Manual Sorting Systems

Issue: *To meet the quality standards represented in these Best Practice specifications for PET bales and PET regrind, sorting systems should be installed that are designed to remove contaminants to the PET recycling process.*

Best Practices: The overriding best practice in manual sorting systems used at plastics intermediate processing facilities is adequate training of plant personnel in the identifying characteristics that will visually distinguish PET plastic bottles from plastic bottles of different resin types, and in distinguishing acceptable PET items from unacceptable PET items for recycling. This discussion will assume that the PET processor is accepting baled PET bottles and containers and sorting them to produce high quality PET regrind. Properly trained inspection personnel can become quite proficient in producing high quality PET regrind with little or no unacceptable contamination.

Throughout the PET plastic recycling industry, positive manual sort systems are considered to produce the highest quality PET regrind. However, the quality and production capacity of manual sort granulating operations are dependent upon a number of factors including the quality and level of commingling of incoming plastic bottles and containers, how consistently material is fed to the sorting line, and matching belt speeds with material quality.

The quality of the feed stream to sorting lines is a function of proper debaling. Whether done manually or with debaling equipment, debaling should accomplish bottle singulation to the greatest extent possible (minimum bottles sticking together), while providing a consistent and uniform flow of materials to line inspectors at the operating belt speed.

Due to the differing nature of bales from various suppliers, manual sort systems should be equipped with variable speed conveyor belts. In this way, the speed of the belt can be matched to the quality of material passing over the line. Higher quality incoming bales can usually be sorted more quickly than lesser quality bales. Belt speeds used by intermediate processors vary widely based on incoming feedstocks and system design and can range anywhere from 30 feet/minute up to 120 feet/minute. However, the best practice in determining belt speed is to match belt speed with material quality and the ability of line inspectors to achieve an effective sort.

Regardless of where line operators feed PET bottles after they have been positively picked from the sorting line (i.e. directly into the throat entrance of a grinder, or to another conveyor that feeds a grinder), best practice is that the feed entrance be located in front of the operator, so that their feed motion is in the forward direction. This will

reduce ergonomic hazards than can occur from excessive twisting motions and reduce worker fatigue.

There are two best practices in manual sort system design and configuration, provided they are within budget. The first is a multi-level conveyor system design that provides a return loop. In this way, unsorted PET bottles and containers that reach the end of the sorting conveyor drop down to a return conveyor and are returned to the feed hopper to start the sorting cycle over. This system design can greatly decrease processing waste.

Similarly, proper placement of grinders relative to multi-level conveyor configurations allows flexibility to adapt from positive sort feeds to negative sort feeds based on the quality of incoming materials. This is generally accomplished by an interchangeable discharge at the end of the sorting conveyor than can discharge to a return conveyor in a positive sort mode, or directly into a grinder in a negative sort mode. Also, as previously mentioned, a secondary sort for PVC, just prior to granulator infeed should be conducted either manually or automatically.

Manual sorting systems. Manual sorting systems use trained inspectors to visually identify and sort PET bottles and containers into designated categories from a stream of plastic bottles passing over a conveyor. Manual sorting systems are generally one of two types -- positive or negative sort systems. In a positive sort system, PET bottles and containers are removed from a stream of plastic containers being carried over a conveyor system. In a negative sort system, PET bottles and containers are left on the conveyor system and unwanted materials or contaminants are removed from the conveyor line.

When PET bottles and containers are removed in a positive, manual sort, they are either fed directly into a granulator or onto a second conveyor system that feeds into a granulator. The advantage of a system where line inspectors feed a second conveyor is that the second conveyor can be designed to incorporate an automated sorting system as a final check for PVC prior to feeding the granulator.

Throughout the plastics recycling industry, positive sort systems are considered best in generating the highest quality materials. However, they may not always result in the most efficient system as positive sorts are generally more time consuming than negative

sorts. The sorting capacity of plant personnel working on manual sorting lines is a function of the quality of incoming materials, system design and belt speed.

Negative manual sort systems are generally considered to have a potential for greater levels of contamination as many negative sort systems are configured to discharge materials left on the conveyor belt directly into a baler or grinder. If the removal of unwanted materials is not complete, these unwanted materials will enter the next stage of processing and possibly yield contaminated material. However, negative sort systems work well if materials have been "pre-sorted" into specific categories. (Negative sort systems also work well for baling operations). For example, it is easier to pick out contaminants from a stream of predominantly PET soda bottles, rather than to pick out the soda bottles. Some negative sort systems are designed to have inspectors sort from both sides of a conveyor that feeds directly to a baler or grinder to increase material throughput.

Ultimately the choice between positive and negative sort system designs will depend on program budget and the supply characteristics of incoming materials. For example, mixed plastic bottles, whether loose or in bales, are best sorted with a positive sort system, whereas resin segregated plastic bottles may lend themselves towards a negative sort system.

Studies of commercial, manual, visual sortation systems conducted by Plastic Technologies, Inc. (PTI), of Toledo, Ohio, indicate that trained inspectors are capable of sorting 500 to 600 pounds of PET per hour and are more than 80% effective at identifying and removing PVC from the line. However, sorting capability is always a function of the density of plastic bottles feeding the line, belt speed, and the number of plastic bottle types mixed in the stream.

It is often difficult to visually distinguish PVC bottles from PET bottles without individually inspecting a bottle for a characteristic molding mark or looking for crease marks that occur on PVC bottles when pinched. This is particularly true when a large number of bottles are passing over a conveyor surface and such individual bottle inspection is not cost effective. The efficiency of visual, manual sorting systems in removing PVC from PET can be improved through the use of ultraviolet (UV) light. While ultraviolet light is not visible to the human eye, certain materials, because of their unique chemical structure, emit visible light (fluorescence) when exposed to ultraviolet light which can then be detected by the human eye.

PET is fluorescent and appears blue when exposed to UV light. The chemical structure of PVC does not cause fluorescence, but many of the additives used in the manufacture of PVC bottles do. These additives will cause PVC bottles and containers to appear yellow or green when exposed to UV light. By designing systems that expose bottles passing over a conveyor to ultraviolet lights, removal efficiencies for PVC by trained personnel can increase to as much as 99% under the proper conditions, according to PTI. Because of the concentration required by this kind of identification procedure, it is recommended that line inspectors work no more than two hours at a time.

However, there are limits to the effectiveness of sortation with UV light. "Pre-sorting" is necessary prior to UV sorting of PVC from PET. For example, green PET bottles must be sorted out, as green PET bottles will remain green when exposed to UV light and can be confused with PVC. Because UV light can degrade certain plastics over time, many PVC and PET containers are manufactured with additives to absorb the UV portion of natural sunlight to protect the products contained in them. These containers will appear dark under UV light and are difficult to detect. Some blue tinted PVC bottles can fluoresce blue under UV light and be confused with PET bottles, adding to its limitations. Finally, some forms of UV light have been linked to the formation of cataracts and skin cancer. Although the type of UV light used in sort systems is considered safe, systems should be designed with shields and viewing windows that filter out UV light to prevent worker exposure and avoid any possible exposure risks.