



Do-It-Yourself Hot Water

How to make simple solar water heater?

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Introduction

Why solar water heating?

Amount of energy used today to heat domestic water is enormous. Compared to burning of fossil fuels, direct energy from the Sun produces heat that is almost free, environmentally clean and socially more acceptable. Possible energy savings for hot water in sunnier places are 80 percent or more and in cloudiest climates are from 50-60 percents.

Why Do-it-yourself?

First reason is price.

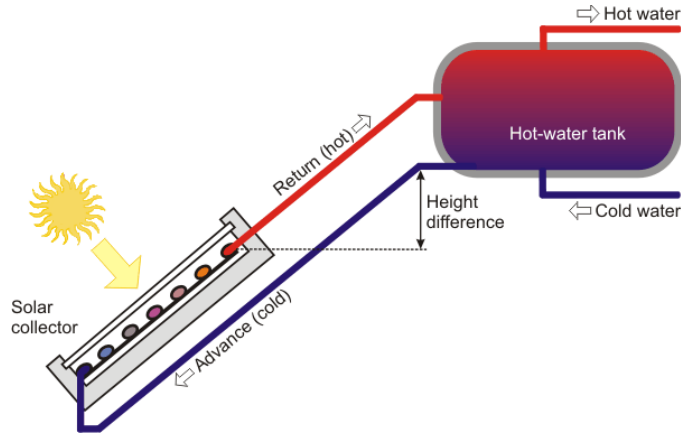
Although there are many different types of solar water heating systems on the market and they are paid-off in few-year period, they are still big investment for most of the people.

Second, making of one is not too complicated, even for less experienced DIYers (from own experience), but there are few important points to remember:

- Solar water heating relies on one simple principle:
dark colors absorbs heat
- The bigger the surface exposed to sun, more heat you get
- Heat is energy that is inclining to entropy, in other words, if not stored heat gain will be rapidly lost

How does it work?

Thermosyphon system shown here is one of the most popular water heater worldwide.

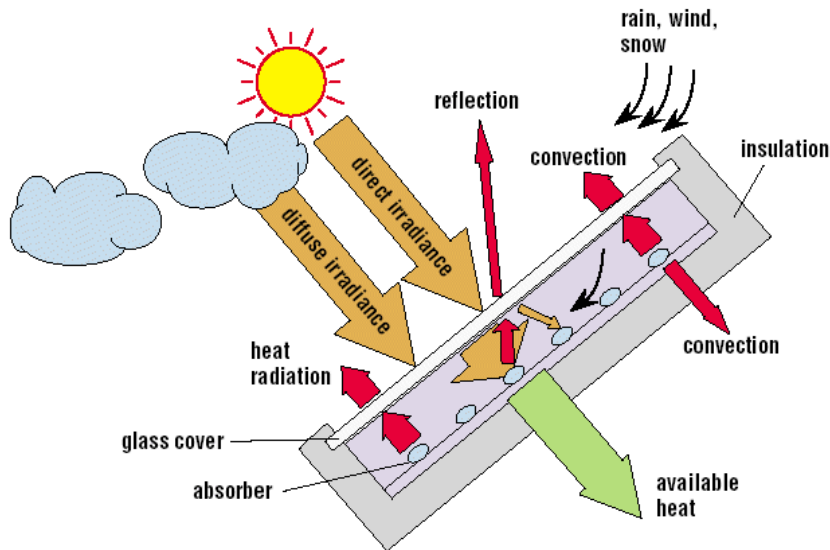


Picture 1.

They are easily recognizable by the fact that the water reservoir (tank) must be located directly above the collector.

Thermosyphon systems work on the principle of heat rising. In so-called open-loop system (for non-freezing climates only), the potable water enters the bottom of the collector and rises to the tank as it warms. If tank is well insulated there will be less heat loss when there is no sun.

Heart of the system, solar collector shown below, works on the simple principle of heat absorption. It consist of network of pipes through which water is heated. On a typical summer day (sunny and warm) the fluid in the collector reaches 60-80°C. On a clear winter day (sunny and cold) it can reach 50-65°C. When is cloudy and warm it can reach 20-30°C, and on a cloud and cold day 10-15°C. As long as temperature in the collector is greater than that of your incoming cold water (10°C) your solar hot water is saving you energy.



