Important Considerations for Dilute Phase Conveying That Will Optimize Your Process

Delivering Consistency

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Delivering Consistency

Delivering material to your process requires:

- Understanding your raw materials
- Best practices for conveying the material
- Accurately delivering the right amount of materials

Understanding Your Dry Bulk Materials

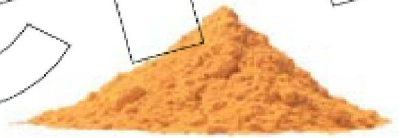
Friable materials

Abrasive materials

Moist, sticky materials

Hazardous materials

Non-free flowing products



Contamination sensitive products

Large particles

Free-flowing materials

Materials that fluidize or liquify

Products that pack, plug, cake or smear

Blends or masterbatch

Material Testing

Why test my materials?

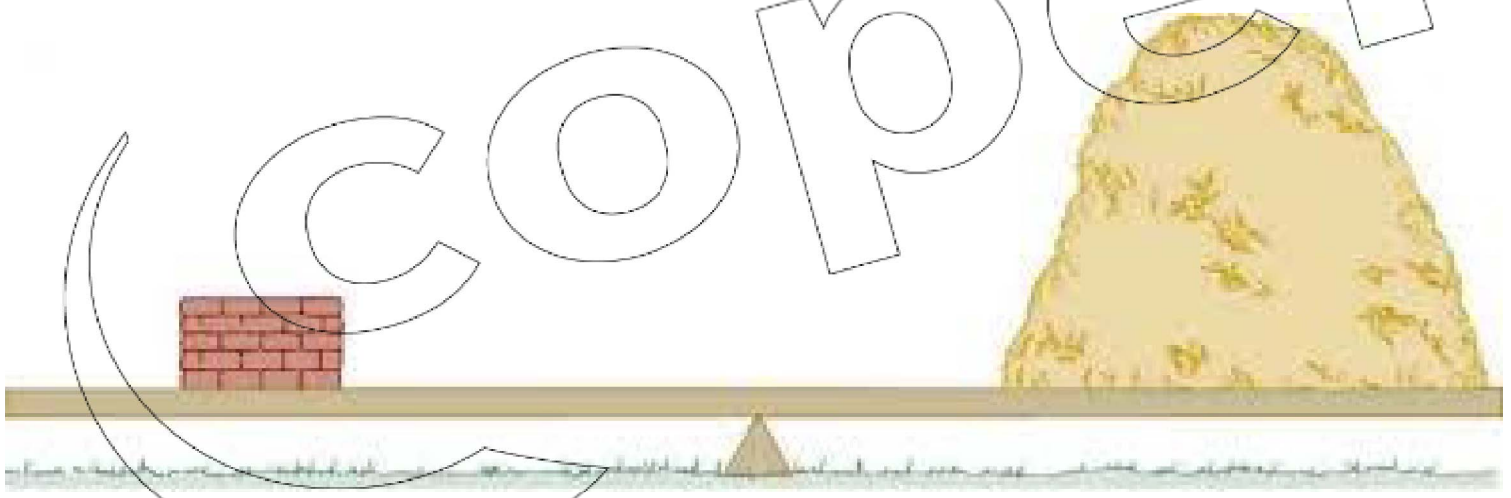
- Confirm bulk density
- Determine flowability issues
- Define critical velocities
- Verify particle size and shape
- Substantiate abnormal material characteristics – sticky, abrasive, temperature sensitivity

Bulk Density

Why is bulk density so important?

