Printing Substrates: End of Life Options

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Abstract

Printers today have a dizzying array of choices when selecting print media. Further complicating the situation is the pressure for 'environmentally friendly' solutions. Around the planet, people are recovering materials at an increasing rate. Recycling and biodegradability are current catchphrases, but there are additional methods of dealing with the world's waste.

Landfills

Landfills are the 'original' method of disposal. There is evidence that the first recorded landfill sites were in Knossos (the capital of Greece) in 3000 BC. Waste was put into large pits and covered with earth. And in 500 BC, Athens opened a municipal landfill site, and decreed that the waste be at least one mile beyond the city gates.

Landfills are situated where clay deposits and other land features act as natural buffers. The bottom and sides are lined with clay and plastic to keep liquid waste (known as leachate) from escaping to the soil. Drains collect leachate and pump it to the surface for treating. Groundwells monitor water quality and detect contamination. Only a few cells are filled at the same time to minimize wind and rain exposure and a layer of earth is spread over the cells each day, called daily cover. When full, each cell is capped with layer of clay and seeded with grass. Several factors need to be considered when designing a landfill – location, stability of ground, capacity, protection of soil and water, nuisances, hazards management, and costs.

Driving forces for landfills:

- Not all waste can be recycled or burned
- Proper design can prevent hazardous wastes from seeping into underground water supplies
- Landfills are now being designed so organic waste is allowed to biodegrade
- Can be sources of energy via methane gas – either sold or burned to generate steam and electricity

Restraining forces:

- Concern about leachates
- A new landfill may not be inexpensive to build and maintain
- Confusion exists about what landfills can provide for biodegradable materials
- Considered 'wasteful' as end of life options for many materials that could be recycled or incinerated for energy recovery

Incinerators

In 1297 in Britain, a law was passed to require that home owners keep the front of the structure refuse-free, and most was burned in open fires. In 1847, the first 'destructor' was constructed in Nottingham, and over the next 30 years about 250 destructors were built in the UK.

Plastics are a great source of fuel for waste-to-energy plants; their energy value is equivalent to fuel oil. In addition, plastics can help other wastes burn more efficiently. The high combustion temperature makes it possible to use the energy for heating, industrial applications and electricity production. Typically three types of waste are accepted: household, non-hazardous industrial and rejects from sorting centers.

Collection vehicles dump the waste to be incinerated into vast trenches. The waste is pushed gradually into the oven which runs at 750-1000°C. Heat from the waste is used in a boiler and steam is piped to a turbine generator to create electricity. The heaviest ash falls into a collection point and passed over with an electromagnet, and flue gases are scrubbed to treat dioxins. Gases pass through a particulate removal system and are released through the stack.

Driving forces for incinerators:

- Good for treatment of clinical and hazardous wastes where high temperatures destroy pathogens and toxins
- Good for mixed/contaminated plastics and complex materials
- Popular in countries where land is scarce
- Avoids the release of methane

Restraining forces:

- Concern about risk of pollutants
- Filters to rap pollutants must be changed frequently
- Old incinerators may still release dioxins as well as varying levels of heavy metals
- 'Not in my back yard' phenomenon is prevalent

A best practice example of an incinerator is Spittelau in Vienna. Continuous checks and innovations in waste gas purification, setting standards for emissions. On average, all emissions from Spittelau are less than 30% of threshold values.

Recycling

In 2000 BC, during the European Bronze Age, bronze scrap recovery systems were in place. In more recent times, recovered material included leather, feathers, down and textiles. Timber was salvaged and reused, and gold was melted down and recast.

Recycling is the process of recovering scrap and waste plastics and reprocessing them into useful products – also known as down-cycling. Plastics recovery in the US is small, only about 7% of the total plastic waste. Certain plastics and applications have much higher rates, and have grown steadily, such as recycling plastic bottles. Programs such as these get folks used to the idea of recycling, create a good infrastructure and are a good way to expand programs. Collection methods for recycling include curbside pickup, drop-off centers, buy-back programs and refund programs. Many communities are switching to 'single stream' programs. The materials collected are sent to Material Recovery Facilities (MRFs) for sorting – either by manual, mechanical or magnetic methods. Mixed plastics are further sorted by type, via flotation, optical or air jet methods. These sorted plastics are baled and sent to reclaimers. At the reclaiming facilities, the scrap is passed along shaker screens to remove trash and dirt, then washed and ground into flakes. The flakes are dried, melted, filtered and pelletized. The pellets are extruded to make a variety of products such as composite lumber, carpet, containers, etc.

