**4.0 Improvement analysis**

There is no doubt that plastic bottles have lots of room for improvement. As mentioned in the previous sections, plastics have huge impact on the environment. They take lots of time to degrade, they are very wasteful, and they require crude oil to produce which by itself is another huge pollutant. However, the biggest incentive of using plastic bottles is that they are much cheaper compared to the alternatives. In the following sections, we will discuss some alternatives to the plastic material. Each of them has its own advantages and disadvantages.

**4.1 Alternative material 1: Glass:**

**4.1.1 Glass bottles production**

**Diagram

Description automatically generated**The first alternative material we are discussing is glass. In terms of post-production environmental impact, glass is much better than plastic. Glass can be made with different components. The most common once are sand mixed with soda ash and limestone. This mixture is then heated to 2770 degrees Fahrenheit over a day then it is cut to cylindrical gobs, each of them is the exact amount required to make one bottle. These gobs are fed to a bottle forming machine. After seconds, it comes out as a paracen, a miniature version of the finished bottle. Another machine then blows compressed air inside the paracens and shapes the final bottle. Bottles then travel through flames cooling then down slowly.

*Figure 4.1.1 Glass bottle manufacturing process*

*(source* <https://www.sgsbottle.com/uploads/20200316/glass-bottle-manufacturing-process.png>)

Diagram, timeline

Description automatically generated At first it seems like glass takes lots of energy to produce. While this is true, glass still takes less energy to produce than plastic. One ton of glass produces 0.822 tons of CO2 while the same quantity of plastic produces 6 tons of CO2.

*Figure 4.1.2 Glass advantages over plastics*

*(source:* <https://uk.saint-gobain-building-glass.com/sites/saint-gobain-building-glass.com/files/inline-images/graphic1_0.PNG>*)*

**4.1.2 Glass recycling**

One of the best advantages of glass as a material, is that it is 100% recyclable, can be recycled endlessly without loss in quality. The glass recycling process simply goes as follows; the glass is first cleaned. Then it is sorted by colour. Finally, the glass is crushed and reduced to very small pieces that are then sent to glass manufacturers to use instead of sand. However, there are still lots of challenges. Today worldwide, more than 28 billion glass bottles end up in the wastelands. This immense quantity of bottles could be recycled to save raw materials and to reduce carbon footprint. In fact, approximately 186 000 tones of CO2 emissions are saved by recycling glass as shown in the following figure.

Diagram

Description automatically generated*Figure 4.1.3 CO2 Emissions saving of recycled glass*

*(source* https://www.britglass.org.uk/sites/default/files/Glass-recycling-life-cycle-carbon-dioxide-emissions-report.pdf)

**4.1.3 Glass disadvantages**

Although glass has lots of advantages in terms of environmental impact and practical use (i.e., does not modify flavor like plastic) it has numerous disadvantages that prevents it from being dominant.

**Cost of production, shipping, and handling**

Obviously, since glass is denser and heavier than plastic, it is more costly to produce and transport. Although the plastic and glass manufacturing process are quite similar, it differs from the amount of energy required to heat and melt the material. Glass melts at around 1500 degrees Celsius while plastic melts at around 170 degrees Celsius. For transportation, the main cost difference is the amount of fuel required to transport glass is greater since it is heavier. Also, the shaking and bumping during the shipping may cause damage to glass bottles and add to the loses of the manufacturers.

Bibliography

How it is made Glass bottles. Youtube . https://www.youtube.com/watch?v=1PBW-MB\_yCw. Published September 15, 2020. Accessed June 16, 2021.

<https://www.sgsbottle.com/uploads/20200316/glass-bottle-manufacturing-process.png>. Accessed June 16, 2021.

<https://uk.saint-gobain-building-glass.com/sites/saint-gobain-building-glass.com/files/inline-images/graphic1_0.PNG>. Accessed June 16, 2021.

Glass Recycling Facts. Glass Recycling Facts - Glass Packaging Institute. https://www.gpi.org/glass-recycling-facts#:~:text=Glass%20Facts-,Glass%20is%20100%25%20recyclable%20and%20can%20be%20recycled%20endlessly%20without,for%20furnace%2Dready%20recycled%20glass.&text=Recycled%20glass%20can%20be%20substituted,to%2095%25%20of%20raw%20materials. Accessed June 16, 2021. Accessed June 16, 2021.

Glass recycling life cycle carbon dioxide emissions report. britglass UK. https://www.britglass.org.uk/sites/default/files/Glass-recycling-life-cycle-carbon-dioxide-emissions-report.pdf. Published November 2003. Accessed June 16, 2021.

Glass Bottles vs Plastic Bottles - Lower Cost Gives Plastic the Advantage: Drug Plastics & Glass. Drug Plastics & Glass Co., Inc. https://www.drugplastics.com/glass-bottles-vs-plastic-bottles-lower-cost-gives-plastic-the-advantage/. Published November 9, 2020. Accessed June 16, 2021.