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Quality Solar Energy Products

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Collector Manifolding Requirements for Commercial SDHW Installations

Commercial solar water heating systems often involve large numbers of collectors that are best arranged in bands of many panels. There are a number of factors to consider in designing the layout and piping for such arrays. The following recommendations are intended to provide guidance during design and installation to maintain the collector warranty. Consideration must be given to the selection of proper header size, the number of collectors to be manifolded in the array, flow balance and appropriate allowance f6r normal expansion and contraction in the headers.

HEADER SIZE & NUMBER OF COLLECTORS

These two design decisions are intimately related and are driven by the recommendation to keep the flow velocity in the first and last panel in an array to around 3 feet per second to insure the proper flow of around 1 GPM per panel. Standard pipe tables yield flow rates of 8 GPM for 1" pipe and about 18 GPM for 1.5". Since the first and last panel in an array must be able to take the full flow into and out of the array, this means **no more than 8 panels with 1'' headers, or 18 panels with 1.5'' headers, may be used in a single array or bank.** Reverse return piping and balancing valves on each array are highly recommended. Piping must be sized to maintain flow velocities in any bank at between 3 to 5 feet per second. **No panel may experience a flow velocity in excess of 7 feet per second.**

BALANCED FLOW WITHIN ARRAYS

Several empirical models suggest that flow imbalance occurs when the number of risers in the system exceeds twelve, i.e. one to two typical collectors. Field experience suggests that this is not entirely true, although without detailed data this is difficult to substantiate. The models predict that there will be a very high flow in the ends of the array or bank and low, or even no, flow in the middle. The only way to verify this is to measure the plate temperature in each collector in the array. This is difficult to do with thermometers or surface sensors as the headers represent the only easily accessible heat surface area to test and they will contain a mixture of temperatures from all the panels. Infrared thermometers or thermography represents the easiest way to make such measurements. To insure balanced flow and provide a means to achieve and maintain it, it is recommended that valves, or orifice plates, be installed between the array headers - generally a third of the way from the inlet in the top header and two-thirds of the way down on the lower header. These valves will help to balance the flow by forcing water through the middle panels.

EXPANSION AND CONTRACTION

Copper pipe expands and contracts with increasing or decreasing temperature at the rate of 0.0000094 in/in/F. Flat plate collectors can experience a temperature ranges of 300 - 400° F in an 8 - 18 panel array header. The actual expansion is therefore several inches. The temperature range is defined by the lowest ambient air temperature the panel will experience and the highest plate temperature, which is stagnation under no flow conditions. Stagnation temperature can be estimated by using the expression Ta + (Fr(ta)/FrUl)*I, where Ta is the ambient air temperature, Fr(ta) is the y intercept of the collector efficiency equation, FrUI is the slope of the equation and I is the maximum hourly insolation the collector may experience. (Note: Ta should correspond to the temperature during that hour).

A long array may go through as much as 1 - 2 inches of expansion. Most of that movement can go out the capped end of the header, but the pipe tends to expand in both directions. To accommodate the anticipated movement at the pipe connection ends, care should be taken to provide a "swing" joint that allows for the connecting pipe to move outward from the collectors. This is usually easy on the outlet end of the header, as the pipe tends to drop down to the roof or rack yielding a joint of 4 - 6 feet. The inlet piping is the one to watch, as there is a tendency to make a short, tight connection with a tee or elbow that tends to "pin" that end of the header. A good practice is to run the pipe back to the legs of a rack or up 4 - 6 feet on a roof to create a "swing" joint. lf it is not possible to make these connections, then some type of expansion joint should be used either at the header ends or between collectors at enough joints to accommodate the expected expansion. Such joints must be able to survive the collector stagnation temperature and/or allow for complete drainage in freeze protected systems.