period of 5 seconds to start the edger motor. There are 720 of these 5-second periods in an hour. Dividing the 88 kilowatts by 720 provides the average kilowatt hours required to start the motor of 0.12222. At $0.06 per kilowatt hour, it costs $0.007 to start the motor. Thus it costs less to start the motor than to let it idle for 1 minute. If these two costs were the only consideration, it would be better to turn off the edger. However, mill managers should consider the possibility that turning motors off and on might create a higher peak power demand than is created in the normal mill startup. This is especially true if normal mill startup is staggered to keep the peak demand at a minimum. Most power companies adjust their price for electricity based on the peak demand of the mill.

- To what extent is the edger being utilized?

The recorder strip chart shows the edger productive an average of 16.60 minutes each hour. In other words it is only being used approximately one-quarter of the time when the mill is processing the log sizes and producing the product types found in the study. However, before we can say the edger is underutilized, we must know if these are normal for the mill. If so, the edger is underutilized. If not, studies of other milling situations would have to be made before this question could be answered.

- Is the 200-horsepower motor large enough to handle the material being processed through the combination edger?

During the study the highest peak power for gang sawing a cant was 109 kilowatts. The highest peak power for edging a board was 45 kilowatts. The recorder strip chart showed that occasionally a board was edged at the same time that a cant was being gang sawed. If these two peak powers had occurred at the same time, a peak power of approximately 154 kilowatts would have been produced. This can be compared to the power required to run the motor at full load, which can be calculated as follows:

KW (full load)
$$= (I \times E \times 1.75 \times PF) / 1000$$
$$= (224 \times 460 \times 1.75 \times 0.88) / 1000$$
$$= 158.68$$

Where:

KW = kilowatts required for full load operation of motor

I = full load current value obtained from the motor nameplate

E = voltage used to run motor

PF = full load power factor for this type and size motor (obtained from manufacturer)

The 154 kilowatts of power needed to process both the board and cant at the same time is less than the 158.68 kilowatts required by the motor under full load. Although these values were not measured directly, they do indicate that the motor will probably not be overloaded if both are processed at once.

- What do the power factors shown in the results tell us?

As stated earlier, power factor expresses the part of apparent power flowing in an alternating current circuit that is true power. Motors tend to pull the power factor down. To counter this, capacitors are added to the circuit to bring the power factor back to an acceptable level. If this is not done at the mill location, power companies must add this capacitance to their system. They then add the cost to the mill's electric bill. In some cases, it pays for the mill manager to install capacitors at the mill. As shown in the study results, power loads between 10 and 68 kilowatts pull the power factor down to between 28 and 51 percent. More important is that the edger motor ran at idle approximately 5.06 hours per shift with a power factor of 28 percent. This indicates that the manager should consider installing capacitors, especially if he has other motors running at idle a large percentage of the time. The same watt/varmeter used on the edger motor can be used on the total mill electrical circuit to determine the capacitance needed. The procedure for determining capacitance needs is discussed in General Technical Report NE-71 (Adams 1982).

- What is the power and cost by size class of processing individual pieces through a combination edger?

With the data collected during this study, we cannot answer this question. However, if along with the thickness and width we had recorded the length of each piece; and if we had identified each piece on the recorder strip chart as it was processed, we could have determined the power and cost for processing each individual piece. Although the sawmill operator might have little use for this type of information, it can have application in research. For example, this type of information is presently being used to compare the power required to saw with a thick kerf circular headsaw against the power required to saw with a thin kerf circular headsaw. This type of information will also be used in a future study to determine the actual power cost of producing different products in a sawmill.

In answering the above questions, I have illustrated some of the practical uses that can be made of a recording watt/varmeter. Using this meter on the different pieces of equipment in a sawmill can provide managers and researchers with information needed to improve the energy efficiency of mills.

Literature Cited

Adams, Edward L. **Using a recording watt/varmeter to measure power consumption of sawmill equipment.** 1982. USDA For. Serv. Gen. Tech. Rep. NE-71. 8 p.

Appendix

Table 3. Frequency distribution by diameter and length classes for input logs

Class	Number of logs	Percent
Diameter class		
9	6	5
10	17	15
11	20	17
12	23	20
13	14	12
14	11	9
15	7	6
16	6	5
17	3	3
18	2	2
19	2	2
20	2	2
24	2	2
26	1	1
Totals	116	100
Length class		
8	32	28
10	32	28
12	20	17
14	30	26
16	2	2
Totals	116	100

Table 4. Products produced at headrig and products further processed by the edger

Thickness and size	Headrig (No.)	Edger (No.)	Edger (%)
LUMBER			
Thickness (inches)			
4/4	33	4	12
5/4	174	98	56
6/4	284	185	65
8/4	128	91	71
Totals	619	378	61
CANTS			
Size (inches)			
4x6	2	2	100
4x7	2	2	100
4x10	4	4	100
5x6	36	0	0
5x8	1	1	100
6x6	22	22	100
6x8	17	17	100
6x10	3	3	100
6x12	2	2	100
8x8	3	3	100
8x9	3	3	100
8x11	2	2	100
8x12	2	2	100
Totals	99	63	64

Adams, Edward L. **Use of recording watt/varmeter to evaluate the electrical power requirements of a combination edger.** Broomall, PA: Northeast. For. Exp. Stn.; 1983; USDA For. Serv. Gen. Tech. Rep. NE-79. 5 p.

A variety of uses can be made of the data provided by a recording watt/varmeter. One was used to measure power consumed by a combination edger processing red oak material—cants gang-sawed on one side of the edger and boards edged on the other. Log sizes processed through the headrig and sizes of material processed through the edger were also recorded.

ODC 832.11

Keywords: Sawmills; machinery; power

Headquarters of the Northeastern Forest Experiment Station are in Broomall, Pa. Field laboratories are maintained at:

- Amherst, Massachusetts, in cooperation with the University of Massachusetts.
- Berea, Kentucky, in cooperation with Berea College.
- Burlington, Vermont, in cooperation with the University of Vermont.
- Delaware, Ohio.
- Durham, New Hampshire, in cooperation with the University of New Hampshire.
- Hamden, Connecticut, in cooperation with Yale University.
- Morgantown, West Virginia, in cooperation with West Virginia University, Morgantown.
- Orono, Maine, in cooperation with the University of Maine, Orono.
- Parsons, West Virginia.
- Princeton, West Virginia.
- Syracuse, New York, in cooperation with the State University of New York College of Environmental Sciences and Forestry at Syracuse University, Syracuse.
- University Park, Pennsylvania, in cooperation with the Pennsylvania State University.
- Warren, Pennsylvania.

☆U.S. GOVERNMENT PRINTING OFFICE: 1982-605-024:49