Recycling Water: An Investigation of How to Conserve Unused Water

Science Fair 2024-25 Logbook

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Actual logbook is in-person with dates, specific information, and recorded day-to-day entries

Background Research:

- October 15, 2024
- October 22, 2024
- October 29, 2024
- October 30, 2024

CYSF Portal: https://platform.cysf.ca/project/edit/basic_project_info/

Websites

Sewage/City System:

https://www.calgary.ca/water/drinking-water.html

Statistics:
https://www.google.com/search?q=waste+water+by+waiting+for+hot&oq=waste+water+by+waiting+for+hot&gs_lcrp=EgZjaHJvbWUyBggAEEUYOTIHCAEQIRigATIHCAIQIRigATIHCAMQIRigAdIBCDM4ODRqMGo3qAIAsAIA&sourceid=chrome&ie=UTF-8

https://www.premierh2o.com/blogs/news/37679553-how-much-water-is-wasted-waiting-for-water-to-warm-up#:~:text=An%20average%20home%20has%20125,to%20get%20the%20hot%20water.

Wastewater treatment:
https://www.google.com/search?q=waste+water+treatment&oq=waste+water+tre&gs_lcrp=EgZjaHJvbWUqBwgAEAAYgAQyBwgAEAAYgAQyBwgBEAAYgAQyBwgCEAAYgAQyBwgDEAAYgAQyBwgEEAAYgAQyBggFEEUYOTIHCAYQABiABDIHCAcQABiABDIHCAgQABiABDIHCAkQABiABNIBCDQyNDVqMGo3qAIAsAIA&sourceid=chrome&ie=UTF-8

Piping Distance:
https://www.google.com/search?q=why+does+it+take+long+time+for+water+to+turn+hot&oq=why+does+it+take+long+time+for+water+to+turn+hot&gs_lcrp=EgZjaHJvbWUyBggAEEUYOTIHCAEQIRigATIHCAIQIRigATIHCAMQIRigATIHCAQQIRigATIHCAUQIRifBTIHCAYQIRifBTIHCAcQIRifBTIHCAgQIRifBTIHCAkQIRifBdIBCTExMzQ1ajBqN6gCALACAA&sourceid=chrome&ie=UTF-8

Dual water heaters:

https://www.google.com/search?q=why+is+it+bad+to+have+two+water+heaters&oq=why+is+it+bad+to+have+two+water+heaters&gs_lcrp=EgZjaHJvbWUyBggAEEUYOTIHCAEQIRigATIHCAIQIRigATIHCAMQIRifBdIBCDg2MTdqMGo3qAIAsAIA&sourceid=chrome&ie=UTF-8

Helpful article:

https://www.billygo.com/blog/four-ways-to-get-instant-hot-water-at-the-faucet/

Recirculating hot water system:

https://www.google.com/search?sca_esv=439ed1f28d78315f&q=.+Recirculating+Hot+Water+Systems&source=lnms&fbs=AEQNm0Bqzy2A7JdsZg3J6bXbexmPYRAnmocz_wSkO9o2d70T0heh0g9PP-lN5PtKwO3uHaElUXXU1c91d54ABW-Z31cLhLPdwywmWCwUE-x89fYV873QTjus1pdZQ9I9wgZFMeuI_01wwR60_PWHRGFURAT8waCFEyB-ALWnw8hUz5RSX1PhWPYZhArMDHRoBme8Y3nyF2MkVP7vEuweIHEcVkxGaWI-TA&sa=X&ved=2ahUKEwjk1_7nr7eJAxUGIzQIHSe2CGQQ0pQJegQIExAB&biw=767&bih=730&dpr=1.25

https://www.homedepot.ca/product/watts-instant-hot-water-recirculating-system/1000728120

https://timbersill.com/hot-water-recirculating-pumps/pros-and-cons-hot-water-recirculating-pumps/

Point of use system (POU):

https://www.google.com/search?sca_esv=439ed1f28d78315f&q=point+of+use+water+heater&source=lnms&fbs=AEQNm0BcOTtrxLAuu_QwMeob8rlZbzgoNyvm-EGzMCdSVm7atMhtCrLJ0m6k84h6T6DB014WeU4rbyzPU3h0X6I7eJetECfAiszBFzAlA4IW8fbORN4r8coDmlBjJFVSsQ9-Z6BIOZiuM0NgmramNm45q9BNBU7i_RePsuiZxRPBABDX1_R9GQhHW4PNZ7--cES09VRmNIf9C0HRAP0jSU18Urip-_F3Rw&sa=X&ved=2ahUKEwjPg-XXtLeJAxU8GTQIHeFQHCAQ0pQJegQIExAB&biw=767&bih=730&dpr=1.25

Tankless:

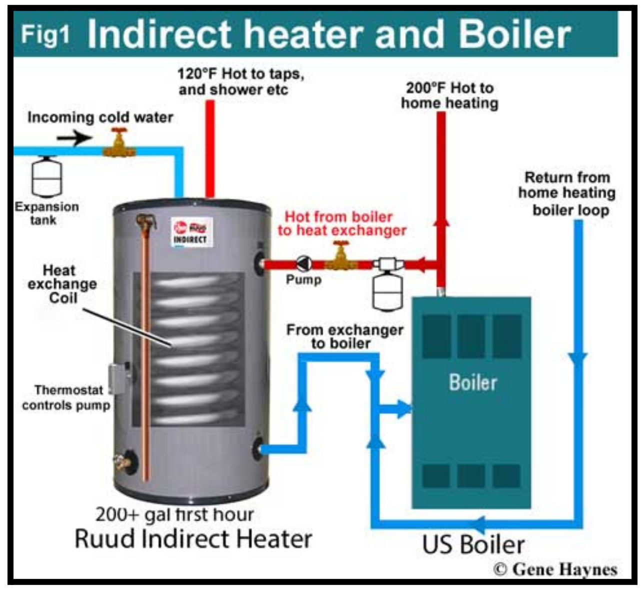
https://www.arpis.com/blog/pros-and-cons-tankless-water-heaters/#:~:text=Before%20you%20commit%20to%20buying,Access%20to%20fuel.

