Section 5: Solar Swimming Pool Heating Systems is devoted to solar systems that heat swimming pools.

- **Module: System Components, Installation and Operation** illustrates and describes the physical elements of solar pool heating systems. Guidelines for component and system installation are provided.

Section 5
Module: Pool System Components, Installation and Operation

Solar pool heating is a task for which solar energy is admirably suited. Desired pool temperatures range from 72°F to 85°F, only slightly above the winter daytime mean temperature in most of Florida. This small temperature differential permits the installation of solar pool heating systems which are simple and inexpensive and which operate with high efficiencies.

Economics

Solar swimming pool heaters save money. They represent an outstanding example of a use of solar energy that is economical today. Everyone benefits from their use – the pool owners reduce their monthly pool heating expenses, the installation contractor can make an acceptable profit and our nation has more gas and oil for critical needs.

Heat Loss Mechanisms

Evaporative Losses

Heat loss due to evaporation is familiar to anyone who has ever stood in a breezy spot, wearing a wet bathing suit. Evaporation cools the surface of a swimming pool in the same way.

The rate of evaporation from a pool surface is dependent upon wind velocity, air temperature, relative humidity and pool water temperature. Common everyday living experiences illustrate the way in which these variables affect that rate. Standing in the wind or in front of a fan accelerates evaporation, making a person feel cooler, but on warm, muggy days with high relative humidity, evaporation is inhibited and it is hard to stay comfortable.

Warm water evaporates more rapidly than cool water. Up to 70 percent of a swimming pool's heat energy loss results from evaporation of water from its surface. Evaporative losses are directly proportional to wind velocities at the pool surface and are higher from warm pools than from cooler pools.

Because most of the heat loss from a swimming pool is caused by evaporation of water from the surface, every effort should be made to reduce the evaporation process. Air temperature and relative humidity (both of which influence the rate of evaporation) are beyond our control.

Convective Losses

Convective losses occur when air cooler than the pool water blows across the pool surface. The layer of air that has been warmed by contact with the water is carried away by the wind and replaced with cooler air – a process that continues as long as the air is in motion. Anyone who has been exposed to a cold winter wind knows that convective heat loss can be substantial and that it increases with the wind’s speed. Detailed observations show the heat energy lost from a pool in this fashion is directly proportional to the wind speed at the surface – doubling when the air velocity doubles.

In Florida, as much as 20 percent of a swimming pool’s thermal energy loss is caused by convection. Because pools openly exposed to the wind will lose proportionally more energy than will shielded pools, windbreaks are desirable to reduce wind speed at the pool surface. Windbreaks such as hedges, trees, solid fences, buildings and mounds should be placed so as to shield the pool from cool winds. The direction of prevailing winds for any given month is available from your nearest weather station. Remember that cool winds come from the N, NE or NW in Florida.

Radiative Losses

Swimming pools radiate energy directly to the sky, another important energy loss mechanism.

Under normal conditions, clouds, dust and Florida's high humidity raise the year-round average sky temperature to only about 20°F less than the air temperature. Even with a small difference in temperature between the pool surface and the sky, radiative losses may exceed 10 percent of the total swimming pool energy losses.

Conductive Losses

Since a swimming pool is in direct contact with the ground or air around it, it can lose heat energy by conduction. The amount of energy transferred even from above ground pool walls to the air is quite small compared to the amount lost from the pool surface to the air. Dry ground and concrete are relatively good insulators, so the energy lost through the sides and bottom of an in-ground pool is also small. In fact, much of the energy conducted into the ground during the day is recovered when the pool temperature drops slightly during the night. In general, conductive losses through the walls of in-ground pools may be ignored.

However, pools immersed in groundwater that is influenced by tidal motion will lose an increased amount of energy through their walls. Heat flows from the pool to the ground-water surrounding it. As the groundwater is moved by the tides, it will be replaced periodically by cooler water. The quantity of heat loss in this situation is higher than for pools in dry ground and is not negligible. This loss is still low compared to losses through evaporation, convection and radiation.

Figure 1 summarizes the principal heat loss mechanisms for underground pools and shows their relative magnitude under one hypothetical set of Florida weather conditions.

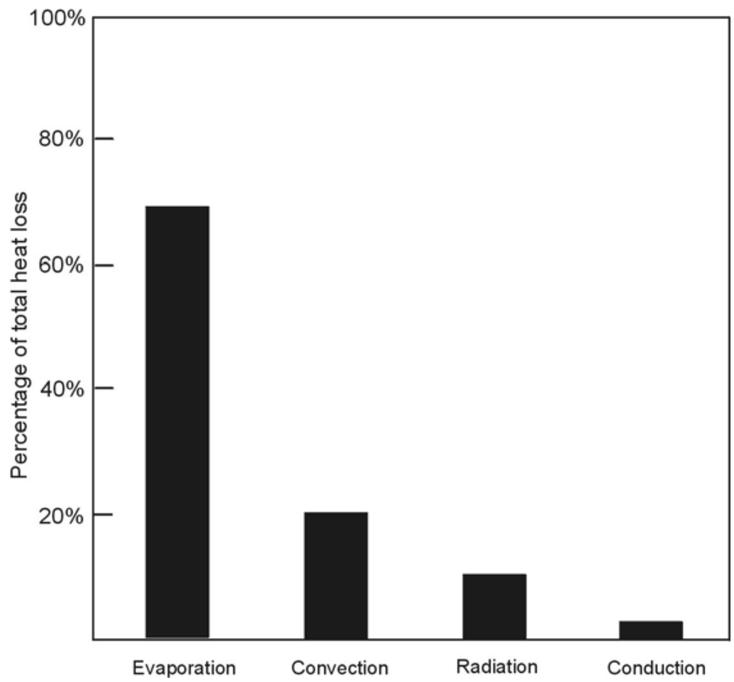

Figure 1 Swimming pool heat loss mechanisms

Passive Pool Heating

The use of passive techniques is the simplest and most cost-effective method of keeping swimming pools warm. A passive solar system is one in which the heat flows naturally – without the assistance of pumps and fans. Every effort should be made to incorporate the following three features in new pool construction to minimize the expense of supplementary energy for pool heating:

1. Place the pool in a sunny spot.
2. Reduce the wind velocity at the pool surface with suitable windbreaks.
3. Use a pool cover when the pool is not in use to minimize evaporation losses.

Swimming pools themselves are very effective solar energy collectors. The water absorbs more than 75 percent of the solar energy striking the pool surface (Figure 2). If possible, locate the swimming pool so it receives sunshine from about three hours before until three hours after solar noon. During this time period, the sun's rays travel through a relatively short atmospheric path and thus are at their maximum intensity. Additionally, there is less tendency for the sun's rays to be reflected from the pool surface during midday than during early morning and late afternoon, because they strike the pool surface at a small angle of incidence.

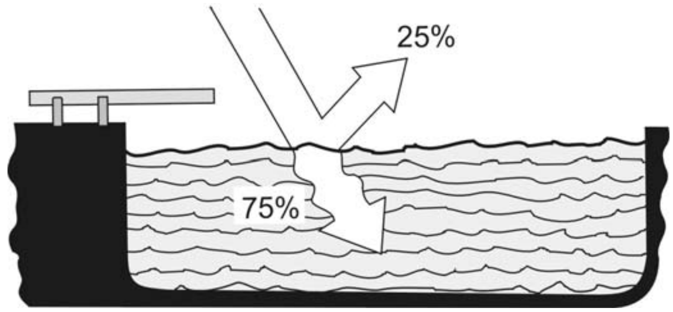

Figure 2 The swimming pool as a solar collector

Screen Enclosures

Screen enclosures reduce the amount of solar energy that strikes the pool surface. When the sun shines perpendicularly to the screen material, only about 15 percent of the energy is obstructed since the screen area is 85 percent open air space. However, when the sun strikes the material at an angle, much less of the radiation gets through, and the amount available to warm the pool is reduced. Experiments conducted at FSEC place this reduction as high as 30-40 percent on a clear day. More auxiliary energy will be required to maintain comfortable swimming temperatures if the pool has a screen enclosure.

Windspeed Reduction

Reducing wind velocity at the water surface reduces convective and evaporative losses. Solid fences or tall hedges located close to the pool perimeter are effective windbreaks. Buildings, trees and mounds also protect the pool from the cooling effect of prevailing winter winds. Locate the pool to take maximum advantage of these obstructions, being careful they do not shade the water surface from the sun. Windbreaks are particularly desirable near the ocean or adjacent to lakes, where the average wind speed is higher than in more sheltered locations. Figure 3 shows an example of a well-shielded pool.

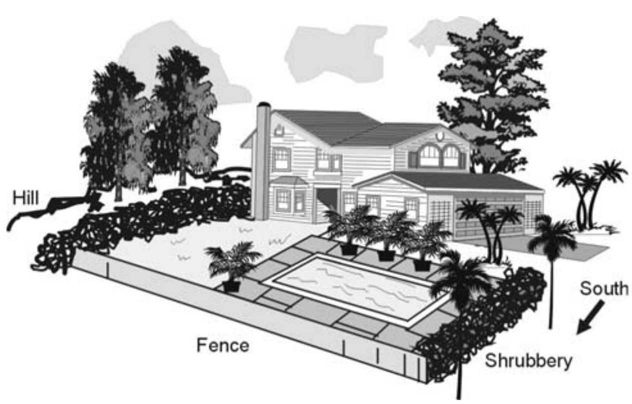

Figure 3 A well-protected pool

Pool Covers

Pool covers are effective in reducing heat losses. There are two basic types of pool covers on the market today: opaque and transparent. By reducing evaporation they reduce the quantity of chemicals needed, and they help to keep dirt and leaves out of the pool. Pool covers also reduce pool maintenance costs.

Transparent Pool Covers. Transparent covers will not only reduce evaporative losses. They will also turn the pool into a passive solar collector. Sunlight passes through the cover material and is absorbed by the pool water.

Because evaporation accounts for about 70 percent of pool heat loss, the beneficial effect of pool covers can be dramatic.

Figure 4 shows the approximate number of additional days annually that an unshaded, sunscreened pool, well protected from the wind, can be maintained above 80°F through the use of transparent covers. Climatic regions are shown in Figure 5. For example, in Gainesville, which is in the north central zone, a pool cover used for 14 hours each day extends the swimming season by approximately two months. The 14-hour period is assumed to include the coolest part of the day. Values presented must be used cautiously because the figures are based on historical weather data and a future month or even year may deviate substantially from the average.

