OPERATING TIME AND POWER CONSUMPTION OF HEATING ELEMENTS IN ELECTRIC HOT-WATER HEATERS

By
Richard L. Witz[1], Clarence F. Becker[2], and Howard M. Olson[3]
Agricultural Engineering Department

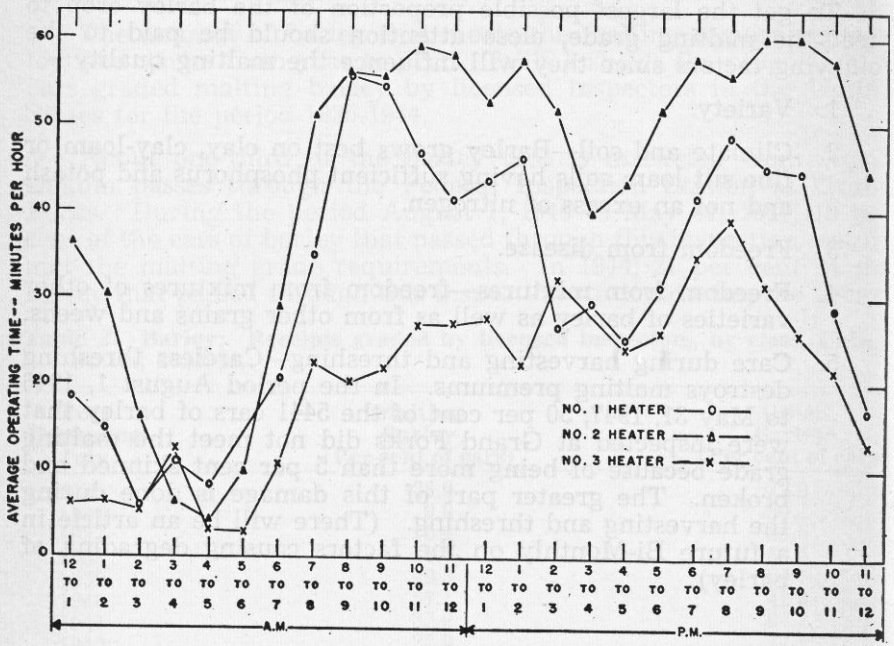
In an effort to determine the operating time and power consumption of the heating elements in electric hot water heaters a watt-hour meter and recording ammeter were installed on three farm home electric heaters in the Milnor, North Dakota area. The meters were left on each heater for a period of two weeks.

The following is a description of the heaters used in the test:

No. 1 Heater. 220-volt, 52-gallon heater with a single 1000-watt element. Number in family—5. Appliances consuming hot water—washing machine, kitchen sink, and bathroom with tub and sink.

No. 2 Heater. 220-volt, 50-gallon heater with a 1500-watt upper heating element and a 1000-watt lower heating element. Number in family—5. Appliances consuming hot water—washing machine, kitchen and basement sinks, and bathroom with tub and sink.

Fig. 1. Average time heating elements operated during each hour of the day.



[1]Associate Agricultural Engineer.
[2]Graduate Assistant.
[3]Student Assistant.

Table 1. Average operating time of electric heating elements on three hot-water heaters during each hour of the day.

Time of Day	Water Heater No. 1	2*	3*	Average
a.m.	Minutes Per Hour			
12 to 1	18.4	36.4	6.0	20.2
1 to 2	14.6	30.5	6.3	17.1
2 to 3	5.9	16.0	5.4	9.1
3 to 4	10.9	6.5	12.2	9.9
4 to 5	8.2	4.2	3.3	5.2
5 to 6	8.3	10.0	3.0	7.1
6 to 7	20.6	28.9	10.6	20.0
7 to 8	34.8	51.0	22.2	36.0
8 to 9	55.7	56.0	20.1	43.8
9 to 10	54.6	55.6	21.5	43.8
10 to 11	46.8	59.0	26.8	44.2
11 to 12	41.1	58.2	26.9	42.0
p.m.				
12 to 1	43.8	52.7	27.6	41.5
1 to 2	46.3	57.2	22.2	41.9
2 to 3	26.8	51.7	32.1	36.8
3 to 4	29.4	39.8	29.3	32.8
4 to 5	25.1	43.2	23.1	30.4
5 to 6	31.2	51.6	25.0	35.8
6 to 7	41.5	57.7	33.6	44.2
7 to 8	48.8	55.4	38.0	47.5
8 to 9	45.0	60.0	30.6	45.1
9 to 10	44.4	60.0	25.8	43.5
10 to 11	29.0	57.1	21.7	35.8
11 to 12	17.1	44.3	13.6	25.0
Average	31.8	43.3	20.4	31.6

*Two-element heaters so connected that heaters cannot operate simultaneously. Time indicated includes both heaters.