Wastewater Treatment vs Water Treatment

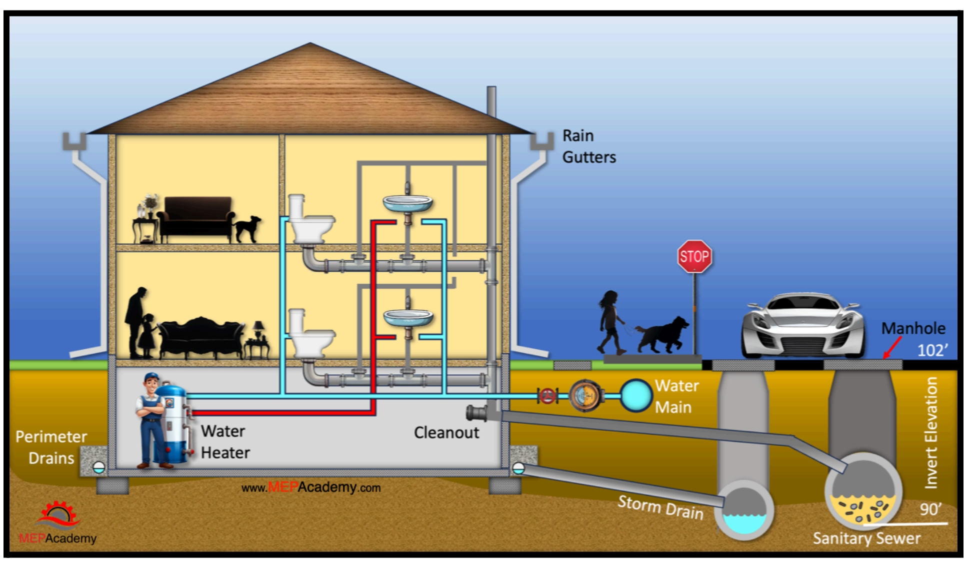
https://www.pwea.org/docs/BROCHURE_APPROVED_-__What_is_the_Difference_between_Water_and_Wastewater_Treatment.pdf

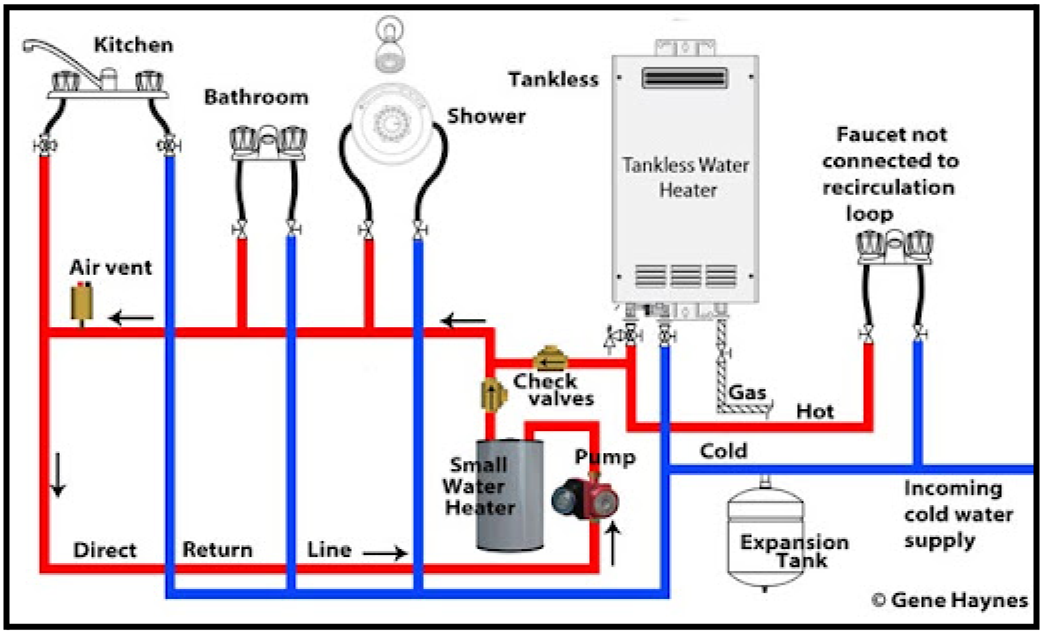
(Water heater tank)

