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POINTS TO CONSIDER WHEN CHOOSING A RESIDENTIAL HOT WATER HEATER

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Points to consider when choosing a residential hot water heater

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Residential service water heaters are being called upon to supply more and more hot water as the number of automatic clothes washers and dishwashers in use in Canadian homes increases yearly. New homes for middle and higher income families often contain two bathrooms and many have automatic dishwashers as standard equipment. Furthermore, because the cost of energy for hot water heating has risen so little in comparison with the rise in incomes, many families no longer make any attempt to economize on hot water consumption. Advertisements of the utilities and fuel interests not only strive to promote the use of abundant hot water but tend to claim superiority, in one way or another, for their product's ability to meet the demand. The prospective buyer is thus hard put to choose a water heater based on an equal assessment of the facts pertaining to each.

This Note discusses the relative merits of residential storage-type automatic service water heaters operating with heat energy derived from an electrical element or elements, a gas burner, or an oil burner. Heaters operating with solid fuel are seldom automatic and are almost always of the side-arm type with an auxiliary storage tank. They are, therefore, not strictly comparable.

Safety

Regardless of the type of energy used in automatic storage-type water heaters, these appliances are required to meet specifications of a recognized testing authority such as the Canadian Standards Association (CSA) or the Canadian Gas Association (CGA) before they are acceptable to home builders or a housing authority such as Central Mortgage and Housing Corporation. Conformance to these standards is evidenced by the monogram of the testing agency on the nameplate of the appliance. When such an appliance is installed by competent persons according to CSA installation codes and the National Building Code, it must be equipped with a water pressure relief valve and either a water temperature relief valve or a high temperature limit control that operates independently of the thermostat or aquastat and shuts off the fuel or electricity in the event of excessive water temperature.

Regarding the relative safety of the energy sources, it is obvious that natural gas or liquefied petroleum gas, by their very nature, require extra precautions to prevent leakage. Although not as lethal as the old manufactured or "city" gas, they are, nevertheless, toxic. More especially, their highly flammable nature makes them potentially hazardous as they are already in a gaseous form and require only mixing with air to produce a combustible mixture. An oil leak results in an objectionable odour and a messy clean-up operation but does not present the potentially hazardous condition of a gas leak. However, if a fire should occur from other causes oil does present a danger, especially if the storage tank or oil line should rupture. Electricity, although free from combustion hazards is not without danger to personnel from electric shock or damage to materials from ignition if equipment should become faulty.

Convenience

Convenience of location is one advantage of electric service water heaters. Because the fuel-fired models require flue connections they must be reasonably close to a chimney. These same flue pipes require cleaning at least once a year in the case of oil but probably less often in the case of gas. Burners require more maintenance than electric elements although properly adjusted burners will operate with reasonable cleanliness. Electric elements are subject to scaling with certain waters but may remain maintenance-free for many years.

Reliability

Reliability of continuous energy supply is another factor to be considered. Fuel oil tanks have been known to run out of oil if the supplier is not alert. Utilities such as gas and electricity are subject to emergency shutdown, especially electricity where power lines are exposed to ice and wind storms. If the power is off, however, oil and gas burners are generally inoperative anyway because of lack of energy for the controls, except for certain gas burners in which the electric power for the controls is self-generated by thermocouples.

Durability of the water storage tank is an important factor in the

Estimated weekly minimum consumption

The following table gives the estimated weekly minimum hot water consumption for a middle-income family of two adults and two children with an automatic clothes washer but no automatic dishwasher:

	Sun	Mon	Tues	Wed	Thurs	Fri	Sat	Total
Tub bath or 5 min shower 12½ gal			50		25		50	125
Dishwashing 2½ gal/meal	7½	7½	7½	7½	7½	7½	7½	52½
Personal Toilet 1½ gal/person/day	6	6	6	6	6	6	6	42
Automatic Washer 17½ gal/load		52½		35		35		122½
	13½	66	63½	48½	38½	48½	63½	342