No. 3 Heater. 220-volt, 50-gallon heater with a 2000-watt upper heating element and a 1250-watt lower element. Number in family—5. Appliances consuming hot water—automatic washing machine, kitchen sink, and shower and sink in bathroom.

Farms cooperating were instructed to attempt to maintain normal consumption of hot water during the test period. All heaters were operated on a 24 hour basis.

A study of Table 1 and Fig. 1 indicates that the peak operating time for the heater elements occurs between 7:00 a.m. and 2:00 p.m. and 6:00 and 9:00 p.m. in the evening. The average operating time in minutes per hour per day of the heating elements were: No. 1 heater, 31.8 minutes; No. 2 heater, 43.3 minutes; and No. 3 heater, 20.4 minutes. The average time for the three heaters was 31.6 minutes. The power consumption in kilowatt hours per 24 hours was: No. 1 heater, 13.8 KWH; No. 2 heater, 17.3 KWH; and No. 3 heater, 10.7 KWH. The average power consumption for the three heaters was 13.9 KWH.

Table 1 and Fig. 2 show information on the peak power consumption of hot water heaters during the week. A study of the

graph reveals that the main peak occurs during the first part of the week and then a smaller peak toward the end of the week usually falling on Saturday. This graph may not be typical for all hot water heaters because of the variation in habits of housewives in regard to wash day, cleaning day, etc. Daily hot water consumption and thus the peak operating time of the heater elements will be the greatest on these days.

Fig. 2. Operating time of heating element in water heaters each day of the week.

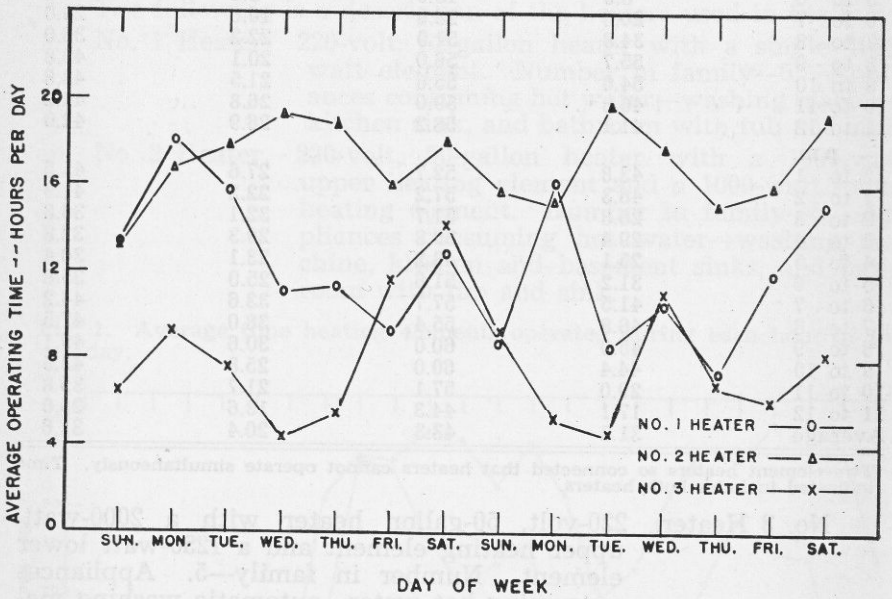


Table 2. Average operating time of electric heating elements on three hot-water heaters during each day for a two-week period.

Day	Water Heater No. 1	2*	3*	Average
		Hours Per Day		
Sunday	13.4	13.2	6.5	11.0
Monday	18.0	16.7	9.4	14.7
Tuesday	15.6	17.8	7.5	20.5
Wednesday	11.1	19.3	4.4	11.6
Thursday	11.3	18.9	5.4	11.9
Friday	9.3	16.0	11.5	12.3
Saturday	12.9	18.0	14.2	15.0
Sunday	8.7	15.9	9.2	11.3
Monday	16.2	15.2	5.2	12.2
Tuesday	8.6	19.7	4.6	11.0
Wednesday	10.6	17.6	11.2	13.1
Thursday	11.6	12.7	6.8	10.4
Friday	12.0	16.0	6.3	11.4
Saturday	15.2	19.3	8.3	14.3
Average	12.5	16.9	7.9	12.8

*Two-element heaters so connected that the heaters cannot operate simultaneously. Time indicated includes both heaters.