*Boiler and plumbing system



House plumbing system



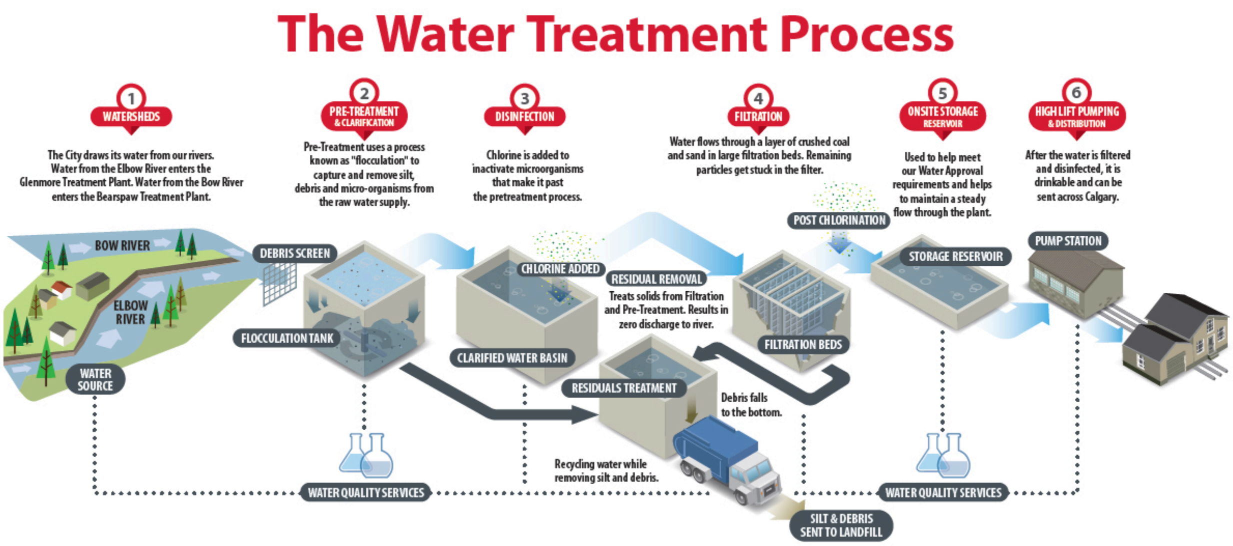


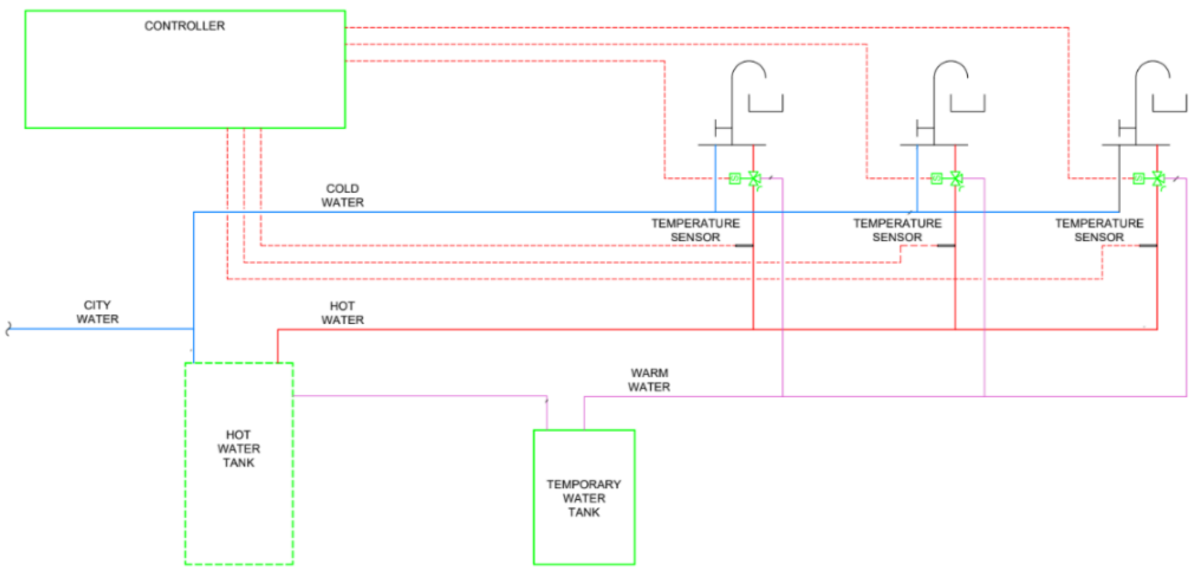
Inefficient recirculating water system

POU system

Intro Doc:

- [x] ~~What is global problem~~
- [x] ~~What is household problem~~
- [x] ~~How much water is wasted~~
- [x] ~~Reason water is cold (piping)~~
- [x] ~~Current system used~~
- [x] ~~Dual water heaters disadvantages~~
- [x] ~~Proposed system in experiment~~




CONTROLLER
COLD WATER
TEMPERATURE SENSOR
TEMPERATURE SENSOR
TEMPERATURE SENSOR
CITY WATER
HOT WATER
WARM WATER
HOT WATER TANK
TEMPORARY WATER TANK

https://docs.google.com/document/d/1_AibZGZWvaokeVD_dlWpF3FN5idFt3STuuND0c5_als/edit?tab=t.0

Introduction:

Running the tap until the water reaches a desired temperature can lead to wasting cold water that is not utilised by the consumer. In most homes, this may happen on a daily basis, whenever one wants a hot shower or warm water to wash one's hands or vegetables. While the delay of hot water could just seem like a household inconvenience, it actually poses a far greater global problem that has not been truly solved and deliberated.

The complication that comes with waiting for cold water to turn warm or hot is that the unused cold water is simply wasted and just goes down the drain, back into the sewage system, and directly sent to the wastewater treatment plant. In the plant, this clean, unused water is considered the same as truly dirty water. Thus, it undergoes the same treatment process which ultimately takes up lots of energy to clean and filter a substance that was not even used in the first place. For instance, a study done by researchers at the University of South Florida found that for the average person, each day 100 gallons of potable water is actually consumed; treating the used water which requires around 1000 watts of energy to treat and then redistribute back into the sewage system. In comparison, it only takes 5 watts to charge a phone, so with 1000 watts, there is enough energy to charge 200 phones–an enormous amount. Additionally, each day an average of 31 gallons of water is wasted per household merely from running the faucets and showers in an attempt to get hot water. This is equivalent to one household wasting roughly 300 watts of energy in a single day.

Another study done in 2015 found that, "over twenty-five million homes waste approximately 300 billion gallons of water annually". This causes a significant amount of energy to be wasted, which increases the amount of greenhouse gases that are emitted, overall escalating the average carbon footprint, during this process. Though it might seem like just a minor annoyance, the cold water that is wasted daily will add up and make a difference to our carbon emissions. Therefore, it is, overall, damaging our environment and contributing to global warming at an alarming rate.

In fact, wasting energy from the wastewater and water treatment plants to purify the untouched cold water is not the only consequence. A far greater problem of wasting the resources in these processes is also time and money consuming. By needing to filter more water (even though the cold water is not even used), substances and chemicals, such as chlorine, that are in high demand, are also wasted. It also takes up more time to actually purify the water due to higher amounts.

