Using Radiative Technology to Create a Better Dishwasher

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Dishwashers

- According to eia.gov, 67% of American households own a dishwasher
- Of those 67% households, 80% of them use their dishwashers at least once a week
- In households with large families, dishwashers are invaluable tools, as they are more efficient in energy usage and in time than hand washing
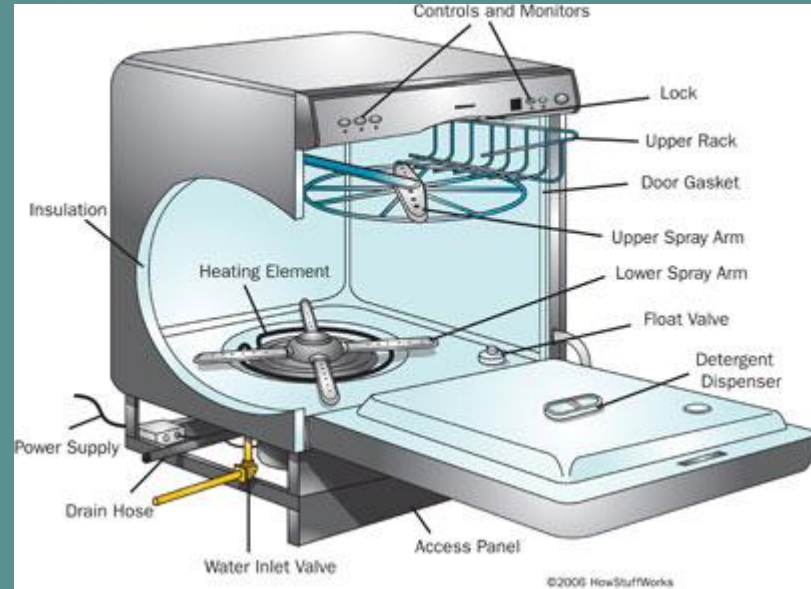

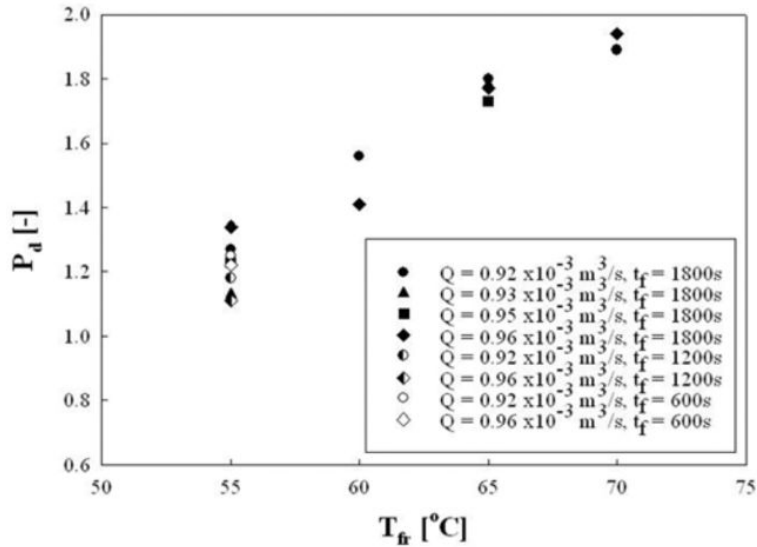*Figure 1:* How a dishwasher works, reprinted from HowStuffWorks, n.d.

The Modern Dishwasher Problems

Figure 2: Picture of Dishwasher, Reprinted from IStock Photos, n.d.

- A dishwasher cycle is currently 2-4 hours long
- People find that dishes aren't completely dry after cycle
- Dishwasher effectiveness is exchanged for energy consumption savings
- Additional rinsing items needed for proper usage

In Depth Analysis of Dryness

Figure 3: Chart of Temperature vs Dryness, Reprinted from "Drying performance of a dishwasher with internal air circulation" (2014)

- In the paper by Seoung Jeoung and Dong Lee (2014), they quantified Dryness from a 0-2 scale(0 being wet and 2 being completely dry)
- They got 1.8 dryness in the average cycle
- Dishwasher uses heat from wash cycle to dry
- When there is no heat (less dirty dishes) the machine consumes more energy

Our Innovation

- We Propose to use an optional Radiative Heat Feature to fix the drying problems
- It will be optional since we know that not everyone is in a rush to do the dishes
- Radiative Heat is the same heat that comes from the sun
- It is proven to be safe in building use
- It drys certain materials faster than any other method

Figure 4: Radiant Panels, Reprinted from "Radiant Panel Linear", Copyright 2020 Price Industries

What Will it Solve?

