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An Investigation into Polystyrene Recycling at UBC

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ABSTRACT

Polystyrene waste is a large portion of UBC's daily overall waste. UBC has 350 active hazardous waste generating laboratories that dispose of polystyrene. This practice is not sustainable in the long term due to the fact that polystyrene is not biodegradable and continues to occupy space in landfills. An estimated $25,000 is needed per year to carry out a campus wide recycling program for polystyrene with a local company, Pacific Mobile Depots. After investigating the pilot program that UBC is currently implementing at the Brain Research Centre, it is apparent that carrying polystyrene recycling program with Pacific Mobile Depots is not sustainable. This is because the program is not cost efficient or beneficial for the environment due to the high costs of transportation. A sustainable alternative to the current pilot program is to invest in a polystyrene compactor on campus that can process polystyrene waste into a valuable commodity. At a price of only $35,000 for the compactor, UBC's return on investment (ROI) is less than 2 years in comparison to paying Pacific Mobile Depots $25,000 per their services.

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GLOSSARY

Biodegradable	Capable of decomposing.
Extrusion	When material is pushed through a die to create a shape.
Monomer	A simple chemical molecular entity that can combine with other monomers to form more complex structures.
Molding	Creating something by casting it in a mold.
Polymer	A chemical compound of molecules consisting of repeating simple monomers.
Polystyrene	A lightweight plastic often used for insulation and as a food container.
Sustainability	Using resources in a manner that meets current needs without negatively affecting future generations.

1.0 INTRODUCTION

Styrofoam is a name trademarked by Dow Chemical Company for extruded polystyrene foam (Dow Chemical Company, 2010). Styrofoam is often used as a generic term for all products produced from polystyrene. Polystyrene products are common throughout the world. Retail boxes, food containers, and building insulation are just some of the many types of products that are produced from polystyrene.

Due to the inexpensive manufacturing cost of polystyrene, the demand for its insulating and protective properties is very high. The product is not biodegradable and is currently being recycled poorly throughout the world (American Chemistry Council, 2010). Therefore, there is great interest in recycling technologies to reduce the amount of polystyrene waste in landfills.

Most of the world's polystyrene products are not recycled. Recycling programs for polystyrene are not currently in place on a large scale (Styro-Tech, 2009). However, there are methods available to recycle and reuse polystyrene that are not yet getting major attention from large companies and institutions. UBC is currently testing a limited polystyrene recycling program that is not sustainable on a campus-wide scale (UBC Sustainability, 2010). This report will provide background information on polystyrene, methods of recycling, information on the limited UBC recycling program and why it is not sustainable, and recommendations that UBC should put in place in order to effectively manage polystyrene waste.

2.0 ABOUT POLYSTYRENE

Polystyrene has a chemical composition of carbon and hydrogen $(C_8H_8)_n$. Styrene is the naturally occurring monomer that makes up the polymer, polystyrene (American Chemistry Council, 2010). A chemical composition of polystyrene is illustrated in Figure 1.

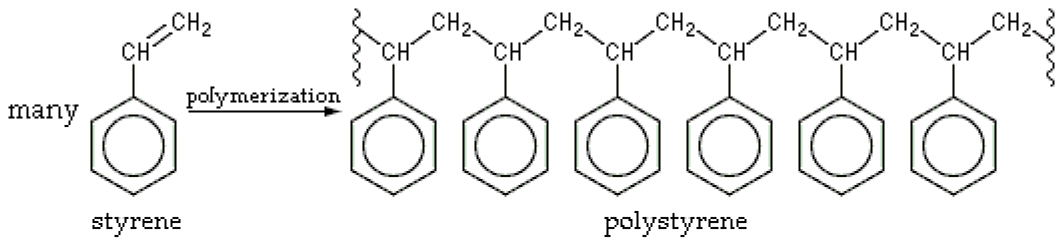

Figure 1: Chemical composition of polystyrene
Source: *Padleckas, H.* 2005.