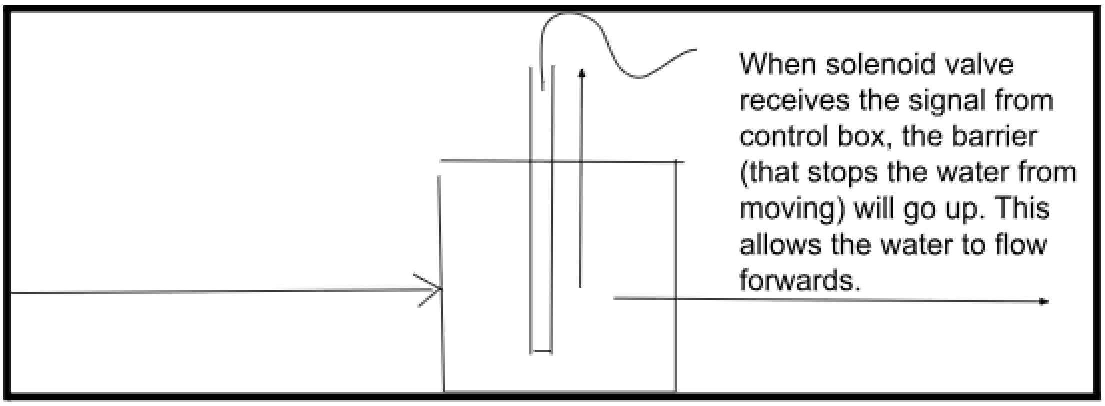
The reason behind this issue is that the long pipes that connect a faucet or shower contain once heated water that has turned cold. This is because the longer the water sits in the pipes, the more thermal energy and heat it will lose; thus, causing the water that is already in the pipes to be pushed up first from the water heater (boiler tank) and come to the faucet before the hot water. Especially in larger buildings or homes, the farther away a faucet is from the water heater, the longer it will take for the hot water to get there, which means more cold water is wasted and simply goes down the drain.

There are multiple inefficient and energy-demanding solutions that have been created to solve the problem of waiting for a long time for hot water to arrive at the faucet. Firstly, it has been proposed that less cold water is wasted when installing dual (two) water heater systems in a house, but this is expensive, electricity and energy demanding, and inconvenient since it increases the risk of water leaks and damage. Additionally, it has also been proposed to use a recirculating hot water system in which the hot water is constantly circulating and being pumped automatically, so it is available at the faucet immediately. This means the plumbing system would just be a loop of heated water that is connected to every faucet in a house. Although this system would provide all the faucets with hot water, it also proves to waste energy because the water would need to be continuously heated with thermal energy and electricity that the pump would depend on, even if the water does not need to be heated at that moment. This is a high-cost and inefficient solution to conserving cold water. Regardless of whether a person wants the hot water at the moment, it will always be running through the pipes. Also, when using this system, there are faulty mishaps and problems that occur on a regular basis. For instance, when one desires cold water, often lukewarm or hot water is pumped into the faucet instead of purely cold water because with this system, it takes longer for cold water to reach the tap. Another disadvantage to this system is that each recirculating pump is approximately $400-700, and requires frequent replacements about every two years. This is hard to manually fix especially if the sensor is inside the pump. Along with replacements, the recirculation pump can also be quite loud and disruptive in smaller houses, which can disturb daily life. Along with the recirculation system, there is also the point-of-use tank water heater (POU). This method includes utilising a small heating source close to a faucet, sink, or shower, in order to decrease the distance from the water heater to the faucet. Though the point-of-use system also provides instant hot water, it, in turn, demands high costs of electricity, utilises much more energy, and is costly. Lastly, the tankless water heater system, such as the point-of-use tankless water heater, is one that is newer and more modern. The disadvantages of using a tankless heater is that it demands higher upfront costs than normal tank systems, has flow rate limitations (which affects how many faucets in one building can use this system without losing function or effectiveness), and requires a water softener (due to minerals in hard water building up inside the heater).

In order to counteract this problem with an inexpensive, energy-conserving, and environment-friendly solution, it is crucial to use a new plumbing system that conserves the cold water that is not used and make sure hot water can be immediately used by the user.

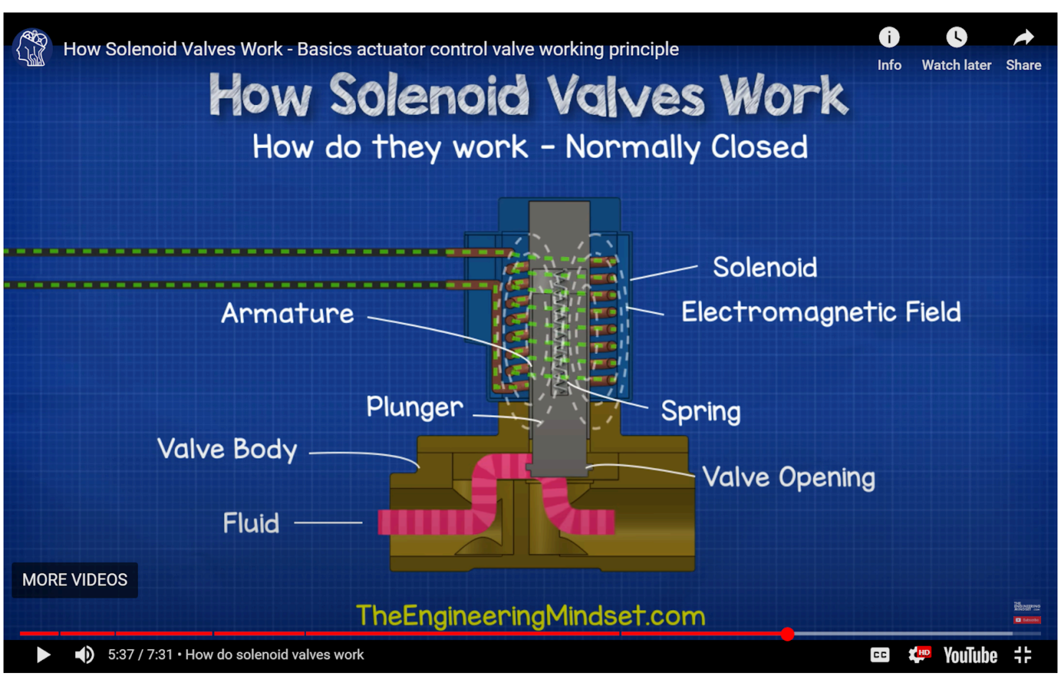
Solenoid Valves

Need two-way because one valve will release cold water into the storage tank, while one will allow hot water to reach the tap.

