



## DIY Shower Water Heat Exchanger

When you think about what goes on energy wise when you take a shower, its mind boggling wasteful. Your hot water tank heats up several gallons of water from about 60F to about 120F typically using about 6000 BTU worth of energy. The water flows over you once, and then right down the drain taking nearly all of that 6000 BTU of energy you just put into it right down the drain.

Tyler has worked out a pretty simple heat exchanger to extract some of the heat from the shower water as it goes down the drain and use this heat provide some of the heat to the incoming shower water.



in Tyler's design, the cold water on its way to the shower goes through a heat exchanger where it picks up heat from the draining shower water.

Thanks very much to Tyler for sending this in!

**From Tyler:**

### **Design and Construction:**

I use a heat exchanger in my shower drain that runs the cold water line of my shower through and takes the grey water from both my showers and my tub. The exchanger is just 4" ABS with a bunch of loops of 1/2" pex inside.



This shows the new 4 inch ABS pipe section and the coil of PEX that will be used to make the drain water heat exchanger..

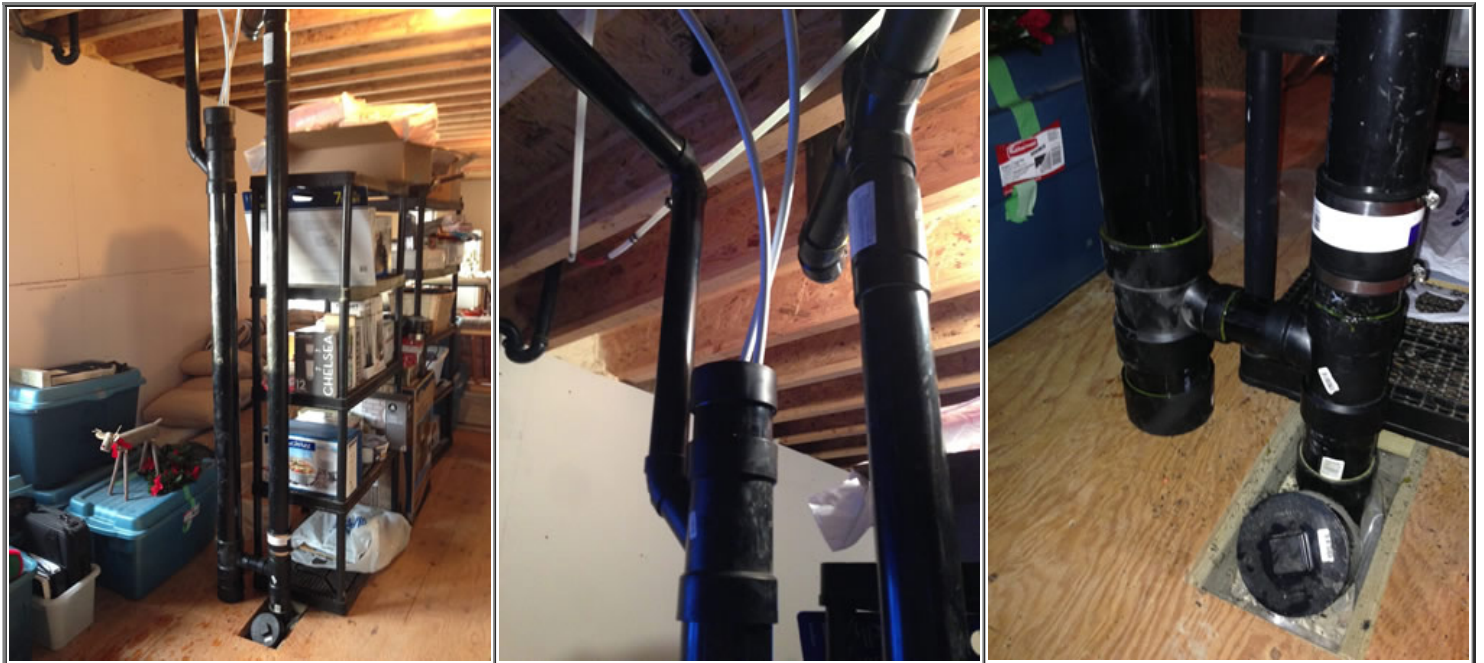


Putting together the bunndle of PEX that will be placed in the new section of shower drain. The PEX connected with brass fittings with crimp rings.