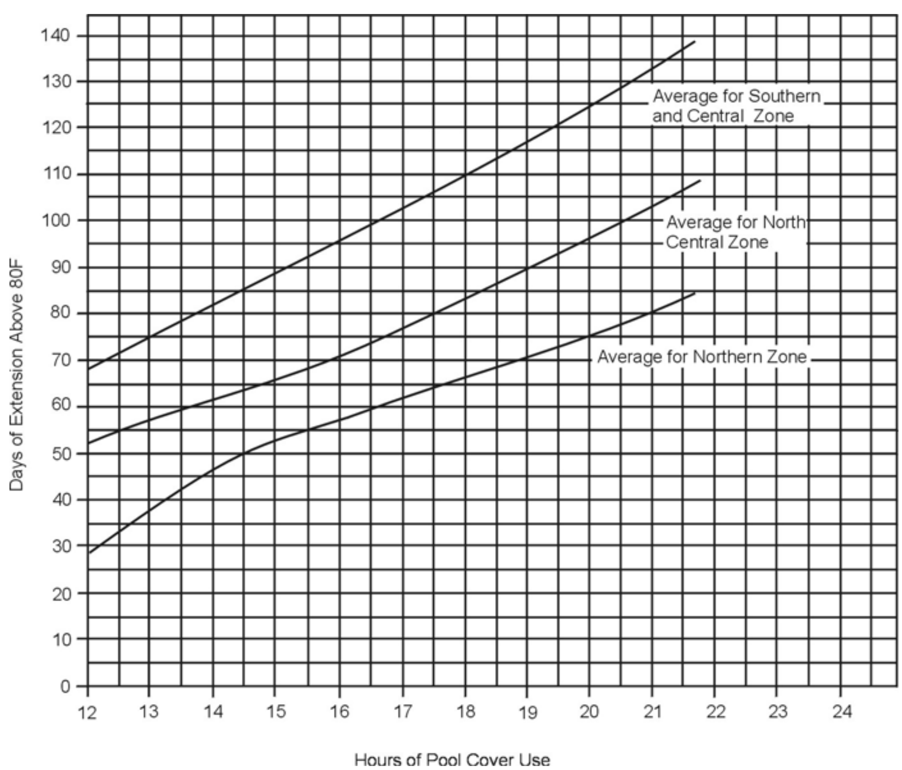

Figure 4 Effect of pool covers

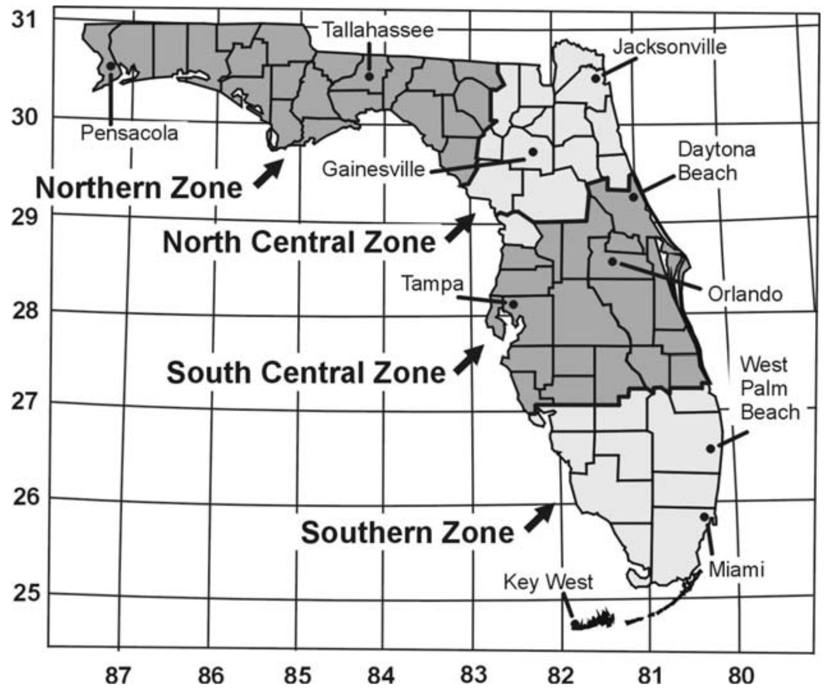

Figure 5 Climatic zones of Florida

Transparent pool covers are made from a variety of materials, such as polyethylene-vinyl copolymers, polyethylene and polyvinylchloride (PVC).

Attention to a few details will extend the life of transparent pool covers. They should not be left folded or rolled up on a hot deck or patio. The sunlight will overheat the inner layers and may even burst the air pockets in bubbled covers. When removing or installing a pool cover, avoid dragging it over the pool deck or any rough surface or sharp obstruction. Although it is recommended that a single, continuous pool cover be used whenever possible, the use of sectioned covers can ease handling in the case of larger pools.

Liquid Films. Some companies that supply pool chemicals offer a liquid evaporation retarder, which may be dropped in minute quantities onto the pool surface. Materials like cetyl alcohol spread to form a layer only a few molecules thick on a water surface. They can reduce evaporation by nearly 60 percent. Of course the materials offered for this purpose are not toxic but they are fairly expensive and must be re-dosed frequently (usually at the close of the daily swimming period). The chemical films do not reduce convective or radiation losses, but they do allow solar gains.

Opaque Covers. Opaque covers are useful for pools that must remain uncovered during daylight hours. Most commercial pools fall into this category. The following types of opaque covers are the most common: woven, plastic safety covers; skinned, flexible foam covers; and rigid or semi-rigid closed cell foam blocks or blankets. The woven safety covers will reduce evaporation losses (if they float and are waterproof) though not as well as a continuous film type cover. Skinned foam covers vary in thickness from less than 1/8 inch to more than 1/2 inch. In common insulating terms, their effectiveness in reducing heat losses ranges from R-1 to R-4. If they fit snugly to the edges of the pool, they will virtually eliminate evaporation losses during the periods when they are in place. Foam block covers such as expanded polystyrene have insulating values between R-4 and R-12, depending on their thickness. If properly fitted and placed on the pool surface, they, too, will nearly eliminate evaporation losses during the hours they are used. Their effectiveness in reducing convective and radiative losses increases directly with their R-value.

Active Pool Heating

Many types of solar collectors are suitable for pool heating. The temperature difference between the water to be heated and the surrounding air is small, so expensive insulating boxes and transparent covers that reduce collector heat loss are not often required. Cool winds above 5 mph substantially reduce the efficiency of unglazed collectors.

Low-Temperature Collectors

Types of low-temperature collectors include black flat-plates, black flexible mats (both with passages for pool water) and black pipes.

Flat-Plate Collectors. Several types of flat-plate collectors, specifically designed for pool heating, are available in both plastic and metal – plastic being the least expensive and most popular in Florida.

Flat-plate collectors for pools feature large-diameter headers at each end and numerous small fluid passageways through the plate portion. The header's primary function is to distribute the flow of pool water evenly to the small passageways in the plate. The header is large enough to serve as the distribution piping, which reduces material and installation labor costs. The fluid passageways, which collect energy from the entire expanse of the surface, are small and are spaced close together across the plate (if it is made of plastic) so most of the collector surface is wetted on its back side. Representative cross sections of plastic collectors are shown in Figure 6. EPDM flexible mat collectors have the same general cross section, as do plastic collectors.

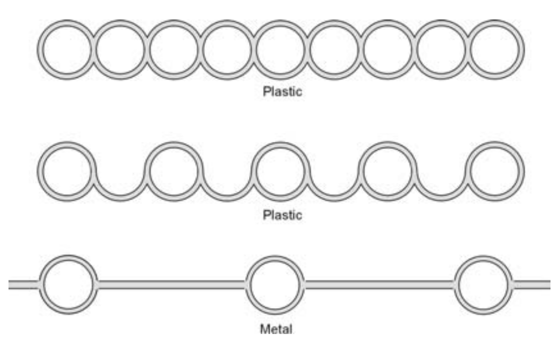

Figure 6 Typical collector designs

High water flow rates also tend to keep collector-to-air-temperature differences low. The total amount of energy delivered to the pool (the most important variable) is the product of the amount of water flowing through the collector multiplied by the water's temperature rise. Five hundred gallons of water raised 1°F contains as much energy as 10 gallons of water raised 50°F, but the collector operating at 10°F above pool temperature will operate less efficiently. Thus, high flow rates increase collector efficiency. Many manufacturers frequently recommend a flow rate as high as one gallon per minute for each 10 square feet of collector area. But such high flow rates are not needed to keep the temperature rise in the collectors below 10°F for best efficiency. Higher flow rates result in high-pressure drops across the collector array. This requires an increase in the horsepower of the circulating pump. Thus, flow rates are usually limited to about one gallon per minute for each 10 square feet of collector area for the configurations shown in Figure 6.

Because even plastic pool heating collectors are expensive, the plastic used must withstand years of exposure to sunlight. The ultraviolet portion of sunlight can break chemical bonds in most plastics and will eventually destroy the material if the process is not retarded. Collector manufacturers use several proprietary combinations of additives or stabilizers and UV inhibitors in the chemical mix of the collector material. These stabilizers and UV inhibitors provide protection from the damaging radiation and retard degradation of the plastic in addition to improving the collector's ability to absorb and conduct the sun's energy. Accurate estimation of plastic durability is difficult; therefore, explicit warranties are desirable. Most manufacturers currently offer a five-year or longer limited warranty. Some plastic collectors are expected to last 25 years.

Plastics are available in numerous formulations and types, many of which are relatively immune to attack from common chemicals. Polypropylene, acrylonitrile-butadiene-styrene (ABS), polyethylene, polybutylene, polyvinylchloride (PVC) and ethylene-propylene with diene monomer (EPDM) are frequently used collector materials. Some have been used to make pool collectors for more than 20 years and have demonstrated their ability to withstand attack by swimming pool chemicals and sunlight for at least that period of time.

Flat-plate collector designs utilizing metals are slightly different from plastic configurations. Metal is a better heat conductor, so relatively long fins can separate the tubes without causing excessive operating temperatures on portions of the collector surface. However, metal collectors are generally not used for pool collectors in Florida because they are subject to corrosion from pool chemicals.

Plumbing Schematics

Flow Control Devices

Solar pool heaters are generally connected to existing pool plumbing systems. This section explains how to make the connections.

A schematic of a frequently used pool filtration loop is shown in Figure 7a. The pump draws the water from the skimmer and main drain, forces it through the filter and returns it to the pool through the conventional heater. Lint, hair and leaf catching strainers are usually installed ahead of the pump.

Solar systems designed to operate with small pressure losses can be added as shown in Figure 7c. A spring-loaded check valve is installed downstream from the filter to prevent collector water from backwashing through the filter and flushing trash into the pool from the strainer when the pump is shut down. A manually operated or automatic valve is placed in the main line between Ts that feed the collector bank and return the solar heated water (Figures 7b and 7c). Ball valves may be placed in the feed and return lines for isolating the solar system from the pool filtration system when the filter is being backwashed or when adjustments are being made to the solar system. When solar heating is desired, the pump timer is adjusted to operate during daylight hours, and the valve in the main line is closed somewhat to restrict or fully interrupt the flow and force water up through the collectors. Valves on the lines to and from the solar system should be fully open.

