How To Understand

Pool Heat Pumps

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Introduction

This special report will help you understand pool heat pumps and their use in heating swimming pools. It includes a detailed and comprehensive review of the construction of a typical heat pump's pool water heat exchanger. It is not the objective of this report to explain the inner workings of the pool heat pump. Instead— this report will focus on how the heat pump is used in swimming pool applications.

The PCS1 (pool convection system one) is used to help explain the heat pump. A good understanding is accomplished by contrasting the pool water heat exchanger properties and internal construction of these two swimming pool heaters.

The PCS1 is a newly patented solar pool heater. In fact, this new solar technology itself is patented. Instead of placing solar panels on your roof to collect solar energy, the PCS1 is a heat exchanger that is physically placed inside your attic. In this newly patented technology, the solar collector is your own roof which is much more massive than a typical solar panel system. Ever stuck your head inside a hot attic? Ever wonder how hot it can get? Ever wonder why we didn't use this heat before now?

The conclusion you should arrive at if you read this entire report is that the pool heat pump is not a good long term solution to heating swimming pools. Instead, it represents an expensive alternative that is obviously not well understood.

Buying a pool heat pump is a questionable purchase in an age when nations around the globe are calling for the elimination of CFC chemicals. Today, there is no effective replacement chemical for use in pool heat pumps. If the compressor system ever fails, you can be assured of one thing. A very high repair bill. Repair bills of up to $1,300.00 are not uncommon when the heat pump's pool heat exchange coil and compressor have failed.

It is predictable that future laws will be passed banning heat pumps as they fail in the field [in other words you can't repair them] while new production is outright prohibited. An international ban on CFC production is set for the year 2000. A 50% reduction in the production of CFC chemicals is scheduled for the year 1997. This is the reason that R12 [freon] and R22 refrigerants have sky rocketed in price over the last few years. It is also the reason pool heat pumps are so expensive.

It is not uncommon for a pool heat pump to be in the $5,000.00 range. It is also not uncommon for an additional $1,200.00 in electrical installation costs to be incurred during the heat pump's installation. Pool heat pumps draw a sizable amount of electrical current and they do not simply plug into a wall outlet. All heat pumps have to be connected to the electrical power by a qualified electrician.

Cities like Irvine, California have already banned the use of CFCs. In other words, they have banned the use of pool heat pumps—today! Anyone who buys a pool heat pump today is buying a product that is slated for international obsolescence. Any new chemical that may arise in the future [to keep heat pump technology viable] will most likely be totally incompatible with the existing systems of today that use R12 or R22 refrigerants. This— according to industry news reports!

Such an obsolete product will be expensive to repair. Why didn't your pool heat pump contractor tell you this information? The contractor was selling a very expensive pool heater. OR, he wanted to avoid a discussion of obsolescence. OR, he was uninformed about heat pump technology. Even today—many pool contractors are still uninformed about heat pump technology and what is happening internationally. They are also uninformed about energy efficient pools and how to heat them inexpensively using the newly patented PCS1.

Heat Pump Electrical Needs

Table 1 on the next page illustrates the current requirements of 13 popular swimming pool heat pump heaters. The voltage requirement is 220-240 volts a-c. The table also compares the C.O.P. which stands for "coefficient of performance". This is an indication of how the heat pump compares to a standard electrical resistance heater. For example: A swimming pool heat pump with a C.O.P. of 4 is four times more efficient than an electric resistance heater.

This means the heat pump provides four times the heating capacity or btus [British thermal units] for the same cost as an electric resistance heater. Another way of looking at this is if an electric pool heater costs $300.00 per month to heat a particular swimming pool, a heat pump with a C.O.P. of 4 would only cost $75.00 per month to heat the same swimming pool. It is typical for pool heat pumps to average $125.00 - 150.00 per month in electrical operating costs. The current requirements shown in Table 1 explain the heavy monthly operating costs of most heat pumps.

