

A Brief Overview of Plastic Sorting Technology

Presented by:

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Sorting History

Sorting has changed overtime with PET and HDPE

- Original CSD Plastic bottles - Base cup bottles had HDPE base, metal caps, PVC cap liners, paper label, and glue.
- Now the PET bottles have PP caps, plastic labels, and minimal glue.



Sorting History

The technology and companies continues to change as the materials change and new innovations arise.

- The sorting technologies first started in other industries (coffee beans, potato chips, rice etc.)
- In plastic recycling sorting technology started with bottles
- Shortly followed by flake sorters



Sorting Wavelengths

The diagram shows the electromagnetic spectrum with wavelength (λ) in metres on the top axis (10⁴ to 10⁻¹⁴) and frequency (ν) in hertz on the bottom axis (10⁴ to 10²²). A rainbow bar represents the visible light spectrum, which is highlighted with a red box. Other regions shown include Radio waves, Radar, Microwaves, Infrared, Ultraviolet, X-rays, and Gamma rays.

1. Visible Light
2. Near Infrared (NIR)
3. X-Ray

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1. Visible Light

The diagram shows the electromagnetic spectrum with wavelength (λ) in metres on the top axis (10⁴ to 10⁻¹⁴) and frequency (ν) in hertz on the bottom axis (10⁴ to 10²²). A rainbow bar represents the visible light spectrum, which is highlighted with a red box.

Optical Sorting visually sorting a bottle or flake through Photodetector (light sensors), Camera, or the Human eye.

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1. Visible Light Sorting Use

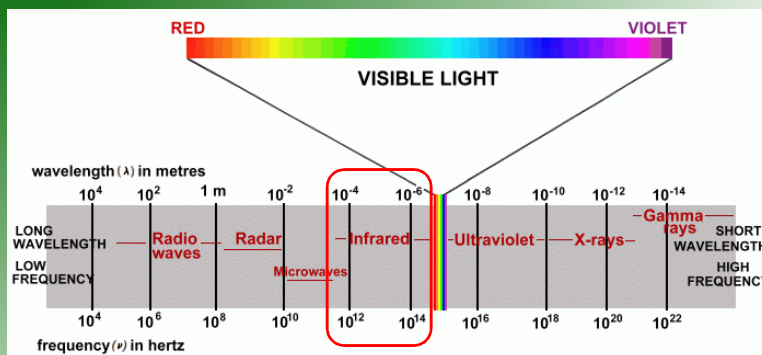
- Visible sorting is technology that can do what the human eye can do – can visually sort material. It is used to separate colored polymers or labels. There are different types of visible technology.
- It can not be used to separate plastic by resin type unless the material is visually changed (for example - a colorant is added).
- Can be used with both bottles and flake.

Example:

- Separating clear PET from, green, blue, amber etc.
- Separating natural HDPE from colored HDPE etc.



2. Infrared Light



Near Infrared (NIR) imaging, like visual imaging, is the collection, recording, and displaying of light from a scene. However, 'infrared' refers to light with longer wavelengths than that of visual light. Infrared imaging is also referred to as thermal imaging; these terms are taken to be identical. Infrared imaging shows the thermal patterns emitted from, or reflected off of a target, and as such, it does not require visual light.



2. Near Infrared Sorting Use

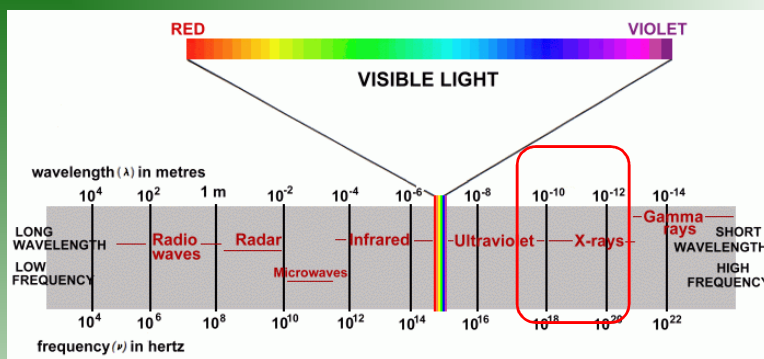
- **NIR** is looking at the wavelength for different material chemistries and consequently can be used to separate plastics by resin type.
- It is used extensively in MRFs to separate HDPE and PET containers but can't "see" glass or metal because those material's molecular structure doesn't "vibrate".
- If shrink label covers majority of bottle surface, it will sort by label resin type rather than by container resin type.
- "Markers" in resin can be differentiated by NIR

Example:

- Could be used to separate #1-7 plastics but currently may be considered cost prohibitive.
- Can differentiate PET, PVC, PS and others.



