lyondellbasell
Advancing Possible

Handling and Storage of LyondellBasell Polymers

Table of Contents

Introduction 3
- Handling and Storage of LyondellBasell Polymers 4
- Operation Clean Sweep 4

How LyondellBasell Products Get to Customers 5

Transfer and Storage Systems 5
- Piping Design 7
  - Layout and Length 7
  - Pipe Interior 8
- Transfer System Air 9
  - A Pressurized-Air, Dilute-Phase System 9
  - A Vacuum, Dilute-Phase System 10
- The Silo 11
  - Funnel or Mass Flow Design 11
  - Measuring the Resin in the Silo 12

Handling a Delivery of Pellets or Powder 13
- Recommended Safety Points Before Opening Hatches 13
- Static Electricity 13
- Preparing the Hopper Car for Unloading 14
- Unloading the Hopper Car 14
  - Hoses 14
  - Venting 16
  - Plant Transfer System 16
  - After Unloading Each Compartment 16
  - After the Car is Completely Unloaded 17
  - Unloading Checklist 18
- Differences Between Hopper Truck and Hopper Car Unloading 19
- Gaylord Box Handling 19
- 50-lb. Bag Handling 20

Special Handling for LyondellBasell Performance Polymers 20
- Ethylene Copolymers 20
- Wire and Cable Resins and Compounds 20
- Polyolefin Powders 21

Quality Assurance 21
- Meeting the Goals of Operation Clean Sweep 22

Appendix 1: Pellet Conveying Troubleshooting Guide 24

Appendix 2: Safety and Handling Information for Microthene F Microfine Polyolefin Powders 27

Appendix 3: Trade Names for Products of LyondellBasell Chemicals, LP 28

INTRODUCTION

The movement of polymer pellets is a necessary part of our production, shipment and the customers' handling of these products before processing. At our customers' facilitiy a smooth transfer of resin from delivery vehicle to silo starts with the design of the transfer system itself and ends with proper procedures for daily operations. To assist customers with the safe and proper handling and storage of our polyolefin products, this manual provides recommendations for:

- Piping design
- Transfer system air
- The silo
- Safety points
- Unloading hopper cars, hopper trucks and handling Gaylord boxes and 50-pound bags
- Special handling required for performance products
- A troubleshooting guide

Following these suggested policies and procedures can minimize the contamination associated with pellet movement that might cause difficulties in production.

When pellets are transferred at high velocities through a piping system, the heat generated from the friction between the pellets and the pipe surface causes the pellets to warm to their softening point. At this temperature, part of the pellet softens and smears on the interior walls of the piping where it almost instantly solidifies again, forming a skin along the pipe surface. Further transfers of polymer cause this skin to peel off, resulting in strands of polymer of varying lengths mixed with the pellets. These strands, commonly referred to as "streamers," "angel hair" or "snakeskin," can plug the filters of the conveying system. As different grades of material pass through the system, the streamers may have different physical properties. These streamers, if they make their way to the processing operation, can contaminate the feed material and stop production.

"Fines" are created from the abrasion that occurs as the pellets come in contact with the surfaces of the piping system. When the pellets bounce against the surface of the pipe, very small pieces can break off the surface of the pellets. These tiny pieces of polymer act like dust and can plug the filters in a vacuum-driven piping system. In sufficient quantity, fines can also interrupt production.

HANDLING AND STORAGE OF LYONDELLBASELL POLYMERS

In this manual, we interchangeably refer to LyondellBasell polyolefin products (polyethylene, polypropylene, and ethylene vinyl acetate copolymers) as polyolefins, pellets (because that is their shape) and resin. LyondellBasell performance products addressed in this manual include resins and compounds for wire and cable extrusion; polyolefin powders for rotational molding and compounding, bulk and sheet molding compounds and specialty applications; and ethylene vinyl acetate copolymers for adhesives, sealants and coatings.

LyondellBasell polymer products are shipped directly to customers in rail hopper cars and/or hopper trucks from production facilities or shipped to regional distribution centers, where the products are then loaded onto trucks or into boxes and bags. All the distribution and handling of our products before shipment are through enclosed systems. This process minimizes the possibility that the product loaded has any contamination, such as dust, leaves, water, trash, dirt, gravel and other material that can enter a system if it is exposed to air and inclement weather (Figure 1).

When those hopper cars, hopper trucks, loads of boxes or bags of polyolefin resin arrive at your plant, you are dealing with a large, expensive "package" full of small, polyolefin pellets or powder that must be moved from one place to another as quickly as possible. When the transfer goes as it should, the resin gets to its silo or storage area without hang-ups, blocking, bridging or plugging. The empty hopper car gets returned to the railroad agent undamaged or the hopper truck goes on to its destination. Any spilled pellets get collected in catch pans and disposed of and production of your product continues abated.

Figure 1. Loading a polyolefin product into a hopper car.

Operation Clean Sweep

LyonndellBasell supports and encourages its customers to support Operation Clean Sweep, a program aimed at preventing the release of plastic pellets from manufacturing facilities into the environment. More information on Operation Clean Sween can be found at www.opcleansweep.org.

The U.S. EPA's Storm Water Regulations classify resin pellets as "significant materials," making the exposure of even a single pellet in storm water run-off without a permit subject to regulatory action. Birds, fish and other wildlife can be injured or killed as a result of ingesting plastic pellets. **On pages 2 3-24 of this manual is a list of specific steps to prevent resin release into the environment.**

HOW LYONDELLBASELL PRODUCTS GET TO CUSTOMERS

By far, the largest volume of LyondellBasell products are shipped to customers by rail in hopper cars, which typically carry 185,000 pounds of polyethylene. Hopper cars are usually divided into four compartments (Figure 2). In a standard, four-compartment car, the compartments are labeled "B" for brake-end compartment, "A" for the opposite end compartment, and 'BC" and "AC" respectively for the two center compartments.

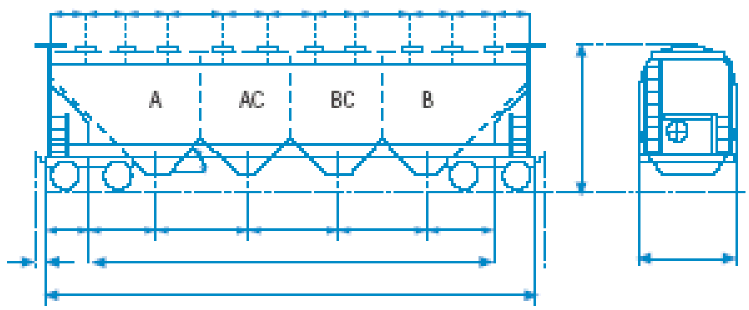


Figure 2. A typical hopper car is divided into four compartments.

A hopper truck transports 45,000 pounds of polymer on average. LyondellBasell also ships products in 1,000- and 1,500-pound Gaylord boxes and 50-pound polyethylene or woven polypropylene bags. A trailer load of these packages totals 42,000 pounds of product plus the pallet and carton weights. To store 50-pound bags, we recommend stacking them as shown in Figure 3.