Heat Pump Listing

Table 1

MFR#	Model No.	C.O.P.	Amps Req'd	KW Rating
A	24	4.00	12.5	3.00
A	36	4.00	15.5	3.72
B	45	3.5 to 5.5	14	3.36
B	60	3.5 to 5.5	18	4.32
B	75	3.5 to 5.5	24	5.76
C	24	4.20	20	4.80
C	36	4.70	30	7.20
C	60	4.30	50	12.00
D	325	5.29	20.5	4.92
D	500	5.11	29.4	7.05
E	35	4.00	12.9	3.09
E	50	4.00	17.2	4.12
E	60	4.00	19.2	4.60
SolarAttic™	**PCS1**	**44.00**	**1.8**	**.396**

NOTES:

1. **MFR#** refers to a specific manufacturer of swimming pool heat pumps.
2. Model No. refers to the specific manufacturers data sheet described by Model.
3. The formula for the coefficient of performance is **C.O.P. = Btus Out ÷ Btus In**
4. Amps Req'd refers to the amperage rating of this particular heat pump.
5. KW Rating refers to the Kilowatt rating. This figure was calculated using 240 vac.
6. PCS1 is shown for comparison purposes only. It is not a heat pump!

How To Calculate Heat Pump Operating Costs

This is a cost estimating template, simply fill in the appropriate numbers and perform the simple calculations shown. This template will help you to determine the cost of operating a Heat Pump swimming pool heater.

A. Cost Per Kilowatt of Electricity ____________
Note: Call your electric company for your rate

B. Kilowatt Rating of Heat Pump Heater ____________
Note: Look on Heat Pump Name Plate

Alternate KW Rating Approach
Heater Amperage rating = _______Amps
Heater Voltage rating = _______ Volts
Multiply amps times volts and divide by 1000 for KW

Example: 12 amps x 220 volts = 2640 watts
2640 watts ÷ 1000 = 2.64 KW

C. Hours per day heater is used ____________

D. Daily Operating Cost = (A x B x C) ____________

Example:
.09/kw x 2.64 kw heater x 10 hrs/day = $2.37/day

E. Days in the month heater is used ____________

F. Monthly Operating Cost = (D x E) ____________

Example:
2.37 x 30 days per month = $71.28

The cost of operating a Heat Pump swimming pool heater is substantially higher than the PCS1. The above example calculations are for a very small heat pump. In reality, most heat pumps will be twice as expensive to operate. Note also the high maintenance cost that can arise if the CFC chemical system in the heat pump fails.

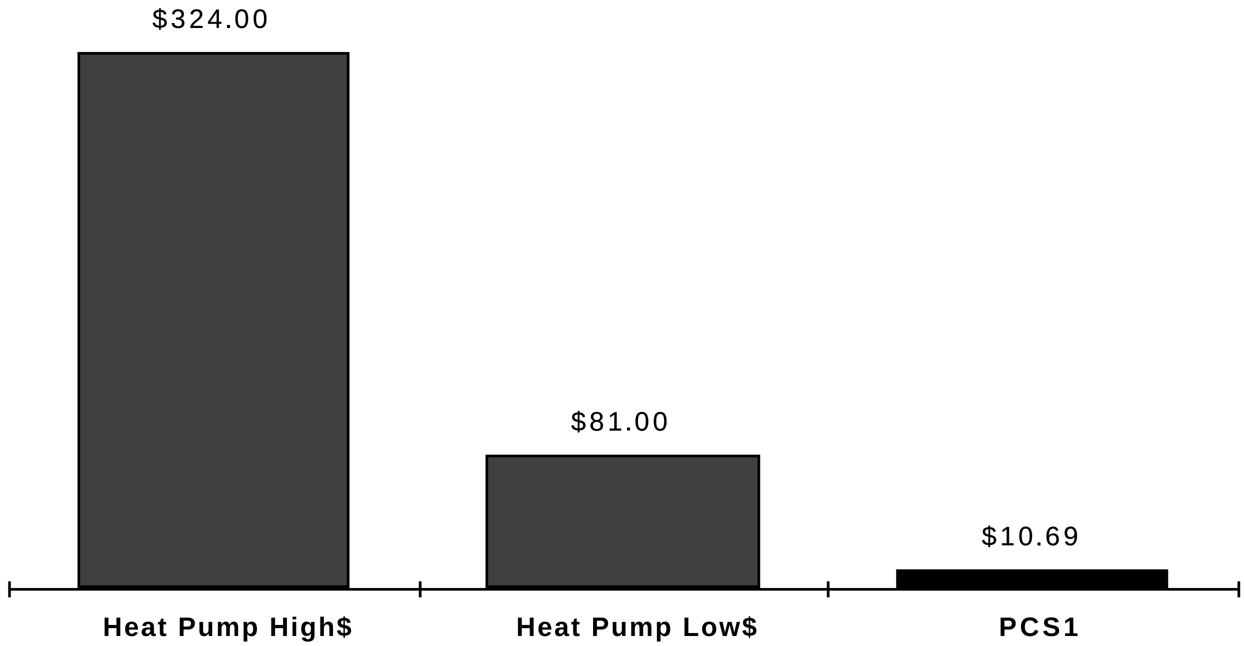
A swimming pool heat pump operates like a solar system. It usually takes a few days to get the pool up to the desired temperature and then the heat pump works daily to keep the pool at the desired temperature. The PCS1 does the same type of heating. This can be thought of as "constant temperature maintenance" heating of the swimming pool. In contrast, most fossil fuel heaters like natural gas heaters are "intermittent" heaters. These heaters are rated at higher btu ratings and can raise the pool 10-30° F in a given 24 hour period of time. Heat Pumps like solar systems are constant heaters and would only raise the pool a few degrees each day.