Picture 2.

Collector

It consist of 4 main pieces put in the wood box, attached from back up:

- I) Aluminum plate (back)
- II) Wooden frame + insulation (mineral wool)
- III) Copper pipe matrix with attached aluminum plates so called "clip-fins"
- IV) Glazing cover - Polycarbonate plate (front)
See picture 4.

Materials and tools needed

	Dimenzions	Pieces
Wood pieces	2000x100x20 mm	2
Wood pieces	1000x100x20 mm	3
Wood pieces	2000x30x7 mm	3
Wood pieces	2000x10x10 mm	2
Aluminium plate	2000x1000x0,5 mm	2
Twin wall polycarbonate plate	2000x1000x4 mm	1
Aluminium foil	2000x1000 mm	1
Copper pipes, Ø 22	2000 mm	1
Ø 15	1900 mm	5
Copper fittings	T 22/15/22 mm	8
Copper fittings	„knee“ 22 mm	2
Copper reduction	22/15 mm	2
screws for wood	80x6 mm	20
	20x4 mm	100
Mineral wool, insulation	2000x1000x50 mm	1
Black mat colour for metal + primer	750ml	1
Wood protection paint	750ml	1
Plastic holder for pipe Ø22		2
Silicone mastic	1 tube	1
Wood glue	750g	1
Soldering alloy	1 roll	1
Cleaning paste for soldering	1 tube	1

Using all these things we will obtain a 2 square meter solar collector ready to be installed.

Tools

	pieces
Screwdrivers, + & -	2
Hand woodsaw (or small electric one)	1
Portable electric drill	1
Drill for metal = 4 mm	1
Drills for wood = 3.5, 7, 22 mm	1 pcs each
Sand paper	10 sheets
Soldering lamp	1
Scissors for metal	1
Hammer	1
Rubber hammer	1
Bending tool for alu sheet, see below!	1
Paint brush	2

Copper pipe cutter or saw for metal	1
Cutter	1
Riveting tool	1
Working gloves	1
Tape measure	1

Bending tool

It is used to bend the alu-plates so they can fit on the pipes and transfer heat with bigger surface.

Needed materials are:

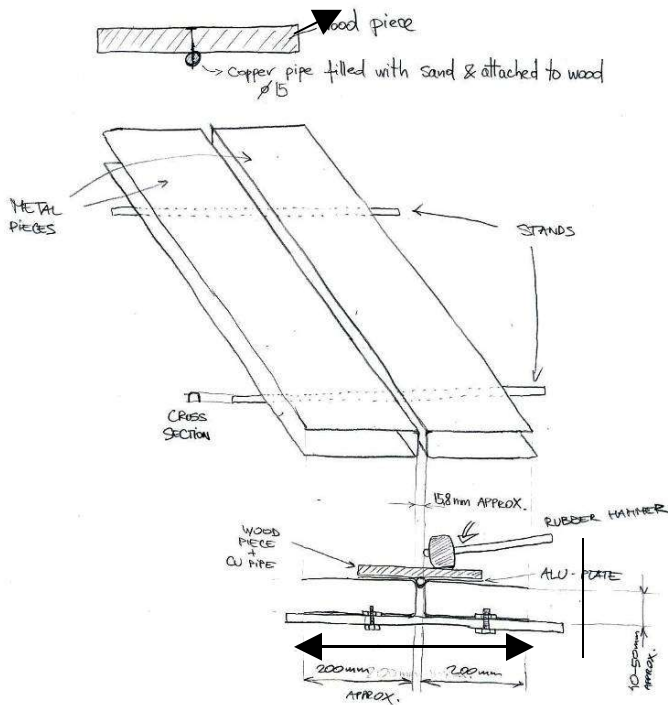
Steel rectangular profile 50x50, 2mm thick = 2 pcs. of 650mm long

Steel rectangular profile 30x30, 2mm = 2 pcs. of 120mm long, for stands.

Metric screws 50x6mm = 4 pcs.

Hard wood (oak) 600x120x25mm = 1pcs.

Hard wood



50 mm

Tool can be assembled in few minutes if all these materials are provided.

Once You have this tool you can use it for future DIY collectors or lend it Your neighbor!

Picture

3.