An automatic dishwasher at about 6 gal per load would increase the above totals by 11½ gal per day or about 80 gal per week. The distribution of hot water use in the above table is probably the most economic from the standpoint of daily demand. If baths or showers were taken on washdays, the daily demand as listed could be nearly doubled.

selection of a service water heater. With certain kinds of water, galvanized steel tanks will corrode quickly, some lasting only a year; with other types of water these tanks are perfectly satisfactory. Tank life in a difficult water area can be prolonged by the use of special couplings separating steel tanks from copper piping or by magnesium anodes which corrode and are replaced periodically. Copper tanks or steel tanks lined with vitreous enamel ("glass") or hydraulic cement ("stone") generally give longer life than galvanized steel tanks but they are more costly. According to the requirements of the 1965 Residential Standards, issued by the Associate Committee on the National Building Code and used by Central Mortgage and Housing Corporation, all water tanks must have a service life of at least 10 years with the kind of water encountered. The use of high temperature water promotes corrosion in water storage tanks, especially galvanized steel tanks. Automatic dishwashers generally require 150 to 180°F water and in planning for the use of such an appliance a copper tank, a "glass"-lined steel tank or a "stone"-lined steel tank should be used, accompanied by a mixing valve for other household uses. If no automatic dishwasher is used, longer tank life can be realized by reducing the heater thermostat setting to about 140°F.

Adequacy

Whether or not a specific service water heater provides sufficient hot water depends upon several factors: the size of the tank, the capacity of the burner or elements, and, of course, the demand. The total demand is not as important as the peak demand in choosing a water heater. Most authorities agree that normally the minimum peak demand would be three successive loads of washing in an automatic washer or about 50 gallons of water heated through 100° (from about 50 to 150°F) over a period of 2 hours. Assuming a full 25-gal tank of 150°F water before beginning the washing it would require a fuel burner with an input rating of approximately 36,000 Btu per hr with a combustion efficiency of 70 percent to maintain sufficient hot water for the final load of washing. Alternatively, an electric water heater with the same water tank volume would require 7½ kw of electricity to maintain the water temperature at 120°F but that is almost twice the wattage most electric circuits can handle.

Electric water heaters, therefore, must have a tank capacity of at least 50 gallons to meet this peak demand. As the above considerations are minimum, larger houses with extra bathrooms, and especially those with automatic dishwashers that may require 180°F water, would need more tank capacity or higher energy input, or both. For fast recovery or abundant continuous hot water supply, oil-fired water heaters are often chosen because these heaters are equipped with large capacity burners. The smallest atomizing-type oil burners that can operate without nozzle clogging problems are equipped with a nozzle of .65 U.S. gal/hr capacity which corresponds to an input rating of about 2½ times the rating of 36,000 Btu per hr for minimum hot water supply. With new methods of atomization, smaller capacity oil burners suitable for the lower capacity service water heaters are now coming on the market.

The weekly total of 342 gallons should be considered minimum consumption, but using this figure as an example, the monthly energy required to raise the temperature of this amount of water by 100°F would be 342 x 10 x 100 x 4.33 = 1,480,000 Btu of net energy.

The gross energy equals the net energy divided by the efficiency of the use of the energy. Assuming tank casing and piping heat losses for all types of water heaters to be 5 percent with an additional heat loss of 25 percent to the flue of gas-fired and oil-fired units, the gross monthly energy requirements for minimum water heating in this family would be:

(a) **for electricity** 1,480,000 ÷ .95 = 1,558,000 Btu = 456 kwh/month

(b) **for natural gas** 1,480,000 ÷ .70 = 2,113,000 Btu = 1970 cu ft/month

(c) **for oil** 1,480,000 ÷ .70 = 2,113,000 Btu = 13.0 gal/month.

Cost

Perhaps the biggest factor in the choice of a service water heater is its cost — both initial cost and cost of operation. Initial cost is relatively easy to determine. The current costs, installed, are about $150.00 for a two-element 40-gal electric heater, about $180.00 for a 25-gal gas burning heater, and about $340 for an oil-fired heater with a 25-gal tank, all of these assuming a "glass"-lined tank and equipped with automatic controls. The same units may be rented, the electric and gas units renting for about $1.75 a month plus tax, and the oil unit for about $3.00 a month plus tax.