The solar collection process operates for an estimated 10 hours each day. This means a good solar system will keep providing heat to the pool for 10 hours each sunny or partially sunny day. Since swimming pool heat pumps are similar in how they are rated, you can use a 10 hour day for electrical consumption calculations.

Use the data for the popular swimming pool heat pumps shown in Table 1 and calculate their monthly operating costs based on your local electricity rates. Note that the heat pumps listed are single phase 240 vac. Some larger heat pumps require three phase power. These are primarily commercial units. As long as you have the KW rating of the heat pump, you can calculate how much it will cost to operate.

Using a 10 hour day, 30 day month, and 9¢ per kilowatt hour, it can be observed that these heat pumps will range in cost from $81.00 - $324.00 per month to operate. In contrast, the newly patented PCS1 only costs $10.69 per month to operate. This is shown graphically on the next page.

Monthly Operating Costs



So far, you've learned . . .

1. CFC chemicals used in heat pumps are scheduled to cease production.

2. To date, there is no effective replacement CFC chemical for heat pumps.

3. If a new chemical is developed for heat pump technology, it will most likely be incompatible with today's heat pumps that use R12 and R22.

4. Cities, States & Countries are banning the use of CFC based products.

5. Restrictive energy laws in the future may prevent today's CFC based pool heating products from being repaired.

6. The cost of replacement CFC chemicals are very high today.

7. If the compressor, chemical or heat exchanger in a heat pump pool heater should fail, it could easily cost $1,300.00 or more to get it repaired.
8. Heat pump pool heaters consume a large amount of electrical current.
9. Heat pump pool heaters can incur a large electrical installation cost.
10. The cost of operating heat pumps can range from $81.00 - $324.00 per month depending upon electricity costs, hours used / day and days used / month.
11. Heat Pumps cost 7.6 to 30.9 times the monthly operating cost of the PCS1.

Reliability

Now—lets talk about product life and reliability issues. The PCS1 has extended life characteristics over heat pumps used to heat swimming pools. The following discussion explains these extended life characteristics. Figure 1 is a perspective drawing of a **typical** heat pump swimming **pool water heat exchanger**. Refer now to Figure 1 on page 12 for the following discussion.

Heat Pump Construction

Figure 1 shows that part of the heat pump that actually transfers heat into the swimming pool's water. The swimming pool water heat exchanger [**110**] consists of a flexible rubber coil [**112**] several feet long and physically coiled and located in the bottom of the heat pump. Inside this flexible rubber coil [**112**] is another flexible piece of copper or cupro-nickel pipe [**114**] that carries heated refrigerant gas. This heated refrigerant gas is typically R-22 or R-12 [freon]. These chemicals are chlorofluorocarbons or CFC's and have been found to damage the earth's ozone layer. Again, the use of these chemicals are being restricted today by new laws and a total ban is being planned for by the year 2000.

