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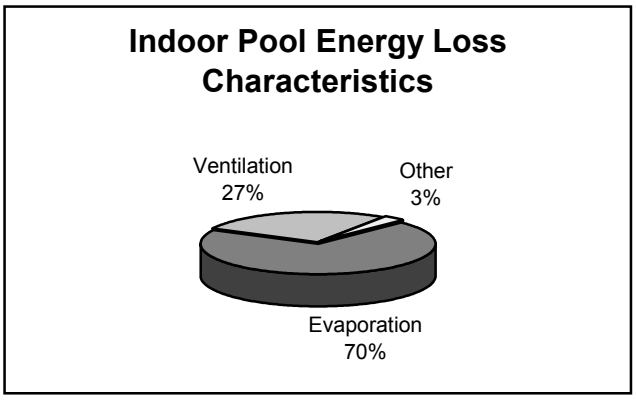
Heat loss data

Overview

There is no doubt that swimming pools are big energy consumers. North American pool owners spend billions of dollars annually to heat their pools. Much of this energy is often wasted and can be saved with proper management. The information contained in this report analyses the main causes of energy loss and offers solutions to minimize operating costs.

How do pools lose heat?

Pools lose energy in a variety of ways, evaporation, radiation to the sky and heat loss to the ground. As the diagram shows, evaporation is by far the largest source of energy loss, and therefore should be the main focus in reducing energy bills.



It only takes 1 Btu to raise 1 pound of water 1 degree, but each pound of 80° water that evaporates takes a whopping 1048 Btu's of heat out of the pool.

Although indoor swimming pools are not subject to the day / night

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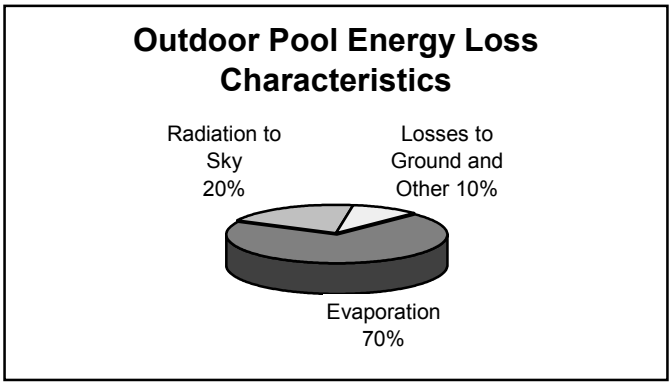
fluctuations in temperature and solar radiation they still consume vast quantities of energy. To prevent condensation on cold surfaces, rusting of structural components and damage to paint and drywall, indoor swimming pools should incorporate ventilation or dehumidification systems. These are expensive to operate.

Energy Management

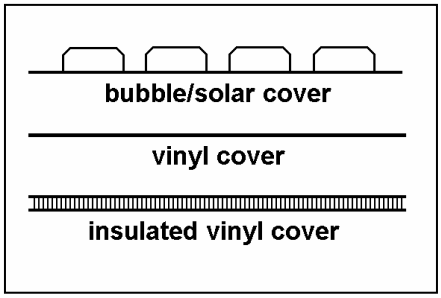
There are many energy management improvements that can be implemented with indoor and outdoor pools. Following is a brief overview of the most common methods.

Pool Covers



Covering your pool when it's not in use is the single most effective way of reducing energy loss. Savings of 40-60% are easily obtainable. Pool covers provide other benefits besides saving energy. They conserve make-up water by 30-50%, reduce chemical consumption and minimize the quantity of dirt and debris entering the swimming pool.

Below are three types of pool covers. Refer to the fact sheet on pool covers for more detailed information. Please note: Covers must be managed properly for safety. They should always be completely removed before anyone enters the pool.



Wind Breaks

Wind greatly increase evaporation from outdoor pools. A 10 Km wind at the surface of the pool can increase energy consumption by 300%. The addition of trees, shrubs, fences, or other wind

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break material can significantly lower the heat loss from an uncovered pool.

The windbreak needs to be high enough and close enough to the pool that it doesn't create turbulence on the water surface. It should also be positioned in a manner not to shade the swimming pool.

Minimal use of water features

The use of water features or excessive turbulence on the water surface from misdirected return jets greatly increases evaporation, and thus energy loss.