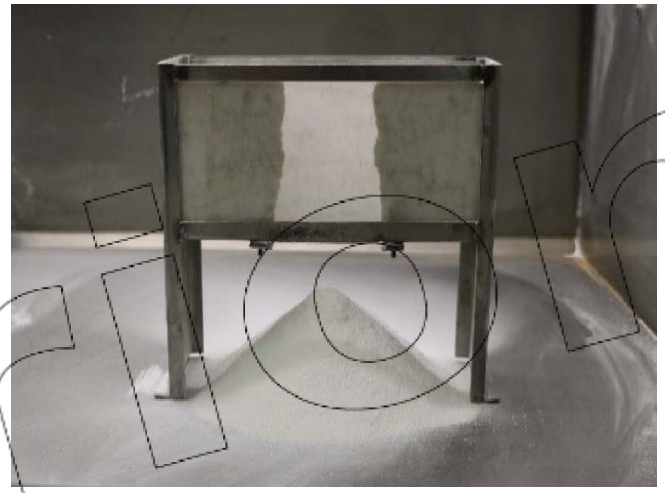
Bulk density can change throughout the process. As a result, it can:

- Affect size of feeding equipment
- Impacts size of material handling system
- Determines the required airflow to make the material move



Material Characteristics

Observing basic characteristics of your material, such as particle size, shape, ability to agglomerate, adherence to surfaces, and sensitivity to temperature can influence the performance of the system.

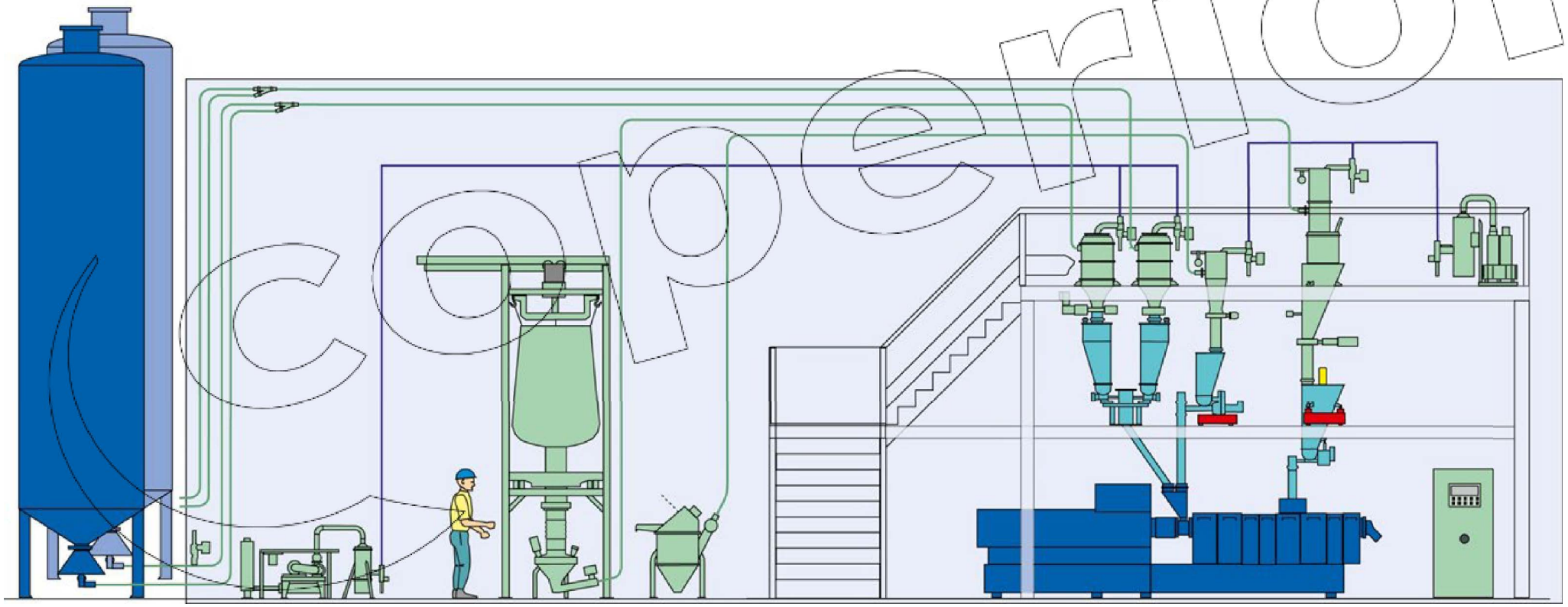


Conveying Material to the Process

- Storage bin / Bulk bag unloader / Silo
- Pneumatic conveying systems
- Mechanical feed / Conveying systems
- Continuous feeding equipment
  - Volumetric
  - Gravimetric / Loss-in-Weight (LIW)