TRANSFER AND STORAGE SYSTEMS

To handle bulk shipments of polyolefins, LyondellBasell recommends the following design suggestions for the layout of new or modified transfer systems. **Figure 4** is a typical polyolefin resin handling and storage system for high volumes of material arriving via railcar or hopper truck.

Most hopper car transfer systems work by creating a vacuum that pulls the resin out of the hopper car and into the silo or in-plant transfer system. This vacuum/suction system has the simplest material-feed arrangement among the types of transfer systems available, so hopper cars, trucks, bins and boxes can all be unloaded without the need for complicated equipment at the feed end. Secondly, this system provides the best dust and fines control.

Figure 3. Fifty-pound bags of polyethylene stacked on a pallet and wrapped.

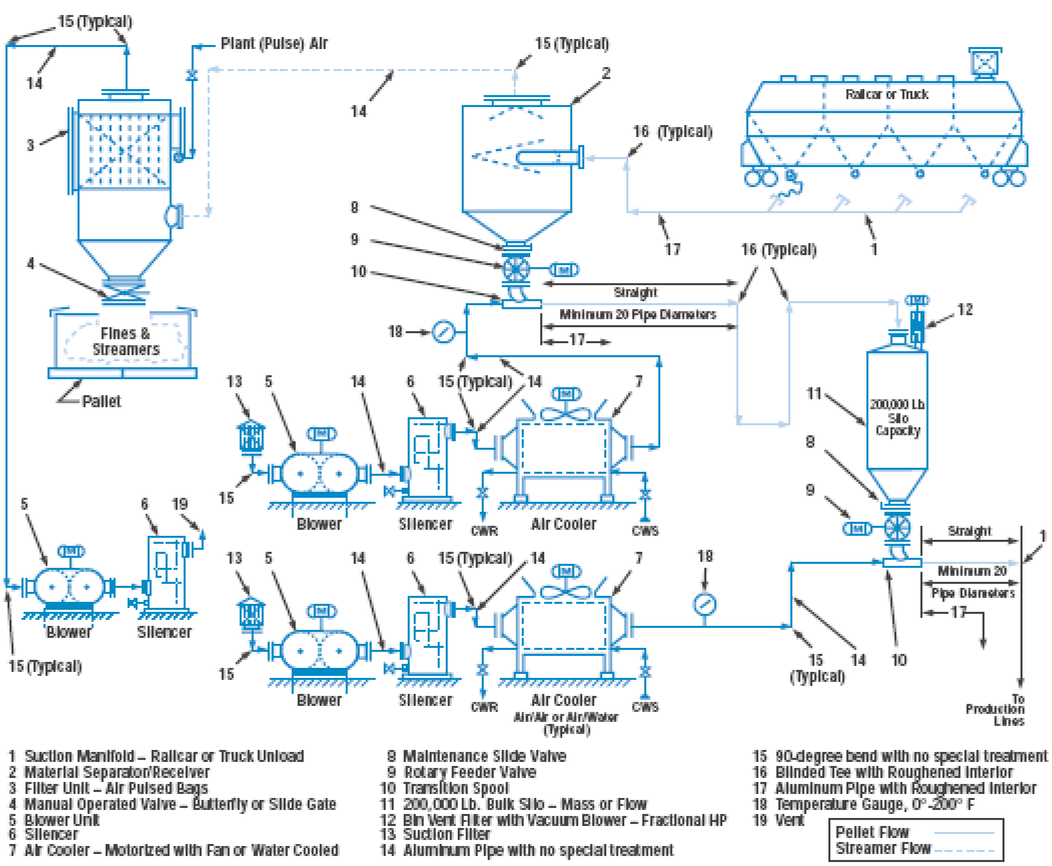
This system's major disadvantage is its limited conveying range. The greater the distance the pellets must travel, the greater the vacuum pulled must be. With higher vacuums, the air-to-solids ratio is increased and leads to slower unloading.

Hopper trucks use a built-in system of blowers that push the resin out and into the in-plant transfer system. Optimum hopper truck pick-up air velocity is 4,500 feet per minute (fpm).

The most common in-plant transfer system is a dilute-phase system. Dilute-phase systems are sometimes called "stream-flow conveying." A high-enough air velocity and a low-enough conveyed solids-to-air ratio characterize this system so the solids pass through the line suspended in a relatively uniform stream.

If the piping (also called "lines") in the in-plant transfer system is not designed properly, problems can result, including inefficient resin transfer, generation of fines and streamers, contamination, excess power usage and increased downtime as lines must be disassembled more often for thorough cleaning. The following sections of this manual review several parts of the transfer system.

Figure 4. Recommended resin pellet handling/storing system for unloading a railcar or truck.



PIPING DESIGN

Layout and Length

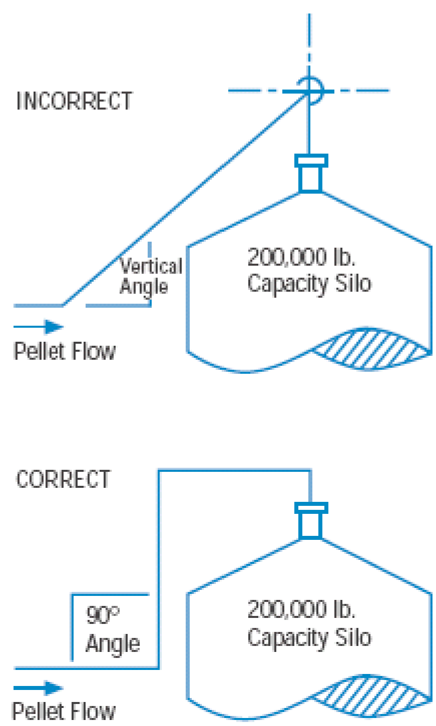
The layout and length of the transfer piping or lines determine to a large extent how easy and trouble-free it is to move the resin from the car or truck to the silo. Transfer piping should run as short a distance as possible between the unloading area and the storage silo. Shorter distances mean fewer opportunities for contamination to enter the system or for fines and streamers to form within the system. Parking and unloading areas for hopper trucks should optimally be around 20 feet from the silo; 40 feet is the maximum distance for efficient unloading. However, since hopper cars go only where the rails take them, transfer piping between rail sidings and silos can be considerably longer.

In designing a transfer system, the engineer must strike a balance between minimizing the distance from the unloading sites to the storage silos and minimizing the distance from storage silos to work areas. Transfer piping between the silo and the processing machines should optimally run no more than 200 feet to 300 feet. Keeping to that measure may mean much longer lengths of transfer piping on the front end from the unloading area to the storage silo.