Closing the valve in the main line may increase flow through the collectors. It may seem logical to reduce the flow rate through the solar array to make the return water warmer, and this can be done; however, it is not logical – the collectors will be forced to operate at higher temperatures, their efficiencies will drop, and less solar energy will be delivered to the pool. The temperature rise through the collectors should be kept low, less than 10°F on warm, sunny days, unless the manufacturer's specifications call for a higher temperature differential.

Forcing water through the solar system uses some of the pump's power, thus reducing the flow rate through the pool filtration system. As the main line valve is closed, pressure on a gauge mounted on the filter or discharge side of the pump will rise slightly. If the valve is closed entirely, all of the flow is diverted through the solar array and the collection efficiency increases. If the pressure at the filter does not rise unduly, the solar system should be operated in this way. However, the more the pressure rises, the slower the flow through the filtration system. This will increase the length of time required for the entire pool's contents to be filtered. Thus, it may be necessary to allow some of the flow to bypass the collectors. An inexpensive plastic flow meter can be used on the main line connection to monitor flow rates through the filtration system. Check with local building officials to determine minimum filtration flow rates or pool turnover times required in your area.

When the existing pool pump lacks enough power to circulate sufficient flow through the solar system and the filtration system, a booster pump may be required. It should be installed as shown in Figure 7d. Common pool-circulating pumps with or without the strainer basket are suitable for this application.

The booster pump should be placed in the line feeding the solar collectors, not in the main circulation line. In this position it will operate (consuming electricity) only when circulation through the solar collectors is wanted. Of course, the booster pump may be operated by the same time clock as that for the filter pump, but more often it will have a separate control. If both pumps operate from the same timer, it should be set so the pumps come on during daylight hours. In this case, the timer must be rated for the sum of the circulation pump and the solar booster pump.

If the booster pump is separately controlled, the filter pump may run for a longer portion of the day, and the booster pump should turn on during appropriate periods but only when the filter pump is operating.

Manual flow control or control with time clocks is simple and inexpensive but has drawbacks. Since clocks do not sense weather conditions, the circulating pump may be running when there is insufficient solar energy available to warm the pool water. Collectors may lose energy rather than gain it if weather conditions are unfavorable. Automatic flow controls overcome this difficulty. The most common plumbing schematic for systems using these devices is shown in Figure 8.

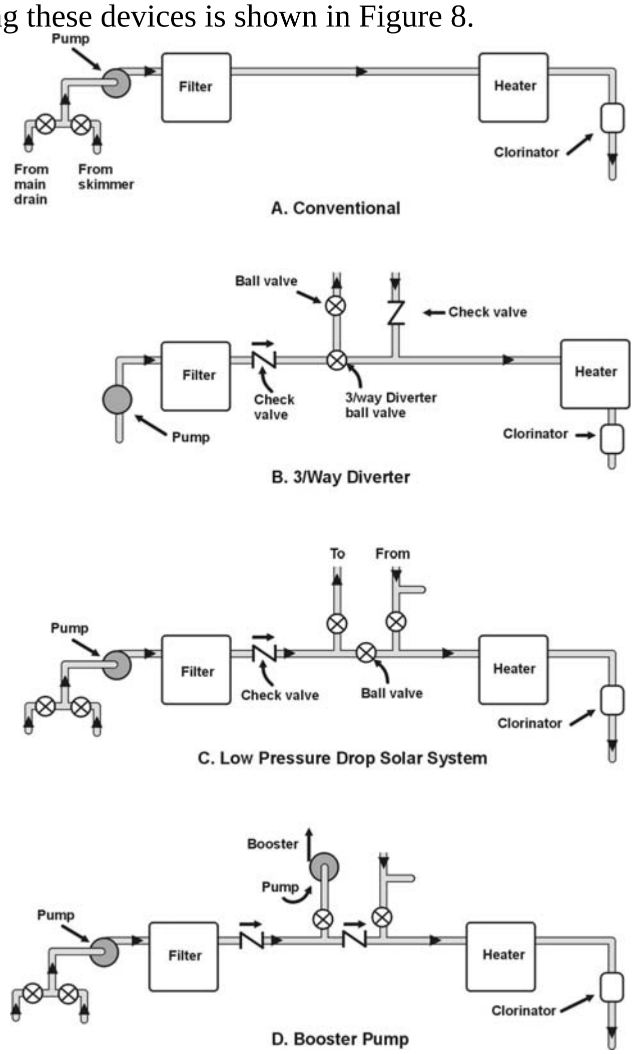

Figure 7 Plumbing schematics

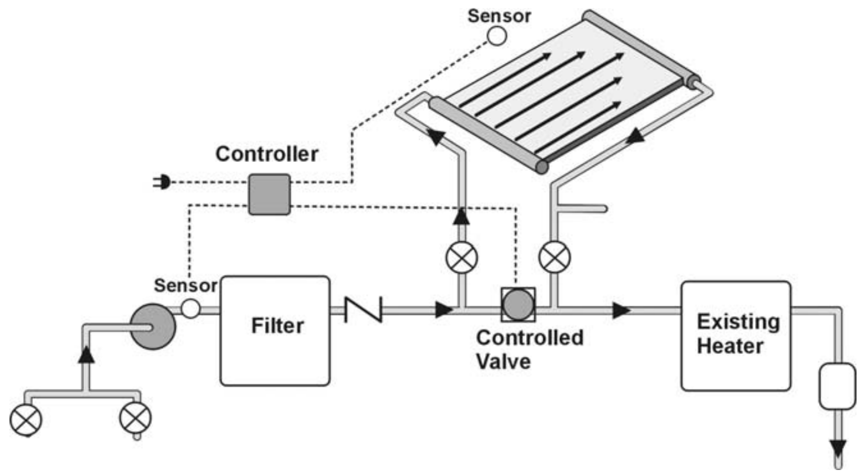

Figure 8 Automatic control plumbing schematic

Accurate differential temperature control is difficult to achieve because of the small temperature rise that takes place in solar pool heaters. A sensor, tapped into the piping at a convenient place ahead of the collector return line, measures the pool water temperature. Another sensor is housed in a plastic block and placed near the solar collectors, so its temperature parallels that of the collector (or it may be attached to the collector outlet). When the pool water temperature exceeds the collector temperature, the control valve remains in the open position and the flow bypasses the collector loop. When the collector temperature exceeds the pool water temperature, the valve is closed, forcing the flow through the collectors. In practice it has proven equally effective to control the flow through the collectors with a single solar sensor, which turns on the solar pump and/or activates the diverting valve above a fixed solar intensity level.

When operating properly, a differential controller automatically adjusts to changing conditions, monitoring variations in collector temperature caused by clouds, other weather factors and the approach of evening. When collector temperature drops, the control de-energizes the valve and flow bypasses the collector. Maximum pool temperature limits can be programmed into some controls.

Control valves may be actuated hydraulically or electrically. One of the earliest valves used was a hydraulically operated pinch valve consisting of a cylinder with an expandable bladder inside. A high-pressure line connected to the discharge side of the pump is used to expand the bladder, pinching off the flow and diverting it through the solar system. A low-pressure line connected to the suction side of the pump deflates the bladder and allows the flow to pass unimpeded. An automatic controller accomplishes switching between the high- and low-pressure lines.

Electrically operated valves are also used. A differential controller may be used to operate a solenoid that, in turn, activates the main valve in much the same way the pinch valve is activated. Be sure the valve you select is specifically designed and constructed for use on pool systems. Automatic control schematics, taken from the installation diagrams of two low-temperature collector manufacturers are shown in Figures 9 and 10.

The most common method to divert the flow of water to the solar collectors from the pool is to use a 3-way valve on the solar supply line. Similar to the in-line ball valve or isolation valve, the three-way diverter valve is commonly used in the swimming pool and spa industries.

Some of the 3-way manual valves are made to be used for solar pool heating. The 3-way valve has a motorized diverter that attaches to the top of the valve to convert the manual valve into an automatic or motorized valve. Other 3-way diverter valves are manufactured with the motor assembly on the valve. In this case, a differential controller sends low voltage power to the diverter actuator (or motor) and rotates the valve sending the water from the filter to the solar collectors. A check valve after the 3-way valve allows the solar collectors to drain into the pool when the pump is not operating. This may provide freeze protection if the system tilt and piping was installed to allow continuous drainage.