Return jets should be directed so that they provide a circular flow within the structure without creating excessive ripples on the water surface. Water features should only be turned on when people are using the swimming pool. Misused water features may increase heating bills by 25 percent. Likewise, water overflowing from a spa back into a pool (in pool / spa installations) or over a negative edge should be minimized.

Solar Heating Systems

One of the most cost-effective methods to heat swimming pools is solar radiation.

There are two main types of solar systems, glazed and unglazed. Unglazed, the most popular type of installation consists of a number of small diameter rubber tubes running between the feed and collection manifolds. The swimming pool water is pumped through the black tubing collecting solar radiation. The tubes, collectively known as solar panels should account for approximately two thirds of the swimming pool square footage and be in stalled facing south.

Glazed systems incorporate black absorber plates, a heat exchanger and a non-freezing transfer fluid to transfer the heat from the encased solar panel to the swimming pool water. The high cost of these systems normally limits their installation to houses with ascetic requirements. All solar systems should be used in conjunction with a swimming pool cover.

High Efficiency Heaters

There are a number of options when considering the purchase of a swimming pool heater: conventional gas heaters, heat pumps and geothermal solutions.

Conventional gas heaters vary in efficiency from approximately 75 per cent for a cheaper installation to 97 per cent for a high efficiency heater. Heat pumps have varying coefficients of performance (COPs) ranging from 5.0 – 8.0 (A COP of 6

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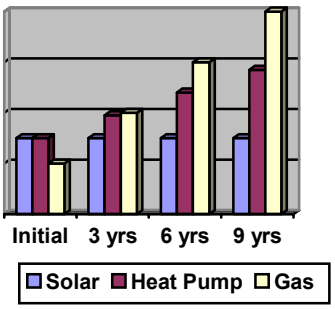

means that for every unit of electricity that you put into running the heat pump you get six times the output in heat). Geo thermal installations are highly dependant upon location and installation techniques when considering efficiencies.

Careful analysis of capital cost v.'s operating cost v.'s length of season v.'s required water temperature should be completed before purchasing any of these appliances. The following graph provides a comparison of the purchase and operating costs for average priced appliances used on a standard 18 x 32' pool for a normal swimming season (June – September). Please use the graph for comparative values only.

Efficient Pumps/Motors

Properly sized, energy-efficient pumps and motors can significantly lower the electrical consumption of pool operating costs. Motors use many times their initial cost in electrical consumption over their life and can often consume several times their cost in the first year alone. The energy savings from an efficient motor can pay for itself in a very short time.

Water temperature control

Carefully consider the temperature of the swimming pool water. Each degree rise in the temperature can cost you an additional 10% in heating bills. The National Swimming Pool Foundation recommends 78-80° for active swimming and 82-84° for general use.

Turn the temperature down, or turn the heater off whenever the pool is not being used for several days. Experiment with the temperature to determine how long it takes to heat it back up to the desired level. Lowering the temperature always saves more energy than maintaining an unused swimming pool at normal operating temperatures.

Keep all the intake grates clear of foreign debris. Clogged drains require the pump to work harder. For residential pools, try reducing filtration time to 12 hours/day. If the water doesn't appear clean, increase the run time until the water clarity is restored. A time clock will automate this process. Tune up your pool heater annually. A properly maintained pool heater is more efficient.

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Heatsaver

Heatsaver is an ingenious chemical that reduces evaporation by increasing the surface tension of the swimming pool or spa water.

The chemical has a lower density than water causing it to 'float' to the surface. Located on top of the water, it forms an invisible blanket, reducing evaporation and heat loss.

It is non toxic and non detrimental to the swimming pool, spa and all associated equipment. Please see a complete breakdown later in this report.

Swimming pool operating costs

Electricity Cost (c per kWhr)	$0.06

SWIMMING POOL PUMP OPERATING COSTS

Pump Size (horsepower)	Volts	Amps	KiloWatts	Monthly operating cost
1/2 hp	115	4.5	0.5175	$21.50
3/4 hp	115	6	0.69	$28.67
1 hp	115	7.2	0.828	$34.40
1 1/2 hp	115	9.2	1.058	$43.95
2 hp	115	11	1.265	$52.55

SWIMMING POOL LIGHT OPERATING COSTS

Light Size	kW	Hourly Operating Costs
100 W	0.1	$0.01
250 W	0.25	$0.01
500 W	0.5	$0.03

Introduction

The following two tables of information is based upon the operating costs for an average, uncovered 16 x 32' swimming pool with moderate wind protection and no water features. It assumes that the return jets are not breaking the water and the pool is located in an area with normal wind speed. The current gas and electricity prices are quoted where applicable.