The operating cost is difficult to estimate because of the complicated rate structures used by most utilities; rate structures that vary considerably from place to place. Where a "flat" rate for water heaters is in effect, or in the case of oil-fired heaters where the price per gallon is constant, the monthly bill is more easily predictable; even the yearly cost is obtainable using the gallonage from past experience or average consumption figures from handbooks. In urban centers, however, the usual rate structure for electricity and gas charges more for the first kilowatt-hours of electricity or hundreds of cubic feet of gas, and decreases the price per unit in steps as more and more energy is used. To complicate matters even more, the gas utilities often have two rate structures when the house is heated with gas, one for "winter" and one for "summer" both of which decrease in cost as more gas is used. The more appliances a customer has operating on gas the larger the number of months of the year he can enjoy the cheaper or "summer" rates. Thus when no separate meter is used for the water heater, it is very difficult to estimate the true operating cost when using gas.

As an example of the complicated rate structures that utility companies use for billing consumers, the following were the rates in effect in the city of Ottawa during 1968-1969:

(a) electricity

Two cents per kwh for the first 60 kwh per month, plus 1 cent per kwh for the next 60 kwh per month, plus ½ cent per kwh for the next 880 kwh per month, plus 1 cent per kwh for all power in excess of 1,000 kwh.

minimum monthly bill — 83 cents gross

monthly service charge — 66 cents

(b)-natural gas

A flat-rate water-heating service of $2.70 for all gas used per month for single family dwellings or a "water-heating and other use" flat

rate of 15 cents per Ccf (hundred cubic feet) for all gas used per month with a minimum monthly bill of $1.50. Where the customer is using natural gas for house heating there is a complicated rate structure as previously described ranging from $1.50 per Ccf to 10 cents per Ccf per month for the "winter billing period" and from 15 cents to 10 cents per Ccf per month for the "summer billing period."

(c) fuel oil

The cost of operation is directly proportional to the consumption since the cost of No. 2 furnace oil in Ottawa is a constant 19.5 cents per gallon regardless of the amount used. Recently, the cost of regular maintenance, that is, yearly cleaning and re-adjusting, has been absorbed by the oil supplier.

It is obvious from the above rate structures that where electricity or gas is used to heat service water, the cost of operation is going to depend upon the point in the rate structure reached by the amount of energy used. In electric water heating, if it is assumed that the first 120 kwh are used for lights and miscellaneous electrical uses, this places the electric cooking and water heating into the ½ cent per kwh area. But, if an electric dryer is also used, the total consumption will likely run well over 1,000 kwh and hence into the 1 cent per kwh area. One could argue, therefore, whether the dryer or the service water heater was using the more expensive electricity.

In the same manner, if gas is the energy used for water heating, it is obvious that the estimated cost will depend on the number of other gas appliances in use. The only method of arriving at a realistic cost estimate of operating any single appliance is to make a complete energy study of the house involving two estimates: the cost of all the energy with the appliance in question in use; and, the cost of all the energy without the appliance in use. The difference would be the true estimated cost of operating the appliance.

Summary

The choice of a storage-type service water heater depends, first of all, on the utilities available to the consumer and to what extent they are being used for other appliances. Initial cost is also a big factor in choosing the actual equipment itself. The choice will depend greatly upon how much money one is willing to pay for greater adequacy and quicker heat-up periods requiring larger and more expensive equipment. Such expense may be warranted in the opinion of some, while others will want to economize with equipment that is borderline in adequacy and speed of operation. Finally, the cost of operation is probably the largest factor influencing the choice, and unfortunately the true cost of operation is difficult to compute accurately with gas and electricity rate structures as complex as they often are. In some instances, it might be cheaper to rent rather than own one's heater, thus avoiding costs of repair and maintenance. Whatever the choice, it should only be made after careful study and assessment of all the possibilities, rather than being based merely upon friendly advice or florid advertising.