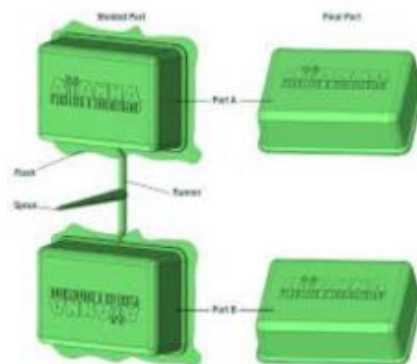


Assessment 2- Part 1  
Due on July 11th, 2020  
at 15:00 hrs.

**Instructions**

You should send the the solution to me by 15:00hrs  
The subject of your e-mail should be: **Your name.A2P1**  
No solutions will be accepted afterwards

1. Your company has been using polypropylene for injection molding and “suddenly” the part you were injecting presented a flash problem. List at least three possible causes and how you could correct the problem. (5pts)



Causes of flashes:

- Mould cast are sliding or do not fit well
- Injection pressure is too high
- Clamping/locking force is not enough

Solutions:

- Lower the injection pressure to reduce the injection speed
- Increase the clamping force
- Redesign the mound parts to prevent sliding

2. There has been an explosion in a residential area affecting a dozen of houses and some people got injured. The explosion occurred due to a gas leak from a high density polyethylene (HDPE) pipe used for residential natural gas distribution. You have been asked to act as a *polymer expert* and the forensic evidence you found was that the pipe has a 10 meters long rupture parallel to the length of the pipe. What could you say to the judge about the probable cause rupture? (5 pts)

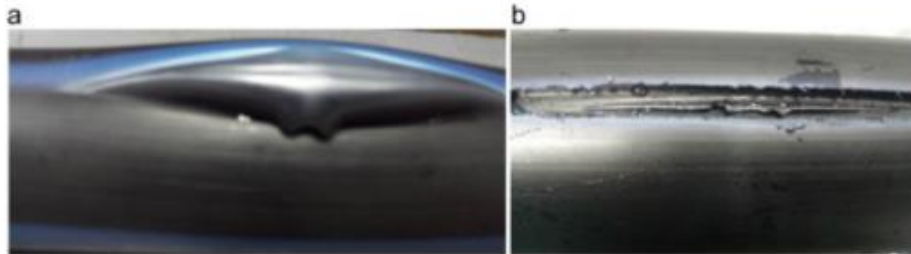
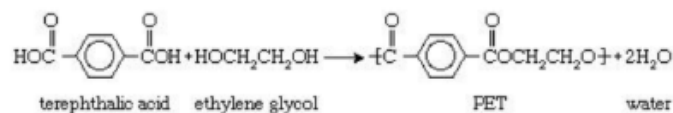


Figure from: HDPE pipes failure analysis and damage modeling. *Engineering Failure Analysis* Volume 71, January 2017, Pages 157-165

The fracture makes sense as the polymer chains are prone to be aligned lengthwise the pipe, and the fracture happens in that direction. It is possible that during the cooling step within the extrusion process is not set correctly, causing undesired crystallization.

3. You started a business for recycling polyethylene terephthalate (PET) coming from drinking water bottles. The company cut the plastic into flakes, wash the plastic in a mild sodium hydroxide solution to get rid of the glue used in the labels. Afterwards they are washed with water, dried and pelletized. However, the MFI of the final resin has increased a lot. What do you think this is happening and how could you prevent it from happening? (5 pts)

*Note: The formula for the PET is the one presented in the right side of the chemical reaction that occurs when PET is produced:*



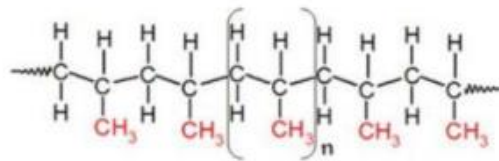
The solution is the implementation of additives to improve the characteristics of the polymer. During processing (repetitive recycling) polymers experience both thermal and mechanical stress. Depending on the structure, bonds break or low molar mass molecules are replaced. For example, the use of stabilizers help to repress undesirable reactions. The purpose is to maintain the desired characteristics of the polymer over a longer time.