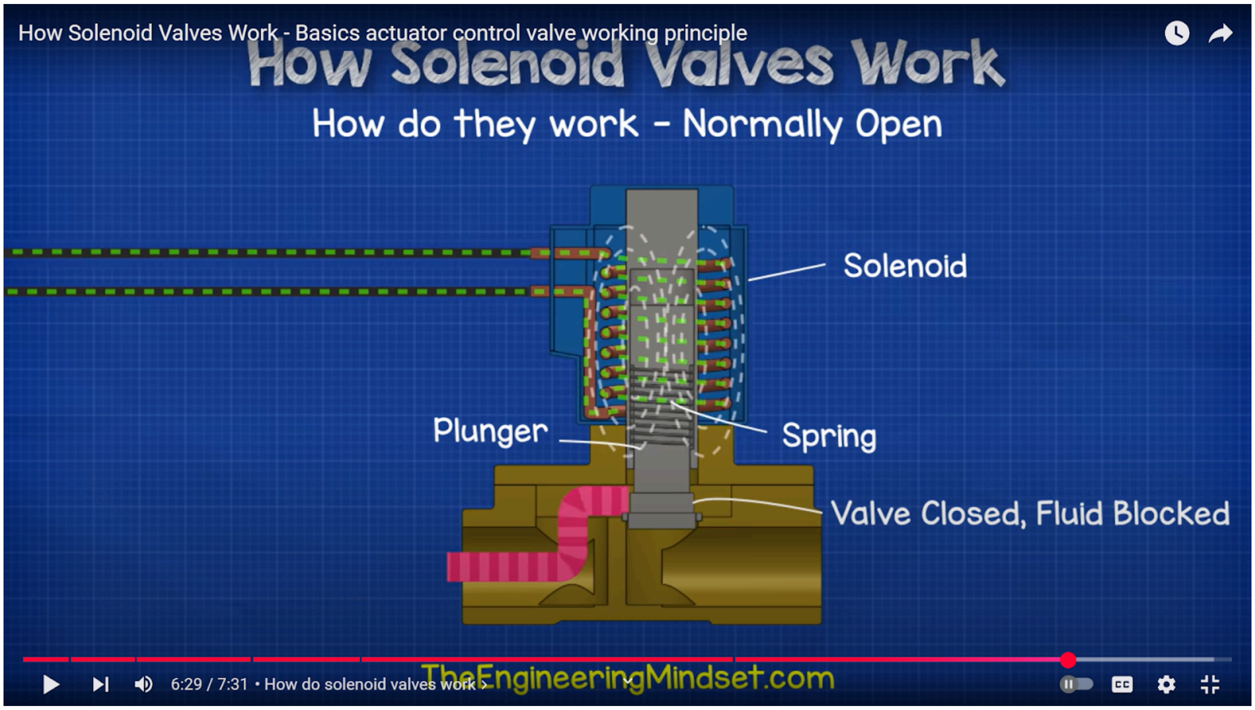


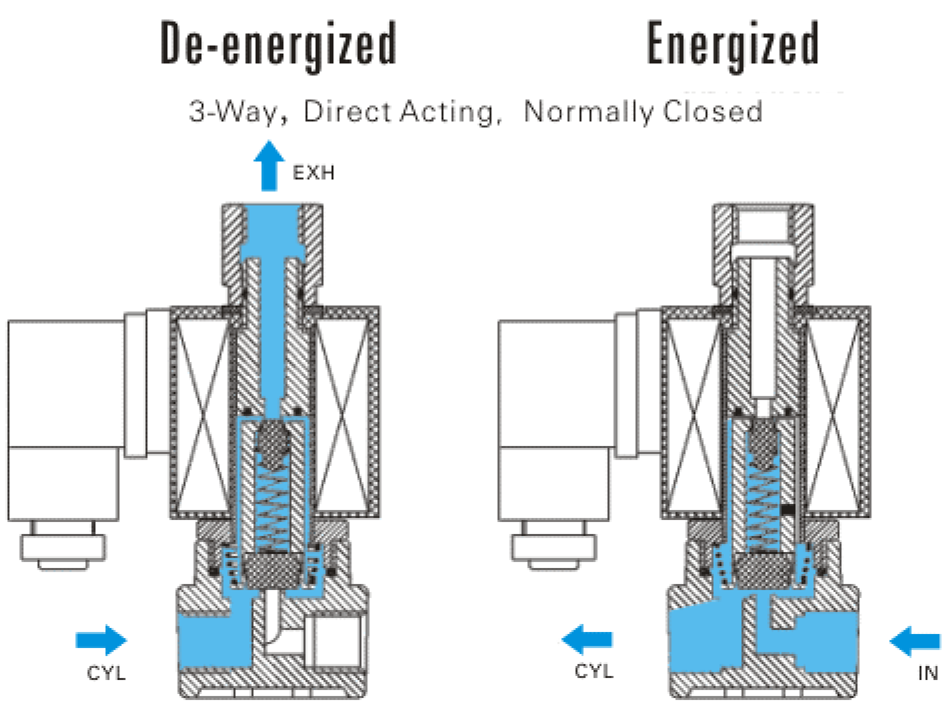
How do solenoid valves work?

- Depends on the purpose (which type of fluid?) and other factors
- Coiled wire on top of valve has electromagnetic field that allows electric current to pass through, which then
- 2 way valves have a normally open and normally closed
    - Normally Closed (NC) when valve is energized: spring (from magnetic force) will allow plunger (which is a barrier) to lift up- this causes the fluid to flow forwards **pulling motion**



- Normally Open (NO) when valve is energized: the electromagnetic field (around the spring and plunger) moves in an opposite direction, which causes the plunger to move downwards- this causes the fluid to be blocked and will no longer move (stops flow) **pushing motion**





Temperature Sensor:

- Thermistor: semiconductor-kind of resistor → resistance depends on temperature
- Will send signal to the solenoid valve when to let water pass through the NC or NO

Control Box vs Arduino

Arduino Mega 2560 pros:

- Can control up to 20 solenoid valves
    - Important because if this method is used in house, don't need separate control boxes for each tap or water outlet- just need arduino
    - Can program different temperatures for each water outlet (ex: temperature of shower water is different from temperature of washing vegetables)
- Multiple solenoid valves controlled with arduino so different water outlets in house all can use

https://forum.arduino.cc/t/advice-on-setting-up-arduino-to-control-20-solenoid-valves/278082

Buy:
https://www.amazon.ca/Project-Complete-Ultimate-TUTORIAL-Mega2560/dp/B01EWNUUUA?th=1

Controls Box:

- For smaller model, control box shows and outlines purpose of arduino because it has same method of sensing temperature and sending signal to valves

Arduino Programming and Temperature Sensor:

Arduino:

- Board controls the temperature and regulates sensor
- Signals

Temp Sensor:

- thermistor from Elegoo kit (10k resistor paired with thermistor)
- Must make waterproof → use epoxy coating (Amazon)
- Has to put into pipe (drill hole and fill gaps)

Apparatus:

1. Circuit Board
- ☐ Thermistor (NTC) → 10k resistor (to decrease voltage in flow of current to prevent overload)
- ☐ NPN S8050 Transistor (amplify thermistor's electrical signal in circuit)
  - ☐ Because signal is too small without transistor
- ☐ 1k resistor for solenoid valve (to decrease voltage in flow of current of the valve's route)
- ☐ Solenoid valve (mini 2 position 3 way DC12V 0.17A Water Air Solenoid Valve)
- ☐ Diode Rectifier MIC IN4007 (allows current flow through only one direction)
  - ☐ Function: prevents RF spikes in circuit (caused by discharge of static electricity in the receiver – RF: radio frequency, spike: sudden surge of electricity that can overheat the circuit)\

2. Pipes
- ☐ ¼ inch ID (inside diameter)
- ☐ Solenoid Valve: ¼ inch OD (outside diameter)

Problems and Solutions

1. Need a valve that opens and closes simply based on temperature

Solution: Solenoid valve? Can attach sensor and thermostat to know when to open and close (for the hot/cold water to be directed either to the outlet or back into the HWT)

2. Similarity to Recirculating System?

Result: No, because hot water is continuously circulated by a special pump - used in big houses, not smaller ones because of the far distance from HWT to the different outlets (like sink) and also, wastes energy because it is always circulating

3. Water pressure

Solution: add a pump in pipes so that the water has force and momentum to move forwards

OR SIMPLER SOLUTION:

- Just use gravity to allow water circulation to go down

4. Is my model cost-friendly? Easy to apply in normal houses?

Yes, better for smaller houses

Methods:

Due to the typical household inconvenience (of wasting cold water while waiting for hot water) that many houses, buildings, and structures face, this project will look deeper into finding a solution that is capable of saving this wasted cold water, easy to install, cost-friendly, and energy-efficient.

First and foremost, the method that is introduced in this study is named *Recycling Water*, as it cycles back cold water that is not utilized, before it is even used, back into the water pipe where it came from. In most buildings, water (whether it is cold or hot) comes from the city's Water Treatment Plant. In Calgary, this would be located in either Glenmore or Bearspaw. Through underground pipes connected the a city's underground main water line to a building's house water main, which is a large pipe that leads into the house. Once this water reaches the house, there are two routes it can take: cold or hot. If it is cold water, it is directly sent into the pipes that connect to a building's faucets, while the process of receiving hot water is more tedious. It must go through the building's hot water tank (or otherwise known as the water heater), which takes a longer time for hot water to be produced than cold water.

A common problem that happens after this step, is that the hot water sitting in these pipes gets cold, after it is not used by a certain faucet for a period of time. The average time it takes for hot water (50 degrees celsius) to turn "cold" is approximately 30 minutes to a couple of hours (according to Newton's Law of Cooling, which describes the rate of heat loss of an object). This shows that when one turns on a faucet, such as a shower, the hot water that was sent through the pipes from the hot water tank, but not used, will cool down rapidly, turning it unusable due to the lack of heat. If a person uses this shower only once a day, then each day, the same process will be repeated and the hot water that turned cold (from sitting in the pipes) will be sent directly down the drain, until the water from the heater tank pushes the cold water out, and the faucet receives the new hot water.

In the new method proposed in this project, the hot water that has turned cold will not simply go down the drain, but instead get *recycled* back into the cold water system. To do this, a model was created, which helps show the different steps of what this procedure would look like.

Instead of this hot-to-cold water even coming out the faucet, it would be stopped by a solenoid valve that has a temperature sensor to feel the hotness or coldness of the desired temperature, to ensure that the unused water will not even come out of the faucet, and alternatively, be sent to a water storage tank, which connects back into the cold water pipes for further usage.

There are many different parts and structures that I will include in my prototype. I will expand on four things: the three-way solenoid valve, temperature sensor, controlling and programming, as well as the main assembly of all the parts.

Firstly, a three-way solenoid valve is a type of device that controls the passage of a fluid through a pipe, that follows a program or is automatic. There are two types of solenoid valves: normally open (NO) and normally closed (NC). A solenoid valve consists of a coiled wire on top of the valve that has an electromagnetic field that allows electric currents to pass through which causes the plunger to move up or down depending on if it is NO or NC. A plunger is a metal stick that acts like a barrier to stop the flow of a fluid. In a normally closed solenoid valve, the plunger blocks the pipe from allowing fluid to pass. Once the electromagnetic field sends a signal to the spring, it forces the plunger to go upwards, causing the barrier to lift, which allows the fluid to pass through the pipe. In a normally open solenoid valve, when it is energized, the electromagnetic field around the spring and plunger moves in the opposite direction of the NC valve, which causes the plunger to push down and block the fluid, which will stop the flow through the pipe.

The three-way solenoid valve is very important in my model because it is programmed to stop or allow the flow of water, based on the hotness or coldness of the water, which is signified by the message sent from the temperature sensor. Since there are three openings to this valve, two of them will be outlets and one will be the inlet. The first outlet will connect to the *water storage tank*, where the cold water is stored then sent back to cold water pipes. This will be the normally open valve, as the hot-turned-to-cold water that is sitting in the pipes will go to. It will be the closest to the valve because this water would have already been there from the previous use of hot water, but had just turned cold. The second outlet will connect to the faucet, where the hot water will directly come out from. This means it will be the normally closed valve because the plunge will only open if the temperature is high enough (the temperature will be determined by the thermistor which I will explain in the next segment). The third valve opening will be neither open or closed, since it is allowing water to pass through and is the inlet. This pipe is connected to the hot water tank.

