MECH 472 HW 1

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Tim Nonet

**A (Scrap Plastic)**

1. Requirements and Specifications:
   1. Plastic must be brought above melting temp but not go above any temperature that would fundamentally change the plastic.
      1. Could be stirred continuously to improve melting time and prevent local heat extremes.
   2. Enough heat load must be supplied to melt the plastic at least 20kg/hr.
   3. Melting plastic often gives off fumes, so a ventilation system must be used (will not discuss in these designs)
   4. A method of moving the molten plastic to an extruder or mold must be used.
2. Given Quantities:
   1. Cylindrical rods of plastic must be created (melted, shaped, and solidified) at a rate of 20kg/hr.
   2. Type of Plastics
      1. Size, Color, Shape, Material, Quality, Contaminations
   3. Temperature of Air
3. Design Variables:
   1. How will the plastic be heated?
      1. Type of Furnace/Oven
   2. How will the plastic be shaped?
      1. Extruder/Mold
   3. How will the plastic be cooled?
      1. Air? Water?
   4. Will the process be continuous or will it need an operator to move large amounts of material between phases of the process?
   5. How long will the rods need to be?
      1. One continuous roll or xft sections?
   6. What is the diameter of a rod?
      1. What tolerances are needed?
4. Constraints/Limitations:
   1. Plastic can’t be heated up too hot or will burn or change chemically
   2. Scrap plastic might be of different material so there must be a check of what can be melted, what can be mixed and what temperatures need to be achieved.
   3. Noxious Fumes might be generated

Design:  
Steps:

1. Melting of Plastic:
   1. Option 1: Operators move plastic into a large crucible and then place into a furnace that then melts the plastic.
      1. Pros: Simple, can easily be sized to the desired rate of melting plastic, can be run of tradition power systems (Gas, Electric), Very well understood technology
      2. Cons: Difficult to insure proper temperature so no burning occurs, limited control on mixing if plastic. Lots of wasted heat, would require significant cooling inside, dangerous?
   2. Options 2: Operators dump plastic into a large “double boiler” type of melting device.
      1. Pros: Great control of temperature, efficient heating, can be run of gas or electric.
      2. Cons: More complicated than a furnace, less conventional than a furnace so might be more expensive.
2. Shaping of Plastic:
   1. Option 1: Extruders:
      1. Pros: Can make variable length rods, easily automated, few moving parts
      2. Cons: Reliant on conditions of plastic (Temperature, consistency), expensive for high quality parts
   2. Option 2: Molds:
      1. Pros: Simple to use, not sensitive to plastic conditions
      2. Cons: Must be sized for each plastic rod length. Requires human operators or complex automation. Requires cooling of molds
3. Cooling of Plastic:
   1. Option 1: Air Cooling:
      1. Pros: Cheap, Easily scalable, easy inspections
      2. Cons: Slower than liquid cooling, requires significant A/C
   2. Option 2: Submerged in Cool Liquid:
      1. Pros: Fast, cheap supplies of cool liquids form mains, requires less building cooling as heat can be removed with the liquid down the drain (assuming plastic does not effect water quality)
      2. Cons: More expensive and more complicated than an air cooling set up. Harder to scale than air cooling.

Final Design:  
Use a furnace to melt plastics, then pour the liquid plastic into molds, once the plastic has solidified enough to be removed from the mold then air cooled until final temperate is achieved.

Sketch:

Modeling Approach:

Reasoning:

I selected this design because it was by far the simplest. There is no need for automation when only 20kg of plastic is needed every hour. Thus the use of molds and a furnace should be able to handle the rate. In addition, the cooling required for the final stage should not require a huge A/C system. In addition, the use of molds allows a greater range of cylinders to be made at a single time instead of using an extruder which would require a complex set up for each extruder head.

**C (Hot water Transport)**

1. Requirements and Specifications:
   1. Water to be transported 200m horizontally and +5m vertically to a storage tank
   2. Maximum Flow rate of 10gals/min
   3. Sufficient insulation must be used to prevent cooling of water
   4. Certain pressure requirements
2. Given Quantities:
   1. T\_f – T\_i <= T\_change
   2. Q <= 10 gals/min
   3. P <= P\_set
   4. T\_amb = T\_amb
3. Design Specifications:
   1. How much insulation should be on the pipe?
   2. What should the diameter of the pipe be?
      1. What should it be made out of?
   3. What type of pump should be used?
   4. Where should the most efficient flow rate be at?
4. Constraints/Limitations:
   1. The pump must be able to operate at high temperatures or be cooled.
   2. The Tank must be insulated as well to prevent cooling of the water.

Design:

Steps:

1. Moving Water:
   1. Pumping through a Pipe:
      1. Pros: very simple, few moving parts, automated, can be highly insulated
      2. Cons: requires installing a pipe and checking for leaks, must be shut down for work/maintenance, lots of surface area for cooling and thus must be highly insulated.
   2. Transporting water via large tank on truck.
      1. Description: Fill large insulated tanks at processing plant. Move tanks with a truck to location.
      2. Pros: Less surface area to lose heat (no long pipe), can change volume flow rate tremendously (changing the number of tanks being moved per day). Maintenance is much easier to detect/preform than a long insulated tube.
      3. Cons: Requires at least one human operator at all times. Reliant on weather conditions. Prone to human error

Final Design:  
Use a dynamic water pump that can run at up to 100 C to pump water through a highly insulated pipe to the storage tank.

Sketch:

Reasoning:  
I selected this design because of the easy of use and level of automation allowed. In addition, if sufficient insolation is placed on the pump and pipes the system would operate nearly identically year round (especially if the pipe was buried underground). In addition, this system could be much more efficient than the truck design and could in theory see close to optimal kinetic energy performance if the proper pump and tubing was used.