Driving forces for recycling:

- Enables conservation of non-renewable fossil fuels
- Reduces energy consumed
- Reduces amounts of solid waste going to landfill
- Many well established applications exist
- Infrastructure is in place
- Public perception is very positive
- Landfill costs are rising

Restraining forces:

- Collection may be difficult if products are scattered
- Need an end market
- Needs 'clean' stream of materials
- Confusion about which plastics are easiest to recycle or accepted in local facilities
- Sorting of filmic materials may be difficult in certain facilities
- Disposable plastic bags are being banned, although they may be recycled
- 'Effort' to recycle may hinder consistent practice

DuPont™ Tyvek® has been recycled for many years via two programs: Tyvek® envelopes can be sent back to the production plant in Richmond, VA and are down-cycled into composite lumber, fencing, playground equipment, etc. Tyvek® banners are recycled in Malaysia, also down-cycled into similar uses.

Composting and Biodegrading

As far back as 2000BC, composting is known to be part of life in China. Many references in Mesopotamia and Roman/Greek history refer to the use of manure and other organics in agriculture.

There has been fast growth in biodegradable materials; in 2006 the global production capacity for these polymers was 360k tons compared with 20k tons in 1995, and 2008 estimated production capacity is set to reach 600k tons.

Biodegradability is defined as material degraded into small pieces which can be used as 'food sources' by microorganisms and transformed into CO2 , H2O, energy and neutral residue. This can occur in many environments: soil, composting facilities, water treatment plants and marine locations. Not all biodegradable materials biodegrade under all conditions. There is a two step process for biodegrading: (1) The long polymer chains cut at the carbon-carbon chain, requiring heat, moisture or enzymes. Degradation is when the plastic weakens and fragments. (2) The shorter carbon chains pass through the cell walls of the microbes and are used as an energy source.

To be considered compostable, materials must disintegrate rapidly, must biodegrade quickly during composting, must not reduce the value or utility of the final product and must not contain high amounts of regulated materials. Although facilities exist for composting, they are primarily designed for organic materials such as yard wastes, rather than printing or packaging products. Organic waste is fed to a conveyor belt, which takes it through a sorting room where non-organics are removed. Rotating mixers pulverize the material and mix the organic wastes. Organic materials are loaded into channels and water and solid waste are added to 'promote' decomposition. After a month of decomposing, the material is filtered and sold as mulch.

Driving forces for biodegradability:

- Enables conservation of non-renewable fossil fuels
- Public perception is very positive
- Landfill costs are rising
- Faster degradation of litter
- Plastics manufacturers aim to develop large-scale markets for compostable plastics

Restraining forces:

- Can interfere with recycling of plastics – sorting difficulties
- Confusion about definitions
- Many require much higher temperatures to degrade than available in home composting
- Commercial facilities not widespread
- Littering could increase
- Chemistry strongly influences the degradability
- Landfills aren't necessarily designed for composting

Many examples of compostable materials are in the market, comprised of wood pulp, cellulosic, corn starch, PLA, polyethylene, co-polyester, thermoplastic starch and starch with biodegradable polymers.

Reduce/Reuse

Rag and bone men date back to 1588, when Elizabeth I granted special privileges for rag collection for paper. Other reuse activities included bones for glue, scrap iron, and clothes for re-sale.

The wise use of plastics can reduce packaging in several ways. Plastics jars use up to 90% less material by weight than glass. Shrink labels can eliminate the need for some parts of packaging. Two liter bottles and milk jugs weigh less than 1/3 what they did in the 70s. The durability of plastic makes it ideal for reuse, such as storage bins, sealable containers and shopping bags. Plastic pallets are impervious to moisture and many chemicals, so can be used over and over.

Driving forces for reduce/reuse:

- Consumers are aware of waste
- Lighter weights can mean lower freight costs
- Landfills are filling up or being eliminated
- Recycling and composting may be too complicated or even difficult

- Governments and companies are requiring reuse (such as banning shopping bags)
- ‘Using less’ perceived as most economical

Restraining forces:

- Packaging or materials often not perceived as strong or protective enough
- Products may need special packaging for shelf life or shipping considerations
- Products made from recycled materials sometimes viewed as too expensive and/or inferior

Conclusion

A blend of recovery and end of life options creates efficient waste management. No single country or region has all the solutions, so sharing ideas is critical. The overall life cycle impact should be taken into account, and the long term/big picture situation considered. The environmental impact of the product should be understood throughout the life cycle. Success of any program can be measured via economic prosperity, environmental stewardship and good corporate citizenship. Aligning with suppliers and partners equally committed to sustainability is important, and reasonable targets should be selected to show commitment. Product and package designs that encourage sustainability should be chosen whenever possible. ‘Green-washing’ should be avoided at all costs and appropriate and truthful language should always be used. Consumers are becoming more aware of their role, so providing clear information about to be more resource efficient is critical. Sustainable goals are about the future of the planet – the one we live on today and the better, safer, healthier planet we aspire to leave for tomorrow.

Biography

Carolyn Burns is Global Marketing Manager of DuPont Graphics, in the Nonwovens business unit. She has responsibility for various nonwoven materials such as Tyvek®, for use in printed applications including tags and labels, maps and wide format media. She has been active in numerous trade associations throughout her career, and served on the Board of Directors of the Tag and Label Manufacturers Institute. Carolyn has a BS in Chemical Engineering from the University of Virginia.