Polystyrene is an inert chemical. This means that it is very stable and will not start react with other chemicals (American Chemistry Council, 2010). This chemical property makes polystyrene a very desirable material to be used as food containers and other storage containers . There is no fear that the polystyrene container and food items will mix to create a harmful resultant chemical.

There are several ways to manufacture polystyrene products. The most common methods are injection molding, extrusion, and expanding (Styro-Tech, 2009). A chemical property of polystyrene is that it becomes soft when heated. This property makes injection molding very easy. Polystyrene is heated until it is soft and then placed into a mold cavity. The polystyrene cools and hardens into the shape of the mold cavity (Harden Machinery, 2010).

Extrusion is a production method that results in a rigid final product. Rigidity is desirable for products such as toys, cutlery, CD cases, and license plate frames. In extrusion, polystyrene is pushed through a pre-cut shape. The resulting polystyrene that is pushed out conforms to the shape that it was pushed through (Harden Machinery, 2010). The extrusion process is illustrated in Figure 2.

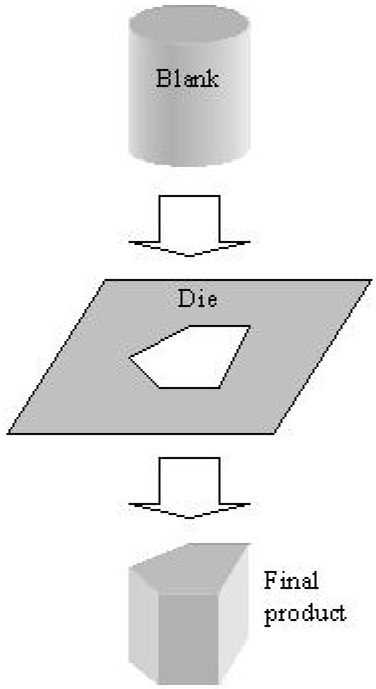

Figure 2: The extrusion process
Source: *Brown*, *Tyler*. 2008.

Expanding polystyrene is another method in which polystyrene products are produced. Small, dense polystyrene beads are placed into a mold cavity. The mold is then placed into an expander where it is heated with steam. The steam causes the polystyrene beads to expand and stick to each other until the mold cavity is entirely filled. The resulting polystyrene product is then cooled and made ready for distribution (American Chemistry Council, 2010).

3.0 ENVIRONMENTAL CONSEQUENCES

Polystyrene has a low scrap value and is difficult to transport. Because of this, most polystyrene is thrown into landfills instead of being recycled. Because polystyrene is not biodegradable, it remains in landfills with no value. This practice is not sustainable as there is limited land available for waste storage

Landfills are designed to take products that do not biodegrade because the process of biodegradation can emit harmful liquid and gaseous by-products. These harmful by-products contaminate soil, ground water, and air (Styro-Tech, 2009). Since polystyrene does not biodegrade, it is not immediately harmful to place it in landfills. The inert characteristics of polystyrene make sure that it does not cause any contamination. However, this method of polystyrene disposal is not sustainable for the following reasons:

1. Polystyrene does not decompose. It will reside in landfills and will continue taking up space. As more polystyrene is created, it will take up even more space.
2. Polystyrene products are very low in density. Polystyrene products are composed mostly of air. This means trucking these materials to landfills is very inefficient because a truck load of polystyrene products may only be 5% in actual polystyrene. This causes pollution and a large carbon foot print from the fuel used in transportation (Wastefree UBC, 2009).
3. Polystyrene is fully recyclable.

Due to these reasons, polystyrene recycling is a more sustainable approach in dealing with polystyrene waste.

4.0 AQUA-PAK

Aqua-Pak is a company that produces expanded polystyrene packaging for protection, insulation, and aesthetics (Aqua-Pak, 2009). Operations at the Surrey, B.C. plant began in 1987 in response to a demand for insulated packaging by the salmon farming industry. Since then, Aqua-Pak has expanded its products into other industries in which expanded polystyrene packaging is needed.

