



Trying a heater on for size

By Eric Herman

What does the service technician need to know to replace a gas-fired pool or spa heater that's seen better days? It takes some figuring, but you, too, can be a heater-sizing expert!

Replacing a defunct pool or spa heater for a customer on your route? Adding a heater to an equipment pad that previously lacked one? Welcome to the world of heater sizing and the art of finding just the unit to provide your customer with a cost- and energy-efficient source of heated pool or spa water.

Doing the job right means the water will heat to the desired temperature in the desired time frame. An undersized heater will heat too slowly, and although heater manufacturers advise that bigger is always better when choosing a heater, a significantly oversized unit will do the job but will increase the cost of the installation.

Settling on just the right heater therefore means customer satisfaction — and leaves you to work with a trouble-free heating system on your service route.

Warming up

Before you begin the selection process, you have to know what the customer needs. For instance, is the heater going to heat a pool? Or is it going to be used on a spa? Although many units can be used for either vessel separately, the thought process behind selection

differs for pools and spas.

In a pool, for instance, one of the primary factors used in calculating heater size is heat loss from the surface. In a spa, however, surface area is far less a factor because so many spas are covered, which greatly reduces surface heat loss. Instead, heat-up time relative to the spa's gallonage is the critical factor.

Now you need to find out if the customer plans on using the heater for *maintenance heating* or if they are only going to turn on the burners occasionally for *intermittent* or *spot heating*. Although calculating heater size for the two types of heating strategies is basically the same, maintenance heating is typically calculated using surface area, while heaters used for *intermittent* heating often are sized by factoring total volume.

If your customer isn't sure on this

point, it basically breaks down to a question of usage: If the pool is used nearly every day during the swimming season — or year-round, for that matter — maintenance heating is the best strategy. If the vessel is host to bathers only occasionally, however, it is far more cost-effective to heat the water only when needed.

Another critical determination is what *type* of heater is best suited for the application. That is, which fossil fuel will be put to use — natural gas, liquid propane or heating oil? In some geographic areas, natural gas is either unavailable or excessively expensive, making one of the other fuels more desirable.

You also need to know if there are codes in your area governing the type of *pilot-ignition system* used in heaters. In some states, *continuous pilots* (or *millivolt systems*) are banned for all new installations. *Intermittent ignition systems* requiring an electrical hookup are required in these jurisdictions.

It is also quite important to ascertain whether the available utility hookup provides adequate pressure to run the heater. Gas piping, meters and other delivery equipment must be sized correctly to ensure an adequate

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gas supply. (These concerns will be covered in detail in P/SN's upcoming guide to heater installation.)

Defining the variables

As is the case with just about every other component in a pool or spa circulation system, there are variables in heater sizing that you must address. Whether you use a manufacturer's sizing chart or a generic heater sizing table — such as those provided by the American

Gas Association — you need to gather and play with numbers to make the right choice.

Here's the data you need:

- **Surface area:** The main job of a vessel's heater is to offset the heat that is lost from the water's surface, particularly for maintenance-style heating. Here's a rundown of the basic surface-area calculations:

- Rectangular pool: length x width
- Oval pool: 1/2 length x 1/2 width x 3.14
- Rectangular pool with rounded ends: length x width x .8
- Kidney-shaped pool: length x width x .75

Things get a bit trickier with free-form pools. Here, you must carefully draw an image of the pool's perimeter on standard 1/4-inch grid paper. Using a scale of 1/8-inch per foot, for example, means that each of the 1/4-inch squares on the grid will equal two feet on each side, giving each grid square an area of four square feet.

Next, you count the squares that fall *entirely* within the drawn perimeter of the pool. Then count all of the squares that fall approximately 3/4 within the surface area of the pool as three square feet, those with half in the pool surface area two square feet and so on. Add up the value of all of the squares on the drawing.

Generic pool heater sizing chart — temperature

maintenance (Outdoors — 3.5 m.p.h. wind, surface area method)

Note: These heat losses are based on an assumed wind velocity of 3-1/2 m.p.h. for a velocity of 5 m.p.h. Multiply these losses by 1.25, and for 10 m.p.h. multiply by 2.0.

Temp. Rise:	10°	15°	20°	25°	30°
Surface Area (Sq Ft)	Required Heater Output in Btus/hr:				
200	21,000	31,500	42,000	52,500	63,000
300	31,500	47,300	73,000	78,800	94,500
400	42,000	63,000	84,000	105,000	126,000
500	52,500	78,800	105,000	131,000	157,000
600	63,000	94,500	126,000	157,000	189,000
700	73,500	110,000	147,000	184,000	220,000
800	84,000	126,000	168,000	210,000	252,000
900	94,500	142,000	189,000	236,000	284,000
1,000	105,000	157,000	210,000	263,000	315,000

Charts courtesy NSPI

- **Volume:** For spas and for pools in which a spot-heating technique is to be used, total water volume is used rather than surface area in calculating heater size.

To calculate volume, use the surface-area data derived above and multiply it by the average depth, thus developing a cubic-foot measurement of the vessel. To determine total gallonage, multiply the pool or spa's cubic water footage by 7.48 — the number of gallons in a cubic foot of water.