4. Your company is injecting a plastic part like the one given below (black marks indicated by the arrows), and you are asked to solve the problem. What would you do? (5 pts)



When injecting polymer into a mould, air needs to escape the mould by small windows (aka. vents). The air escaping process is known as venting. If the air does not escape fast enough, pressure builds up inside the mould. Polymers (aka. hydrocarbons) under pressurized conditions heat up and the "diesel effect" takes place, carbonizing some of the polymer. The result is charcoal-like edges in the final product. The solution would be to redesign/clean the air vent to allow proper air circulation.

5. You have been interviewed by a company producing polypropylene and they are asking you what could happen if they add peroxide while they extruded the polymer to produce pellets that will be sold for the production of fibers. What would be your answer? (5 pts)



Free radical polymerization will take place. Peroxides are organic radical sources. During free radical polymerization, a radical (created from the decay of peroxides) adds to the double carbon to carbon bonds of a monomer, resulting in a new radical extending from the monomer unit. The result would be polymeric pellets with a higher molecular weight.

6. You have a **blown film** business and you use HDPE resins. A vendor wants to become your supplier and ask you to consider his HDPE resin. He claims that the resin he is trying to sell to you has the same MFI and the same shear viscosity curve as the one you are using. The price of the resin is 15% cheaper than the one you are using. Would you buy the resin?

- In order to answer this question you need to justify it from the processing as well as from the rheological point of view
- Yes. In blown film his processes are used to manufacture very thin films. As it is not possible to make the profile of the extruder die as thin as desired without the back pressure becoming too high so that these very thin films cannot be extruded directly, in such a way that the rheological properties of the melt play an important role. As soon as the film leaves the tool it is inflated by pressurized air. Depending on the speed of the extrusion and the pressure of the air flow, the film become thinner. The tubular film is then cooled while maintaining a blown form. The viscosity of the polymer melt dictates the size of the die and therefore the features of the final product, in this case is imperative to ensure the MFI is the same. A sample may be requested for prior testing.

7. The company you are working on decides to switch resins and instead of using a Polypropylene resin they decide to go for a Polyester resin. What type of recommendations, if any, would you give to insure that the product will keep meeting the quality control specifications such as mechanical properties.
8. You have a company that produces a polymer pipe and one of your clients is complaining about the diameter of the product being out of specifications. This customer is very important since 40% of your sells go to that company.
- What would you do to get the product back into specification without compromising the pipe high pressure specifications? Otherwise you could be sued by the final user, if a gas leak explosion, God forbids, occurs.

Ensure that the crosslinking of polymer chains are well form to have better mechanical and thermal properties

9. Order the resins,
- From the highest to the lowest molecular weight and
  - From the highest to the less shear thinning

Resin	Zero Shear Viscosity (Pa.s)	Mw	PDI	shear thinning
A	$1.8 \times 10^5$		2	
B	$2.1 \times 10^6$		4	
C	$3.1 \times 10^4$		14	
D	$8.9 \times 10^3$		6	
E	$2.5 \times 10^4$		8	

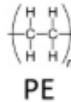
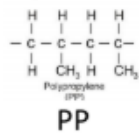
Mw ranking from high to low:

- D
- C
- E
- B
- A

Mw ranking from high to low:

- C
- E
- D
- B
- A

10. If you recycle Polypropylene (PP), Acryl-Butadiene-Styrene (ABS) and Polyethylene(PE)



- what type of problems you might run into,
- how would you solve them?

The mixing of the polymers would yield unexpected properties depending on the quantities of each polymer. The properties can be adjusted with the use of additives.

Additives:

- Stabilizers – prevent undesirable reactions / maintain the polymer desired characteristics over a longer time such as antioxidants.
- Lubricants – help to the reduction of friction between the polymer and the reactor wall
- UV-stabilizers – protect organic materials from the visible and UV light
- Plasticizers – harden the mechanical characteristics of the polymer
- Fillers – aid in the ease of stretching and weight lightening of the polymer material
- Antistatic agents – modifies the polymer surface structure, such as fungicides.
- Fire retardants – reduce the flammability of the material
- Blowing agents – used to transform polymer materials into foam (by the increase in flexibility)