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Solar Dish Collector used in a Solar Hot Water System

Administrator

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Parabolic Solar Dish Concentrator

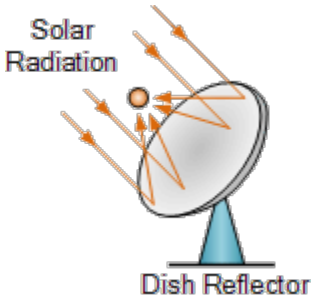
Another type of concentrating solar collector that optically reflects and focuses the suns incident solar energy onto a small receiving area using mirrors or lenses is called a **Solar Dish Collector**, or more technically, a *point focusing collector*. By concentrating the sunlight to a single spot, the intensity of the receiving solar energy is magnified many times over with each mirror or lens acting as a single sun shining directly at the same focal point on the dish meaning that more overall power per square meter of dish is achieved.

The concentration factor, also known as the “number of suns”, of a *solar dish collector* can be greater than 1,000 suns reaching temperatures at the focal point of the receiver (called

the “target”) approaching several hundred or even several thousand degrees Celsius depending upon the size of dish and its location.

Unlike the previous solar collector which was in the shape of a long trough, a parabolic solar dish collector is very similar in appearance to a large satellite TV or radar dish making it much smaller than a long trough collector. The curved parabolic shaped dish, which is generally referred to as a “solar concentrator” is the main solar component for this type of solar heating system.

Solar Reflection



The solar dish is formed into a paraboloidal shape by stamping them out from thin sheet metal or thin aluminium coated mylar, and which themselves can be anywhere between a few feet to several metres in diameter. The parabolic dish collects the incoming solar energy directly from the sun and concentrates or focuses it on a small focal point area positioned in front of the dish.

The parabolic solar dish is covered with many small mirror reflectors all around its shape to help concentrate the thermal energy into a single focal point were the heat absorber is

located producing more overall thermal energy per square meter of dish.

These highly polished mirrors can reflect more than 90% of the sunlight that hits them increasing the efficiency of the dish by more than 20% compared to the parabolic trough collector. Mirrors are generally used instead of a single highly polished dish because they are relatively inexpensive, can be easily cleaned and last a long time in an extreme outdoor environment, making them an excellent choice for the reflective surface of a solar dish collector. Also individual mirrors can be easily changed if damaged.

As well as the solar dish collector, some form of thermal receiver is required to convert the focused beam of intense solar energy into heat. The solar receiver can be as simple as a small evacuated tube or a more complex solar heat engine, such as a Stirling Engine. Due to the very high temperatures at the focal point, a thermal oil type fluid is generally used instead of water inside the receiver, which transfers the intense heat created by focusing the sunlight on the receiver. Like the trough collectors, solar dish collectors can be used singly or linked together for larger industrial type applications.

Solar Dish Collector

Solar Dish Collector type systems can also be part of another solar technology called a “solar dish-engine” system. The dish part of a solar dish engine system is very similar to the one described above, but may include many individual but smaller parabolic mirrors instead of one large single dish all angled and focused to the same focal point.

Solar Dish Engine

As their name suggests, dish-engine solar collectors include a special type of solar engine built into the solar receiver. This so called heat engine, is driven by the solar thermal energy converting it into rotational mechanical output by the cyclic compression of the engine’s working gas, which is usually helium or hydrogen.

The mechanical power that is produced is then used to drive an electrical generator or alternator producing a significant amount of AC electrical power. These types of solar heat

engines are commonly called a Stirling Engine after its inventor Robert Stirling in the year 1817.

Stirling engines belong to the group of closed-loop hot-gas machines that work on the basic principal that a gas will change its volume when subjected to a heat change producing an isothermal compression of the cold and isothermal expansion of the hot gas at a constant volume. This temperature change, and thus the continuous operation of the engine, is produced by moving the gas between two different chambers producing a constantly high and a constantly low temperature.

The efficiency and operation of the Stirling heat engine is determined by the operating temperature of the gas which is kept between 650^{o}C and 750^{o}C. To constantly keep the reflected solar radiation at the correct focal point and temperature during the whole of the day, a two-axis sun tracking system is used with the dish which continuously rotates the solar concentrator.

Like the other types of concentrating solar collector technologies, practical solar dish collectors or Stirling collectors are not suitable for domestic hot water systems due to their size, cost and very high operating temperatures. As with solar trough collectors, solar dish/Stirling systems are also modular in design allowing them to be connected together to form a collector field were they are connected in parallel rows ranging in size from a few kilowatts to tens of megawatts.

Solar Dish Cooker

Solar Dish Cooker and Pot

As well as using solar dish collectors to generate electricity at very high temperatures, the concentrating type parabolic solar dish can also be used to cook food. Something as simple as an old abandoned one metre diameter satellite dish covered in aluminium foil can be turned into a solar cooker with a black cast iron cooking pot located at its focal point. In fact a parabolic solar cooker can even be made using an umbrella and covering the inside with ordinary aluminium foil but its efficiency would be limited.

Solar cookers can be used in camping or remote areas to boil water, fry eggs or cook cakes and breads at temperatures well over 200^{o}C, which is hot enough for cooking most foods without the danger of a fire. Solar cookers, and ovens are relatively inexpensive and easy to make for remote cooking applications, even backpack versions are sold for camping. However, solar cookers require frequent adjustment to stay focused on the sun as well as supervision for safe operation.

A word of warning about using *solar cookers*, the focal point

and cooking pot gets very hot so it is advisable to wear good quality sunglasses and gloves as the focused solar energy glare can create nasty burns or could damage your eyes for good. So avoid standing on the sunny side of a solar dish collector.

In the next tutorial about Solar Heating we will look at another type of solar thermal collector which is designed to concentrate the received solar radiation even more into a single focal point using an array of adjustable mirrors around its base. This type of solar thermal collector can reach temperatures well into the thousands of degrees and is called a Solar Power Tower. Solar power towers focus the sun's energy onto a single point hot enough to melt salt.