ELECTRICAL CONSUMPTION BY SWIMMING POOLS

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GAS CONSUMPTION BY CONVENTIONAL GAS HEATERS

Gas Cost ($ per GJ)			$9.22	
SWIMMING POOL HEATING COSTS				
Months	Mnthly Gas Consumption (GJ)		Mnthly Cost $	
	26 deg C 79 deg F	30 deg C 86 deg F	26 deg C 79 deg F	30 deg C 86 deg F
May	35.71	88.10	$ 329.28	$ 812.24
June	33.33	68.24	$ 307.33	$ 629.17
July	28.57	57.14	$ 263.42	$ 526.85
Aug	45.24	72.10	$ 417.09	$ 664.76
Sept	57.14	83.33	$ 526.86	$ 768.33
	Total		$1,843.99	$ 3,401.35

PAY BACK PERIOD

The pay back period for installation of all the heating options listed within this document may be equated using the following formula.

The seasonal and projected seasonal operating costs can be calculated by using the quoted seasonal costs and the appliance efficiency ratings.

Payback period = (Total installation cost of new heater – Cost of repairs to existing heater) / (Present seasonal operating costs – Projected seasonal operating costs)

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Solar Pool Heating Systems

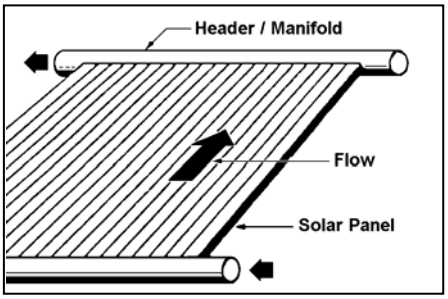
Why Solar?

Most swimming pools require some type of heating, whether to bring the pool up to temperature in the spring, to maintain a desired temperature during the swimming season, or to extend the swimming season. You can use conventional gas or electric heaters, but you may have large monthly bills from your local utility company.

Another option is to install a heating system that captures the free heat of the sun. Solar energy is a renewable domestic fuel that's widely available. Today, solar pool heating systems can be cost competitive with conventional heaters. Their advantage is very low operating costs.

Solar Collectors

The simplest solar collector is a black hose lying in the sun circulating water. The sun shines on the black hose and heats up the water flowing through it. This is not a very efficient or durable solar collector.



To increase the efficiency of collecting solar heat, manufacturers have designed several types of collectors that maximize the amount of solar energy collected and are designed to last 15-20 years.

Most solar collectors are flat sheets, called absorber plates, with tubes running from bottom to top. Headers at the top and bottom supply the fluid to be heated. Some have a glazing over the top of the collector that aids in preventing the wind and cold air from carrying away the heat before it can get to its destination. This greatly increases the cost of the collector.

Solar collectors are made of a variety of materials. Collectors that operate only when temperatures are above freezing can be made of lower cost materials such as thermoplastic rubber or polypropylene. These collectors can be used year round in the far southern part of the U.S. or seasonally throughout the rest of North America.

Collectors that operate in colder climates on a year-round basis generally incorporate copper absorber plates covered by tempered glass. This allows the

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collector to maintain most of its efficiency even during the cold winter months. As long as the sun is shining, it will collect solar heat. These collector systems require transfer fluid and heat exchangers, greatly increasing the total system cost.

Solar Heating Systems

Solar collectors are only one part of a total solar pool heating system. Most systems include the pool pump and two heat sensors connected to a solar controller. One sensor measures the temperature at the collector surface. The other measures the pool temperature. If the difference between the two is sufficient, the controller sends a signal to a motorized valve that closes and directs the pool water through the solar collectors.

All the water circulated by the filter passes through the solar system. Each time the water passes through the collectors it is heated 2-5 degrees. A properly sized solar system can raise the pool temperature 10-20 degrees and maintain a comfortable swimming temperature.

Glazed collectors trap heat using copper absorber plates, heat exchangers and transfer fluids. They have the ability to collect large amounts of solar heat even in the coldest weather. Their biggest disadvantage is cost. They generally cost many times the value of their unglazed counterparts.

Siting

There are a number of things to consider when determining if a solar pool heating system is right for your pool.