The bundle of PEX being placed in the new shower drain. Once the bundle is in place, a cap with holes for the two PEX lines is installed and sealed with silicone caulk.



The new section of drain stack with the PEX in it is on the left. The newly routed 2 inch shower/tub drain comes in near the top left of the new drain stack. The new drain stack is joined back into the main stack as shown on the picture on the right. All of these pipes will be enclosed in a new planned wall with access for any required servicing. All of this plumbing is located in the basement.

The 4 inch pipe on the right is the original stack that served all the showers toilets and sinks. I just separated the the shower/tub drain and run them through the new stack on the left with the PEX heat exchanger, and then rejoin the two stacks as shown in the right picture.

The shower drain water just gravity feeds through the PEX heat exchanger area.

The top of new shower drain stack is sealed with a pipe cap with holes drilled for the PEX and then sealed with silicone caulk.

There are valves in the ceiling to isolate the two PEX lines going to the heat exchanger that allow it to be bypassed if there is a problem with it.

## Performance and Cost

After the first trial it warms the incoming cold water from 18c(66F) to 25c(77F) with 35c(95F) drain water. I thought it would do more but since my cold water is fairly warm already (stored in the basement) the lower temp differential probably hurts efficiency... It is quite noticeably hotter in the shower and I'm able to turn it down quite a bit!

If you assume a 10C (18F) warmup of the water going through the heat exchanger (based on somewhat cooler cold water than Tyler has).

The, the energy saving for a 10 gallon shower is about 1500 BTU per shower -- an about 30% saving in energy to heat shower water.

If you assume three showers a day, and an 90% efficient water heater, the saving per year is about 2.0 million BTU per year, or nearly 600 KWH per year.

Further optimization of the heat exchanger and drain pipe might gain further energy savings.

The total cost of materials was about \$180.

The saving for 600 KWH of electricity here in Saskatchewan is about \$70.

## Potential Improvements

Efficiency improvements- there was room for more pex loops which would slow down the flow and increase surface area but I left some space as I was afraid of water backing up. I think there could be a few more added though without any worries.

I had thought of different ways to use the 4" abs as a tank kept full at all times but I couldn't come up with a good design to avoid buildup of dirt/sludge and it would have a greater potential for leaks or spills. Also it would lose heat to the basement and have a slower response whereas this system gives a fairly immediate benefit. I would think a horizontal type exchanger would be more efficient but would be a little more difficult to fit and support.

Tyler

March 17, 2014

## Other Gray Water Heat Recovery References

A couple links to other grey water heat recovery ideas and projects:

[Canada study on what could be a DIY grey water heat exchanger...](#)

[A grey water heater exchanger in a barrel...](#)

[Another idea on recovering some grey water heat fro space heating...](#)

[Thoughts on another approach to an energy efficient shower design...](#)

[A commercial show water heat exchanger...](#)

Be aware that in many places this single wall heat exchanger design would not meet code.

## Comments

If you have any questions or ideas for improvment, this is the place.

28 Comments    Build It Solar

 Login ▾

 Recommend   24    Share

Sort by Newest ▾



Join the discussion...

LOG IN WITH

OR SIGN UP WITH DISQUS [?](#)

Name



**Nick Welch** • a year ago

Lots of shortcomings with this design... the back and forth looping of the pex doesn't result in counterflow geometry like the commercial units have. The water only transfers heat when trickling down the pex; water on the outer wall doesn't transfer any heat. The bottom appears to capture a stagnant pool of water. There is only a single wall between fresh water and drain water, which is not allowed by code due to contamination concerns. Pex inside of a drain pipe makes it impossible to snake and it will accumulate crap. And it cost \$180? You can get a 42" Thermodrain for about \$330USD. Not much more money for the real deal that solves all these problems.

