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Readers' Forum

How Much is Enough

When operating a water cleaning system, it is important to understand the relationship between the heat load of water as expressed in Btu (British Thermal Unit) and the amount of heat available in the cleaning system. In particular, attention must be paid to the impact Btu loading will have on your process.

Virtually all aqueous cleaning processes use heat to improve cleaning and /or rinsing. Some processes are very dependent on there being sufficient heat available to soften soils, enhance rinsing or accelerate chemical reactions.

Trouble often arises when a system is exposed to excessively high Btu loads in relationship to the amount of heat the cleaner can develop. Often, the increased load will be present when product is processed faster than the system was designed to handle. Additionally, it is the heated rinse operation that will often be the first to suffer degradation when the cleaner is finished beyond its design parameters.

Before covering the details of Btu loading and process temperature impact, we need to set a clear example and then observe the effects of various rinse stream volumes versus various capacity heat sources. In this example, we will perform two rinse operations. Our rinsing system will be contained in a simple polypropylene tank. This tank will have an overflow drain for the water to escape. The tank itself will have a pump and an electrical heat source. The pump takes the heated tank water and performs a coarse heated rinse operation followed by a final rinse spray which falls into the tank and is heated as well.

For this exercise, we will not attempt to account for heat loss through evaporation or conduction through the tank walls and plumbing. Instead, we will isolate strictly on the heat loss as cool water is deposited into the rinse tank, is heated, and then cascades to drain carrying its heat with it.

The volume of final rinse water is dependent on how quickly product passes through the stage. To provide the same level of rinsing as speed increases, so must final rinse volume. Suppose a process temperature set point of 140°F is needed for optimal rinsing in the heated stage. Based on this we can calculate the amount of Btu load a final rinse stream of 60°F water will present to a 140°F environment.

One Btu is defined as a one degree Fahrenheit rise in temperature for one pound of water. Further, there are approximately 8.3 pounds of water per gallon (US). (Keep in mind KW required or Btu load determines operating cost, not KW available.) So, if we have a final rinse stream of 2 GPM and e run it for one hour, we will need to use the following equations to determine Btu load and KW (kilowatt) equirements:

(Weight of water per Gallon) x (GPM) x (Total temperature change) x (60 minutes) = (Btu/hour)

(Btu/hour) x (KWH per Btu) = Total KW load

Substituting:

8.3 pounds x 2 GPM x (1 0° set point 60° input water) x 60 minutes = 79,6 0 Btu/hour

The constant for Btu to kilowatts is 0.0002923 KW/Btu. Multiplying 79,680 x 0.000 923 yields a KW load of 23.3 KW.

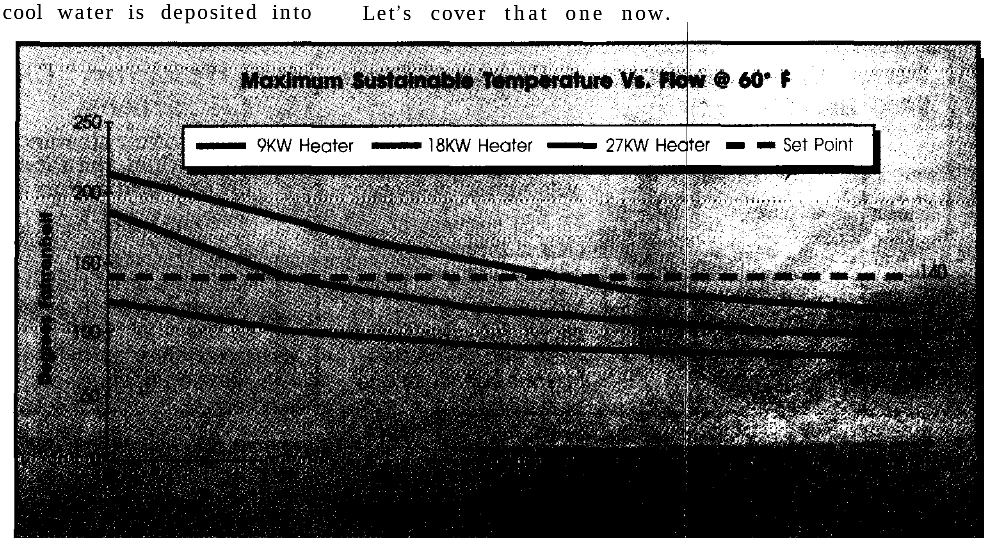
By rearranging the equation we can determine the maximum temperature that can be sustained by a given KW at a given volume flow:

(KW available) / ((60 minutes) x (GPM) x (Weight of water per gallon)) / (KWH per Btu) = Maximum Sustainable Temperature Rise. When this result is added to the incoming water temperature, the Maximum Sustainable Temperature is revealed.

Table 1 (page 14) shows the results of spreadsheet calculations for the test matrix.

With this knowledge we can address several questions, for instance:

1. How much final rinse water can I add before violating my process set point?
2. How much heat will my recirculating rinse need to support my process speeds and volumes?
3. Does available heating capacity affect operating cost? Let's cover that one now.



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On the surface it appears that a system with less Kw heating capacity will operate with better economy than a system with more KW. Less KW means less electrical demand, therefore a lower electrical bill at the end of the month.

However, when you examine the data, two systems, one with 18KW and another with 27KW will have identical operating costs when the final rinse **flow** rate is 1.5 GPM. Why? By looking at the data. we can see both systems have sufficient energy to hold the 140°F set point. The 27KW system will simply do this with a lower duty cycle than the 18KW system. The point to take away from this example is: the process final rinse Btu load determines operating cost. The heating system of the cleaner reacts to it and either keeps up with the load or not. So, available system heating capacity affects operation capability, not operation cost. More available heat means a wider window of final rinse flows can be accommodated while sustaining the needed r circulating rinse set point.

An additional benefit of higher KW tank heaters is a faster start-up time from cold, thereby yielding a higher equipment use percentage.

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Table 1.

KWH/Btu	00002923
Lbs/Gallon (US) of water	8 3
Input water temperature	60
Operating Temperature	140

All degrees in Fahrenheit

	Gallons per minute					
	1,00	1,5	2.0	2.5	3.0	3.5
9KW heater	122°	101°	910	85°	81°	78°
18KW heater	184°	142°	122°	109°	101°	95°
27KW heater	212°*	184”	153°	134°	122°	113°

*Could maintain boil