One mistake often made in the design of a transfer system is not allowing enough time for the pellets to reach velocities that prevent saltation. At the saltation point, the air velocity is no longer high enough to keep the pellets moving. The pellets fall out of the air stream and move along the bottom of the piping. This movement increases power requirements and can lead to plugging of the system. To provide the time needed for the pellets to enter the conveying air stream at the bottom of the silo and reach conveying velocities, a straight section of piping, equal in length to 20 times the diameter of the pipe used, is necessary before reaching a vertical bend or "elbow."

Transfer piping should run horizontally and vertically, not diagonally. In other words, all elbows — and the number of elbows should be kept to a minimum — should have angles of 90 degrees. Tipping the piping should be avoided. If the pipes must be tipped, then their slant should be no more than 10 degrees from the vertical or horizontal plane. Sloped or tipped lines allow the pellets to slide back and can lead to plugging of the line **(Figure 5).**

Figure 5. Piping sections running horizontally and vertically with elbow, showing correct and incorrect angles.



Long radius elbows are not recommended for pellet conveying when streamers are a concern. “Blinded tees,” or other specialty elbows designed to minimize creation of fines and streamers, should be used **(see Figures 6-9)**. Contact your LyondellBasell technical service representative for further details.

If possible, long horizontal distances should be avoided.

- It is easier to push pellets vertically than horizontally.
- Because of their bulk density, pellets are more likely to fall out of the air stream as they move horizontally.
- Less blowing air is needed to move the resin vertically.
- The horizontal movement of the pellets along the pipe walls builds up heat in the pipes, which can lead to the formation of fines and streamers.

In short, in laying out transfer system piping, minimize the number of changes in direction the flow of pellets must take from their unloading point to the storage silo. Minimizing the number of bends, twists and turns in the transfer piping minimizes the occurrence of pressure drops as the pellet stream moves through the piping.

Fewer pressure drops mean fewer chances for pellets — softened by their exposure to friction and warm blowing air – to drop out of the stream, slide along the walls of the elbows and create streamers. More on these types of contamination follows in the next section of this manual.

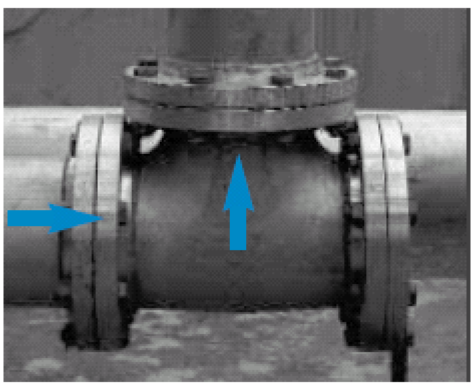


Figure 6. A blinded tee

Pipe Interior

Decreasing the time the pellet slides along the pipe’s interior surface reduces the sliding friction that can cause streamer formation. The most common way to minimize this time is to roughen the inside surface of the conveying line. When pellets contact a rough surface, they roll or tumble instead of slide.

When the pellets bounce against the rough surface, they do leave a very small amount of residue called fines. After bouncing against the rough surface, the pellets continue in the direction of the airflow. Conveying pipes can also be purchased with specially manufactured, rough, interior surfaces. LyondellBasell plants use various types

Figure 7. Blinded tees

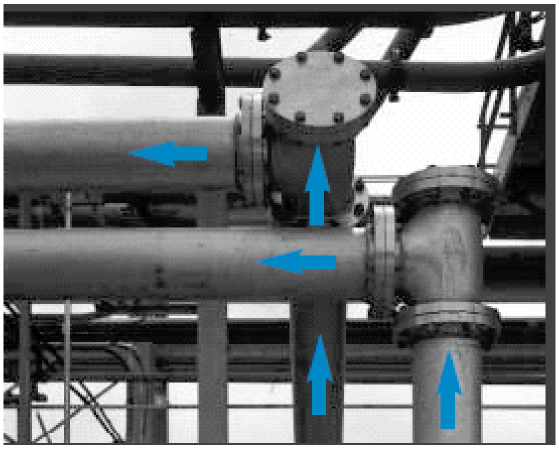


Figure 8. **Blinded tees**

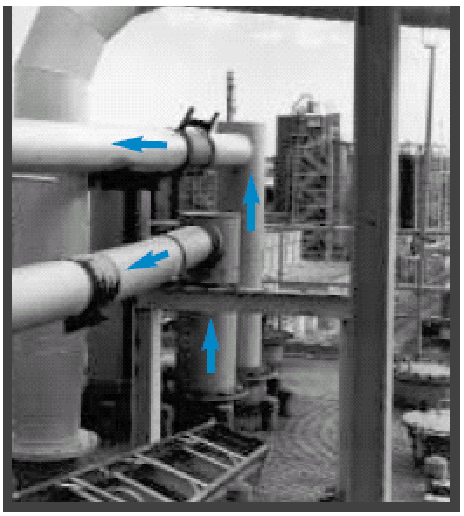


Figure 9. **Blinded tees**

of piping to prolong piping life and minimize streamers. Contact your LyondellBasell technical service representative for more information.

Recently, there has been an increase in the use of blinded tees and short-radius elbows where a change of pellet direction is required. When pellets come to the blinded end of a tee, they hit a layer of pellets in the end of the tee and then proceed in a new direction. At the end of the transfer process, the blinded end empties itself. There has been no documentation of cross-contamination due to resin remaining in the pocket of the blinded tee between transfers.

Piping system inspection and maintenance should be performed periodically to assess the condition of the roughened inner surfaces. Wear on these sections can be easily seen. Roughened surfaces can be restored in elbows. Straight sections showing wear can often be rotated at least once before additional roughening becomes necessary. Interior pipe walls can be roughened by sandblasting or shot peening.

LyondellBasell does not recommend roughening be done while the pipe is in place or “on line.” as it is very difficult to completely purge the system of contaminants afterwards.

See **Appendix 1**: Pellet Conveying Troubleshooting Guide for suggested courses of action on some of the most common pellet conveying problems.

TRANSFER SYSTEM AIR

The most important rules for successful resin transfer are to keep transfer air temperatures low and velocity in-range. Air pressures should be minimized and the distance the pellets must travel between the hopper car or truck and the silo kept as short as possible. Following these guidelines concerning operational design and transer systems can result in the reduction or elimination of fines and streamers. If the transfer system and the layout of the conveying lines are well designed in the first place, a number of efficiencies and savings beyond the initial installation can also be achieved.

Blowing air is also used to purge transfer lines and silos to clean them and prevent current shipments of resin from being contaminated by the remains of previous ones. Purging the lines in this manner is highly recommended when different products are conveyed by the same system.

A Pressurized-Air, Dilute-Phase System
The air transfer system that moves pellets from the hopper car must be constantly monitored. Some form of cooling system using water or air is necessary. The temperature of the transfer air should not exceed 100°F when conveying PE homopolymers and all PP products. Higher temperatures can add to the effect of friction and soften the pellets, leading to streamer formation, as described previously.