Step by step

Most important pre-phase is to calculate and to measure parts. If the outer measures of the collector are 2x1 meter, inside box measures will be decreased by thickness of the wood pieces. (Maybe you cannot find exactly 2cm thick wood)

Depending on collector box inside measures, calculate copper matrix and alu clip-fins (later painted black mat to absorb heat). Make copper matrix that way distances between vertical pipes (15mm) are equal. That way you will have 5 alu clip fins in horizontal line and 3 in vertical line, total of 15.

So, if the inside measures are 196x96cm (2cm thick timber), copper matrix with attached clip-fins should be just big enough to fit into collector box.

4

Measure how much pipe is entering the fitting (calculation is shorter for this amount), and dimensions of the fittings, and leave 2 cm on the top and bottom for the plastic pipe holder (measure it too).

First do the sketch with all measures and then start to cut the pipes.

When measuring the dimensions of the clip fins (3 per each pipe), calculate the bent part (half circle around pipe 15, see step 4).

So, clip fin width should be increased by difference between half circle (O/2) and diameter of the pipe 15mm. By formula $O=2r\pi$, it comes out:

$$O = 2 \times 0,75 \times 3,14 = 4,71\text{cm}$$

$$O/2 = 2,35\text{cm}$$

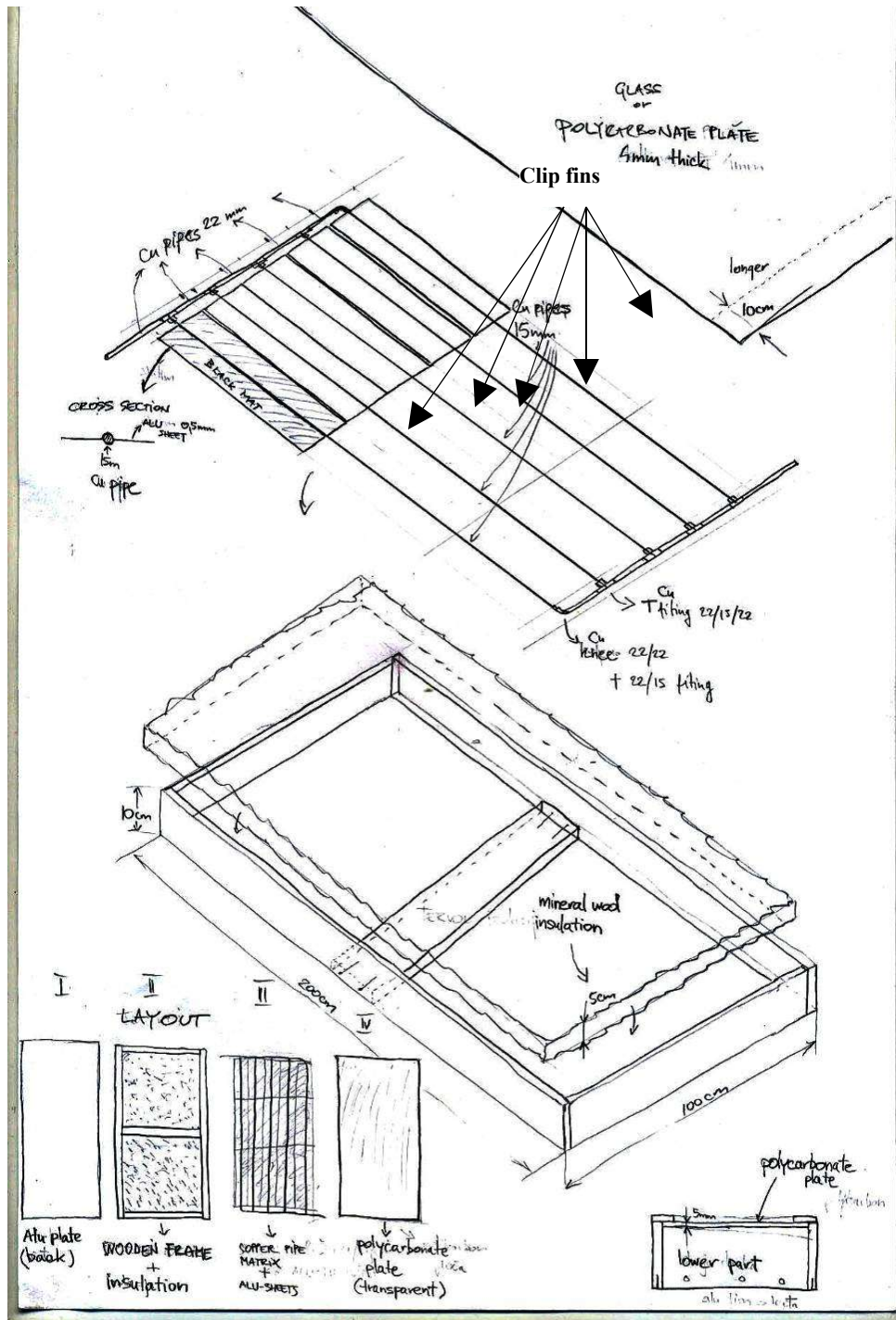
$$\Delta = 2,35 - 1,5 = \mathbf{0,85 \text{ cm}}$$