-   Radiative Technology will get rid of the need for any rinsing materials
-   Shorter cycle times
-   No need to rely on the energy used in the wash process
-   The Dishes will always be completely dry

Types of Radiative Heat

Figure 5: Hydronic Radiant Floor Layout, Reprinted from "How Hydronic HEat Works", n.d.
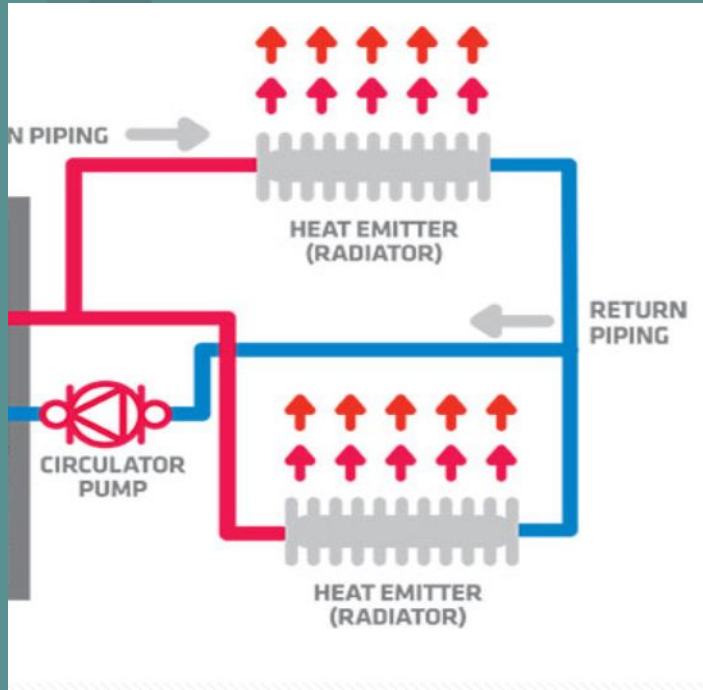
- The first type of Radiative Heat Technology that we are considering is Hydronic Radiant Floors
- This technology relies on using heated water to produce heat
- This is convenient since dishwashers already use water and so it can be reused
- By reusing heat and water we can save a lot of energy
- A layout of the floor is in the picture along with the main components

Radiative Heating Continued

- The second radiative technology we are considering is Radiant Panels
- Radiant Panels create heat by using electricity and hot water
- This technology is currently the best in terms of response time and temperature accuracy
- We want to see if this these technologies are energy efficient and how effective they are

Figure 4: Radiant Panels, Reprinted from "Radiant Panel Linear", Copyright 2020 Price Industries

Technical Description of Product

Figure 1: How a dishwasher works, reprinted from HowStuffWorks, n.d.
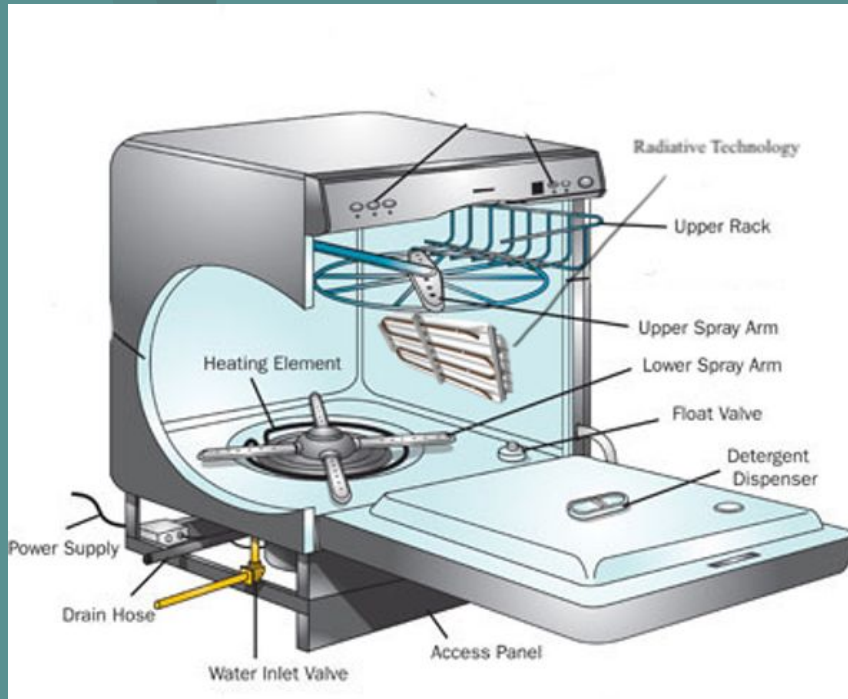
1. **Power Supply** - The power supply is attached with a cord that allows the dishwasher to take electricity.