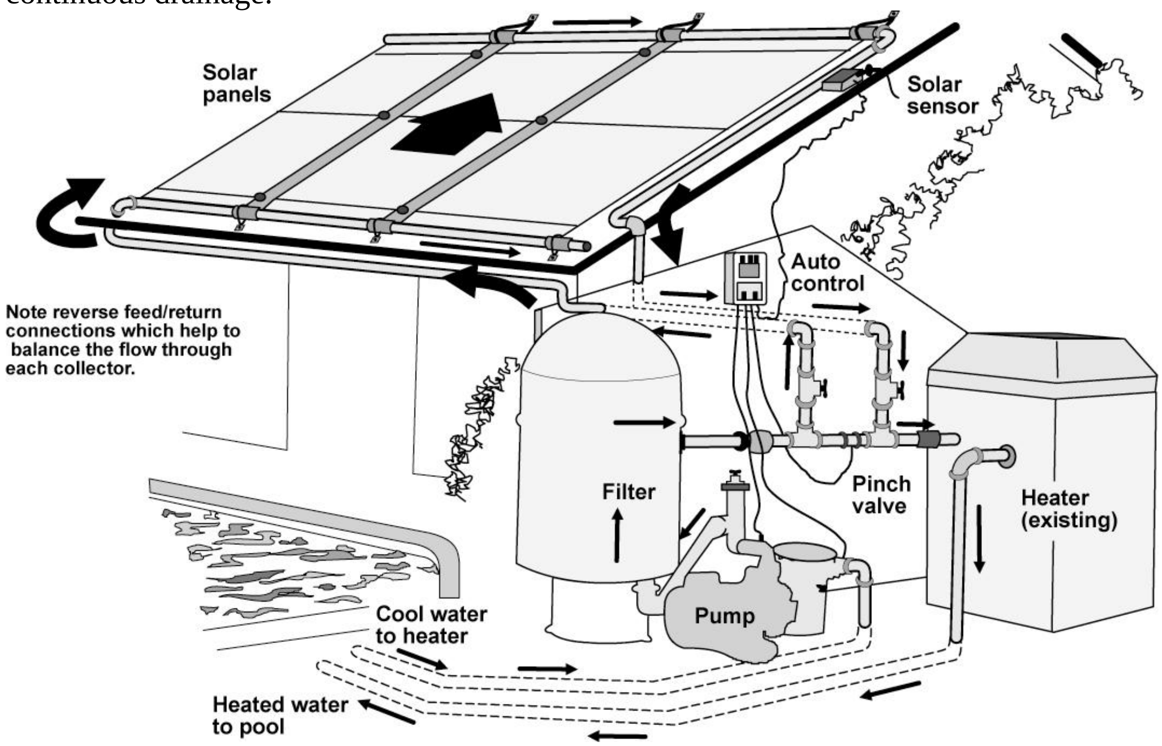

Figure 9 Plumbing schematic

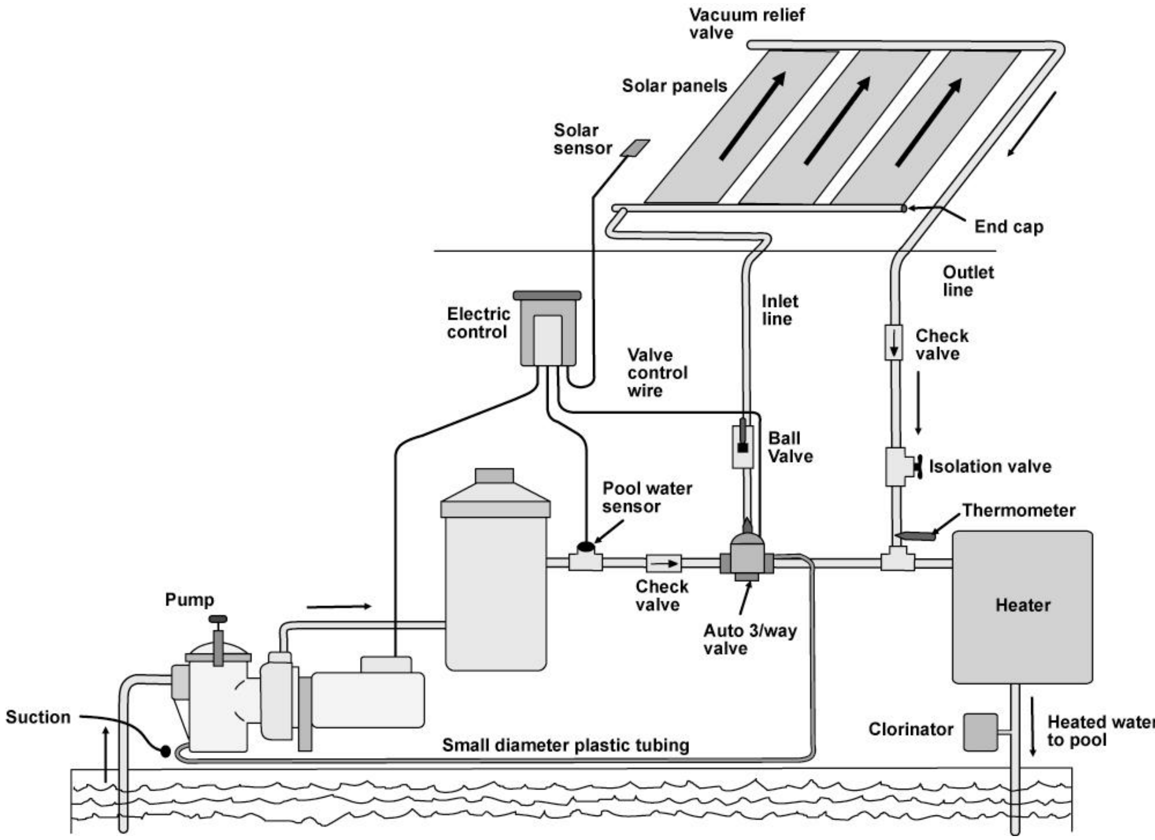

Figure 10 Plumbing schematic

Corrosion Problems

Improper pool chemistry can cause accelerated corrosion. The pool water pH should normally be maintained between 7.4 and 7.8. PH is a measure of the acidic and basic character of a solution. A pH of 1-7 is on the acidic side. The lower the number the more acid it is. A pH of 7-14 represents increasing alkalinity. Low pH (less than 7.2) may be caused by improper use of pool additives. Under acid conditions (low pH), chloride and sulfate ions in the pool combine with water to form acids capable of breaking down protective films. Low pH also accelerates the corrosion of most metals.

Excessive concentrations of copper ions in pool water may lead to the formation of colored precipitates on the pool wall if the pH is allowed to drop. Several copper compounds have been identified as causing this problem; however, since many common algaecides are based on copper compounds, the concentration of free copper ions in pool water may relate to the use of these chemicals as well as the corrosion of copper piping materials. Care should be exercised in maintaining proper pH levels whether copper or plastic piping is used in a solar pool heater.

Sizing Filter Pumps and Pipe Runs

For simple installations, sizing the filters, pumps and pipe runs to circulate and keep the necessary pool water clean and heated may be successfully accomplished by following the instructions contained in the following sections. For large or complex installations, more detailed manuals or a person knowledgeable with hydraulics should be consulted.

A basic knowledge of the characteristics of a swimming pool's circulation system will be useful to installers in selecting the components appropriate for the solar heating of a specific pool.

Sizing Filtration and Circulation Systems

Proper sizing of swimming pool filters, circulation pumps and pipe runs may be accomplished by using the information provided in this section in conjunction with data routinely provided by manufacturers of those components.

Filter Sizing Graphs. Filter sizing is accomplished by using graphs, such as Figure 11, provided by filter manufacturers. The following types of filters are those most often used to keep swimming pools clean.

Sand, gravel or anthracite filters are sometimes operated at a flow rate as high as 20 gallons per minute (gpm)/ft^2. It should be noted that some code jurisdictions limit the flow rate through these filters to three gpm/ft^2. Diatomaceous earth (DE) filters usually operate well at about two gpm/ft^2. Both sand and DE filters may be cleaned by backwashing and discharging the dirty water into a sewer or other appropriate outlet. An air gap in the discharge line is often required to ensure against backflow contamination from the sewer. Cartridge filters are usually operated at a flow rate of about one gpm/ft^2 and may be reverse flushed and reused. When the cartridges become excessively dirty they are simply replaced.

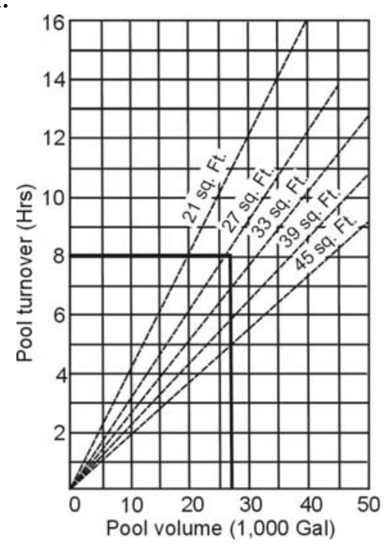

Figure 11 Diatomaceous earth filter sizing graph for flow rate of 2 gpm/ft^2

In pool filtration systems, the need for cleaning is indicated by high readings on a pressure gauge, which is located between the filter and the pump. Filter manufacturers specify the readings at which they recommend maintenance. The pressure drop due to properly sized clean filters is usually about five psi. The backwashing valve assembly on DE and sand filters may add another five psi.

Pump Sizing Graphs. To size the pumps it is necessary to establish a flow rate in gpm and then add up all the pressure drops that occur when water flows through the system at that rate. Figure 12 is a graph on which pressure drop and flow rate are plotted for typical swimming pool circulation pumps.

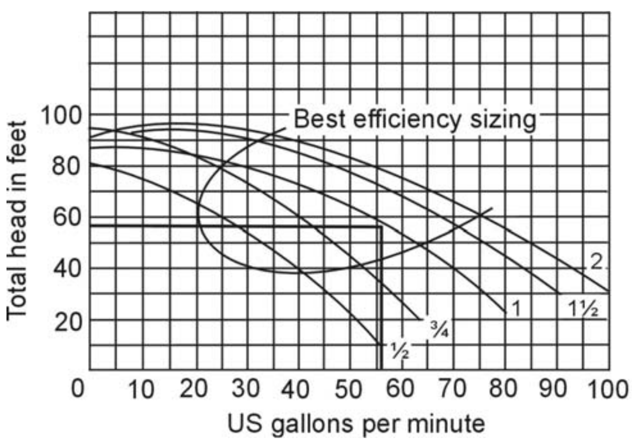

Figure 12 Pump performance

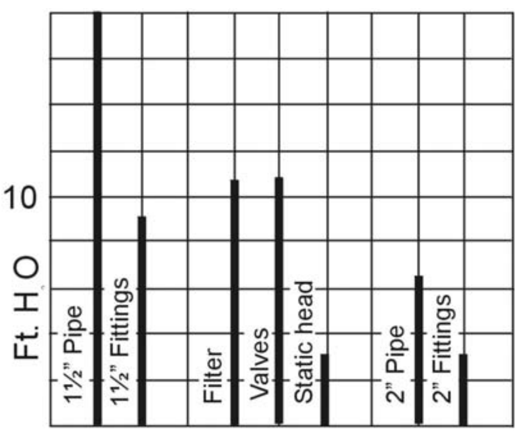

Figure 13 Relative pressure

Sizing Connecting Piping. Connecting piping may be sized using pipe flow charts (Figures 14 and 15). Piping should be large enough to prevent excessively high flow rates that cause erosion of interior pipe and fitting surfaces. Some code jurisdictions limit the rate of water flow through copper pipes to five feet per second. Adequately sized piping and pumps help reduce maintenance and operating costs.