If the pellets are ethylene copolymers, the air temperature must be maintained at even lower temperatures. Blowers on ethylene copolymer transfer lines should be cooled with chilled water to an air temperature of about 90°F. **See Table 1** for the softening point – not the melting point – of the resin that you are purchasing. The transfer-air temperature must be kept well below that level.

Table 1

Product Trade Name	Polymer Type	Approximate Softening Temperature[1] (°F)
Alathon®, Petrothene®, Microthene®	HDPE	255
Microthene, Petrothene, Petrothene Select	LLDPE	185
Petrothene, Microthene, Ultrathene®	LDPE & EVA Copolymers	145
Petrothene	PP (all types)	220

[1] Softening point temperature has a range of ± 15 °F

Transfer air should be filtered to prevent contamination of the resin by debris. Hopper trucks are equipped with filters on the inlet and outlet sides of their blowers, but filters must be attached to hopper car hatches (on non-vented cars) and outlet tubes. If filters are clogged or dirty, the temperature of the transfer air rises. **REGULAR MAINTENANCE IS ESSENTIAL**.

Typically, about 2.5 cubic-feet-per-minute of air are used for each pound of material being conveyed. The minimum pick-up velocity for a pressure system is 4,200 fpm. A higher pick-up velocity increases the friction of the pellets on the pipe, increasing the chance of streamer formation. A lower pick-up velocity may go below the “saltation point,” the velocity at which pellets begin to settle out of the air stream to the bottom of the piping. Optimum pick-up velocity is approximately 4,500 fpm.

Air temperatures must be kept as low as possible. For every pound the air pressure increases across a blower and filter, the air temperature increases about 15°F. The ideal air temperature of 90°F after the blower should be maintained with an air cooler.

The pressurized air system is designed so the air stream is separated from the pellets by a filter. The pellets are released from the air stream, but fines and streamers, if present, accumulate on the filter. After transfer the filter is pulsed with a blast of high-pressure air to dislodge the fines and streamers, which are then collected for disposal. Without regular maintenance, the weight of the accumulated fines and streamers can cause the built-up material to drop into the flow of pellets and clog the transfer system.

A Vacuum, Dilute-Phase System

Particularly for temperature-sensitive resins, such as ethylene copolymers and crosslinkable wire and cable compounds, vacuum conveying works better than pressurized air systems. Although more expensive to install and operate, conveying temperatures in a vacuum system are lower, which prevents problems discussed earlier. The most common transfer systems for hopper-car unloading utilize vacuum conveying.

For vacuum conveying in a dilute-phase system, the pellets go into a disengagement hopper which separates the air from the material being transferred, thus avoiding the accumulation of fines and streamers that can plug the transfer system.

THE SILO

Funnel or Mass Flow Design

For a silo to accommodate a hopper carload of polyolefin resin, it must be able to hold 200,000 pounds. Ideally, silos are made from stainless steel, but aluminum and carbon steel silos with epoxy linings are common. This lining must be checked periodically for wear. If the lining is worn and thin in areas, contamination of the resin can result where the pellets contact the carbon steel **(Figure 10)**.

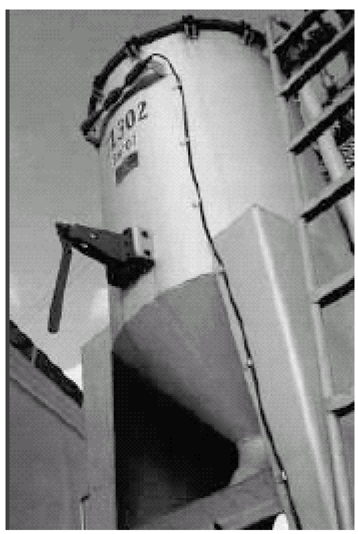


Figure 10. Silo with a 60-degree cone-shaped bottom for ease of product flow and maintenance.

Silos are usually designed to store products within a range of bulk densities. If you do not know whether your silo was designed to handle polyolefins, contact the manufacturer. Silos can collapse if the bulk density of the stored material is too high for the silo to handle. **CAUTION:** Do not overload your silo. For the typical bulk density of LyondellBasell polymers, see **Table 2**.

Table 2

PLANT	EVA	HDPE	LDPE	LLDPE	PP
Bayport, TX			33 – 36		
Chocolate Bayou, TX		33 – 35			
Clinton, IA	33 – 37	33 – 37	33 – 34		
La Porte, TX			34 – 36	31 – 32	
Matagorda, TX		33 – 37			
Morris, IL			33 – 36	32 – 36	32 – 33
Victoria, TX		37 - 39			

Silos with diameters of 10 feet are common, but silos with 12- and 14-foot diameters are now available. The standard cone-shaped bottom of the silo has an angle of at least 60 degrees for the polymer to flow easily; silos with larger diameters must be supported at a greater height above the ground than silos with smaller diameters. However, larger diameter silos are shorter in height overall than ones with smaller diameters, an advantage in terms of handling product. Cone bottoms with slopes of 60 degrees or more are recommended. These bottoms are easier to clean and maintain and are necessary if the silo is used to store polyolefin powders.

At the bottom of the silo cone is a rotary airlock, a device that prevents air loss when the resin is transferred or removed from storage and controls the feed rate to the conveying system. The controls on this device should be connected to the blower so the blower can be operated with or without the rotary airlock operating. However, the opposite situation should be prevented: the airlock should never be able to operate unless the blower is running.

Another device, a powered bin-vent filter, is located at the top of the silo. This device prevents backpressure in the silo and stops fugitive fines and streamers from being released into the atmosphere. This filter should be periodically checked and cleaned.

The silos themselves should be cleaned at least annually, more often if soft products are stored, and whenever the product stored is changed. Silo cleaning should include a thorough washing followed by air drying before filling with resin.

Measuring the Resin in the Silo

The most common measurement techniques utilize weigh cells on the silos themselves. While these systems provide a direct readout of the weight of material in the bin, they can be expensive and difficult to maintain. The cost to retrofit weigh cells to an existing silo may be prohibitive.

The level of material in the silo can also be determined by using a strapping tape, essentially a measuring tape with a weight on the end. A pyramid-shaped weight placed on the tape with the flat end down is often used because this shape can rest on the surface of the pellets. Tables are used to convert the free space in the bin to volume and then to weight.

The manual strapping operation is simple, effective and inexpensive, but not as accurate as weigh cells in good working order. Proper procedures to prevent contamination and avoid safety hazards must be in place and enforced for all measurement operations. Catch bars should be installed on all silo openings or hatches to prevent falls. Proper use of safety harnesses may also be necessary.