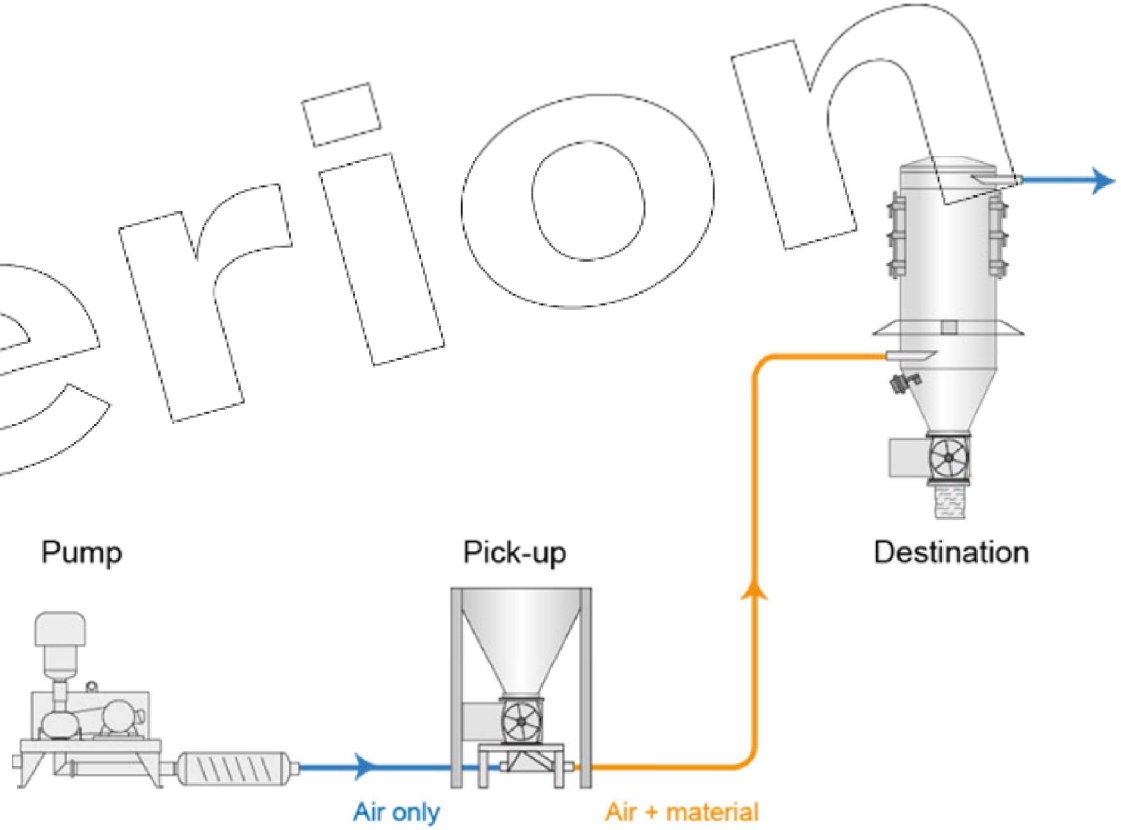
Pneumatic Conveying

A method of conveying bulk material using gas (usually air), to blow or vacuum the material from its source to its destination.