^ | v • Reply • Share ›



This comment was deleted.



**GaryBIS** Mod → Guest • 3 years ago

Heat exchange depends on the material and the area. Plastic heat exchangers work fine if the heat exchange area is increased.

For water to water heat exchangers the thermal resistance of the water films on each side of the heat exchanger walls add significantly to the total heat exchange resistance and these are the same for plastic or metal heat exchangers, so even though the metal might have more than a hundred times the thermal conductance of plastic, you only need about 3 times more heat exchange area in a plastic heat exchanger to for equivalent performance.

Gary

^ | v • Reply • Share ›



**GaryBIS** Mod • 3 years ago

Hi Tyler,

Have you had a chance to check the pex heat exchanger to see if there is any build up of soap, etc. as its used over time?

Gary

^ | v • Reply • Share ›



**T Thall** → GaryBIS • 2 years ago

I haven't re-checked it no... I recently got a new flir thermal camera, ill try and get some images/measurements with that as it seems a lot more accurate than my old laser pointer...

^ | v • Reply • Share ›



**GaryBIS** Mod → T Thall • 2 years ago

Sounds good -- thanks Gary

^ | v • Reply • Share ›



**T Thall** → GaryBIS • 2 years ago

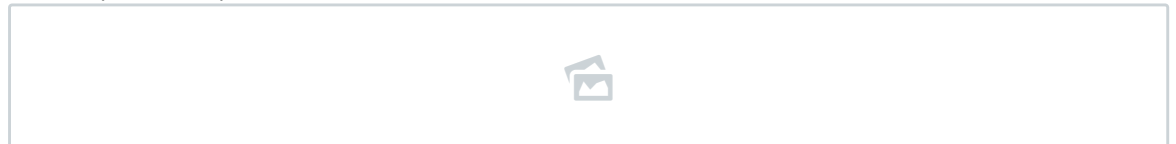
I just rechecked it near the end of two showers with the flir:

-15.2c incoming

-22.0c exiting

-29.8c drain temp

Here is a pic of the top...



^ | v • Reply • Share ›



**GaryBIS** Mod → T Thall • 2 years ago

Thanks Tyler,

It looks like the performance is about the same as it was initially -- not much, if any, drop in performance.

Please keep us posted if any further developments.

Gary

^ | v · Reply · Share ›



**JoostBuntinx** · 3 years ago

3 showers a day... is that a habit in the US? We had some americans here , and they showered everyday. We only go to the bath/shower once a week when you do officework....

^ | v · Reply · Share ›



**GaryBIS** Mod → JoostBuntinx · 3 years ago

Hi,

I just used three showers a day per family (not per person).

Gary

^ | v · Reply · Share ›



**JoostBuntinx** → GaryBIS · 3 years ago

Yup, I have a family of 4, my wife and tw kids, on average 10 showers /week, mostly dirty kids :)

^ | v · Reply · Share ›



**AllynO** · 3 years ago

You know what I do in the wintertime to recycle all that heated shower water? I shut the drain in the tub, take the shower, and come back later when the heat has escaped into the room. Just saying...material cost 0...maintenance cost ~0...efficiency near 100%!

2 ^ | v · Reply · Share ›



**T Thall** → AllynO · 2 years ago

We have a stand up shower...

^ | v · Reply · Share ›



**GaryBIS** Mod → AllynO · 3 years ago

Hard to go wrong with that approach as long as the bit of extra humidity is not a problem.

I wonder if there is some approach that works the same way, but keeps the shower drain water out of sight, as having the drain water in sight would probably be an issue with some people?