Aqua-Pak's main business is supplying polystyrene packaging for perishable food items such as fish, insulated concrete forms for insulation inside buildings, trays for potted plants, and custom packaging (Aqua-Pak, 2009). Aqua-Pak also plays a part in the recycling process of polystyrene. Aqua-Pak purchases used expanded polystyrene and processes it through a compactor. Aqua-Pak then sells the resulting compressed polystyrene to Timbron and Netco, companies based in California, USA, that use the recycled polystyrene to produce goods (Timbron International, 2010). Timbron produces decorative non-structural household products while Netco produces picture frames. This process in particular is one that draws interest.

Aqua-Pak buys used expanded polystyrene from companies and institutions that have no use for the polystyrene (Aqua-Pak, 2009). The used expanded polystyrene is brought in to the shipping and receiving area in Surrey, B.C. via trucks. This method of transportation is unfavourable as trucks leave a large carbon footprint. However, there is no viable alternative method of transportation for the polystyrene.

Aqua-Pak then feeds the used polystyrene into a polystyrene compactor (Aqua-Pak, 2009). The compactor reduces the polystyrene by a factor of 50. The compactor has two components that work in tandem to produce compacted polystyrene logs (Harden Machinery, 2010). The pre-breaker first breaks the polystyrene into small flakes. The auger compactor then presses the polystyrene flakes into dense logs. These polystyrene logs are then packaged, placed on pallets, and loaded into trucks where they are driven to California. Timbron and Netco purchase the polystyrene logs to produce recycled goods.

Timbron and Netco melt the polystyrene and blend it with other materials (Timbron International, 2010). This mixture is then put through a molding machine to get the desired outcome. The resulting product is painted and packaged for distribution. The process is fairly standard among product manufacturers. The only unique part of the process is that the materials used are a blend of recycled polystyrene and other additives.

5.0 UBC PILOT PROGRAM

UBC generates over 12 tonnes of garbage daily (Wastefree UBC, 2000). Much of that waste is from UBC Food Services. 40% of the waste generated at Food Services consists of disposable containers, such as coffee cups, plates, and boxes. At present, used polystyrene of any kind is thrown in trash along with other waste items. Much wasted polystyrene is being sent to dumps when the potential to recycle is so great. However, initiatives are being taken by UBC Health, Safety and Environment (HSE) to encourage polystyrene recycling (UBC Health, Safety, and Environment, 2009).

The Brain Research Centre, which consists of nine labs at the UBC Hospital, is currently piloting a four-month polystyrene recycling project (UBC Sustainability, 2010). Clean polystyrene boxes and chips/peanuts are placed into separate bags. Trucks from Pacific Mobile Depots then collect these bags from the UBC Hospital loading dock at a charge of $5 per bag. The bags of polystyrene are sent to Aqua-Pak where they compaction process begins.

The polystyrene recycling initiative by the HSE is not feasible on a campus-wide basis. While data has yet to be released, it is apparent that this pilot cannot be scaled and adapted to fit the entire UBC campus. The charge $5 per bag is too costly for the amount of polystyrene that UBC produces. In order to justify the cost, UBC’s polystyrene waste needs to be drastically reduced.

6.0 RECOMMENDATIONS

UBC has the resources needed to implement a polystyrene recycling system on campus. The main component consists of a polystyrene compactor. The cost of owning a polystyrene compactor is approximately 35 thousand dollars (Harden Machinery, 2010). A polystyrene compactor can be purchased from manufacturers in countries around the world, including the US and China.

The machine is simple to control and can be operated by a UBC custodian staff. As illustrated in Table 1, a large polystyrene compactor is 124" x 29.5" x 78.7" in size (Harden Machinery, 2010). This indicates that the polystyrene can be stationed within a small sized room or facility on campus. Furthermore, UBC has plenty of unused land available in which the compactor can reside.