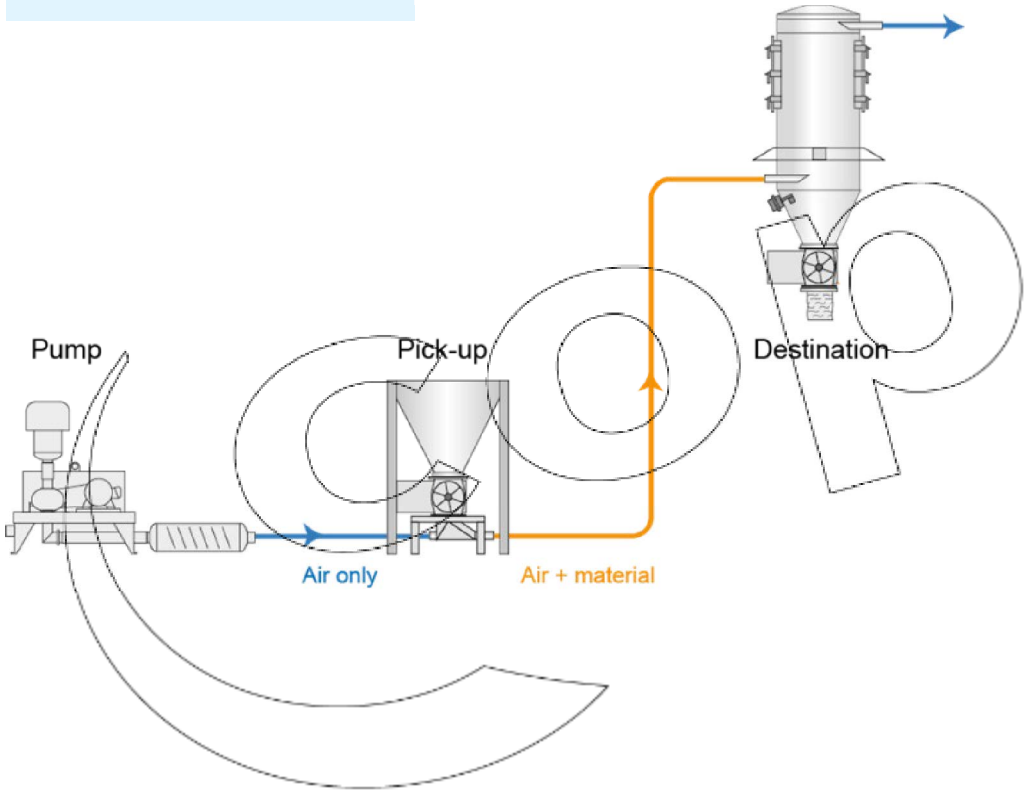
Basic Elements of a System

- A gas source to convey the bulk solid (usually a blower)
- Something to ensure the bulk solid gets into the convey line and successfully gets moved by the conveying gas
- Convey line (will include tube / pipe, bends, couplings, possibly valves)
- Something to separate the bulk solid from the gas at the destination point
- *Controls* (the brain of the system)

