# Plastic Pipe in Solar Heating Systems

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# Foreword

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The purpose of this technical note is to provide general information on plastic pipe used in solar heating systems.

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The Plastics Pipe Institute, Inc.

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PLASTIC PIPE IN SOLAR HEATING SYSTEMS

## 1.0 Objective

This report describes, in a simplified manner, the technologies used in the solar heating industry; the limitation, if any, of plastic piping in each; and includes reference sections on recommendations to cope successfully with those limitations.

## 2.0 History

The use of thermal solar energy was virtually nonexistent 45 years ago, but has grown to become a significant industry in the United States. Most solar applications are geographically concentrated in the states of California, Arizona, New Mexico, Colorado, Hawaii and Florida, although the technology is effective in all US states.

Solar heating (also known as thermal solar) systems range in size and complexity. The very simplest consist of nothing more than a black pipe or tubing lying in the sun connected to a swimming pool circulating pump. More complex systems consist of highly engineered collectors with one or more layers of glazing plus piping, pumps and controls for temperature and pressure. These systems frequently involve heat transfer fluids other than water, heat storage tanks and heat exchangers. For the purposes of this report, all subsequent references to plastic pipe apply only to the piping outside of the collectors themselves unless otherwise stated.

Plastic piping can play a major role in this application. See Table 1 for a list of materials with elevated temperature capabilities. Plastic piping's combination of flexibility, relatively high temperature properties, and resistance to freeze damage and corrosion are major advantages for this end-use. There are, however, precautions that should be taken to prevent misapplication.

## 3.0 Collector Technologies

The most significant use of solar heating has been for residential and commercial swimming pools, followed by domestic hot water and space heating. Solar collectors are classified according to their water discharge temperatures: low temperature, medium temperature and high temperature. Low temperature systems generally operate at a temperature of 110° F (43°C) and have a maximum stagnation temperature of 180° F (82°C). Medium temperature collectors typically have discharge temperatures of 180-200° F (82 - 93°C) but can generate stagnation temperatures of up to 280° F (154°C) or more for several hours. High temperature collectors routinely operate at temperatures of at least 210° F (99°C) and can generate stagnation temperatures of more than 400° F (204°C). High temperature collectors operate above the capabilities of the materials in this document.

There are several different plastic pipe materials that may be used directly with low temperature collectors with no special precautions. In addition, much plastic piping is being used extensively inside unglazed collectors where operating temperatures rarely exceed 110° F (43°C) on a frequent basis. To protect against ultraviolet exposure damage and to increase efficiency, plastic piping for use in collector panels should contain a minimum of 2% carbon black of proper particle size and with good dispersion as well as contain antioxidants. Check with the pipe manufacturer to be sure the pipe is suitable for long term exposure to sunlight.

Plastic piping should not be used in systems with high temperature collectors including evacuated tube or concentrating types because of the extreme temperatures they can reach.

Medium temperature collectors constitute the largest segment of the market. These glazed collectors are used in domestic hot water and space heating systems. Depending on the type of collector and system design, some special precautions should be taken. The major types of medium temperature systems are described in the following paragraphs along with appropriate precautions.

Medium temperature systems are either “passive” or ”active”. Passive solar systems use no pumps, controls or mechanical equipment to transport the heated water. The integral collector storage (ICS) is a passive design which uses a tank or tube assembly absorber in an insulated metal case which is covered with a glazing material, usually glass. The absorber is painted flat black or coated with a “selective” material to increase solar energy absorption. Another type of passive solar heater is called “thermosiphon.” In this design a storage tank is mounted above the solar collector on the roof surface.

All passive solar water heaters operate by the same principle; when a hot water tap is turned on in the building, cold water from the city water supply flows through the solar collector first and is pre-heated before entering the conventional gas, oil or electric water heater thereby considerably reducing or even eliminating consumption of fossil fuel energy.

Because of the large volume of water in the collector, passive solar systems are not subject to high stagnation temperatures. Thus, plastic piping can be used throughout, including a hook-up directly to the collector system.