Is there a large, sunny roof or open area available for mounting several hundred square feet of solar collector? Does the area have unobstructed sunlight from 8:00 am to 4:00 PM during the heating season or even later in the day for mid-summer use? Is it possible to securely anchor the collectors on the selected area? The solar collectors can be mounted on a roof, on a deck, on a rack, or on the ground.

Please note: The system should be installed in accordance with all local building and zoning requirements.

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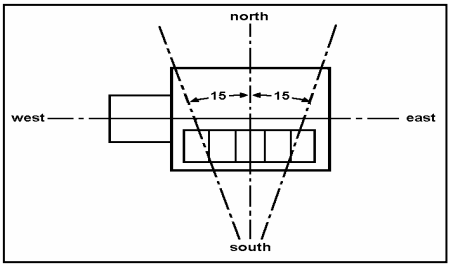
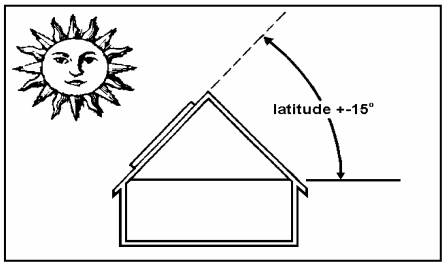


Orientation and Tilt

Collectors should face within fifteen degrees of due south. The ideal collector angle is based on latitude, and the time of year the panels are used. For summer only heating, use latitude minus 10-15°. For winter only heating, use latitude plus 10-15°. For year around heating, install the collectors at latitude. Adding additional collector area can compensate variations from these ideals.



Sizing

Solar pool heating systems can be installed to provide up to 100% of your pool heating needs. The size of the system depends on available solar radiation, wind factors, average temperatures for the region, and collector orientation and angle. Contact your local supplier for a proper sizing calculation.

Pool Covers

It is a good idea to make your pool as efficient as possible before considering a solar pool heating system. The easiest way to lower your pool heating costs is to use a pool cover or some form of heat retention chemical. By reducing your pool heating needs you can purchase a smaller system, saving money.

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Installation Costs

Qty	Description	Unit Cost	Total
7	Panels - 4' x 10'	$ 428.00	$ 2,996.00
1	Solar System Kit		$ 42.00
1	Misc Material		$ 30.00
1	PVC Pipe and Fittings		$ 250.00
	Labor		$ 450.00
		P.S.T.	$ 248.85
		G.S.T.	$ 263.76
		Total	$ 4,280.61

The following table lists the typical cost of installing a basic solar system on a 16 x 32' swimming pool.

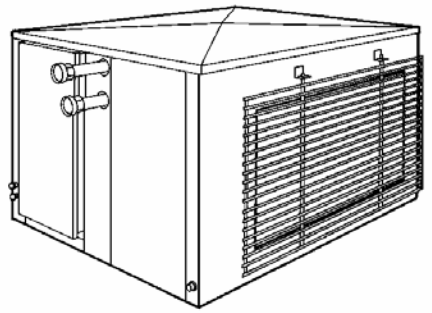
The following assumptions were made:

Sufficient space and correct alignment was available for the installation of the panels. The existing circulation pump was sufficient to pump water through the solar system. No other booster pumps were required. The equipment room piping was configured in a manner allowing for easy installation of the solar system. No automatic control system was included in the installation. Covers and rollers, a necessity with solar, were not included in the estimate.

POOL / SPA COMBINATIONS

Swimming pool / spa installations that use the same equipment to filter and heat both bodies of water require careful consideration when installing solar systems. They require some form of conventional heat (i.e. gas heaters or heat exchanger) to heat the spa up to the desired temperature. They also require some form of control to prevent superheated spa water from flowing through the panels. One option is to install a separate booster pump specific to the swimming pool solar system. This would allow the pool and spa to be heated simultaneously.

Heat Pump Pool Heaters



An emerging method of heating swimming pools is through the use of a heat pump. Heat pumps do not generate heat, they simply capture it and move it from one place to another. Their efficiency is dependent on the ambient conditions.

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How efficient is a heat pump? Heat pumps do not have a simple efficiency number to work with. Their efficiency is measured by Coefficient of Performance (COP).

Just like other heating options, heat pumps have varied efficiencies. Their COP can range from 3.0-7.0. The higher the number the more efficient the heat pump. What this means is that for every unit of electricity that you put in to run the heat pump, you get 3-7 units of heat back. Testing the unit with an outdoor temperature of 80°F and a pool temperature of 80°F usually determine the COPs. Please check the Pool Heat Pump Manufacturers Association (PHPMA) for true performance ratings. Manufacturers are renown for over stating their products performance.