Gary

^ | v · Reply · Share ›



**John** · 3 years ago

I like Gary's thoughts, and would share my ideas like this. I like the 4" drain pipe, but would use 3/8" copper, single or parallel. Since drain water hugs the wall of the pipe when draining, lets encourage the path. Take 1 or 2" pvc, whichever will support the fit. Wrap the soft copper around the pvc and slide it into the 4" drain pipe. When doing this, encourage the soft copper to be a snug fitting spiral between the pvc and the 4" drain pipe. Cap off the pvc at the top to discourage any drain water from entering. Having done this constuction, the hot drain water will ride down the pipe over the copper in a circular manner to the bottom. I believe maximum heat exchange will occur. I would also insulate all piping from the drain all the way to the bottom. One last thought, I would empty this water above the bottom of the main trunk line which contains toilet waste. The pipe would be on a 45 degree angle so there is no exchange of waste water and lastly a valve installed to extract this gray water if desired. Thank, John

^ | v · Reply · Share ›



**Jason D.** · 3 years ago

I'm surprised this works at all. Drain pipes are filled mostly with air or other gases even when the water is flowing. The main reason GWHR pipes work is because water surface tension causes the drain water to cling to the walls of the drain pipe, which allows tubes wrapped around the outside of the drain pipe to extract heat. Your design must allow a portion of the drain water to attach to the outside of the PEX tubes and run down or maybe the drain water backs up at the bottom and submerges part of the PEX run. A horizontal run of pipe might help with this if the inner pipes can be made to stay at the bottom of the drain pipe.

As someone else mentioned, caution should be used with piping like PEX since some bacteria and viruses may be able to pass through the walls. Something like copper with it's antimicrobial properties would mitigate that, but it may be extremely difficult to fit into the drain pipe without kinking or having connections that corrode over time.

^ | v · Reply · Share ›



**Guest** · 3 years ago

I had a good friend who had manufactured something similar. He stopped due to concerns of things (viruses?) passing through the tubing

walls. I know that sounds implausible, but he became rather ill until the unit was removed from service. At very least, I would consider using oxygen barrier PEX. The commercial units that are around that are made out of copper and have two walls in between the gray water and the potable.

^ | v · Reply · Share ·



**GaryBIS** Mod → Guest · 3 years ago

Hi,

As you say, it seems improbable that a virus could get through the pex wall. The smallest viruses are about 70 times larger than a water molecule. Maybe this is over simplified logic, but if water molecules can't get through the pex, how could something 70 times larger get through?

Can we find some hard data on whether a virus can get through a pex pipe wall?

Gary

1 ^ | v · Reply · Share ·



**Jason D.** → GaryBIS · 3 years ago

That's good to know. Maybe virus/bacteria get through the fittings or other joints and not the pipe wall.

^ | v · Reply · Share ·



**Erik S** · 3 years ago

Clever design, putting the cold water pipe inside the drain line!

Remember that as the hot water drains down, it will be cooling off (because your cold water is getting warmer). One way to increase efficiency is to have the cold water start at the bottom and then work it's way up. This could be done by running the cold water line from the top (where the hole is) to the bottom, and then spiralling the tubing back up. I'm not sure it could be done with 4" ABS and 1/2 inch PEX. I just wanted to point out that a counter-flow heat exchanger could have better efficiency. The same is true if you tried a horizontal pipe. If the flows go in the same direction, the best you can do is bring them both to the same temperature, which is about what you have now.

Nice work!

^ | v · Reply · Share ·



**t.thall** → Erik S · 3 years ago

A coil would be much better as it would eliminate all the clamps and elbows and also give the water much more contact time as it winds it's way down but as you said it would take a much more flexible material...

^ | v · Reply · Share ·



**GaryBIS** Mod → t.thall · 3 years ago

Maybe a coil of 3/8th copper?

It could (maybe) enter a sealed hole near the bottom of the new stack and exit at the top -- with no joints inside the stack? And with counter flow.

50 ft of 3/8 copper would have a pressure drop of 4 psi at 2 gpm flow rate. I don't think that would be enough to effect the flow rate much, but two coils in parallel might be used if the pressure drop is too great.