Lengths of the clip fins will be according to the distance of the vertical pipes when it is fixed and soldered in the matrix. (from T fitting to T fitting)

For vertical pipes use 15mm, and for horizontal 22mm (standard).

Fittings used are Copper T-part 22/15/22 and two diagonally situated are knee-fittings + reduction 22/15.

Polycarbonate will be 96 cm wide (inside measure) and should be 10 cm over the bottom edge of the box. That way water does not collect and rot the box.



Picture 4. Solar collector assembly

Step 1

Constructing collector box

Wood that you use should be flat, good quality and already prepared. Cut 2 planks 200 cm long, and 3 planks 100 cm long. Attach them in a way shorter ones will be between longer ones, and put 3rd in the middle, parallel with back of the box. Use larger screws for wood and wood glue.

After that you can put 1st coat of wood protection paint on the box.

important: bottom plank should be 4-5mm lower, so polycarbonate can fit.

See picture 4.

Step 2

Constructing copper matrix.

Cut the pipes, according to your measures. Use copper cutter.

You have to cut 5 pieces of 15mm, and 10 pieces of 22mm.

Pipes going in and out the matrix (22mm) should be long enough to reach 10cm out of the collector box, in order to leave space for fittings.

After that it should look like on the **picture 4**.

Then you have to solder the joints.

It is maybe the most difficult part for DIYers. Try to do it with somebody who is experienced, (plumbers usually know it!). Once you try, it goes relatively well.

After the soldering, check if the matrix is waterproof, pour the water in one side of it and check carefully every joint.

Soldered joints will look like on the picture 5.



Picture 5.

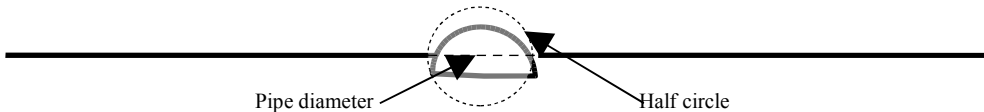
Step 3

Making alu clip-fins

You can find aluminum sheet in 2x1m dimensions, 0,5mm thin, and it should be just enough for the clip fins. After calculating dimensions of the clip fins, mark it on the sheet, and cut it with scissors. You need 15 clip fins.

Then put fin on the middle of the the bending tool (mark the center line along the fin), and press it with copper pipe attached to piece of wood. See **picture 3**. Good rubber hammer will make lot of noise :) , and bend the alu fin fast.

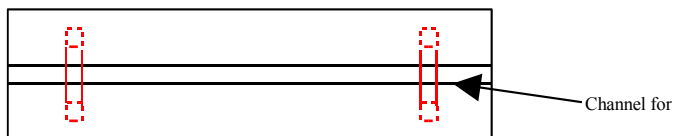
After the bending profile should look something like this.



Step 4

Attaching clip fins

As said before, you will have 3 fins per vertical pipe, total of 15, so fins should be placed that way on the matrix. They will probably be too loose on the pipes and one of the way to fix them is to cut small pieces of alu sheet 2x5 cm approx. (you will have some leftover) and rivet each fin with 2 pieces. First drill 4 holes on each fin (4mm drill), in the middle of red dashed marked areas (on each side of the pipe channel). That will be places for small alu strips. See below.



Then drill a hole for the rivet on the one side of the small piece. After riveting the one side, drill the hole through other side and

rivet it. Use riveting hand tool and rivets small enough to hold firmly. Good and firmly attached fins on the pipe will allow proper heat conduction.