2. **Drain Hose** – The drain hose drains dirty water from the dishwasher through the tube.

3. **Water Inlet Valve** – It allows fresh water to enter while the cleaning cycle is running, and it controls how much water is used during the process.

4. **Access Panel** – It is a small removable portion of the exterior part of the dishwasher. To open and remove the access panel will have all items that can be interacted with.

5. **Detergent Dispenser** – It helps the dispenser to release the detergent at the right time of the wash cycle.

Technical Description continued

Figure 1: How a dishwasher works, reprinted from HowStuffWorks, n.d.
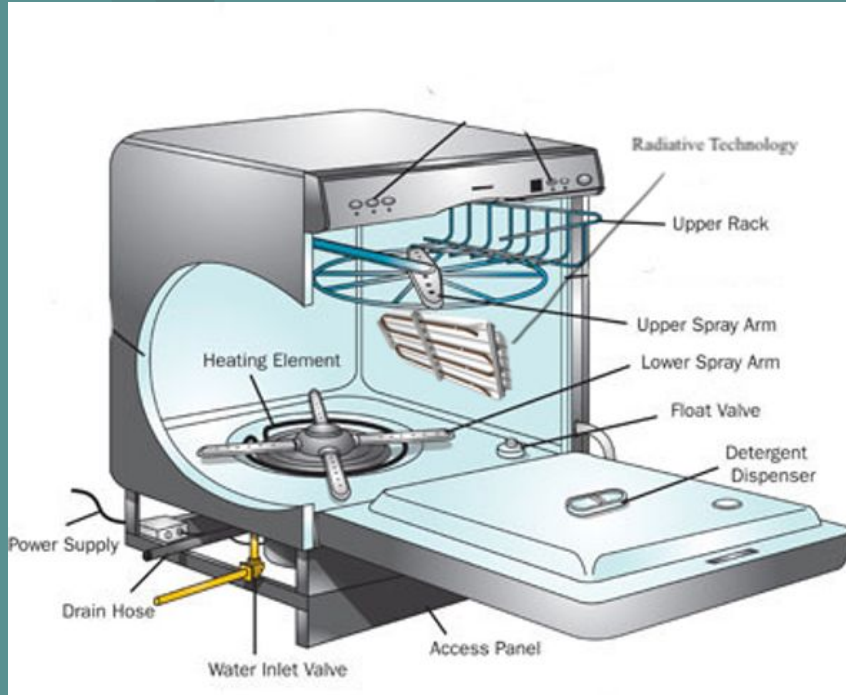
6. **Float Valve** – The float valve has a ball that fits in the cup shape opening. When the water level rises the ball floats which opens the drain hose allowing water to remove to reach a good level.

7. **Upper & Lower Spray Arm** – freely moving component that sprays and cleans dishes

8. **Upper & Lower Rack** – Where all the dishes and other utensils are placed

9. **Heating Element** – This regulates the heat of the water for the cleaning process. It also regulates the heating of air for the drying process.

10. **Radiant Technology-** To finish the design the panels will use radiative heat to ensure that every dish is dry

Project Budget

Item	Costs (Annual)
Equipment	$2,600 - $4,600
Personnel	$191,400 - $374,400
Rent	$46,800
Total	$241,800 - $424,040