3. X-Ray



X-ray X-radiation (composed of X-rays) is a form of electromagnetic radiation. X-rays have a wavelength in the range of 0.01 to 10 nanometers, corresponding to frequencies in the range 30 petahertz to 30 exahertz (3×10^{16} Hz to 3×10^{19} Hz) and energies in the range 120 eV to 120 keV. They are shorter in wavelength than UV rays and longer than gamma rays.




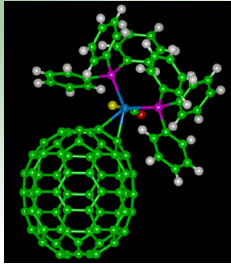
3. X-Ray Sorting Use


- X-Ray is used for sorting when looking at specific atoms. This technology use is currently beginning to be reduced.
- Has been very useful for extremely dirty bottles or container with a lot of label since infrared would be “confused” by dirt/labels and not sort properly by resin type.

Examples

- Originally starting with sorting PVC – Chlorine group










Separating HDPE from PP

Using *infrared light sorting technology* to Separate 2(HDPE) from 5(PP)

- Bottle sorting has been stated to have greatest efficiency.
- Efficiency of separation is determined by
 - Material supply being consistent and specific to the sorting system design
 - Size of incoming material
- Cost of sorting system is dependent of efficiency of sort
 - *Greater efficiency = higher costs because more equipment is needed*















Separating HDPE from PP

Using *infrared light sorting technology* to Separate
2(HDPE) from 5(PP)




- APR Grocery Store Project parts may be large for a bottle type sorter to separate (air compressed) into specific categories. To sort natural and colored vs. HDPE and PP will require more than one pass, at minimum.
- Generally PE /PP detergent bottles have fixed spouts that will likely be sorted to the HDPE pile as the majority of the container is HDPE. This container will need to be ground before further sorting.
- It has been said that the LDPE and HDPE has the potential to be separated from one another as the wavelength have large or small peaks. This is something that sorting technology has not stated but NIR specialist state it is possible.



















Separating HDPE from PP

- **Number of NIR machines needed on average:**


- The material will potentially need to be broken down to 1-2 gallon size objects.
- Multiple passes for Natural HDPE and PP
- Multiple passes for Colored HDPE and PP

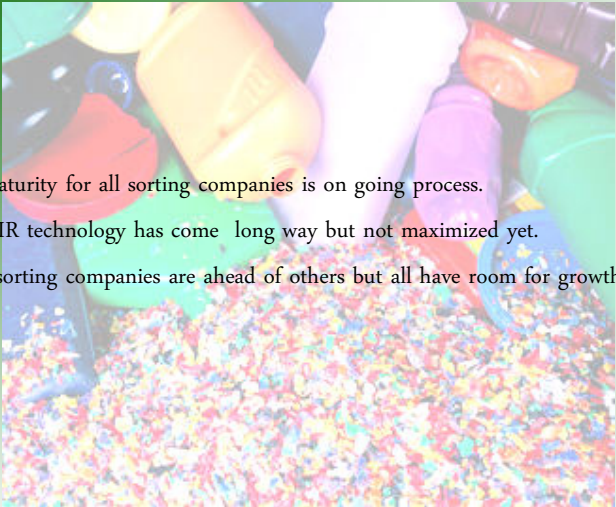











Separating HDPE from PP

- **Maturity**
 - The maturity for all sorting companies is on going process.
 - The NIR technology has come long way but not maximized yet.
 - Some sorting companies are ahead of others but all have room for growth.










Separating HDPE from PP

- **Cost**
 - Cost for sorting equipment has a large range
 - Bottles – visible sorting = \$100,000, NIR = \$250,000, Combined = \$3-400,000
 - The cost is depending on technology/Wavelength range
 - Sorting HDPE and PP will require visible and NIR technology
 - Total cost is not just the Capital cost of the equipment it is also the...
 - Number of machines (capital x?)
 - Maintenance/operating cost
 - Yield loss







Separating 1-7

- Potential to Separate 1-7



- 20-25 companies claim they can sort 1-7 bales.
- 10-12 have demonstrated both flake and bottle sorters.
- The issue still lies with number of sorters and repeat passes to get the efficiency and minimum yield loss.
- Apply same concepts reviewed previously during HDPE and PP sorting to this issue.



Discussions...

Questions...