HANDLING A DELIVERY OF PELLETS OR POWDER

RECOMMENDED SAFETY POINTS BEFORE OPENING HATCHES

- "Blue flag" the track.
- Understand the equipment you are about to operate. If you have any questions, do not proceed without contacting your supervisor or an experienced co-worker. Check for any safety risks before you begin.
- Put on safety goggles, hard hat, safety shoes, protective gloves and hearing protection if you will be working near the transfer units.
- Secure the hopper car. Set the hand brake, derails, chocks, "Car Connected" signs, etc., so the car cannot be moved during the unloading process.
- Place catch trays or tarps around the delivery area to contain spills and meet the requirements of Operation Clean Sweep (see page 4). An alternative is to pave all unloading areas for easy cleanup.
- Inspect the hopper car to make sure no seals are broken and there is no damage to the car. The packing list for the car provides a list of seal numbers and the volume of resin of the car. Any problems with seals or car damage should be reported immediately to your LyondellBasell customer service representative. Do not unload the car until the delivering railroad agent has been notified and you and the agent make a joint inspection.
- Make sure ventilation is adequate. Some resins have residual odors, which may be objectionable.
- If you have to climb on top of the railcar, you must protect yourself from falling off the car. If the car is not located in a building with a safety handrail system, make sure you are wearing a safety harness attached to a cabling-fall-protection system or a stationary rail to catch you if you fall.
- Attach a ground wire to the car and ground all metal handling systems. Non-metal containers can be grounded by placing a grounding rod in the resin.
- Make sure the unloading system is set up so the unloaded resin is sent to the proper location.

STATIC ELECTRICITY

The need for grounding is based on the fact pellets accumulate static charges during transfer and handling, which normally are little more than a nuisance. The lining of the car prevents the charges from dissipating. However, people sampling the hopper car through the hatch should be aware static charges are present. While the shock does not kill, sudden movements after a shock could lead to injuries; if, for example, the person is on top of the car and does not have a harness properly attached to a stationary bar.

One way to prevent shocks during sampling is to momentarily rest the handle of the sampler on the hatch and then push the sampler into the pellets.

PREPARING THE HOPPER CAR FOR UNLOADING

After safe access to the top of the car has been established . . .

- Cut seals and open the hatch on the compartment to be unloaded. **Opening the hatches is not necessary on vented cars.**
- Visually inspect the product in each compartment. Report any contamination, such as water, different-looking resins, dirt, leaves, insects, etc.
- Inspect the hatch opening and install a filter over each opening to prevent contamination from dirt, water, etc.
- Remove both caps on the unloading tube and the plastic valve inserts. Inspect and clean the tube and place a filter on the end that is not in use **(Figure 11)**.
- If there is no obvious contamination, take samples.

Courtesy of Dyna-Bulk, Inc.

Figure 11. Hopper car delivery: inspecting the unloading tube and placing a filter and catch pan.

- Make sure you are wearing clean, rubber gloves when taking samples and that the containers for the samples are clean.
- Wipe the valve outlet with a clean cloth.
- Take the sample and replace the shield and valve caps if the car is not to be unloaded immediately.
- Recheck the hook-up to make sure the product will be transferred to the correct storage silo.
- If the compartment will not be completely unloaded that day, close all outlets and hatches to prevent contamination and vandalism.
- Reseal the compartments.

UNLOADING THE HOPPER CAR

Hoses

- Stainless steel hoses are preferred. Clear plastic hoses are commonly used, but must be checked often for abrasions, breaks and distortion.
- Make sure the hoses are clean. Between deliveries, hose ends should be covered to prevent contamination. Pellets and fines can catch at hose end fittings and can cause contamination of future deliveries, unless hoses are cleaned before and after unloading.

- Make sure metal hoses are set up so the product is flowing in the direction of the coils or spirals. If the product flows in the “wrong” direction, the resin could abrade and fines could result. Most hoses are marked to indicate the direction for correct set-up. LyondellBasell recommends that operators do not stand on the hoses. This action can shorten hose life and is also a safety hazard.
- Hook transfer hoses onto the outlet valve of the hopper car **(Figure 12)** or hopper truck **(Figure 13)**. Make sure the hoses are not lying in water or on dirt, as contamination could be pulled into the system from these sources.
- All sources of air drawn into houses and conveying system must be filtered to prevent dirt, dust and other contamination from entering the system.
- Hoses must be grounded.
- Minimize the number of bends in the flexible hose as bends add to the pressure drop in the conveying system and can lead to plugging of the lines.

Courtesy of Dyna-Bulk, Inc.

Figure 12. Hopper car delivery: hooking up the hoses.

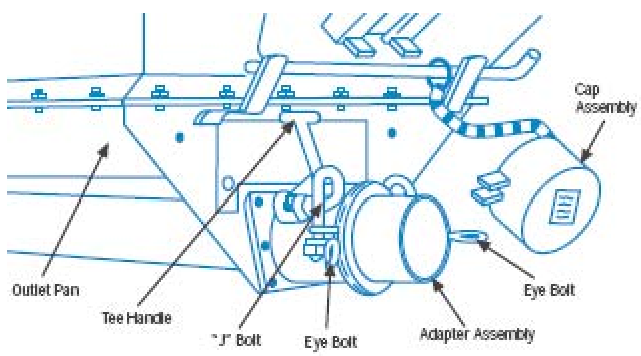


Figure 13. Basic components of an adjustable pneumatic outlet.

Venting

- Make sure roof hatches and tubes at the bottom are opened and covered with filters. If present, remove the plastic film underneath the hatch cover as well as the plastic valve inserts in the unloading tubes. If these “vents” are not opened and unloading occurs, the roof of the hopper car could collapse, resulting in expensive repairs. Properly handling bulk deliveries lessens these costs.

Vented hatch covers can be found on some hopper cars. These cars have air inlets on the hatch covers that allow the car to “breathe.” The construction of the car is protected and load condensation is reduced as a result. Stenciling on the car identifies cars with vented hatch covers. Hatch covers on vented cars do not need to be opened before unloading.

Plant Transfer System

- When prevention of contamination from a previously conveyed material is necessary, wash out and dry by blowing air on parts of the transfer system, particularly the cyclone, airlocks, chutes, etc., to remove dust and pellets from previous deliveries. Make sure these areas are dry before unloading.

After Unloading Each Compartment

- As each compartment empties, the flow rate goes down because air is being drawn into the control valve and the vacuum is decreasing. At this point, rotate the valve to remove product from the side of the compartment closest to the valve. The flow rate should go back up to the set level. When the flow rate goes down again, move the valve back and forth in the compartment to remove all of the resin.
- Shut off the transfer system.
- Disconnect the hose from the outlet for the unloaded compartment. **(NEVER disconnect the hose until you have shut off the blower.)**
- Close the control valve.
- After establishing safe access to the top of the hopper car, make sure the compartments are empty by removing the hatch filter and LOOKING THROUGH THE TOP HATCHES WHILE SHINING A FLASHLIGHT OR WORKLIGHT INTO THE CAR **(Figure 14**.

Figure 14. Hopper car delivery: making sure the compartments are empty.

