How does an Evacuated Tube Heat Pipe solar collector work?

Evacuated Tube

Glass evacuated tubes are the key component of the Evacuated Tube Heat Pipe (ETHP) solar collectors. Each evacuated tube consists of two glass tubes. The outer tube is made of extremely strong transparent borosilicate glass that is able to resist impact from hail up to 38 mm in diameter. The inner tube is also made of borosilicate glass, but coated with a special selective coating (ALN/AIN-SS/CU) which features excellent solar heat absorption and minimal heat reflection properties. The air is withdrawn (evacuated) from the space between the two glass tubes to form a vacuum, which eliminates conductive and convective heat loss.

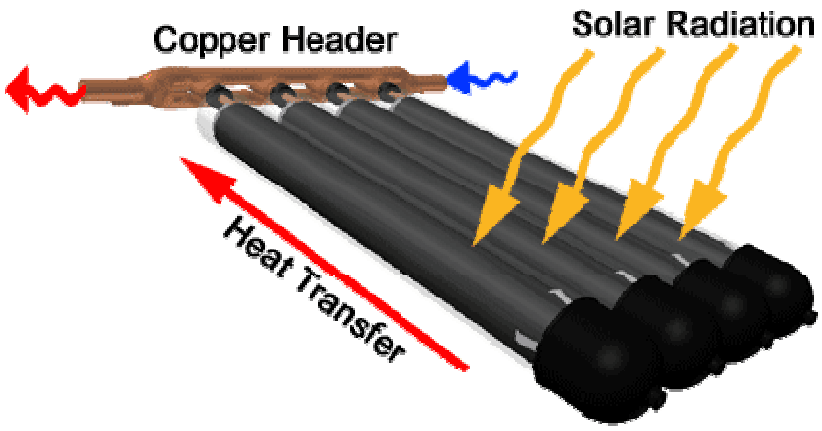
In order to maintain the vacuum between the two glass layers, a barium getter is used (the same as in television tubes). During manufacture this getter is exposed to high temperatures which cause the bottom of the evacuated tube to be coated with a pure layer of barium. This barium layer actively absorbs any CO, CO_2, N_2, O_2, H_2O and H_2 outgases from the tube during storage and operation, thus helping to maintaining the vacuum. The barium layer also provides a clear visual indicator of the vacuum status. The silver colored barium layer will turn white if ever the vacuum is lost. This makes it easy to determine whether or not a tube is operating correctly. See picture below.

The Getter is located at the bottom of the outer tube.

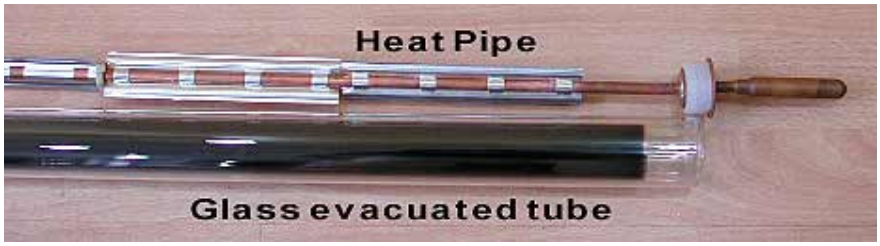
Left Tube = Good --- Right Tube = Faulty
In the left tube two "arms" of the getter are visible. The right tube has had the inner tube and getter removed.

Evacuated Tube Heat Pipe System

Inside the glass evacuated tube described above a copper heat pipe is installed. The copper heat pipe transmits heat to its tip which is plugged into the collector's heat transfer manifold. As water runs through the manifold heat is transferred from the copper heat pipe to the water as shown in die diagram below. The heat transfer manifold gets housed in a highly insulated aluminum housing.

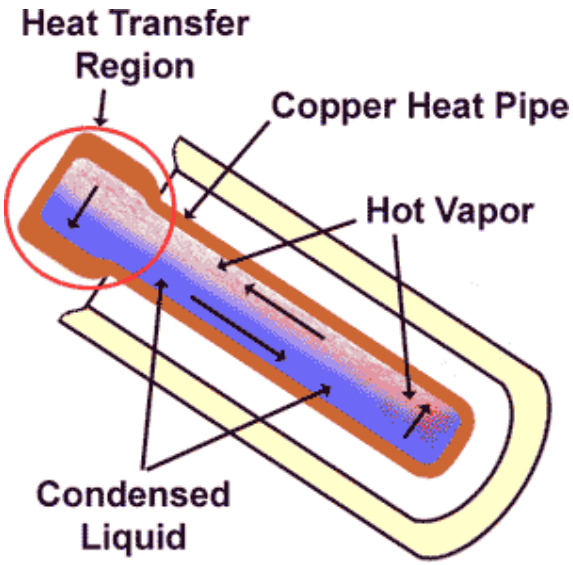


The heat pipe is a very efficient means of transferring heat from within the evacuated tube to the water. The following diagram shows both the glass evacuated tubes and the copper heat pipe. The heat pipe is simply inserted into the glass tube, held in place with high quality silicon based glue.



The heat pipe transfers the heat to the manifold by a very simple method. The copper heat pipe is hollow and contains a small amount of fluid. The hollow centre of the heat pipe is a vacuum, so that at even at temperatures of around 40^{o}C the fluid will vaporize (boil). The vapor rises to the tip (condenser) of the heat pipe where the heat is transferred to the water flowing through the

manifold. This heat transfer causes the vapor to condense and flow back down the heat pipe where the process is once again repeated. The following diagram illustrates this.



This method of heat transfer is thousands of times more efficient than a solid copper rod. Heat is therefore very efficiently transferred from the glass evacuated tube to the water. Since no water is flowing through the collector tubes and the tubes are hermetically sealed it does not suffer from corrosion problems as is the case with other solar collector types.

Unlike other types of solar collectors, ETHP solar collectors still provide excellent results on cloudy days. This is because the tubes are able to absorb the energy from infrared rays which can pass through clouds. Wind and low temperatures also have a minimal effect on the functioning of evacuated tubes due to the insulating properties of the vacuum.

Glass evacuated tubes are aligned in parallel, the angle of mounting depends upon the latitude of your location. Because evacuated tubes are round the amount of solar radiation striking the collector is relatively constant from mid morning to mid afternoon. This feature maximizes the total amount of solar radiation the collector is exposed to each day. Furthermore, the sun is always striking the tubes at an angle which is perpendicular to their surface thus reducing reflection. Therefore it can be said that the evacuated tubes passively track the sun throughout the day and subsequent absorption of solar radiation is therefore maximized.