Thinking about how the water flows down the drain and getting good circulation over the heat exchanger tubing -- I wonder if some sort of twisted vane at the top of the stack could impart some whirl to the drain water so that it tended to stay near the outside of the ABS? This assumes that the copper coil is large enough so that it was out near the inner diameter of the ABS,

It seems to me that I read that the flow in these drain pipes does tend to follow the drain pipe walls.

Gary

^ | v · Reply · Share ·



**Guest** → GaryBIS · 3 years ago

A copper unit would be safer and certainly more efficient. Not as cheap as PEX, but eliminates any concerns. Would love to use plastic, but 3/8" copper is pretty inexpensive.

^ | v · Reply · Share ·



**GaryBIS** Mod → Guest · 3 years ago

To be honest, I just don't see the safety concern, but I guess every one has to make up their own mind about that -- again, it would be nice to have some hard data on this.



The copper ends up being about 3 to 5 times more efficient per sqft fo heat exchange area than PEX, but Tyler has a lot of heat exchange area with the PEX version.

Seems like it would be nice to experiment with both and with arrangements that get good grey water flow over the heat exchanger tubes.

Gary

^ | v · Reply · Share ›



**Guest** → GaryBIS · 3 years ago

I built a similar system several years ago, using 10 meters of 1/2 inch soft copper tube wound in a spiral inside the drain pipe, works really well for 3-4 months until the tubing gets a build up of slimy gunk, the efficiency then drops off markedly. You have to build it so you can easily remove the tube and water blast off the slime.

In the end I redesigned the system similar to a solar panel, with 5 vertical tubes with headers soldered to a sheet of 300mm x 2m piece of copper foil, mounted inside a horizontal case at 10 degree slope. piece of plastic covers the top, very easy to clean, and after 6 months hardly any slime build up.

Cheers

Mike NZ

^ | v · Reply · Share ›



**GaryBIS** Mod → Guest · 3 years ago

Hi Mike,

So, the drain water flows over the outside of the copper collector?

And, then the drain water is collected at the bottom and back into the drain pipe?

Does the horizontal case fill up and keep the warm water in contact with the copper for a bit of time, or does it just drain right through fairly quickly?

Sounds good -- got any pictures?

Gary

^ | v · Reply · Share ›



**4431mike** → GaryBIS · 2 years ago

Hi Gary

I did take some pictures, bit late than never:

Contruction is similar to a solar hot water heating panels that I make, 20mm copper headers, 15mm risers and soft 0.25mm foil fins.

Tubes are hard brazed with silver alloy, fins are lead soldered to risers.

Case is wood, glued edges, fibreglassed inside with 3 coats of resin to seal the timber.

Shower grey water water runs via spreader at the top down foil, transferring heat to cold water circulating to input of the shower mixer; exits via bottom tube to drain fitting.

Cold water enters bottom and exits top of ladder tubes for reverse flow efficiency.

Installation slope is about 10 degrees, top of case has a cover of mylar plastic to keep heat in and bugs out.

Last photo is my plasma welder, can be used in brazing mode for copper pipes, replaces Oxy Acetylene setup, and is much quicker that gas as the flame tip is 8000 C.

Has been in use for over 12 months, slime buildup on the fins is minimal, cleaned approx every 6 months with scrubbing brush and hot soapy water, by lifting the loose fitting cover.

Heat gain of cold water is about 10 degrees C, depending on the temperatue of the cold water entering the bottom.

As our hot water is 95% solar, there is less in the winter months due to a lack of decent sun, so the heat exchanger

performance is quite different.

[see more](#)

^ | v · Reply · Share ›



**GaryBIS** Mod → 4431mike · 2 years ago

Thanks Mike -- very nice!

I'd like to put your pictures and description on its own project page if that's OK with you?

Gary



^ | v • Reply • Share ›



**4431mike** ➔ GaryBIS • 2 years ago

Yes, thats fine, if you require any more details, just let me know.

Gary March 17, 2014

[Contact/About](#)

[Legal Disclaimer](#)

[Copyright 2005 - 2015 by Gary Reysa](#)