- DO NOT use probes to remove bridged material from the car walls or bang on the car walls with heavy objects. These actions can damage hopper cars and their linings, requiring expensive repairs. If bridging occurs, contact your LyondellBasell customer service representative for technical advice.
- Disconnect the transfer system from the hopper car's discharge outlet.
- Remove filters.
- Make sure the valve is closed and all discharge outlets are capped and secured.
- Remove catch trays or tarps and properly dispose of any spilled material.
- Put filters on the openings of the next compartment to be unloaded.
- Attach the hose to the next compartment's outlet and start the blower.
- Check the transfer pressure and get up to the desired transfer rate.
- Repeat this procedure with each compartment in the hopper car.
- Make sure both sides of the hopper car compartment have been emptied, both the "near side" and the "far side."

After the Car is Completely Unloaded

- Close hatches and bottom tubes and reinstall the caps on the tubes and valves.
- Prepare "Empty Return" bill of lading.
- Notify railroad agent to pull the railcar as soon as possible.

Unloading Checklist

- ☐ Are derails, hand brakes, chocks set around the hopper car?
- ☐ Have “Car Connected” signs been placed to prevent accidents?
- ☐ Has the car been inspected for damage or vandalism?
- ☐ Are all the seals intact?
- ☐ Is this the correct hopper car for the selected resin silo?
- ☐ Is the unloading system cleaned and purged? Purge the system with 50 pounds to 100 pounds of product before loading the silo to make sure the system is clean. Contain and properly dispose of the purged material.
- ☐ Has the roof hatch on the compartment to be unloaded been opened to prevent the railcar from collapsing?
- ☐ Have you inspected the contents of each compartment?
- ☐ Have air filters been placed on both the top and bottom hatches on the compartment to be unloaded?
- ☐ Have hoses been inspected to make sure they are clean?
- ☐ Are both the inside and the outside of the hoses dry?
- ☐ Have catch trays or tarps been placed under the outlet?
- ☐ Has a transition piece been attached between the hose and the hopper car opening if the hose has a diameter smaller than six inches?
- ☐ Has the control valve been opened and adjusted so the flow rate is correct? (The easiest way to maintain the flow rate is to remove product from the far side of the compartment first. Heavier flows result in higher transfer temperatures, which can lead to problems.)
- ☐ After unloading one compartment, has the blower been turned off before disconnecting the hose?
- ☐ Have filters been placed on the next set of hatches and openings?
- ☐ After unloading the car entirely, has the valve been closed?
- ☐ Has the transfer system been shut off?
- ☐ Has the railcar been VISUALLY inspected to make sure all product has been removed?
- ☐ Have all the roof hatches been closed and locked down?
- ☐ Has the transfer system been disconnected from the hopper car’s discharge outlet?
- ☐ Have filters been removed?
- ☐ Have caps been placed on all discharge outlets (both sides)?
- ☐ Have the ends of the hoses been checked for loose pellets or fines and these items removed?
- ☐ Have the ends of the hoses been covered to keep them free from contamination?
- ☐ Has the railroad agent been notified to remove the railcar?

DIFFERENCES BETWEEN HOPPER TRUCK AND HOPPER CAR UNLOADING

Instead of using the vacuum system generated by the in-plant transfer system, hopper trucks are unloaded using the air blower on the truck itself. This blower is driven by either the tractor engine or by a remote engine **(Figure 15)**.

Hopper truck unloading sites should be as close to the silo as possible. Air temperature must be kept as low as possible. An after-cooler is recommended when conveying temperatures exceed 100°F.

The unloading hose for hopper trucks has a diameter of four inches, so the connection for the transfer system should also be four inches in diameter.

The dense-dilute phase unloading process is recommended for unloading a hopper truck. The objective of this process is to put as much product into the line and use the smallest volume of air possible to move this amount of product. The desired velocity is just above the velocity at which the line begins to plug. Even though unloading systems can produce higher air velocity, the dense-dilute phase process takes no longer to empty the truck. The increased amount of material moving through the line more than compensates for the lower velocity—and the creation of fines and streamers is minimized through lower air temperatures.

Courtesy of Dyna-Bulk, Inc.

Figure 15. A hopper car is unloaded into a hopper truck for shipment to a customer not serviced by a rail line. The truck's air blower is used to unload the car. Note that the conveying pipe does not touch the ground to prevent moisture and contamination from entering the system.

GAYLORD BOX HANDLING

Maintaining dust-and-dirt-free storage and production areas is the most important way to avoid contamination of the resin that can lead to production problems.

- Brush off the top of the Gaylord box before moving it to the production area.
- In the production area, remove the lid from the box and take the lid away from the production area. For dusty production areas, special covers that minimize contamination, while allowing for unloading, are available for gaylords.
- Carefully open the liner.
- At this point, personnel trained in procedures that prevent contamination should do necessary sampling.
- Wipe the feed mechanism with a clean, lint-free cloth before putting it into the Gaylord box.
- Remove all empty Gaylord boxes from the production area as soon as possible.
- Static charge can build up on transfer hoses. Grounding of the hose may be necessary.

50-POUND BAG HANDLING

As with box handling, maintaining dust-and-dirt-free storage and production areas is the most important way to avoid contamination of the resin that can lead to production problems.

- Brush off bags before they are taken to the production area.
- Cut the bags open with a very sharp knife or tool to prevent any part of the bag from falling into the resin. Some bags have special inlets for unloading wands and do not need to be cut open.
- Empty the resin out of the bag into an enclosed feed bin or into a lined carton or drum.
- Wipe the feed mechanism with a clean, lint-free cloth before putting the feed tube into the resin.
- Take empty bags away from the production area as soon as possible and properly dispose of these bags.

SPECIAL HANDLING FOR LYONDELLBASELL PERFORMANCE POLYMERS

ETHYLENE COPOLYMERS

LyondellBasell's ethylene vinyl acetate copolymers are very heat sensitive. They have lower melting points than polyethylene resins. Copolymers with higher levels of vinyl acetate incorporated, such as Ultrathene® EVA copolymers for adhesives, sealants and coatings applications, have even greater heat sensitivity. The temperature of the blowing air used for transfer of EVA resins must be closely monitored and cooled to temperatures below 90°F. Resin unloading should be completed as quickly as possible, as the longer the time needed to transfer the material, the greater is the chance of heat build-up and blocking. When the material blocks, it sticks together. Since high EVA copolymers are quite tacky, blocking of resin in the transfer lines can be a very serious problem.

Adequate ventilation is essential when dealing with high EVA copolymers, which are often delivered in Gaylord boxes and bags. Although the vinyl acetate is incorporated in the product, some residual odors may exist and can be objectionable.

WIRE AND CABLE RESINS AND COMPOUNDS

With Petrothene® resins and compounds for wire and cable applications, including Petrothene XL crosslinkable wire and cable compounds, the heat sensitivity of the products make blowing air temperature and cooling a major concern. These products should be handled in much the same way as high EVA materials. Again, adequate ventilation is necessary, because chemically crosslinkable compounds have been specially treated and some residual odors may be released when hatches are uncovered and particularly, when bags and boxes are opened.