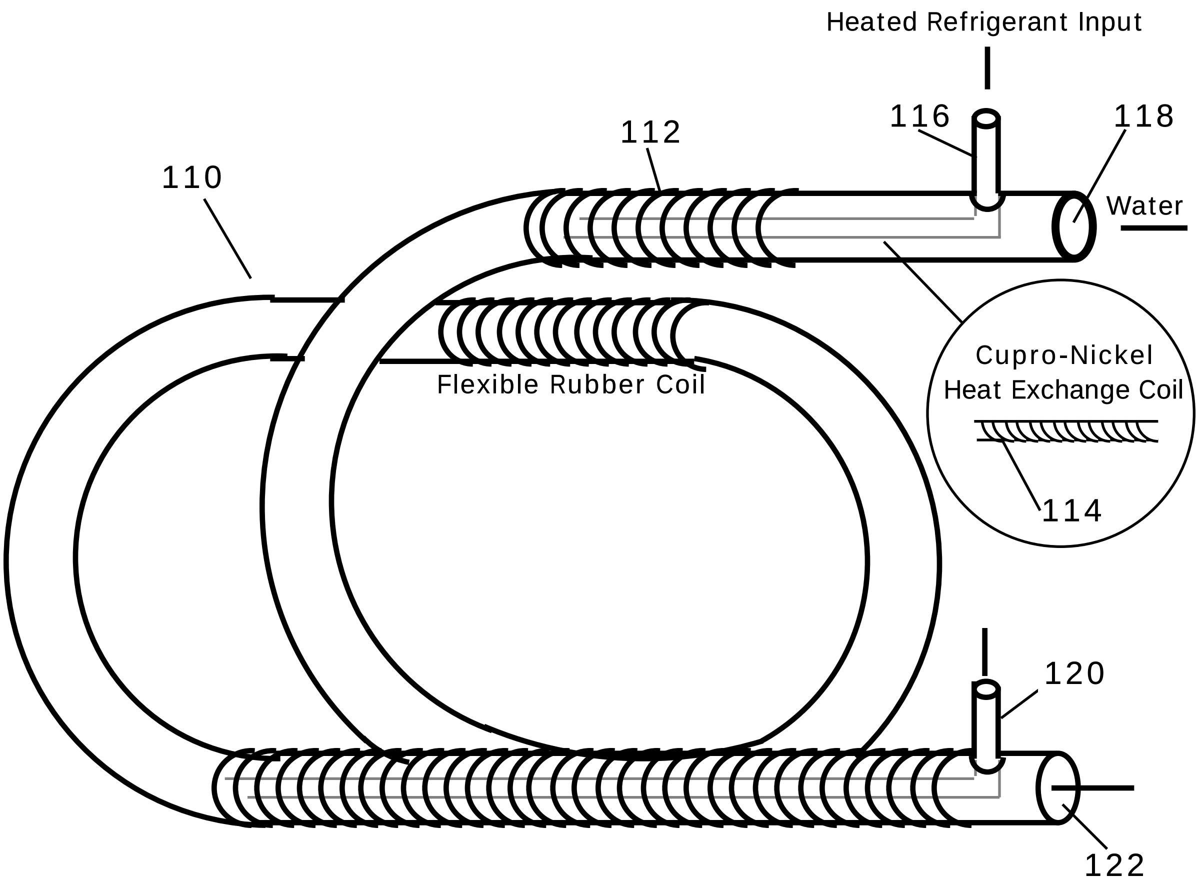
The heat pump works on a reverse refrigeration principle. The refrigerant in the heat pump enters the pool water heat exchanger [at **116**] in a compressed gaseous state. As this hot gas travels through the internal refrigerant coil [**114**], it gives up its heat to the swimming pool water [which enters at **118** and exits at **122**]. As the heat is given up to the pool water, the refrigerant turns from a gaseous state into a liquid state and leaves the exchanger [at **120**]. The refrigerant continues on and within the heat pump is returned to a compressed gaseous state. It then, once again, enters the pool water heat exchanger [at **116**]. This process is continuous while the pool water is being heated.