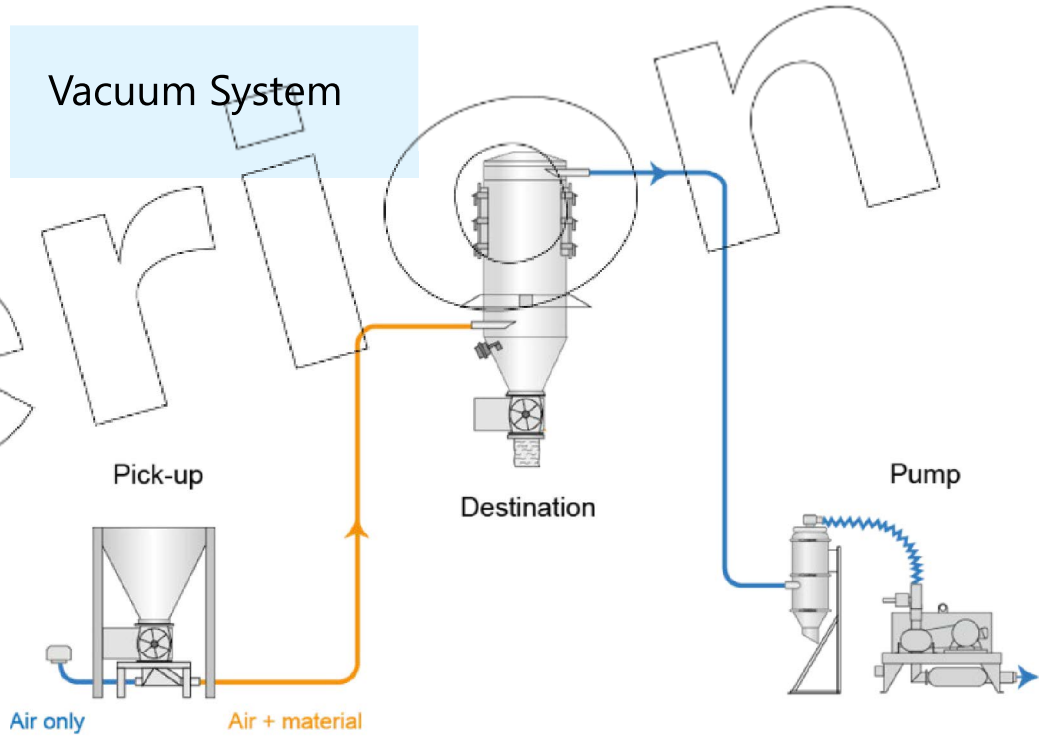


Basic Elements of a System

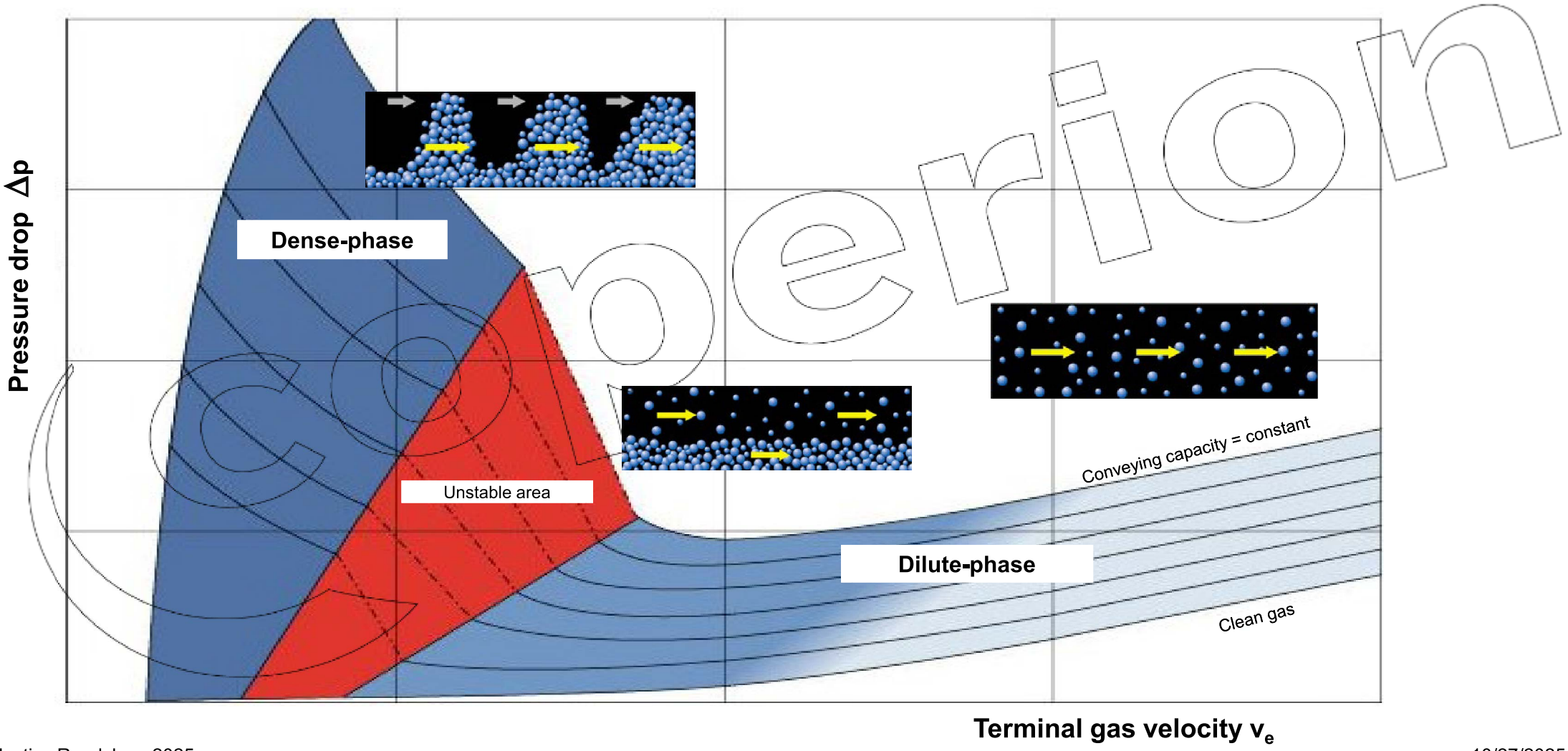
Pressure System



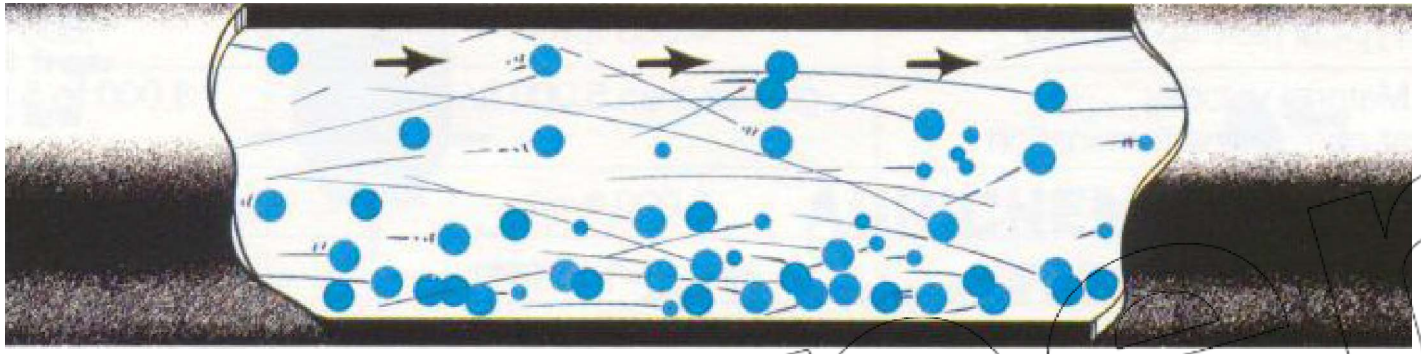
Vacuum System



Dilute Phase Conveying