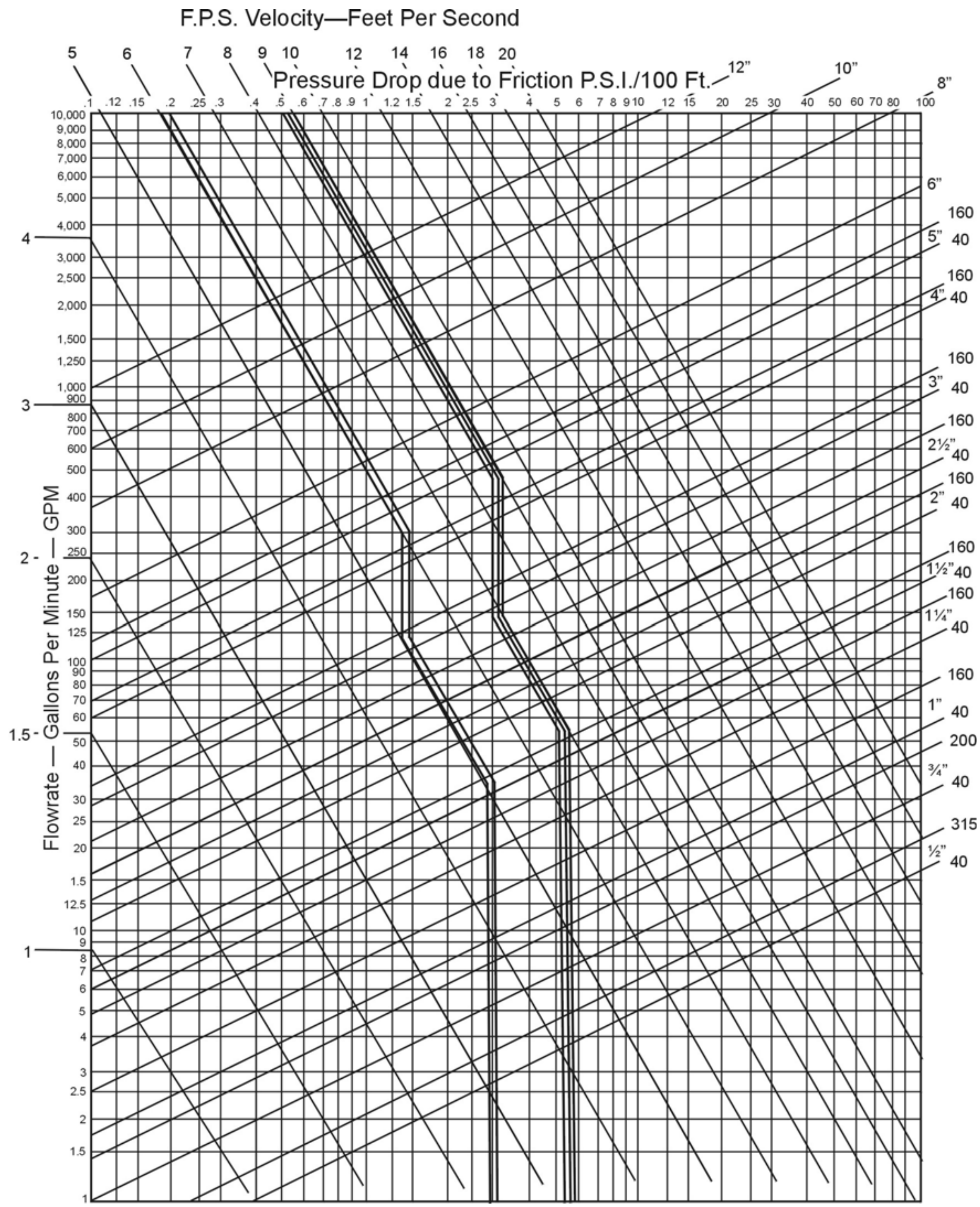

Figure 14 Pressure drop plastic pipe

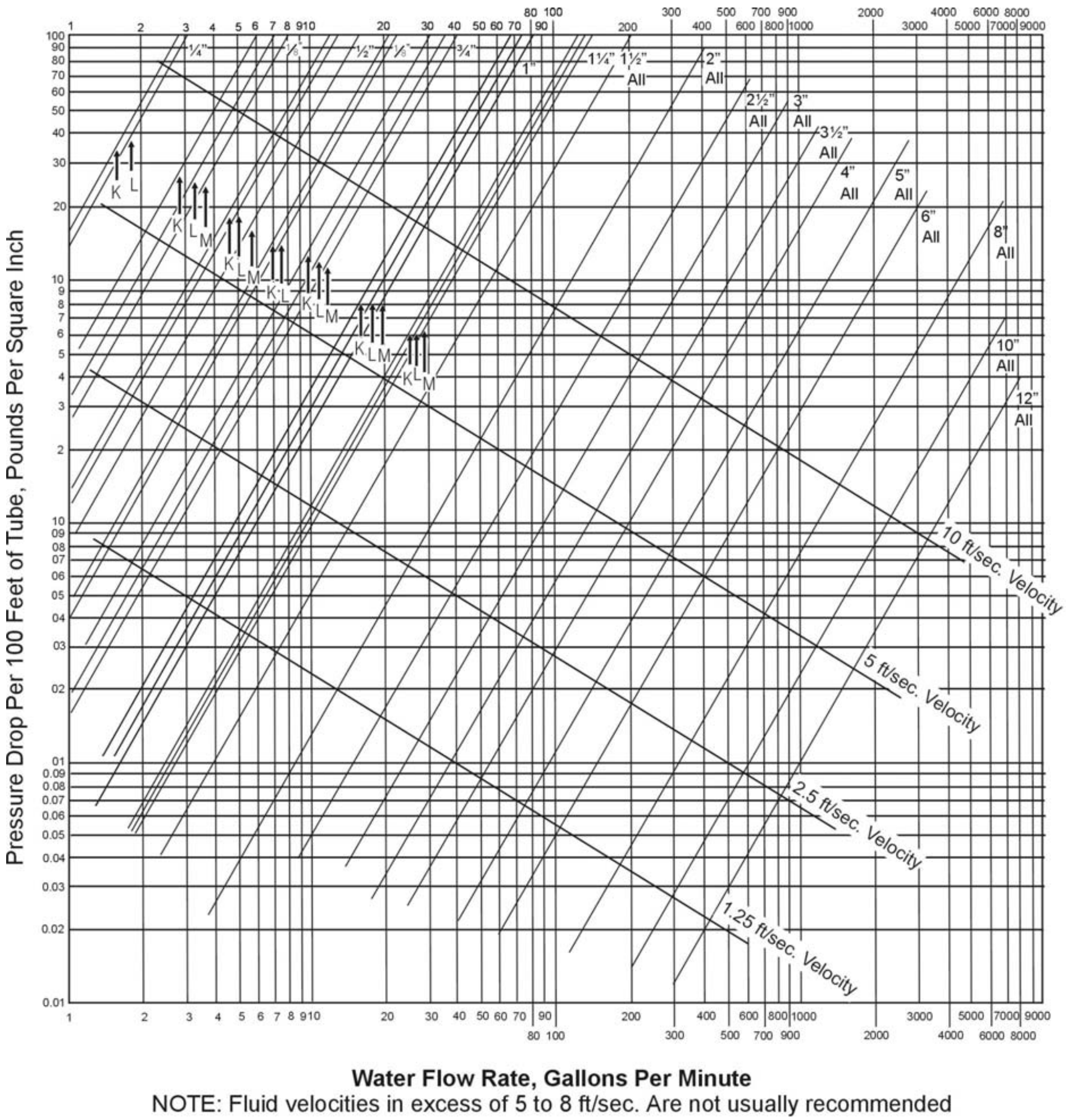

Figure 15 Pressure loss and velocity relationships for water flowing in copper pipe

Examples

The following examples are intended to help clarify sizing procedures.

The owner of a 20-by-40-foot swimming pool with an average depth of 4.5 feet wants to circulate the total pool volume through the filtration system in eight hours. (The turnover rate *is* currently one complete recirculation per eight hours.) The owner plans to use a DE filter and wants to know what size filter and pumps will be required (1) with no heater, (2) with a gas heater, (3) with a solar heater and a gas heater for back-up and (4) with a solar heater without a back-up. The pump will be located so the center of its impeller is three feet above the surface of the pool. One hundred feet of pipe will be required unless solar collectors are used. In that case, 200 feet of connecting pipe will be required. The high point of the solar collector array will be 12 feet above the center of the pump impeller. The solar collectors will be connected to the circulation piping as shown in Figure 8b. The owner also wants to know what size connecting pipe should be installed under any of the four alternative conditions.

STEP 1. Determine the pool volume.

$$\text{Pool volume (gal)} = 20'\text{x } 40'\text{x } 4.5'\text{x } 7.48 \text{ gal/ft}^2 = 26{,}900 \text{ gal.}$$

STEP 2. Determine the DE filter cross sectional area if 2 gpm/ft^2 of filter area is an acceptable flow rate through it, and the pool volume of 26,900 gallons must turn over every eight hours.

Figure 11 shows a cross sectional area between 27/ft^2 and 33/ft^2 will be required. The filter that provides 33/ft^2 of cross sectional area will be the better choice because it will allow a turnover time of slightly less than eight hours.

STEP 3. Determine the flow rate through the filtration system.

Because the entire volume must turn over once each eight hours,

$$\text{Flow rate} = \frac{26{,}900}{8} = 3360 \text{ gallons per hour (gph)}$$

$$\text{Flow rate} = \frac{3{,}360}{60} = 56 \text{ gpm}$$

STEP 4. If no heater is included in the system, determine the total pressure, which the pump will be required to overcome at a flow rate of 56 gpm.

Cause of Pressure Drop	Source of Information	Pressure Drop Lbs/In^2 (Psi)	Pressure Drop Ft of Water (Psi x 2.31)
100 ft 1-1/2" schedule 40 plastic pipe	Figure 14	8	18.5
Fitting	About 1/2 of pipe drop	4	9.2
Valves	Manufacturer's specs.	5	11.6
Filter	Manufacturer's specs.	5	11.6
Lift head			3
Total			**54**

Figure 12 shows a one-hp pump (of the specific design covered by that graph) will circulate 56 gpm against a 57-foot head. A 3/4-hp pump will circulate only 45 gpm against a 51-foot head, so the one-hp pump will be the safest choice.

Discussion*:* It is interesting to note if 2-inch schedule 40 pipe is used, the pressure drop in the pipe is only three psi or seven feet of water, so the total pressure drop is about 37 feet of water. Figure 12 shows a 3/4-hp pump is powerful enough to circulate 52 gpm against a total head of 37 feet of water. (Turnover time increases to 8.6 hours.) Figure 13 illustrates the relative magnitude of the pressure drops.

STEP 5. Determine the size pump that will be required if a gas-fired pool heater is added which causes an additional pressure drop of five psi.

	Pressure Drop	
Cause of Pressure Drop	**Psi**	**Ft of Water**
100 ft –1 1/2" schedule 40 plastic pipe	8	18.5
Fittings	4	9.2
Valves	5	11.6
Filter	5	11.6
Pool heater	5	11.6
Lift head		3
Total		**65**

Figure12 shows a one-hp pump will pump about 50 gpm against 65 feet of water. This is probably close enough to the required volume for practical purposes. (The turnover time is a littler longer – nine hours.)

Discussion*:* Under these conditions, using two-inch pipe reduces the total pressure drop to about 50 feet of water but this does not allow us to use a 3/4-hp pump because the smaller pump will only circulate 46 gpm against a 50-foot head. (In this case, the turnover time would be increased to 10 hours should the 3/4-hp pump be used.)

STEP 6. Determine the size pump that will be required if we add a solar collector system and a gas-fired back-up heater. A pressure drop of two psi is expected across the solar collectors. The system contains an extra 100 feet of pipe and a vacuum breaker located 12 feet above the center of the pump’s impeller.