There is profile view below.



After constructing whole matrix you can paint top side with metal primer and leave it to dry (3-4 hours) and than paint it (1 or 2 coats) with black mat color for metal, resistant to heat.



Picture 6. Completed copper matrix with attached clip fins.

Step 5.

Attaching back side

While the paint is drying, you can put back side of the collector box. Attach aluminum sheet (2x1m, 0,5mm) to the wood frame using smaller screws. If the plate is bit bigger, you can bend it around edges with hammer.



Picture 7.

Step 6.

Insulation

When you have the back of the box you can put insulation in.

Insulation used is mineral wool, but if you can find more environmentally friendly/recycled materials such as coconut-fiber or cellulose based insulation use it.

Dimensions will be like inside of the box, so cut mineral wool if needed.

You can find pieces of 100x50cm, 5cm thick.

Than put thin aluminum foil on the insulation and fix it with staples.

Step 7.

Assembling matrix to collector box

At this stage you should have box with insulation and copper matrix with clip fins painted black. They have to be attached together. Put matrix on the box and mark place where you will cut wood and drill hole. If your calculations were right, matrix with fins will fit in the box and you will have 2cm spacing on top and bottom for the plastic holders.



On the one side drill 22mm hole for the entering pipe and on the diagonally opposite drill same hole and than cut cone piece of wood to lay the exiting pipe (it can be vice versa). After fixing the matrix with plastic pipe holders, put wood cone piece back and glue it with wood glue and sawdust mixture.

You can also seal other side with glue+sawdust.

Matrix should be placed between insulation and polycarbonate and ideally should not touch any.

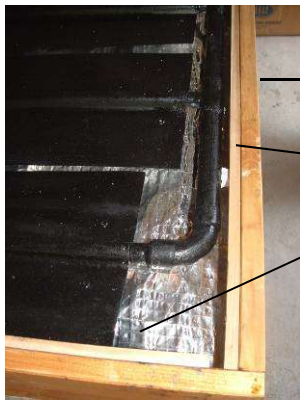
Wood cone piece first cut than put back and glued

Picture 8.

Step 8.

Putting polycarbonate sheet

In order to put polycarbonate sheet, support beadings should be fixed to inner side of the box. Attach it with small screws that way from the top edge of wood box to the beading there is 4mm (thickness of the PC sheet).



For the support beadings use wood pieces, 200x1x1 cm and cut it according to inner measures.

Top edge of wood box

Support beadings

Picture 9.

You can put PC sheet now, and remember to leave approx. 10 cm overhang on the bottom, for rain not to enter the box.

Than put top beading (200x3x0,7 cm) along the longer sides and on the shorter side put only the top one. Attach it with smaller screws, and put silicon mastic between PC sheet and top beading. That way you will close the collector.

Make sure that you paint top beadings with wood protection paint at least once before attaching, and after it paint all wood once again.



Picture 10. Fixing top beading with small screws.

Finally, your collector is ready to install!

There is drawing how you should connect it to water reservoir and thermosyphone system.

Most of the pipes used here are plastic water hoses, except one that goes up from collector to reservoir. (very hot water in sunny conditions). Fittings are regular plumber messing fittings.

"Holender" fittings used are simple to assemble and disassemble.

Reservoir is HDPE for potable water, 150-200 liters.

The water inside the reservoir is not under pressure so plastic one is good choice.