- **Temperature rise:** In most sizing charts for pools, temperature rise is the primary factor along with surface area or volume. Before you can determine temperature rise, however, you must first peg the desired water temperature. For pools, the American Red Cross recommends a range of 78-82 degrees Fahrenheit — a range that seems to satisfy most bathers. In a spa, the temperature should not exceed 104 degrees, as recommended by the National Spa & Pool Institute.

Once you know the *desired* temperature, you need to determine the *average ambient air temperature*. Most experts recommend taking the average daily temperature during the coldest month when the pool or spa will be used. When you subtract the

ambient air temperature from the desired temperature, you've found necessary temperature rise.

- **Heater efficiency:** Expressed as British thermal units (Btus), heater output is the energy that a heater transfers to the water. The heater input is the energy (again in Btus) used to generate that heat. Heater efficiency (HE) is the ration of the output to the input, expressed as a percentage. The U.S. Department of Energy requires pool heaters have an efficiency rating of at least 78 percent.

Heater-sizing charts often express the required heater output necessary to achieve the desired temperature rise for the pool's surface area or volume (see Figure 1 for a generic example). Because heaters are rated by their input, however, you must know the heater efficiency to determine what size heater is required to do the job. In other words, if you multiply the required output by .78, you will have the proper heater rating.

Manufacturers do part of the work for you in their heating charts by replacing the required output with the appropriate heater model number for the desired temperature rise and surface area or pool volume.

- **Heat-up time:** For spas especially, the time required to heat the wa-

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ter to the desired temperature is important when sizing the heater. Indeed, many spa heater sizing charts use required heat-up time as a primary factor and assume a given temperature rise.

For intermittent heating in pools, heat-up time can be also very important, although many sizing charts simply assume a 24-hour heat-up time.

Plugging in the numbers

Once you have determined these key factors, selecting a heater is a simple matter of plugging the numbers into sizing charts. Although they are typically easy to use, the charts are formatted in varying ways. Some plot the temperature rise on one axis with the pool volume on the other (See Figure 1 on p. 46). Here, you cross-reference these two key factors to determine the proper heater output, which is listed in columns across the chart.

Other charts, most of them provided by manufacturers, list model numbers on one axis with the temperature rise on the other. Cross-referencing the heater model with temperature rise then leads you to pool sizes listed in columns on the chart. Finally, some manufacturers offer easy-to-use sizing slide rules. Here, you select the pool volume and temperature rise to determine the model heater.

For spas, heat-up time often is the critical factor. In these applications, sizing charts typically assume an increase in water temperature — say, 30 degrees — with models (or input ratings) listed on one axis and spa gallonage listed on the other (Figure 2). Simply pick the spa volume and the desired heat-up time to find the appropriate heater model or rating.

To determine the heater model on a chart that lists required heater output,

Typical spa heater sizing — intermittent heating, gas volume method, temperature rise of 30°F

Heater Input: (Btu/hr)	125,000	175,000	250,000	325,000	400,000
Spa Volume (Gal)	Minutes Required for Each 30-Degree Temperature Rise:				
200	30	21	15	12	9
300	45	32	23	17	14
400	60	43	30	23	19
500	75	54	38	29	23
600	90	64	45	35	28
700	105	75	53	40	33
800	120	86	60	46	37
900	135	96	68	52	42
1000	150	107	75	58	47

multiply the output by .75 to come up with the heater input. (All heaters list their heater input ratings on their faceplate and in specification manuals. Some techs use this simple, generic calculation to double-check the accuracy of the manufacturer's charts.)

Tips for do-it-yourselfers

For those who prefer to size the heater based on their own calculations, the following formula is the basis for most heater sizing charts used in the industry and can be easily applied to either pools or spas:

Multiply the number of gallons by 8.33 (pounds per gallon) by the temperature rise. The answer is the number of Btus required to heat the pool or spa.

Here's an example using a 40-degree temperature rise in a 400-gallon spa — that is, $400 \times 8.33 \times 40 = 133,280$ Btus.

This number can either be divided by the desired heat-up time to give you the required heater output, or it can be divided by the heater capacity to give you the heat-up time a given model will provide.

Let's assume, continuing the example above, that you have a heater with an output of 266,000 Btus. Here, $133,280$ divided by $266,000$ yields a heat-up time of .5 hours, or 30 minutes. Conversely, if the customer has a specific heating time in mind — say, 30 minutes — the formula works

like this: $133,280$ divided by .5 equals $266,000$ Btus.

In other words, in a 400-gallon spa, you would need a heater with an output of $266,000$ Btus to heat the water in 30 minutes.

Remember the 'intangibles'!

When it comes right down to sizing a heater, it's not all numbers and formulas: Variables thrown in by Mother Nature and the location of the pool need to be factored into your thinking.

- *Wind* can dramatically increase the surface heat loss from a pool or spa. By making waves across the water, the wind effectively increases the surface area of the pool. The rule of thumb: In a pool with an 11 mph wind you need to increase the heater size by 25 percent.

- *Altitude* is another factor that calls for a bigger heater: For each 1,000 feet above sea level, the heater needs to be four percent larger.

- *Shade* also may lead you to beef up the heater. Although there is no precise rule here, if the pool is located in a shaded area, you should throw in a small "fudge factor" to be on the safe side.

In this and other areas, however, it pays to contact heater manufacturers, their local representatives or your local supplier for expert guidance. After all, customer satisfaction is at stake!