Using 1 1/2" and 2" Pipe

Cause of Pressure Drop	Pressure Drop	
	Psi	**Ft of Water**
100 ft of 1 1/2" pipe	8	18.5
Fittings for 1 1/2" pipe	4	9.2
100 ft of 2" pipe	3	6.9
Fittings for 2" pipe	1+	2.3+
Valves	5	11.6
Filter	5	11.6
Solar panels	2	4.6
Gas heater	5	11.6
Static head (3' + 12')		15
Total		**92**

Using Only 2" Pipe

Cause of Pressure Drop	Pressure Drop	
	Psi	**Ft of Water**
200 ft of 2" pipe	6	13.9
Fittings for 2" pipe	3	6.9
Valves	5	11.6
Filter	5	11.6
Solar panels	2	4.6
Gas heater	5	11.6
Static head (3' + 12')		15
Total		**75**

Figure 13 shows if 100 feet of 1-1/2-inch pipe and 100 feet of two-inch pipe are used to make the connections, a two-hp pump will move only 35 gpm against the 92-foot water head. This increases the turnover time to about 13 hours, so a 2 1/2-hp pump will be required. If 200 feet of two-inch pipe is used, a 1 1/2-hp pump will move 52 gpm against the 75-foot head. Again, in this example, 52 gpm will probably turn the pool volume over in an acceptable period of time (8.6 hr).

Discussion: Another option applicable to retrofitting a gas-heated pool piped initially with 1-1/2-inch pipe and a one-hp pump is the addition of a second small pump installed as pictured in Figure 7d. The additional pump will be required to overcome a static head of 12 feet of water and a friction head of 28 feet of water if 1 1/2-inch pipe is used to connect the solar panels to the system. The pressure loss across the panels will still be 4.6 feet of water. The total pressure drop, which the added pump will be required to overcome, will be 12 + 28 + 4.6 or about 45 feet of water head. Figure 12 shows a 3/4-hp pump will circulate 49 gpm against a 45-foot head. It should be noted the two pumps working in series will assist each other and in most cases the turnover times will be no more than eight hours.

Two pumps require more maintenance than does one, but the solar booster pump may be turned off when circulation through the panels is not desired. This reduces electrical consumption.

A final option for pool heating is the addition of solar collectors without a fossil-fired back-up system. Referring to the immediately preceding piping options, the elimination of the gas-fired heater reduces the pressure drop from 92 to 80 feet of water if an additional 100 feet of 1-inch pipe and 100 feet of 2-inch pipe are used to make the connections.

Figure 12 shows a 2-hp pump will pump 54 gpm against an 80-foot head. (The turnover time is 8.3 hours.)

If 2-inch connecting pipe is used throughout, the total pressure drop is reduced to about 63 feet and a 1 hp pump will deliver 50 gpm against a 63-foot head (the turnover time is nine hours). A 1.5 hp pump will circulate about 65 gpm against a 63-foot head (the turnover time is 7 1/2 hours).

Table 1 presents each of the pool heating options and the corresponding pipe and pump sizes which yield the various pool turnover time periods.

Components	**Pipe Size**	**Pump Size Required**	**Turnover Time (In hours)**
System with no heater	100 ft of 1 1/2" schedule 40 plastic	1 hp	8
	100 ft of 2" schedule 40 plastic	3/4 hp	8.6
System with gas or oil heater (5 psi pressure drop)	100 ft of 1 1/2"	1 hp	9
	100 ft of 2"	1 hp	7.2
System with gas and solar (15 ft static head)	100 ft of 1 1/2" plus 100 ft of 2"	2 1/2 hp	8
	200 ft 1 1/2"	2 pumps (1 hp+3/4 hp)	8
	200 ft 2"	1 hp	8.6
System with solar only (15 ft static head)	100 ft 1 1/2" plus 100 ft 2"	2 hp	8.3
	200 ft 2"	1 hp	9
		1 hp	7.5

Table 7.1 Pool Heating Options

None of the stated options alter the turnover rate of the pool sufficiently to require resizing the DE filter. It should contain between 27/ftp^{2}p and 33/ftp^{2}p of filtration area.

Pressure Drop Across the Valves and Fittings

Many swimming pool installers use the simple rules of thumb cited in the previous examples to determine pressure drops caused by the resistance to liquid flow of valves and filters. However, it is important for the solar installer to realize the actual pressure drops vary with both flow rate and mechanical characteristics of specific valves and fittings. Table 2 presents frictional losses expressed in equivalent lengths of pipe for commonly used fittings. (Most fitting manufacturers supply similar tables.) The sum of the equivalent length of all the fittings on the circulation system may be added to the actual length of pipe in the system before the pressure drop is read from Figure 14 (plastic pipe) or Figure 15 (copper pipe). The pressure drop across the backwash valve assembly is accepted as being five psi in the example. Actually, this pressure also varies with flow rate and the mechanical design of specific valves. The variation from valve to valve is too great to make a generalized tabular presentation of pressure drop much more useful than the five psi rule of thumb value. Most filter and backwash valve suppliers can make available accurate tables or graphs for their valves. The information is usually given in psi, which may be converted to feet of water head by multiplying by 2.31.

Fittings – Friction Losses expressed as equivalent lengths of pipe (feet).

Type of fitting	**Material (in ")**	**1**	**1 1/4**	**1 1/2**	**2**	**2 1/2**	**3**	**3 1/2**	**4**	**5**	**6**	**8**	**10**	**12**
Standard tee with flow through branch	Steel	6	8	9	11	14	16	-	20	26	31	40	51	61
	Plastic	9	12	13	17	20	23	-	29	-	45	-	-	-
	Copper	6	8	9	11	14	16	18	20	26	31	40	-	-
90 degree long radius elbow, or run of standard tee	Steel	1.7	2.3	2.8	3.6	4.2	5.2	-	6.8	8.5	10	14	17	20
	Plastic	3	4	5	7	8	10	-	12	-	17	-	-	-
	Copper	1.7	2.3	2.8	3.6	4.2	5.2	6.1	6.8	8.5	10	14	-	-
Adapter slip/ solder fitting to thread insert coupling	Plastic	3	3	3	3	3	3	-	3	-	3	-	-	-
	Copper	1	1	1	1	1	1	1	1	1	1	1	-	-
	Plastic	3	3	3	3	3	3	-	3	-	3	-	-	-
Gate Valve (fully open)	-	.60	.80	.95	1.15	1.4	1.6	1.9	2.1	2.7	3.2	4.3	5.3	6.4
Swing Check Valve	-	7	9	11	13	16	20	23	26	33	39	52	67	77
Ordinary entrance	-	1.5	2.0	2.4	3.0	3.7	4.5	5.2	6.0	7.3	9.0	12	15	17

Table 7.2 Friction Losses

Energy Conservation

The solar heater for a swimming pool should be sized to provide enough heat to satisfy the purchaser. Virtually all installers and purchasers can agree to that. However, the solar installer's responsibilities do not stop there. The system he or she installs should not increase the electrical consumption of the pool's circulation system any more than absolutely necessary. This requires large enough pipe diameters to keep their friction losses low, proper flow through the solar collectors to maximize heat collection yet minimize pressure drop, and adequate collector sizing to minimize the number of hours the pump must operate each day. Obviously, it is pointless to oversize the solar-related components to an extent that reduces the time required for heat collection below that required for acceptable filtration.

Collector Installation

Acceptable solar collector mounting practices are discussed in this section. Because unglazed, low-temperature collectors are most often used for swimming pool heating in Florida, procedures for mounting unglazed plastic flat-plate collectors, flexible solar mats and pipe arrays will be discussed first.

The optimum collector slope for spring and fall operation is equal to the latitude of the site. The best slope for winter is the latitude plus 15° and the collectors should face south if possible. If roof space, which faces within 45° of south, is available, the collectors can be mounted directly on the roof. Remember that only a small penalty is paid for modest deviations from optimum slope or orientation. Supports can be constructed to mount collectors at the ideal orientation, but except in new construction, the additional cost is generally prohibitive. Occasionally it may be necessary to increase the collector area to compensate for less than optimum slopes or orientations.

Collectors should be securely fastened to withstand maximum expected wind loads. Building code requirements for maximum wind velocities vary within the state of Florida from 100 to 146 miles per hour. Wind loads at roof level may exceed 75 pounds per square foot. Check the local building regulations for wind load provisions in your area.

Procedures. To begin the installation, lay out the collectors on the available roof area avoiding as much as possible any area shaded by trees, parts of the building or other obstructions. If large numbers of collectors are involved, they may have to be divided into several banks with collectors in each bank plumbed in parallel. Plumbing arrangements from bank to bank are discussed in the next section.

Once the placement is established, the collectors should be connected. Short, flexible couplings made of EPDM or butyl rubbers often are used. They usually are slipped over the ends of the headers and are clamped firmly with stainless steel clamps. Once fastened together, the collectors are cumbersome to move about. Be sure they're in their final positions before the connections are made.

Collectors often are mounted directly on the roofs. An insulating support structure is sometimes used to protect the panels from abrasive roofing materials and prolong their life by protecting the bottom of the collector from the abrasion caused by expansion and contraction of low temperature collectors. Refer to the manufacturer recommended installation procedure.

Collectors should be laid on the roof and fastened down at the header on both ends. At least two, and preferably three, cross straps should span the panel to further secure it.

Figure 17 shows one possible arrangement. Once again, refer to the manufacturer's recommended installation procedures.

One end of the panel can be fastened to the roof with a short strap or clamp around the header. The other end should be fastened with an elastic material or spring to allow for expansion as the collector temperatures change – a 10-foot plastic collector may expand and contract as much as an inch in length. Straps should be installed across the panel body – one at either end – within a foot of the headers, and one across the middle are recommended. The straps should be made of material, such as nylon or plastic-coated metal, that will not scratch or abrade the collector since they will rub across its surface. The bands should be snugged to clips fastened approximately an inch from the edge of the collector.

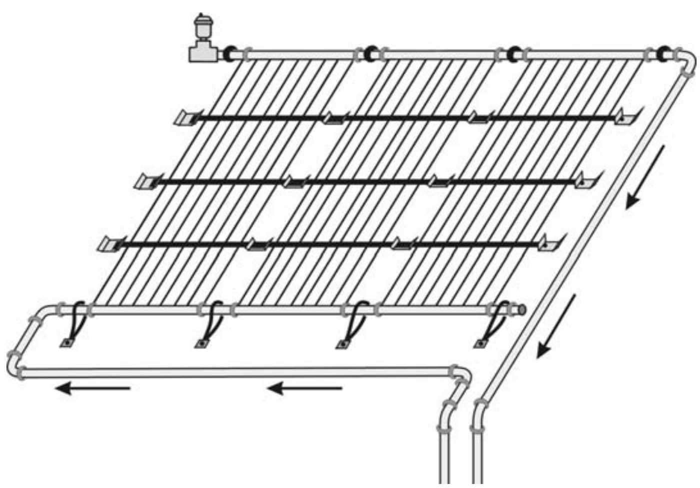

Figure 17 Collector hold-down straps

Figure 18 shows a typical mounting clip, which may be made of rigid plastic or metal. On asphalt shingle roofs, the clips may be fastened directly on top of the shingles – 1/4-inch lag bolts long enough to penetrate the roof sheathing are generally recommended. In keeping with good construction practice, the lag screws should be screwed into as many roof rafters as possible (rather than just roof sheathing) to keep the collectors secure. A pilot hole should be drilled for the lag screw and after the drill chips are cleared away a sealant should be injected with a cartridge gun into the hole. An excess of sealant should be used to form a seal between the mounting clip and the roofing material when the lag bolt is tightened. Polysulfide and the newer polyurethane sealants adhere well to common building materials and appear to be very durable.