Secondly, the next apparatus used in this model is the temperature sensor. It is a thermistor. Thermistors are a semiconductor-kind of resistor, which means that its resistance depends on temperature. It is important to use in this experiment because the water will only pass through the NC valve if it meets the desired temperature. For the desired temperature, this thermistor follows a code (using Arduino), and it is set to 30 degrees celsius as that is one of the common warm temperatures that are used in faucets. Once the thermistor sends a signal to the solenoid valve, it will open and close accordingly. If it reaches 30 degrees celsius, then the pipe going to the water storage tank for the cold water closes, and the pipe towards the faucet opens. If it does not reach 30 degrees celsius, then the pipe going to the faucet will not be opened, and the one going to the water storage tank will remain open.

Thirdly, there are many challenges that need to be faced in the programming and coding of the valves and temperature sensor. For this experiment, an Arduino Mega 2560 will be used, as well as the corresponding Arduino IDE (integrated development environment) coding platform. The Cirkit Design website to help visualize which wires would connect to the breadboard, valves, Arduino Mega 2560, thermistor, and such.

Lastly, there is much to assemble for the actual model. Attaching it to a wooden platform, there were many different parts that resembled materials that are used in actual buildings. The hot water tank will be signified by a plastic water bottle or jug at the top (with hopefully a functioning heater). The pipes were at a smaller scale than in real buildings, but still portrayed them very effectively in my model. In addition to the three-way solenoid valve, many more valves were attached to efficiently connect each pipe with the next.

Analysis:

After creating a prototype that represents all the parts of one pipe "chain" to one faucet, it is clear that this method of saving cold water must be implemented into a larger scale building or house with more pipes, and complexity.

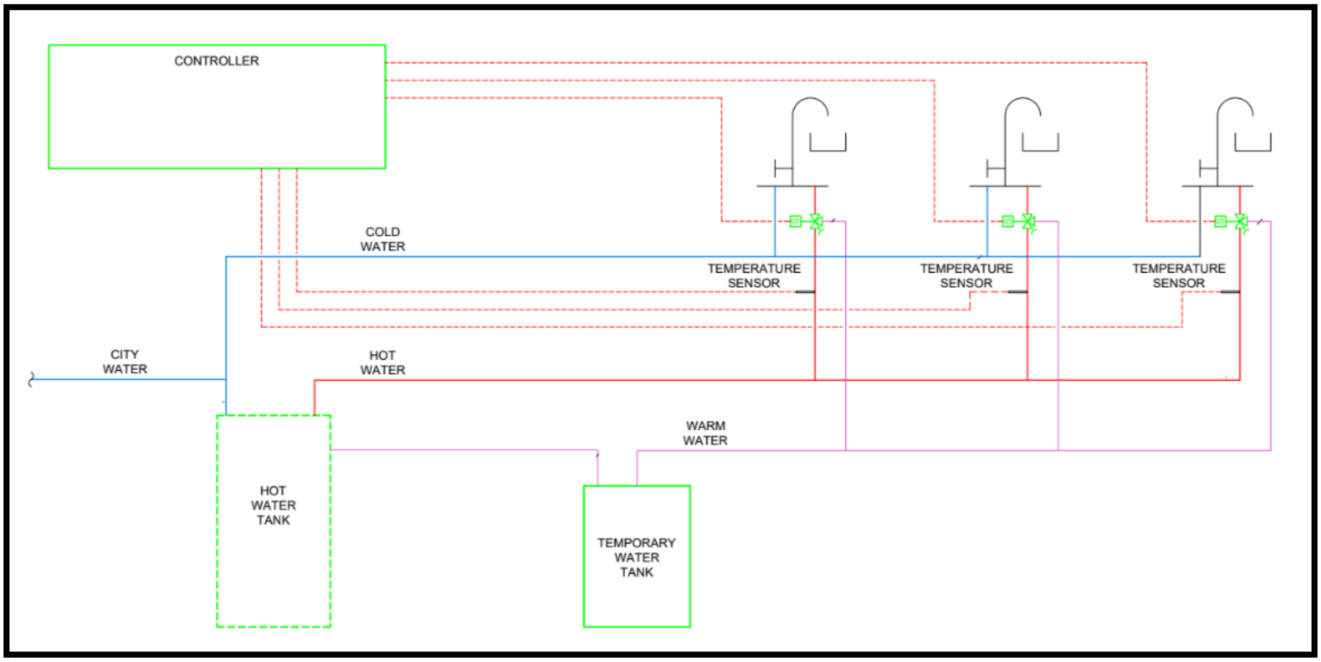


Figure 1. A diagram depicting how this model would be implemented into a real house or building.

After creating a model of what the pipe would look like and how they would function, a diagram was drawn to show how this method of conserving water would be put into a real plumbing system. There are various pipes and parts of the plumbing system that would need to be installed for this conservation and recycling of cold or warm water to really happen.

First, The blue line represents the cold city water incoming from the two main Calgary water sources, usually the Elbow or Bow River. From there, the water can go in two different pipes in the house's plumbing system: hot or cold. If the water is to be cold, then it goes directly to the individual faucets, which is represented by the blue line in Figure 1.

However, if the water is to be hot, the water main from the City of Calgary's pipeline, goes to the hot water tank, where it is heated up and turns hot from cold. During my experiment, the controller and water heater power did not match, thus, an actual water heater tank could not be represented or shown in the model. This is because the controller had an output of 1.2 kilowatts, while the selected heater's power was 2 kilowatts. In order to conduct a safe model, one which would not overpower, the heater's power must have been below 1.2 kilowatts, but there was no suitable one that could be found. To show the incoming hot water in my prototype, I used preheated, hot water instead of a water heater tank.