Dilute Phase Conveying

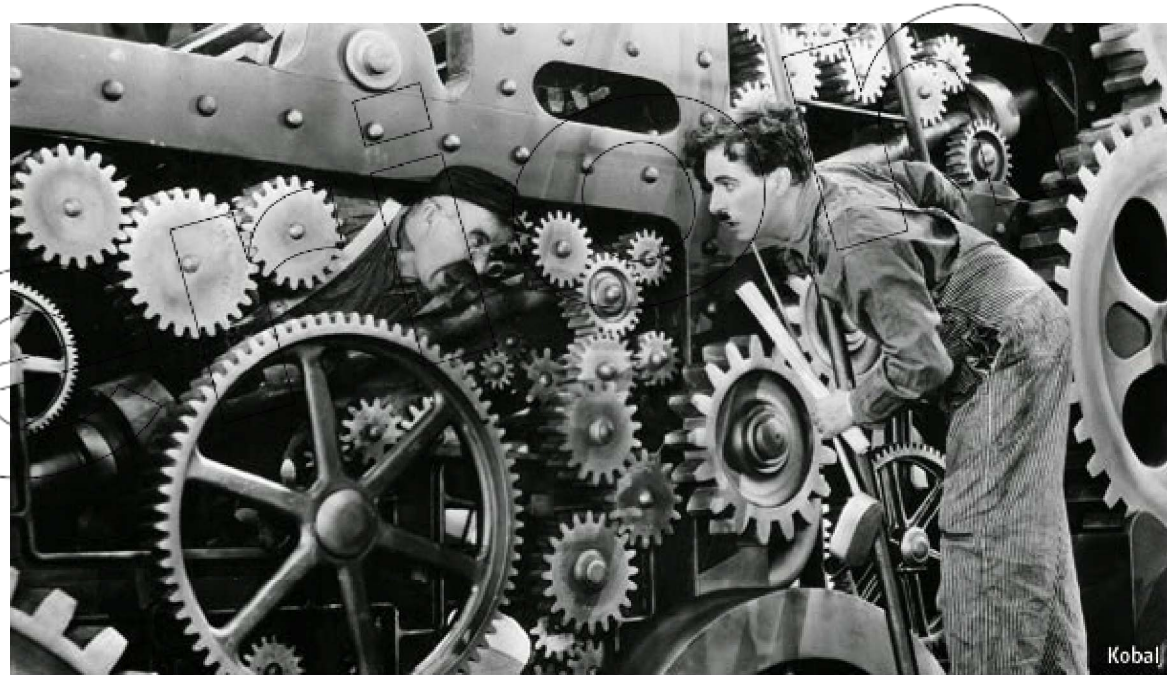


- Material is in complete suspension in the pipe
- Conveying takes place above the **saltation velocity** of the material