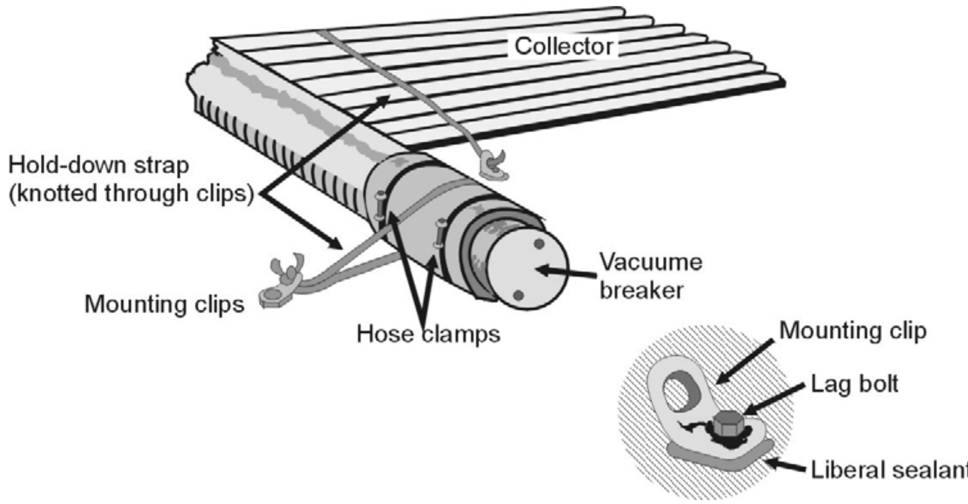

Figure 18 Typical collector mounting clip

Sealing mounting brackets on tar and gravel (built-up roofing) requires careful cleaning around the bracket. Scrape off the old gravel down to the tar, and clear off all dirt and residue. If the tar surface is very dirty or irregular, soften it with a solvent such as mineral spirits. After sealing the clip with polysulfide, pour roofing tar over the bracket base and cover with gravel. This last step is necessary to prevent ultraviolet damage to the tar and premature roof failure.

Mounting collectors on other roof types is more difficult. On cedar shake roofs, mounting screws should pass through the shakes and fasten securely to the plywood or purlins beneath. Don’t be stingy – use good quality sealant and enough of it to form a good, sealed penetration. Don't tighten the fasteners tight enough to split the shake.

Concrete tile roofs, especially common in south Florida, present special mounting difficulties. The safest solution is to construct a rack to support the collectors above the tile surface. The rack should be constructed of a durable material, such as aluminum. It should be strong enough to withstand maximum anticipated wind loads. Substrate and collectors may be fastened to the rack. The rack itself must be securely fastened to the roof trusses, not to the sheathing. This practice should also be used when installing a reverse pitch rack on the backside of a roof.

Figure 19 illustrates a typical mounting bracket arrangement. To install the bracket, a tile must be removed or broken, exposing the waterproof membrane on the sheathing below. This waterproof surface (commonly called slate), not the tiles, forms the moisture barrier and must be resealed where mounting bolts penetrate it.

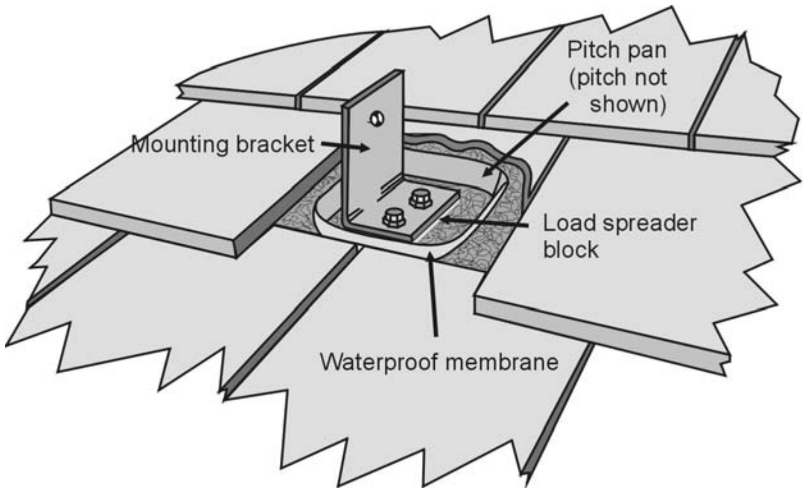

Figure 19 Mounting bracket for tile roofs

The mounting location should be free of dust and debris. Roofing mastic should be applied to the bracket and slate to form a seal when the bracket is drawn down. (Pitch pans around the roof penetrations may be required in some areas.) A substitute for the broken tile may be made from cement mix (using adjacent tiles as a model) and tinted to match the roof. Aluminum and copper materials should be protected from contact with the cement by a layer of tar to reduce corrosion.

Fastening schemes have been proposed which rely upon sealing the roof penetration at the tile surface. Since the waterproof membrane is not the tile itself but rather the slate membrane beneath, these methods are not effective and should be avoided.

Spanish or barrel tile roofs present another tough collector mounting problem. It is extremely difficult to walk on them without breaking some tiles, and it is also difficult to make substitute tiles.

Piping

Solar swimming pool collectors are designed to operate with high flow rates; therefore, the primary objective in piping solar systems is to provide uniform, high-volume flow at the lowest cost and the lowest pump power possible.

Piping to Collectors

For low-temperature collectors, plastic pipe can be used in the plumbing from the pool pump to the solar collectors. PVC and ABS pipe (Schedule 40) are the most commonly used materials for this particular application and have performed satisfactorily. Neither material can withstand high temperatures. Due to the moderate operating temperatures, pipe insulation is not required.

Local plumbing requirements should be adhered to when installing piping leading to and from the collectors. Since large-diameter pipe is quite heavy when filled with water, sturdy supports will be required. Pipe cuts should be deburred before assembly to reduce resistance to flow. Leaks can be avoided by using the correct cement for the pipe involved and properly preparing joints. Because plastic expands and contracts considerably with temperature changes, allowances should be made for change in length. Your pipe supplier can provide you with specific data on the kind of pipe used for a particular job.

Piping Between Collectors

About the same amount of water should pass through each collector. On large installations it is necessary to divide the solar collecting panels into groups and connect the groups with pipe. This requires the piping layout be carefully designed and constructed. Most situations encountered can be satisfied using principles discussed in this section, but for extremely complicated cases it may be wise to consult a hydraulic flow specialist.

Pool heating collectors are almost always connected in parallel. Parallel connections are shown in Figure 20a, series connections in Figure 20b. In the series arrangement, water passes through one collector and then through the next, increasing the pumping horsepower required to maintain adequate flow, as well as causing the downstream collectors to operate at higher, less efficient temperatures. Parallel connections, in which the water is returned directly back to the pool after passing through one collector, are the better choice because those difficulties are avoided.

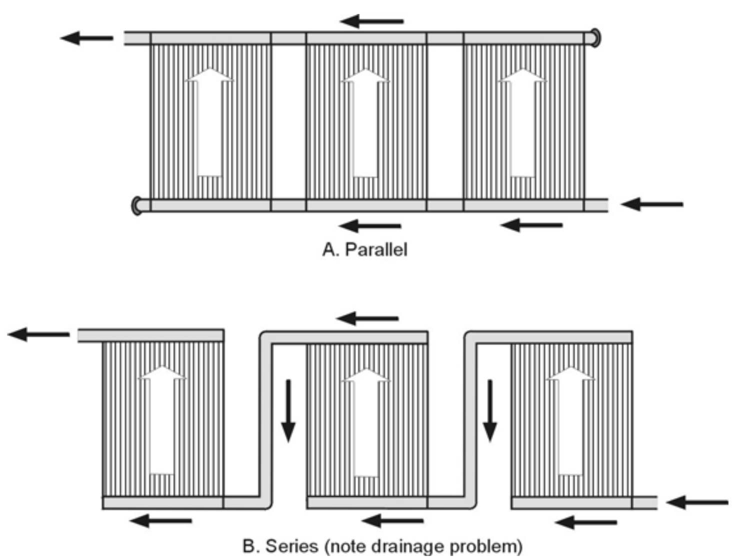

Figure 20 Collector connections

The feed and return lines leading to each collector should be approximately the same length. Figure 21a illustrates the preferred arrangement, and Figure 21b shows a common, but less efficient, connection where the flow tends to be short-circuited through the first few collectors and those at the end are starved for flow (causing a reduction of their performance). In Figure 21a, the length of the water path is the same for all collectors, so the flow is evenly distributed. This style of piping will require extra pipe, but improved collector performance compensates for the additional cost.

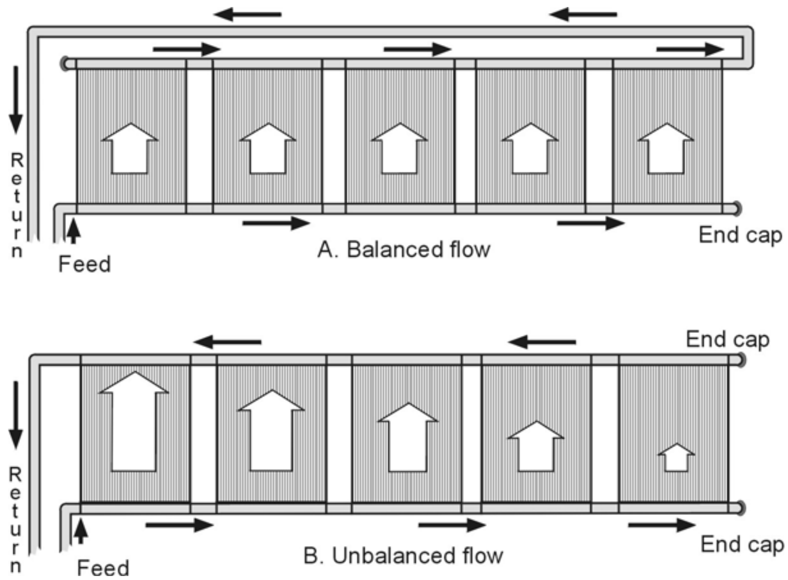

Figure 21 Flow balancing in collector groups

Groups of collectors at different heights should be plumbed in such a way they all receive water from the lowest point in the system and return it from the highest point. Figure 22 illustrates a properly plumbed system. The dashed line indicates a tempting, but unsatisfactory, arrangement. If the return lines do not come from a common height, flow through the panels will be uneven, causing a reduction in performance. Even with this piping layout, a balancing valve may be required to reduce the flow rate in the lower collector(s).