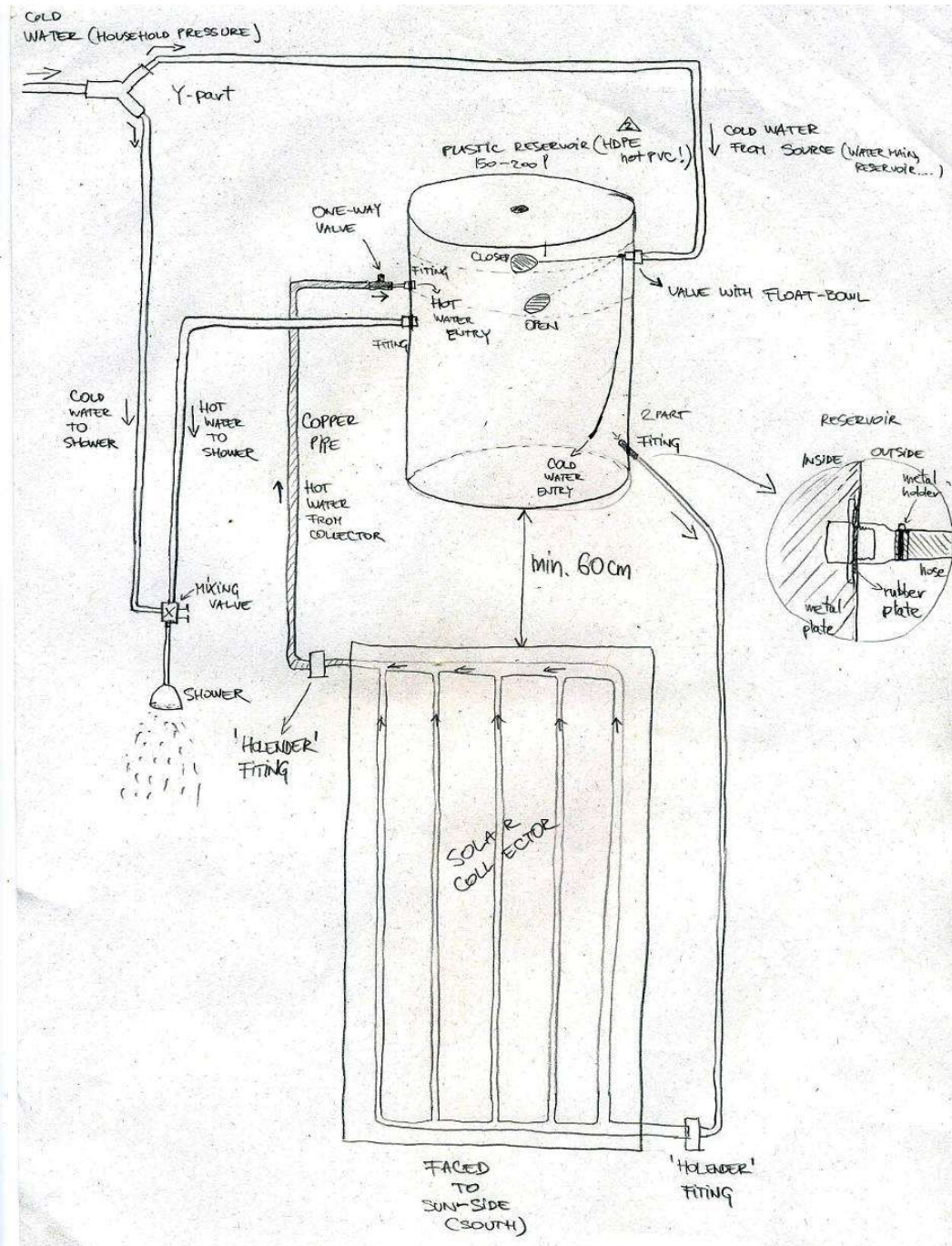
Valve with float bowl is one usually used in older toilet water tanks. It is self-regulated, so when the level of water in the reservoir during shower is falling, float bowl will fall to and open the valve to feed new water.

Be sure that water pressure on the valve is not too high.

Of course remember to face your small solar water heater to Sun side (South on the North hemisphere), and enjoy warm shower.

Materials needed for this system are:

- 1) messing fittings (x 3):
 - inside thread piece (15mm to 1/2 inch)
 - outside thread piece (1/2 inch to water hose)
 - rubber plate
 - metal plate
- 2) "holender" fittings for 22mm pipe (x 2)
- 3) mixing valve for plastic hoses
- 4) one way valve for water
- 5) metal holders for hoses
- 6) "toilet" valve with float bowl
- 7) Y-part, plastic
- 8) shower tap
- 9) copper pipe 15mm
- 10) knee fittings; 15mm and 22mm
- 11) metal hose holders (10 pieces)
- 12) HDPE (High Density PolyEtilen) reservoir 150-200 litres
- 13) plastic water hose



Resources:

- Ion Zamfir, Earth friends, Galati, Romania
- Home power magazine No.107, "Solar Hot water simplified" www.homepower.com
- Permaculture magazine No.39 "The universal panel game" www.permaculture.co.uk

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