POLYOLEFIN POWDERS

Microthene® polyolefin powders for rotational molding are ground to a nominal mesh size of 35 (nominal 500 micron). The bulk density of powders is lower than that of pellets, but transfer systems used for pellets can be used without modification for powders. The angle on the silo cone and hoppers should be 60 degrees or more from the horizontal. All systems should be dust-tight and electrically grounded, as with pellet systems.

Microthene F Microfine polyolefin powders for coatings, low profile additives and other specialty applications can be delivered in 50-pound bags, 500-pound "Supersacks" and 500-pound boxes. These powders have an average diameter of 20 microns. All of the recommendations for bag and box handling apply, along with the special considerations for powders mentioned above.

While microfine powders have been classified as only a "nuisance dust," according to the Occupational Safety and Health Administration (OSHA), they are flammable if ignited. It is essential that all unloading systems are grounded, as noted previously, and all potentially spark-producing equipment is removed from the unloading area. See **Appendix 2** for safety and handling information for these powders.

Quality Assurance

Throughout this manual, we have discussed recommendations for preventing resin contamination. Resin contamination can occur any time during the delivery, handling, transfer and storage process. Therefore, preventing contamination must be part of every stage in the process.

Cleanliness is the first and easiest step. All parts of the in-plant transfer system must be clean and dry. As there are regularly scheduled downtimes for maintaining production equipment, so should there be regularly scheduled downtimes for the inspection and cleaning of transfer equipment. Just the simple procedure of cleaning out lines with blowing air goes a long way toward preventing fines and streamers from developing and contaminating future deliveries. Regular cleaning of transfer lines also finds leaks in the system and prevents expensive resin loss. Regular inspection and cleaning of silos is equally important.

Fines and streamers can also be reduced by:

1. Paying attention to the temperature and velocity of the transfer blowing air, particularly with very temperature-sensitive resins.
2. Utilizing piping with specially treated interior walls.
3. By designing transfer systems that are as short in length as possible with a minimum of bends and no tipped sections.

Each of these recommendations is discussed in greater length earlier in this manual.

MEETING THE GOALS OF OPERATION CLEAN SWEEP

Plastic pellets inadvertently lost at plastic production and warehouse facilities have increased as much as 400 percent in recent years in widely separated locations. These pellets pose a threat to fish and wildlife. The U.S. EPA has classified plastic pellets as "significant materials." The finding of even one pellet in storm water run-off without a permit is now subject to federal regulatory action with the potential for substantial fines and penalties.

Operation Clean Sweep is a plastics-industry-wide effort to prevent the accidental release of pellets into the environment and to improve the public's perception of our industry. Specific recommendations for handling polyolefins to prevent resin loss into the environment have been developed as part of the program, **Operation Clean Sweep**. See http://www.opcleansweep.org/ for more information.

Those recommendations include: Enlist the aid of employees by:

- Establishing written procedures focused on reducing and recovering spilled resins.
- Conducting educational awareness programs for employees to sensitize them to the need to prevent pellet loss.
- Assigning designated employees specific responsibilities for monitoring and managing pellet retention.
- Using teamwork to solve problems and build a consensus of commitment to this task.
- Establishing standard procedures and making sure the proper cleanup tools and materials are readily available.
- Establishing personnel responsibilities by making the cleanup the responsibility of the person(s) causing the spill and insisting on immediate cleanup.
- Developing a system for recovered pellets to be recycled or otherwise used in a manner that prevents their escape into the environment.

Unloading and sampling operations are the prime sources of accidentally spilled pellets. To repeat some points made earlier in this manual:

- Pave unloading areas to facilitate the cleanup of pellets, or use a tarp or catch tray to collect spilled pellets.
- Keep unloading areas swept or vacuumed.
- Anticipate the result of rain or flooding by using a collector grate and filtered storm drain system.
- When sampling from the bottom of a hopper car, be sure the outlet cap is properly reinstalled and sealed.
- When sampling from the top of a hopper car, use wide-mouthed containers or polyethylene bags.
- Thoroughly unload hopper cars and trucks and cycle the outlet valve while air is flowing.

- Visually confirm the compartment is empty before closing all valves and securing outlet caps and hatches.
- Purge lines before unhooking hoses; lift hoses to assist in the purging process.
- Close outlets on compartment before shipping.
- Externally clean bulk containers before releasing them.

Unloading problems increase the risk of spilling pellets. Clogged hoses, bridging of the resin and surges in the unloading lines are common problems. To prevent these problems, consider:

- Eliminating transfer system air leaks and/or increasing the capacity of air conveying systems to prevent plugging.
- Adding loading nozzle interlocks to prevent transfer spills.
- Including a bag house or filter-bag assembly on packaging and transfer lines.

If your resin is delivered in Gaylord boxes or 50-pound bags, you have a somewhat different set of problems concerning pellet release because these packages are moved around often as they are transferred from the truck to the warehouse and finally to the production area. Here are some suggestions to avoid pellet loss:

- Make sure forklift operators are trained in preventing damage to boxes and bags as well as in cleanup procedures.
- Check the length of the forks on the forklift to make sure they do not extend beyond the pallet. If the forks do extend that far, they can cause damage to an adjacent carton.
- Inspect the product as it is unloaded.
- Tape any damaged bags.
- Place catch trays between the dock and tractor-trailer at the shipping/receiving bay.
- Thoroughly empty all bags and boxes: collect, handle and store empty bags and boxes with care to prevent the loss of any remaining pellets.
- Dispose of bags and boxes by recycling, incineration or in a well-managed landfill.

LyondellBasell is a supporter of Operation Clean Sweep and more information about this program is available at http://www.opcleansweep.org. For further suggestions and assistance concerning resin transfer systems, handling procedures and storage, contact your LyondellBasell polyethylene, performance products or wire and cable sales representative, who can connect you with a specialist at LyondellBasell headquarters or a plant location.

APPENDIX 1:

Pellet Conveying Troubleshooting Guide

This guide is presented as general information only. For specific solutions to pellet conveying problems, check with a reputable dealer concerning design problems and possible changes.