Active type solar systems utilize a pump to move heat transfer fluids through the collector. Some utilize swimming pool or potable water as the heat transfer fluid (open systems) while others typically use a non-toxic solution of propylene glycol and water to prevent freezing (closed systems). Heat is transferred from the heat transfer fluid to potable water by means of a heat exchanger in the solar storage tank or heat exchanger/pump appliance. All piping must comply with the local plumbing or mechanical codes.

Hydrocarbon oil or silicone oils are used in high temperature solar systems and are generally not recommended for use with plastic pipe.

**Note**:  Because there are many heat transfer fluid types available, the fluid selected must be approved as being suitable by the plastic pipe manufacturer.

Active type, medium temperature collectors can limit or disqualify the use of plastic piping as stagnation temperatures can exceed 280°F (138°C) as mentioned earlier. Under no circumstances should any plastic piping be used inside the collector or in the system where it will be exposed to such high temperatures unless that particular plastic pipe has been qualified for that temperature of service.

## 4.0 Customer Characteristics and Distribution Channels

In general, solar collector manufacturers do not provide piping for the system. The installer most likely will purchase the piping from a local plumbing supply wholesaler or solar supply house. Installers are usually plumbers, but in some regions solar specialists provide installation services. Installation should be performed by knowledgeable, licensed contractors.

The installation requires knowledge of carpentry to provide roof support or mounting, electricity to install the control system (where applicable), and plumbing to install the piping system and to tie in to the swimming pool or storage tank or the existing domestic water supply. Always be sure the installation meets the requirements of the local building, plumbing and mechanical codes.

As the solar energy industry matures, the swimming pool industry and plumbers are recognizing thermal solar energy as an opportunity to expand business by becoming installers in addition to the solar specialists.

## 5.0 Space Heating

Because of the relatively low fluid temperatures used in radiant floor heating (110-140° F/ 43-60°C), the heated fluid for these systems can be derived from the medium temperature solar systems . For these reasons, many radiant heating systems installed today use solar collectors as the primary heating source. Baseboard hydronic heating requires higher temperatures (typically 180° F/82° C) to be effective, as does a water-to-air heat exchanger located in the plenum of a forced air system.

Features and Benefits of Plastic Piping

| Feature | Benefit |
| --- | --- |
| Ease of Installation, Cost Savings | Minimizing the overall cost of solar heating systems is necessary to make them viable alternatives and to expand customer acceptance. |
| Flexibility | Since most solar systems are installed after the building construction is completed, the flexibility and ease of joining plastic piping systems are a big advantage. In addition, there is no need to use a soldering or brazing torch in an attic full of combustible materials as otherwise might be required for metal piping systems. |
| High Temperature Resistance | For continuous use, thermoplastic pipe must be suitable for high temperature environments. The following materials and composite structures are listed in PPI TR4 with elevated temperature capabilities. |

| | |
| --- | --- |
| PE | 140° F (60° C) |
| CPVC | 180° F (82° C) |
| PA | 180° F (82° C) |
| PE-RT | 180° F (82° C) |
| PEX | 200° F (93° C) |
| PEX-AL-PEX | 200° F (93° C) |
| PE-AL-PE | 140° F (60°C) |
| PERT-AL-PERT | 200° F (93°C) |
| PVDF | 200° F (93° C) |

In addition to materials listed in PPI TR-4, there are other materials whose manufacturers recommend them for elevated temperature applications.

| | |
|---|---|
| PP | 180° F (82° C) |
| PB | 180° F (82° C) |
| PFA | 212° F (100° C) |

The materials listed above are by generic name only. It is necessary that the user verify with the manufacturer that a particular pipe compound is properly formulated (stabilized) to withstand prolonged elevated temperatures. Pressure ratings at elevated temperatures are reduced from the 73° F (23° C) pressure ratings. Consult with the manufacturer for pressure ratings above 73° F (23° C).