In the diagram, after the water is turned hot by the hot water tank, the hot water is sent to the individual faucets throughout the house (red line). With the help of a temperature sensor (whose job is to detect the temperature of the water in the pipes), the solenoid valve will receive a signal, knowing when to open and when to close. The three-way solenoid valve's purpose is to direct the water flow based on how hot or cold the water in the pipes is, from the message sent from the sensor. If the water is below a set temperature restriction, then the solenoid valve will act as usual, allowing the cold (or warm) water to flow through the normally open (NO) pipe, to the temporary water tank (to hold and redistribute the unusable water back to the hot water tank).

In my model, a NTC thermistor acted like the temperature sensor, to detect how hot or cold the water was. The only difference in the sensors and signals in my model and the diagram above is the controller. When a more complicated and larger-scale house is built, the small controller that is connected to the thermistor and solenoid valve (dotted red line) will not be able to control all the faucets, thus a larger one (possibly involving a code) must be used.

In addition, the pink line shows the cold or warm water that did not meet the temperature threshold, going back and being recycled back to the hot water tank. To ensure that the hot water tank does not overfill, a temporary water tank helps store the unused water while it waits to get redistributed back into the hot water system. On the other hand, if the water does meet the temperature threshold, the solenoid valve will lift the plunger in the normally closed pipe (NC), which will allow the hot water to flow into the faucet.

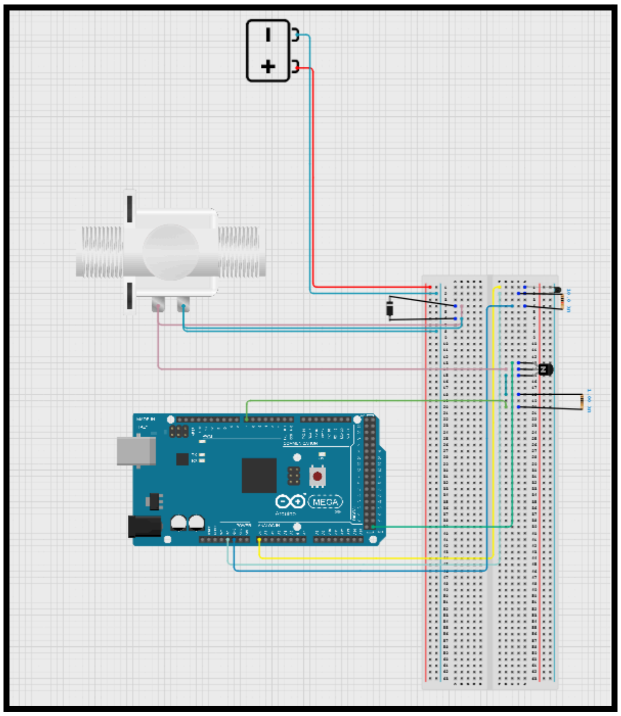


Figure 2. A model of what the original circuit was going to look like, with the Arduino Mega 2560, breadboard, NTC thermistor, and three-way solenoid valve.

Figure 2 depicts the first attempt at the circuit, which ultimately failed. This model was created as a test of what the circuit (using the Arduino code) would look like. It was created on a website, Cirkit Designer, which allowed one to see stimulations of the code and circuit working together. There were many issues with this option (such as matching the code to the wires, figuring out which resistors to use, etc) , however, because of its complex structure and high-ended properties, many days were spent trying to get this model to work, but in the end, the Inkbird ITC-308 was used instead.

Conclusion:

Throughout this experiment, there were many challenges and solutions that had to be faced with when creating the prototype. Unfortunately, the original plan (Plan A) of using an Arduino code and circuit board backfired due to stimulation issues with the code, thus were not able to be utilized. However, this major stepback did not stop my experiment from continuing on.

A solution to counteract this issue was created (Plan B), which involved a simpler design. Unlike Plan A, a circuit and code was not used to control the temperature sensor that activated the three-way solenoid valve's "normally open" (NO) and "normally closed" (NC) outlet pipes. In Plan A, the original idea was to create a code that stimulated the valve to allow water to pass only if it reached a certain temperature threshold (in this case, it was 30 degrees celsius). In Plan B, the Inkbird ITC-308 "Plug and Play Temperature Controller" worked successfully. It is a dual relay output temperature controller, which is usually used in home electric appliances like an oven temperature control. It is able to detect temperatures, with an attached NTC thermistor, and is typically used for heating and cooling, temperature calibration, or raising and lowering heat levels. In the prototype, its thermistor was used to detect the specific temperature at which the solenoid valve would open, while its temperature settings could easily be changed, unlike a complex program or code with an Arduino.

This controller has two temperature displays: one for the set threshold temperature and one for the current temperature of the water. The set threshold temperature represented the temperature at which the solenoid valve's "normally closed" (NC) pipe would open. The NC pipeway is directed to the faucet, while the NO pipeway is directed back to the hot water tank. This means that if the water reached a certain set temperature, the solenoid valve would receive a signal to “unplug” the NC valve, allowing the water (that reached the set, desired temperature) to actively pass through into the faucet. The other temperature display shows the current temperature of the water that is passed through the pipe, where the temperature sensor is.

Another smaller setback was finding the correct sized pipes, as well as a matching solenoid valve. Originally, the plastic pipes that were ordered from Amazon were around three-eighth inches in the inside diameter (ID), however this would prove to be way large for the solenoid valve. Then, I ordered a one-fourth inch on the outside diameter (OD), but this was the wrong size as well because the solenoid valve’s pipes were one-fourth inch OD. This means that only a one-fourth inch ID plastic pipe would fit the solenoid valve body. To prevent problems like this, I should have read the specifications for the materials more in-depth.

Overall, I think this experiment was a success. Spending months on this project enhanced my understanding of how plumbing, pipes, and electrical circuits work. At first, it was a passion project that I wanted to fulfill because wasting cold water is something that happens to everyone on a daily basis. However, the more I got into this project, the more I realized that it was not just about building a prototype: it was about promoting a solution that could help save our planet by wasting less water and decrease the lasting environmental impact that humans have on Earth.

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