Problem	Probable Causes	Suggested Course of Action
Line Plugs	Air velocity below saltation point	Increase air volume
	Reduction in conveying air	Ensure that inlet air filters are clean
		Check for leakage through couplings, line wear holes, valves, diverters, crushed hoses, worn rotary feeders or relief valves at air supply
		Inspect air supply blower or fan motor, drive belts, bearings and impellers for damage or wear
		Ensure that receiver filters are clean
	Receiver vessel full	Check for bridging in receiver vessel cone
		Replace or repair discharge feeder if undersized or worn
	Material build-up	Ensure air is cooled for tacky materials, such as ethylene copolymer resins
		Eliminate sources of moisture which will cause fines to agglomerate
	Improper line configuration	Avoid using more than two consecutive changes of direction
		Avoid long-radius bends, horizontal to vertical, near the pick-up point
Streamers	Friction-induced smearing on pipe walls	Have interior surface of lines roughened

Appendix 1 (Continued)

Problem	Probable Causes	Suggested Course of Action
		Cool down the conveying air to prevent softening of polymer, particularly for ethylene copolymer resins
		Reduce air velocity as much as possible without going below the salation point; the ideal pick-up velocity is 4,500 fpm
		For long transfer lines, reduce air velocity in the last 40 feet by increasing line diameter
		Avoid cyclonic separation into receiver vessel; allow material to free fall
		Install blinded tees or other specialty elbows designed to minimize creation of fines and streamers
		Install elutriator, multi-pass separator/ respirator, scalperator or deduster for streamer removal (generally done only for large volumes)
		Check resin supply at top of incoming railcar, or draw sample directly from truck, box or bags
Fines	Pellet clipping by rotary feeder	Install wedged or baffled entry rotary feeder so feeder pocket does not operate full
		Check for wear on vane tips of rotary feeders and assure proper clearance between the vane tip and the housing
	Pellet breakage from long-radius elbows	Install blinded tees or other specialty elbows designed to minimize creation of fines and streamers
	Pellet breakage from contact with roughened lines	Occurrence is minimal; install an elutriator or deduster if problem is significant
		Check incoming resin supply for improper pellet cut
Excessive line or bend wear	High velocity	Operate at minimum possible air velicity
	Materials of construction	Use wear-resistant materials, particulary at bends

Appendix 1 (Continued)

Problem	Probable Causes	Suggested Course of Action
	Elbow type	Use blinded tees or other specialty elbows where needed
	Piping configuration	Minimizer number of bends in transfer system
Rotary feeder wear	High transfer pressure	Operate at minimum transfer system pressure
		Use double feeder system, one as a feeder and one as an air lock
	Feeder type	Use high performance feeder with tapered or replaceable blade tips
Material receiver or dust collector wear	Pellet momentum	Avoid tangential entry
		Install flapper plate in receiver bin and allow pellets to impact flapper instead of the far bin wall
		Increase line diameter prior to vessel to reduce pellet velocity
System pressure fluctuations	Pellet feed problem	Check vent line from rotary air lock
		Check for bridging at feed point or streamer build-up at feeder discharge
	Receiver vent plugged	Ensure that receiver vent filters are clean
	Relief valve leaking	Check valve seat for plugging or wear
		Avoid operation near valve set pressure
Inadequate capacity	System pressure	Maximize system operating pressure
	Line size	Increase line size at end of system
	Piping configuration	Minimize length of flexible hoses
		Minimize number of bends
		Eliminate upward sloping lines
Resin cross-contamination	Material hold-up in transfer system	Completely purge system before changing resin types
		Avoid low-point pockets in line configuration
		Avoid use of tee-bends for tacky resins, such as ethylene copolymer resins

APPENDIX 2:

Safety and Handling Information for Microthene F Microfine Polyolefin Powders

Polyolefin dust is defined as a combustible material in the "Standard for the Prevention of Dust Explosions in the Plastics Industry" (NFPA 654). Concentrations of polyolefin powder as low as 0.02 oz/ft^3 can burn, releasing sufficient heat to produce a self-propagating reaction that canresult in an explosion.

CAUTION: Users of polyolefin powders should be aware that the explosive concentration is dependent upon the particle size of the powder and upon any substance that may be added to it. Users with questions concerning the explosive capability of polyolefin powders should evaluate their particular composition and operations.

Since polyolefin powder can burn or explode, special care must be exercised when working with the powder to ensure all sources of ignition, such as heat, sparks, flames and static electricity, have been eliminated from the workplace. Specific standards have been developed by the National Fire Protection Association (NFPA 33, NFPA 68, NFPA 70 and NFPA 654) for the proper handling of dusts with inherent combustible/explosive properties. All operations involving the use of polyolefin dusts should conform to these standards.

Polyolefin dust is currently classified as a nuisance material. These materials have a long history of safe use and are not thought to produce irreversible change in lung tissue or produce significant disease or toxic effect when exposure is kept under reasonable control. The Occupational Safety and Health Administration (OSHA) and the American Conference of Governmental Industrial Hygienists (ACGIH) have established permissible exposure limits of 15 and 10 mg/M^3 of air, respectively, for total nuisance dust, and 5 mg/M^3 for the respirable fraction.

Although polyolefin dust is classified as a nuisance dust, good industrial hygiene practices should be followed to prevent avoidable exposures. In any situation, the exposure level should be kept below the OSHA standard. Particle size distribution measurements of Microthene F powders indicate a percentage of the particles are respirable, with approximately 30 percent to 55 percent of the particles having a diameter of 10 microns or less. Since dusts having a diameter of 10 microns or less are theoretically capable of deposition in the lungs, exposures to these powders should be minimized.

Minimizing exposure should be done, where possible, by designing the processing equipment to prevent the release of dusts into the workplace. Where processing equipment cannot be completely enclosed, the best alternative is the use of mechanical ventilation to collect and control the dusts at the point of generation. Good housekeeping practices should be instituted to augment dust control and to ensure that dust in the workplace is not available from accumulation on the floor, the machinery or other structures. Vacuum cleaners of an approved type for combustible dust applications, or fixed pipe suction systems with a remotely located exhauster and collector should be used for cleaning.

If airborne concentrations of polyolefin dust cannot be reduced to acceptable levels, workers should be protected by respiratory equipment. Care must be taken to select a respirator applicable for the purpose intended. In the case of nuisance dusts, either an air-purifying respirator with adequate filtration or an air-supplied respirator may be used, depending on the airborne concentration of the particulates. When using respiratory protection, only NIOSH/OSHA-approved respirators should be selected. Additionally, all aspects of the respirator program should be thoroughly reviewed and approved by a competent health or safety professional.

APPENDIX 3:

Trade Names for Products of LyondellBasell Chemicals, LP

Aquathene®	Ethylene Vinylsilane Copolymer Resins
Alathon®	High Density Polyethylene Resins
Flexathene®	Thermoplastic Polyolefin Resins
Integrate™	Functionalized Polyolefin Resins
Microthene®	Powdered Polyolefin Resins
Petrothene®	Polyethylene and Polypropylene Resins
Petrothene® Select	Polyethylene Resins
Plexar®	Tie-Layer Resins
Ultrathene®	Ethylene Vinyl Acetate (EVA) Copolymer Resins

ABOUT US

LyondellBasell (NYSE: LYB) is one of the largest plastics, chemicals and refining companies in the world. Driven by its employees around the globe, LyondellBasell produces materials and products that are key to advancing solutions to modern challenges like enhancing food safety through lightweight and flexible packaging, protecting the purity of water supplies through stronger and more versatile pipes, improving the safety, comfort and fuel efficiency of many of the cars and trucks on the road, and ensuring the safe and effective functionality in electronics and appliances. LyondellBasell sells products into more than 100 countries and is the world's largest producer of polymer compounds and the largest licensor of polyolefin technologies. More information about LyondellBasell can be found at **www.LyondellBasell.com**.

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