In the middle of the heat pump's refrigerant cycle, heat is taken out of the ambient air and is transferred [absorbed] into the refrigerant by [through the use of] an evaporator coil [part of the heat pump].

The energy dynamics are this: for every watt of energy it costs to run the heat pump, it delivers four to five watts of energy into the pool water in the form of heat. Again, it takes this extra heat from the outside ambient air. Note: The more humid the air, the more heat content the air has.

Pool Water Heat Exchanger

Figure 1



Observations

Now you have a basic understanding of the heat pump's swimming pool water heat exchanger and how it works. From here, I want you to observe a few things about the heat pump and compare it to our new swimming pool heater, the PCS1.

<u>First</u>, observe that the pool water flows around the internal refrigerant coil [114] virtually 100% of the time. We can call this a <u>one coil circuit</u> for the pool's water since only the one coil is exposed to the pool's water chemistry in the heat exchanger [**110**]. **<u>This is a primary consideration</u>**.

Failure Mode

When the swimming pool water is not properly maintained, it can turn acidic. If this happens, it behaves like an acid and quickly "eats" or etches away the refrigerant coil [**114**] causing a leak to occur. This in turn releases all of the CFC refrigerant from the heat pump into the environment and further damages the earth's ozone layer. In addition, the entire compressor system is then damaged as the pool water enters the internal pipes and refrigerant system of the heat pump. According to one manufacturer of heat pumps, the net result is the $1300.00 in repair costs to the heat pump owner that I spoke of earlier.

Pool Water Chemistry

Swimming pool water should be crystal clear; it should not smell of chlorine; and, it should be potable water [drinkable]. This is the optimum pool water chemistry and it is not hard to obtain from proper maintenance. Do not leave your pool unattended as the water can turn acidic, cloudy and algae can grow, etc. This will create major damage to the pool's support system which includes the pool's heater. Damage from a poorly maintained pool can occur in a relatively short period of time [a few days to a few weeks].

Heat Pump Life

With over a decade of field experience using pool heat pumps, this type of failure has occurred many times. A Florida Distributor of swimming pool heat pumps states: "The life of the pool water heat exchanger in a heat pump is **only five years.**" It is a frustrating experience to everyone, but a costly experience to the swimming pool owner. With only one circuit exposed to 100% of the pool's water, we can expect a certain predictable failure rate in an acidic pool which we'll call "**X**".

Multiple Circuits in PCS1

The PCS1 input manifold splits the pool's water into **nine separate coil circuit paths** so that **no single circuit is exposed to 100% of the pool's water**. Each circuit is 16.25 feet in length which is comparable to the heat pump's single refrigerant circuit previously described.

Reduced Exposure in PCS1

In addition, the PCS1 operates with a solar controller and bypass valve that only routes the water into the heat exchanger during periods when the attic has heat available for the swimming pool. In practice, this is typically 10 hours per day [max]. This means that the pool's water chemistry is not presented 100% of the time to the PCS1 heat exchanger. In fact, **the water is only presented 42% of the time to the PCS1**. Calculated: 10 hours maximum use ÷ 24 hour days = 42% duty cycle.

Impact on Life

The PCS1 has two significant factors which heat pumps do not have: A) Nine coil circuits versa only one in the heat pump; and, B) pool water presented only 42% of the time to the PCS1 versa 100% of the time to the heat pump. Since the PCS1, when it gets the pool's water, divides it into nine separate and distinct coil circuits - - **each circuit is therefore only exposed to the swimming pool's water 42% ÷ 9 or 4.6% of the time**.