What Size?

Heat pumps are sized according to the surface area of the pool and the difference between the pool temperature and the average air temperature. The heating load is affected by other factors such as wind exposure, humidity levels and cool night temperatures. Pools located in areas with higher average wind speeds at the pool surface, lower humidity, and cool nights will require a larger heater. You should consult West Coast Pool regarding sizing requirements.

Determining If a Heat Pump Is for You

When considering the cost savings by installing a heat pump you must evaluate the efficiency of your present heater. The following table provides efficiency estimates based on the heaters age.

Years Old	Efficiency
0-5	70-75%
5-10	60-70%
10-15	55-60%
15-20	50-55%
20 +	<50%

Although some heaters state an efficiency rating on the specifications plate, it is often over rated and diminishes with time. A loose rule of thumb is:

Savings provided by a Heat Pump with a COP of 5.0 = 100 – efficiency of present heater

i.e. Replacing a gas heater with an efficiency rating of 70 % will provide savings in operating costs of 30%.

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Other Factors:

Efficiency is one consideration, but you should also consider the reputation of the manufacturer and/or dealer who will install your heater. Get some references of satisfied customers and call the Better Business Bureau if you don't have anything to go on. Be sure to ask for and read all warranties before making you decision.

	Cost of Heat Pump		
1	Titan Heat Pump – 108,600 BTU	$ 7798.00	
	P.S.T.	$ 584.85	
	G.S.T.	$ 545.86	
	Total		$ 8928.71
	Cost of Installation		
	PVC Valves, Fittings & Pipe	$ 260.00	
	Electrical Hook-Up	$ 250.00	
	Labor	$ 750.00	
	P.S.T.	$ 38.25	
	G.S.T.	$ 88.20	
	Total		$ 1386.45
	Typical Cost of a Heat Pump Installation		$ 10,315.16

Heat pumps are not necessarily designed for swimming pool/spa combinations. Although they provide enough BTU's to maintain spa water at the desired temperature, they take a long time to heat the water initially. In most instances a conventional heater will have to be incorporated in to the system.

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Spas and hot tubs

Introduction

The term “hot tub” refers to a free standing wooden tub, whereas a “spa” is an acrylic or fiberglass mould that can be installed above ground or in ground. In this document a spa or hot tub system (mentioned hereafter only as spas) includes the tub, insulating cover, heater, pump, filter and all associated equipment directly related to circulation. It does not include jet pumps or blowers.

Selection of a suitable heater

Electric, natural gas and propane are the normal options for heating spas. Availability of resources, spa volume, heat up time and operating costs should all be considered when selecting a suitable heat source. For example, electric heaters are relatively cheap and easy to install but they take a long time to heat the water. They also cost approximately 60 per cent more to operate than their gas counterparts.

Octagonal Spa		
	Heat type	Cost
7’ x 2’9” deep	Gas	$ 126
	Electric	$ 140
	Propane	$ 200
8’ x 2’9” deep	Gas	$ 132
	Electric	$ 145
	Propane	$ 210

If the spa is to be kept at a constant temperature, electric heat (in conjunction with a well rated thermal cover and good insulation around the structure) is most likely the best option. On the other hand, if the spa is used infrequently it may be better to maintain a low temperature (i.e. sixty degrees Fahrenheit) and heat the water on demand. A gas heater will provide the user with “instant” heat.

The preceding table shows the time to heat a seven-foot, 315 imperial gallon square spa to 40 degrees Celsius.

Annual Heating Costs

The above table shows the estimated heating costs for an outdoor, well insulated spa that has been installed in-ground and fitted with a thermal cover. The figures do not reflect circulation pumps, jet pumps or air blowers. A small energy wise circulation pump will incur approximately $8.00 per month of electricity while jet

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pumps and air blowers are completely dependant upon the frequency of use. The heating costs are based upon the following assumptions:

The water temperature is kept at 40 degrees Celsius during use

The heater is turned off when not in use

The spa is used for approximately ½ hour per day with the jets on

Energy rates are based on electricity at 6 c/kW and natural gas at $9.55 /GJ.