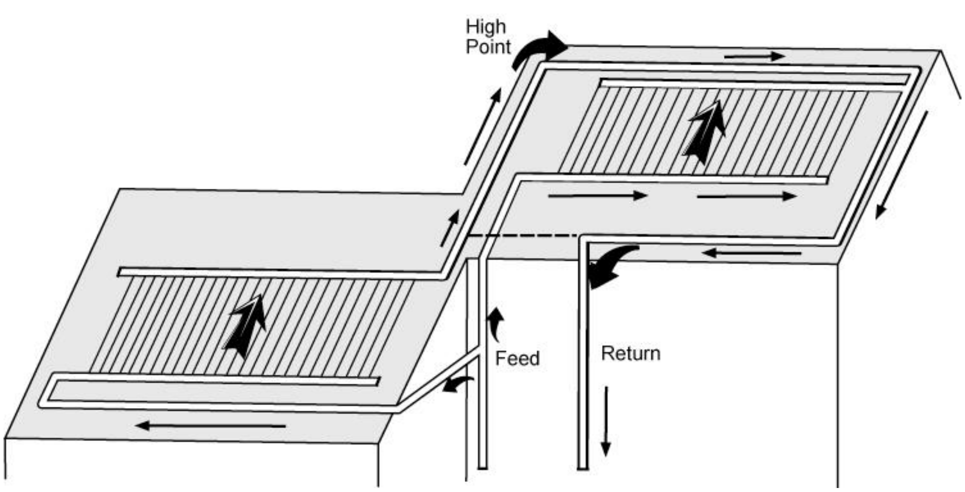

Figure 22 Plumbing collectors at different heights

Balancing valves can be used to obtain uniform flow distribution in other difficult situations, which occur when site requirements make it impractical to balance the flow with simple plumbing arrangements. Balancing valves and, if economics permit, flow meters should be installed in the feed line to each group of collectors. Starting with all valves completely open, gradually close the appropriate valve until the desired flow for each group is obtained. An alternative to the use of flow meters is to measure the outlet temperature of the various collector groups and adjust the balancing valves until these temperatures are within a few degrees of each other.

Connections between collectors and plumbing pipe are commonly made with synthetic rubber couplings, which slide over the header and connecting pipe and are clamped tightly around each by stainless steel bands. To accommodate thermal expansion and misalignment, these couplings are longer than those used between panels.

A vacuum relief valve may be required on the highest collector group to admit air into the system when the pump shuts down and allow the collectors to drain. If necessary, because of height differences, vacuum relief valves can be installed in more than one group of collectors to facilitate drainage. The vacuum relief valve must not admit air into the system during pump operation. If it does, the system may be noisy and will consume excessive amounts of chemicals due to constant bubbling. This means such a valve must be installed at a point where the system pressure is above atmospheric pressure. This requires some experimentation on systems installed on roofs of multistory buildings. In such cases, the water flowing down the return pipe may cause a vacuum in that pipe.

Installing the vacuum relief valve on the return end of the highest supply header will keep the valve pressurized until there is a vacuum caused by draining the supply header. The tilt of the array must allow complete drainage. Unfortunately, some pipe layouts will not allow gravity drainage of the collectors. For example, in piping over the ridge of a roof, the supply and return are higher then the level of the collectors. This prevents proper drainage of the collectors. Installing a freeze protection valve on the bottom header of the collector array may allow gravity to drain the panels during freezing conditions.

Flow Control and Safety Devices

One of the most important components in the flow control system is the control (diverter) valve normally installed in the main filter flow path after the collector feed-line and before the collector return (Figure 7b and 7c). Although this valve can be as simple as a manually operated ball valve, for convenience, it is generally operated automatically.

Several types of control valves are available. These include automatic and manual valves. The automatic valves include:

- 3-way diverter or ball valves
- bladder-type pinch valves
- or specially constructed variations of irrigation valves

Automatic valves

Typically, the valves are operated by an electronic differential controller, which measures collector temperature and compares it to pool temperature. The high temperature (collector) sensor is mounted in a dull plastic housing that has an absorptivity for solar energy approximating that of the solar panel or in-line on the return outlet or pipe near the collector. Since the sensor temperature should simulate the collector temperature, it should be mounted alongside a collector panel and fastened to the same surface to which the panels are fastened. All wire connections should be made secure and watertight, preferably with silicone wire connector nuts, heat-shrinkable insulating tubing or as a last resort, durable sealant.

The lower sensor, which measures pool temperature, should be protected from direct contact with the pool water to prevent galvanic corrosion. Most sensors are a encapsulated with epoxy into a pipe thread brass fitting of ¼" or ½" MIP, installed in a “well” in the pipe between the pool and the circulation pump, or immersed into the water flow. Many times the sensor can be inserted into the drain port of the pump suction basket. It is important to ensure the “cold” sensor registers the temperature of the pool water not the ambient air or warmth from sunshine on the sensor capsule.

The electronic controller itself requires electrical power. Sometimes it can be connected in parallel with the pool pump or timer, but since 120V or 240V electricity is involved installers should consult their local building officials to find out if an electrician is required to make the connection. Approved conduit should be used for this wire.

In the installation of the automatic 3-way actuator and controller, the low voltage output from the controller powers the motor and turns the valve. It is important to ensure proper alignment of the motor, directional flow and direction of diverted flow. Be careful not to actuate the valve and stop flow from the filter. Pressures in excess of the filter’s maximum operating pressure could damage the filter.

Normal operation is flow to the pool from the filter. When the signal from the high temperature sensor indicates heat collection is available at the collectors, the controller activates the valve and diverts the flow from the pool to the collectors.

In the installation of a pinch valve control system, it is necessary to connect two pressure lines between the pool pump and the control box. Small-diameter (1/8-inch) plastic lines are generally used. Since most pool pumps have a 1/4-inch, threaded pipe plug in the side of the strainer housing (near the bottom), the low-pressure line is usually attached to an adapter at that point. The high-pressure line should be tapped into the pipe on the discharge side of the pump.

When the high temperature sensor registers the collectors are warmer than the pool water, the electronic control opens the line from the discharge side of the pump and inflates the bladder in the pinch valve. This diverts flow through the solar system. When the high temperature sensor signals the collectors are cooler than the pool water, the line from the suction side of the pump is opened, forcefully deflating the bladder and allowing flow to bypass the collectors.

Another possible control valve, the irrigation style, achieves the same results but operates in a slightly different fashion. It is plumbed into the system by standard piping procedures. A small suction line is tapped into the pump inlet strainer housing, but in this case, the suction line is connected to the valve body itself. A pressure line is not used. A low voltage wire also connects a small solenoid valve mounted on the valve body to the control box. Most irrigation type valves will increase the pressure and reduce the flow rate of the system.

The system control compares collector temperature with pool temperature as before. If solar heat is available, an electrical signal causes the solenoid valve to open the suction line. This suction closes the main valve diaphragm, diverting flow through the collectors. When solar energy is not available, the solenoid valve remains closed, the main valve diaphragm (which is spring loaded) opens, and the flow bypasses the collector array. (In another version the spring loading keeps the main valve diaphragm closed and the solenoid induces its opening.)

Manual valves

Manual valves can be two- or three-way ball valves or standard flow diverter valves. Operation of these valves is completely manual and includes isolating the flow to the pool by diverting flow to the collectors. It is important that the isolation valve to the pool is between the collector supply and return lines in the system piping design.

Activating the System

After installation is completed, it is necessary to activate and test the system for proper operation. A few of the most important checks are discussed here.

Purging the System

Bits of plastic from rough pipe cuts, sand and other debris should be flushed from the system to avoid clogging small fluid passages in the collectors. Purging can be accomplished by leaving one or two strategically placed joints open. The circulation pump can be briefly turned on to flush water through the system, then final connections can be made. Small amounts of pool water can be discharged onto grass or sand, but large volumes should be piped to safe drains.

Pressure Testing

The entire system should be pressurized to the maximum operating pressure. This can be accomplished in a number of ways.

If piping passes through critical areas, such as an attic or public area, which is not recommended, a continuous run of piping is recommended. Avoid couplings and fittings in areas where a leak could cause significant damage. The system should be pressurized with an air compressor and tested for leaks. Testing the pipe to twice the operating pressure is recommended, but be sure not to exceed the pressure rating of the pipe. Leaks can be located readily by listening for the hiss of escaping air.

Installations where all piping is routed through areas where a temporary leak will do no harm may be pressure tested by turning on the circulating pumps. The appropriate valves in the circulation system should be closed to produce the highest possible pressures in the new piping. Be sure to have someone standing by; ready to turn the pump off in the event a leak is discovered.

During the pressure check, every connection should be visually inspected and shaken to ensure that it is well made.

Testing Control Devices

Automatic control devices should be checked for proper operation. Consult the manufacturer's specifications for the controls being used and determine the possible operating modes. Test in all of these modes and make a permanent record of the results. Checking control operation immediately after installation can prevent costly callbacks later.

Testing Flow Rates

Proper flow through the collector array and filtration system is required. Inexpensive flow meters are available and should be used to confirm desired rates have been achieved. As previously mentioned, turnover time must not be increased above an acceptable level.

Testing Temperature Rises

The temperature difference between the feed line to the solar system and the warmer return line should be checked. Remember, the temperature rise on even a sunny day should be quite modest, approximately 5-10°F, for low-temperature collectors. Thermometers installed in these lines can be used to make accurate readings.

If the temperature rise is too large, it indicates not enough water is passing through the collectors. Check the system thoroughly and correct the problem because collector efficiency drops dramatically as the operating temperature rises. It sounds strange to the homeowner but lots of water being warmed slightly provides more heat than a little water being warmed a lot.

Instructing the Homeowner

There are several important reasons to spend a few minutes instructing the homeowner on the operation of the new solar pool heater. First, it will enable the owner to ascertain whether the system is operating and thus reduce “false alarm” callbacks. Second, it will enable the owner to explain the new unit to friends and neighbors. Third, it will equip the owner to make minor adjustments and reduce service calls for the installer.

Explain the operation of all valves and controls and how the water circulates in the various modes. Spend a little time on the automatic control so that the owner can make seasonal or other adjustments that may be required. Provide the owner with the system manual.

It is very important to explain the amount of energy being delivered to the pool is the product of the temperature rise and the flow rate. High temperature rises feel impressive, but they cause the collectors to operate inefficiently and deliver less heat to the pool. Sometimes this point is difficult to make, so you may have to explain it in several different ways.