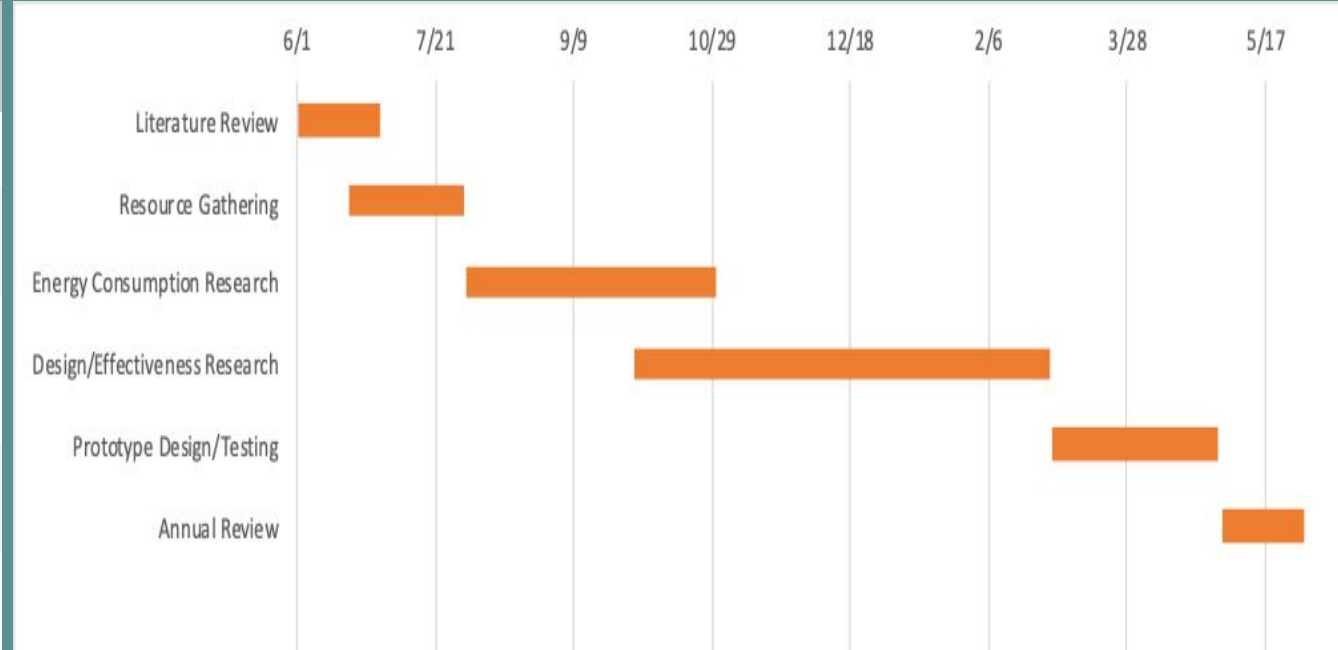Table 1. Project Budget, created by Group Project Members

Project Budget

- Our budget (Table 1) goes over the costs associated with our experiment
- Equipment costs include: 5 Dishwashers, 10 Sq. Ft of radiant heating, and any additional fees
- Personnel costs include: 2 Full time researchers, 2 part time researchers, a statistician, and consultant fees
- Rent costs includes: A monthly rented research lab

Task Schedule

START DATE	END DATE	DESCRIPTION
6/1/20	7/1/20	Literature Review
6/20/20	8/1/20	Resource Gathering
8/1/20	11/1/20	Energy Consumption Research
10/1/20	3/1/21	Design/Effectiveness Research
3/1/21	5/1/21	Prototype Design/Testing
5/1/21	6/1/21	Annual Review

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References

Appliance IQ. (2020). Retrieved from https://www.whirlpool.com/content/whirlpoolv2/en_us/blog.html

Blum, H., & Okwelum, E. (2018). Estimating an economic-efficient frontier for dishwasher consumer choice. Energy Efficiency, 11. Retrieved from https://link.springer.com/article/10.1007/s12053-018-9627-7

Jeong, S. W., & Lee, D. H. (2014). Drying performance of a dishwasher with internal air circulation. Korean Journal of Chemical Engineering, 31. Retrieved from https://link.springer.com/article/10.1007/s11814-014-0194-0

Radiant Heating. (n.d.). Retrieved from https://www.energy.gov/energysaver/home-heating-systems/radiant-heating

Slavin, T. M. (2018, April 20). How Does a Dishwasher Dry? Retrieved from https://www.hunker.com/12145906/how-does-a-dishwasher-dry

U.S. Energy Information Administration. (n.d.). Retrieved from https://www.eia.gov/consumption/residential/data/2015/hc/php/hc3.1.php

Vall, S., Castell, A., & Medrano, M. (2018). Energy Savings Potential of a Novel Radiative Cooling and Solar Thermal Collection Concept in Buildings for Various World Climates. Energy Technol., 6. Retrieved from https://onlinelibrary-wiley-com.ccny-proxy1.libr.ccny.cuny.edu/action/showCitFormats?doi=10.1002/ente.201800164

References continued

Grabianowski, E. (n.d.). [Figure 1] How Dishwashers Work. Retrieved from
https://home.howstuffworks.com/dishwasher.htm

How does Hydronic Heating work? Hydronic Heating Equipment Suppliers. (n.d.). [Figure 5]
Retrieved from https://www.hydroheat.com.au/homeowners/hydronic-heating-works/

Jeong, S. W., & Lee, D. H. (2014) [Figure 3]. Drying performance of a dishwasher with internal air
circulation. Korean Journal of Chemical Engineering, 31. Retrieved from
https://link.springer.com/article/10.1007/s11814-014-0194-0

"Open Dishwasher With Clean Dishes At Home Kitchen Stock Photo." [Figure 2] IStock,
www.istockphoto.com/photos/dishwasher?mediatype=photography&phrase=dishwasher&s
ort=mostpopular.

Radiant Panel Linear – Radiant. (n.d.). [Figure 4] Retrieved from
https://www.priceindustries.com/radiant/products/rpl-radiant-panel-linear?SwitchMarket=I
nternational