Time needed to heat to 40 deg C (104 deg F)			
		Time Needed	
Fuel	Input	Initial Temperature	
		29 deg C	37 deg C
		84 deg F	99 deg F
Electric	4 kW	5.8 hrs	1.5 hrs
	6kW	3.9 hrs	1.0 hrs
	9 kW	2.6 hrs	0.7 hrs
Gas (Btu x 1000)	50	2.0 hrs	0.5 hrs
	75	1.3 hrs	0.4 hrs
	100	1.0 hrs	0.3 hrs
	125	0.8 hrs	0.2 hrs

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Energy efficient operation

Tub Insulation

Ensure that the tub is insulated with continuous foam (without gaps) that covers the exterior of the structure and all water pipes

Insulating Cover

An insulating cover is an essential component of a complete and well-designed hot tub or spa. Insulation of at least RSI 2.1 (R12) is recommended. The cover will cost approximately $ 550.00 for an average sized spa and have a payback period of approximately 1.5 years for natural gas heaters, 1 year for electric and six months for propane.

Energy-efficient pump

When purchasing a hot tub or spa, ensure that the circulation pump is as small as possible, without compromising the filtration or heating aspects of the system. This may be achieved by a small energy wise pump or a two speed circulation/ jet pump.

Also consider installation or inclusion of a timer on the circulation pump. Well insulated spas only lose 2 – 3 degrees Celsius per day. Therefore the heat loss incurred by turning off the circulation pump can be easily recovered.

Heat retention chemicals

Heatsaver is a biodegradable liquid that forms an invisible blanket on swimming pools and spas. Being less dense than water, the liquid floats to the top of the water where its inherent qualities increase the waters surface tension. The increased water tension reduces evaporation, resulting in reduced heating bills, a reduction in make up water and lower humidity levels in indoor pools and spas.

IS IT TOXIC?

No, it is a totally biodegradable liquid that is neither harmful to bathers nor detrimental to equipment. Its only adverse effect is the temporary formation of an oil slick on the water surface. The active ingredient in Heatsaver requires a carrier to disperse it into the body of water. In this case the carrier is alcohol

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based. The oil slick remains on the water for approximately ten minutes until the alcohol evaporates, leaving the active ingredient behind.

What benefits can I expect?

The main benefit is a reduction in heat loss. Heat saver has proven to reduce heating bills by anything up to forty percent. Other benefits include reduced water loss through evaporation and reduced humidity levels in indoor enclosures housing swimming pools and spa's. Our analysis shows that some commercial pools have directly benefited by using the heat retention chemicals.

Pool	Pool Type	Heating System	Length of Test	Humidity Drop	Measured Savings	Heatsaver – Cost per month	Monthly Savings	Payback Ratio	Yearly Net Savings
Resthaven Condominium Pool – Sidney BC	Indoor 50' x 20'	Electric	2 mo's	30%	40%	$ 38	$ 235	6.2 : 1	$ 2364
Ron Andrews Municipal Pool – North Vancouver	Indoor 125' x 45'	Natural Gas	2 mo's	23 %	18 %	$ 133	$ 380	2.9 : 1	$ 2964
Red Lion Hotel # 1 Seattle, Washington	Outdoor 50' x 25'	Natural Gas	2 mo's		34.5 %	$ 38	$ 230	6.1 : 1	$ 2304
Red Lion Hotel # 2 Seattle, Washington	Outdoor 50' x 25'	Natural Gas	2 weeks		45 %	$ 38	$ 295	7.8 : 1	$ 3084
YMCA Pool Victoria BC	Indoor 84' x 42'	Oil	2 mo's		16.5%	$ 90	$ 275	3.1 : 1	$ 2220
Kitsilano Municipal Pool - Vancouver	Outdoor 480' x 70'	Natural Gas	2 mo's		24 %	$ 1420	$ 2700	1.9 : 1	$ 15360
Hotel Vancouver	Indoor 50' x 20'	Steam	2 mo's		12.5 %	$ 28	$ 150	5.4 : 1	$ 1464

How do I add the chemical?

The chemical comes in a user friendly Tropical Fish. The pool owner / operator simply snips the PVC fin off the fish and throws it into the swimming pool. The

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fish sinks, slowly dispensing liquid over a period of 5 – 7 days. If the pool is heavily used, or the fish susceptible to being tampered with, the fish can either be tied to the ladder or added to the skimmer. In the worse case scenario, a metering pump can be added to the equipment to inject carefully dosed amounts of the heat retention chemical to the circulation water.

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