Model	CP100	CP180	CP250	CP370
Total motor power HP	2.2	3.2	7.6	14.8
Styrofoam Volume reduction	40:1	50:1	50:1	50:1
Throughput lb/h	35-55	65-130	175-330	390-700
Feeding capacity f^3/h	70-200	175-530	530-880	880-1200
Feed inlet size inch	16"*10.5"	18.3"*13.2"	26.2"*16.9"	37.8"*23"
Log dimension inch	4.9"*4.9"	7.1"*7.1"	9.8"*9.8"	14.6"*14.6"
Machine weight lb	660	925	1460	3150
Dimensions inch	78.7"*19.7"*66.9"	85.6"*21.7"*70.1"	98.4"*23.6"*72.8"	124"*29.5"*78.7"
Images				

Table 1: Comparison of polystyrene compactors
Source: Harden Machinery, 2010.

Compared to other initiatives UBC is currently pursuing, the cost of owning a polystyrene compactor is insignificant. By comparison, the construction of the future CIRS Building will cost at least $55 million dollars (Energy Evolution, 2007), not including the inherent maintenance costs of the final product. Similarly, UBC spends a significant amount of money on waste management and reduction each year. With a cost of less than one percent of the CIRS Building, a single staff member can operate the polystyrene compactor year round. Therefore, the machine is worth the purchase at least on an experimental basis.

A polystyrene recycling system can be implemented campus wide. The polystyrene waste would first be collected from buildings and facilities around trucked to the compactor. The polystyrene would then be compacted to approximately 2% of its originally size and extruded from the compactor to form dense polystyrene blocks (Harden Machinery, 2010). Afterwards, UBC would then sell the blocks to companies in North America who would utilize the substance to fabricate new products. There are many companies that buy dense polystyrene blocks. UBC could partner with companies that use recycled polystyrene for home insulation, manufacturing of products, fuel, and more.

Operating a polystyrene compactor on campus is more sustainable than having Pacific Mobile Depots collect polystyrene waste from UBC. The pickup process is largely inefficient, costly, and consumes a lot of energy. Transporting a large amount of polystyrene in its expanded form is difficult due to its high volume. If the polystyrene were compressed into 2% of its original volume, Pacific Mobile Depots would be able to transport fifty times more polystyrene per truck than it does currently. UBC estimates that it would spend 25 thousand dollar annually if it were to expand its current pilot polystyrene program to serve the entire campus. At a cost of only 35 thousand dollars, a compactor is the obvious solution to UBC's polystyrene recycling needs.

If UBC were able to conduct the compacting process on campus, the university would be able to effectively promote polystyrene recycling elsewhere in the Lower Mainland. Nearby companies and institutions may implement similar compacting processes. Large department stores and electronics stores, which have a lot of polystyrene as a result of their packaging, could recycle the material using the same method. Furthermore, the city of Vancouver may also take notice of the potential of polystyrene recycling and support a more widespread implementation. Even if the city does not intend to send the resulting compressed material to a company which would reuse it, the reduction in volume would put less pressure on British Columbia's landfills.

6.0 CONCLUSION

Polystyrene continues to be a major problem for the world. Cost effectiveness is the key factor to the excessive use of the product. For this reason it is unlikely to see a reduction in the amount of polystyrene that will be produced in the future. Since the product is not biodegradable, disposing polystyrene waste in landfills is not a sustainable practice, and hence, recycling polystyrene become a needed alternative. There are currently no wide scale polystyrene recycling programs anywhere in the world. By implementing a campus-wide polystyrene recycling program, UBC can promote this practice and show its commitment towards sustainability. Purchasing a polystyrene compactor is the next step in implementing a successful recycling system due to its potential to cut economic and environmental costs while raising UBC's status socially.

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