Does this coil circuit approach lead to an increased life? Yes! In the case of the heat pump, the coil circuit exposure is 100%. In the case of the PCS1, the coil circuit exposure is only 4.6%. Assuming the life of the coil circuit in the heat pump is "**X**" **--** it is now apparent that the PCS1 has a coil circuit relative life **21.7 times that of the heat pump's**. This is shown on the next page in TABLE 2 and is calculated: 100% ÷ 4.6% = 21.7. Which coil circuit do you think will last the longest?

Table 2 on the next page summarizes other important differences. The full load amperage of current drawn by the PCS1 [shown in Table 1] is only 1.8 amps. Table 1 **Amps Req'd** column shows that heat pumps average 12.1 times the current requirements of the PCS1 with a range of 12.5 to 50 amps.

The internal temperature of the heat pump is very high due to the compression of refrigerant gas. This is also true when it comes to the internal pressure found. High internal temperature and high internal pressure can lead to premature failure in any type of device. These factors do not exist in the PCS1.

Life Characteristics

Table 2

#	Heat Exchanger Life Characteristic	PCS1	HEAT PUMP
A	Current Drawn	Low	HIGH
B	Temperature Internal to Exchanger	None	HIGH
C	Pressure Internal to Exchanger	None	HIGH
D	Number of Coil Transfer Circuits	9	1
E	Heat Exchanger Duty Cycle*	42%	100%
F	Coil Circuit Duty Cycle (E ÷ D)*	4.6%	100%
G	Relative Coil Circuit Life	21.7X	1X

*Time exposed to swimming pool water

Construction Summary

The PCS1 has only 4.6% exposure of each heat transfer coil circuit to the swimming pool's water when compared to the heat pump having a 100% coil circuit exposure. The PCS1 does not have the high internal temperature and pressure of the heat pump. The PCS1 does not use CFC chemicals like the heat pump. The PCS1 uses only a fraction of the electrical energy that the heat pump uses. And, the PCS1 has only a fraction of the moving parts that the heat pump has. All of these are "**reliability and life factors**". The fact that the heat pump has them means a shorter life than the PCS1 which does not have them!

WITHOUT THOSE HEAT PUMP PROBLEMS

- ❑ NO POLLUTING OUR CHILDREN'S ENVIRONMENT.
- ❑ NO USE OF CHLOROFLUOROCARBONS (CFC'S).
- ❑ NO DAMAGE TO THE EARTH'S PROTECTIVE OZONE.
- ❑ NO CHEMICALS.
- ❑ NO COMPRESSORS.
- ❑ NO LARGE CURRENT REQUIREMENTS.
- ❑ NO RESTRICTIVE NEW ENERGY LAWS.
- ❑ NO QUESTION ABOUT OPERATING COST SAVINGS.
- ❑ NO HIGH CIRCUIT EXPOSURE TO POOL WATER.
- ❑ NO INTERNAL PRESSURE PROBLEMS.
- ❑ NO INTERNAL TEMPERATURE PROBLEMS.
- ❑ NO FLOW RATE PROBLEMS.
- ❑ NO REFRIGERANT LEAK PROBLEMS.
- ❑ NO REFRIGERANT RECHARGING PROBLEMS.
- ❑ NO EXCESSIVE MOVING PARTS.
- ❑ NO SHORT DESIGN LIFE.
- ❑ NO LIMITED C.O.P. OF 4 TO 6.
- ❑ NO OBSOLETE COMPONENTS.
- ❑ ____________________________________.
- ❑ ____________________________________.

CHECK OFF YOUR REASONS FOR SWITCHING TO THE PCS1

How does the PCS1 work so well? The old fashion way! It uses a proven technology even older than that of the refrigerant cycle: forced air convection. Forced air convection applied in an innovative way to save money heating swimming pools. Forced air convection used with the massive solar collector you already have in the form of a roof. The PCS1 inexpensively and efficiently "exchanges" this free solar heat from the attic into the swimming pool. **The PCS1 does not have the preceding list of heat pump problems!**

Conclusion

Swimming pool heat pump heaters provide no solution to swimming pool owners. In fact, these products can be very costly to both our environment and your pocket book. While they have been viable products in the past, they are now obsolete. The PCS1 makes them an obsolete and expensive approach to swimming pool heating. For further information, you can write, phone or Fax:

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