Plastic Pipe in
Solar Heating Systems
TN-14/2001

1825 Connecticut Ave., NW Suite 680 Washington, DC 20009· P: 202-462-9607· F: 202-462-9779 · www.plasticpipe.org

Foreword

This report was developed and published with the technical help and financial support of the members of the PPI (Plastics Pipe Institute, Inc.). The members have shown their interest in quality products by assisting independent standards-making and user organizations in the development of standards, and also by developing reports on an industry-wide basis to help engineers, code officials, specifying groups, and users.

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

This report has been prepared by PPI as a service of the industry. The information in this report is offered in good faith and believed to be accurate at the time of its preparation, but is offered without any warranty, expressed or implied, including WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. Any reference to or testing of a particular proprietary product should not be construed as an endorsement by PPI, which does not endorse the proprietary products or processes of any manufacturer. The information in this report is offered for consideration by industry members in fulfilling their own compliance responsibilities. PPI assumes no responsibility for compliance with applicable laws and regulations.

PPI intends to revise this report from time to time, in response to comments and suggestions from users of the report. Please send suggestions of improvements to the address below. Information on other publications can be obtained by contacting PPI directly or visiting the web site.

The Plastics Pipe Institute, Inc.
Toll Free: (888) 314-6774
http://www.plasticpipe.org

July 2001

Plastic Pipe in Solar Heating Systems

1. History

The use of solar energy was virtually nonexistent 25 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, and Florida.

Solar heating systems range in size. The very simplest consist of nothing more than a black pipe lying in the sun connected to a swimming pool circulating pump. The more complex systems utilize collectors with 1, 2, or 3 layers of glazing plus piping and pumps. In addition, the later systems may include heat transfer fluids, heat storage tanks, heat exchangers, and temperature and pressure controls. For purposes of this report, all subsequent references to plastic pipe apply only to the piping outside of the collectors unless otherwise stated.

Plastic piping can play a major role in this application. Its combination of flexibility, high temperature properties, resistance to freeze damage, and to corrosion are major advantages to this end-use. There are, however, precautions that should be taken to prevent misuse. This report describes, in a simplified manner, the technologies used in the solar heating industry; the limitations, if any, of plastic piping in each; and includes reference sections on recommendations to cope successfully with those limitations.

2. Collector Technologies

The most significant use of solar heating has been for swimming pool, domestic hot water, and space heating, and occasionally, cooling. 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 110ºF and have a maximum stagnation temperature of 180ºF. Medium temperature collectors typically have discharge temperatures of 180-200ºF but can generate stagnation temperatures of 280ºF or more for several hours. High temperature collectors routinely operate at temperatures of at least 210ºF and can generate stagnation temperatures of more than 400ºF, which are above range of materials in this document.

Pipe or tube made of several plastic materials can be used directly with low temperature collectors with no special precautions. In addition, much plastic piping is being used extensively inside unglazed collectors where temperatures rarely exceed 110ºF 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.

Plastic piping should not be used in conjunction with high temperature collectors such as the evacuated tube or concentrating types because of their extreme temperatures.

In between these two extremes are the systems with medium temperature collectors that constitute the bulk of the market. These glazed collectors are used for 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 types. Passive systems use no pumps or mechanical equipment to transport the heated water. The breadbox (passive) design uses a tank placed under a glazing material. The tank is painted flat black or coated with selective absorber to increase the solar energy absorption. The collector may be the primary storage tank or the storage tank may be in the house. In the later case, when a preset temperature is reached, water flows by gravity to the storage tank in the home and fresh water from the main is added to bring the system up to volume. In the thermosyphon passive design a storage tank is mounted above a collector. Cold water flows down into the collector. As the water is heated in the collector, it rises through thermosyphon action back up to the storage tank.

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 solar systems utilize a pump to move heat transfer fluids through the collector. Some utilize potable water as the heat transfer fluid (open systems) while others use solutions such as ethylene glycol, propylene glycol, silicone oils, or hydrocarbon oils (closed systems). Hydrocarbon oil or silicone oils are generally not recommended with plastic pipe. In closed systems, heat is transferred from the heat transfer fluid to potable water by means of a heat exchanger in the hot water storage tank.

There are many heat transfer fluids, and it is necessary to verify with the manufacturer of the specific plastic pipe being considered that it is suitable with the fluid.

The extreme conditions encountered during stagnation are a problem when using plastic tubing with active medium temperature collectors. As mentioned earlier, stagnation temperatures can exceed 280ºF in most active medium temperature collectors. Under no circumstances should any plastic piping be used inside the

collector or in the system, where it will be exposed to such temperatures unless that plastic has been qualified for that type of service.

3. 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 the local plumbing supply wholesaler or solar supply house. Installers are usually plumbers, but in some areas like California, solar specialists also do installations. Installations may also be done by plumbing supply houses.

The installation requires knowledge of carpentry to provide roof support or mounting, electricity to install the control system, and plumbing to install the piping system and to tie it in to the storage tank and 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 plumbers are recognizing solar energy as an opportunity to expand business by becoming one of the principal installers along with the solar specialist.

4. Space Heating

Because of the relatively low temperatures used in radiant floor heating (110 - 140ºF), the water for these systems can be derived from the low temperature solar systems (100 - 180ºF). For these reasons, many radiant heating systems installed in this country today use solar collectors as the primary heating source. Baseboard hydronic heating requires higher temperatures to be effective, as does a water-to-air heat exchanger located in the plenum of a forced air system.

Features and Benefits

The benefits of plastic pipe to the solar heating are;

Feature	**Benefit**
- Ease of Installation Cost Savings	- Minimizing the overall cost of solar heating systems is necessary to make them visible alternatives and to expand customer acceptance.
- Flexibility	- Since this market is primarily a retrofit market today, ease of installation and joining are a big advantage. In addition, there is no need to use a heating torch in an attic full of combustible materials, as might be required for metal pipe.
- Freeze Tolerant	- Frozen lines can be a major problem in attic runs. Although collectors are protected, supply lines need to be protected from freezing or they should be made of materials that are resistant to damage if water freezes.
- High Temperature Resistance	- For continuous use thermoplastic pipe must be suitable for high temperature environments. The following are materials with PPI elevated temperature ratings listed in TR-4:

PE	140ºF
CPVC	180ºF
PA	180°F
PEX	200ºF
PEX-AL-PEX	200ºF

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 property formulated (stabilized) to withstand prolonged elevated temperatures.