- Conveying pressures are typically < 15 psig
- Pick-up velocities are in the 3000-6000 fpm range

Optimizing Your Pneumatic Systems

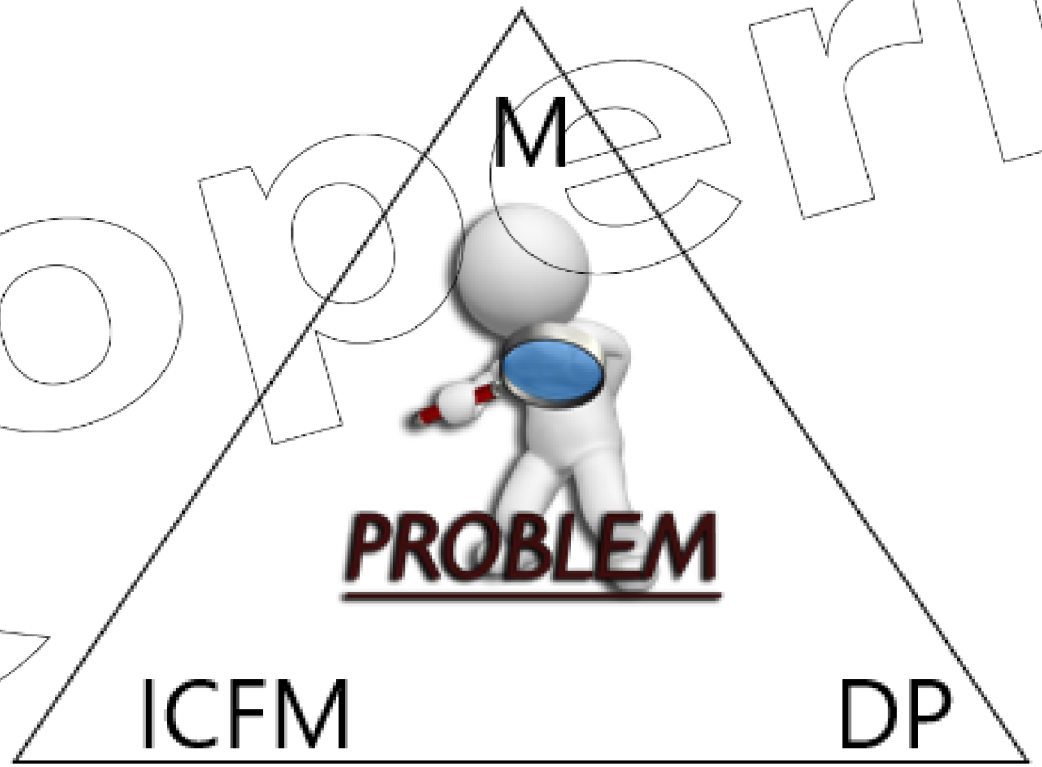
To function correctly, a pneumatic conveying system must:

- Have the proper amount of material feeding into the system
- Have the proper amount of conveying gas in the system
- Be able to overcome restrictions between the start and end of the system



Keys to Optimization

What is affecting the proper amount of material going into the system?



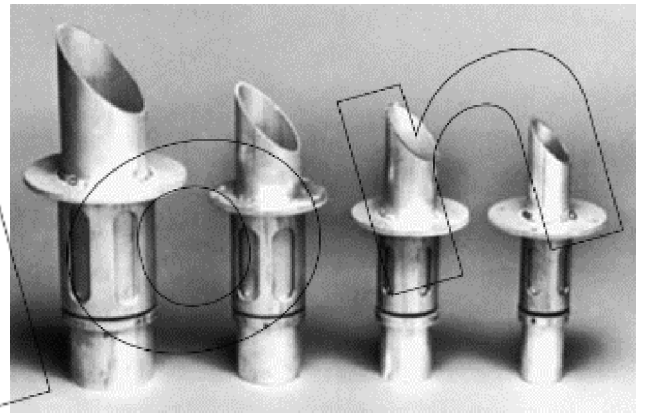
What is affecting the proper amount of gas flow into the system?

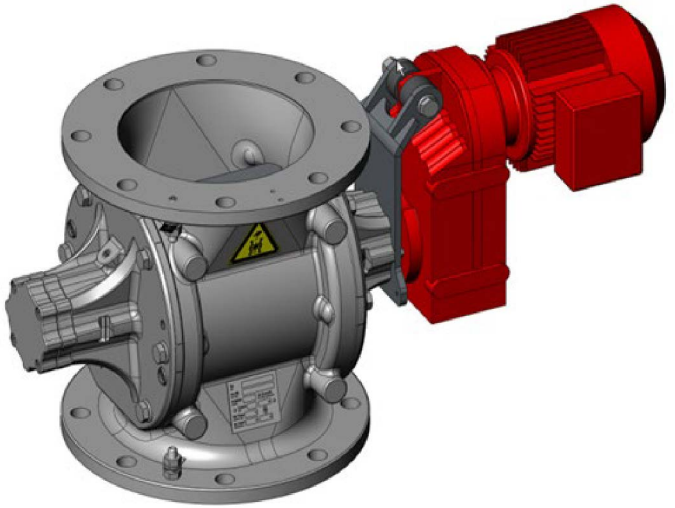
Why am I not able to overcome the restrictions between entry and exit?

Moving Product Into the Gas Stream

Having consistent, reliable and repeatable material entry into the gas stream is critical for optimal system performance.

- The feeding device:
  - Should be selected based on material characteristics.
  - Should be adjustable to achieve the correct material to air ratio
  - Should be designed for the pressure differential above an below it.
  - Should work in conjunction with auxiliary equipment above and below it.



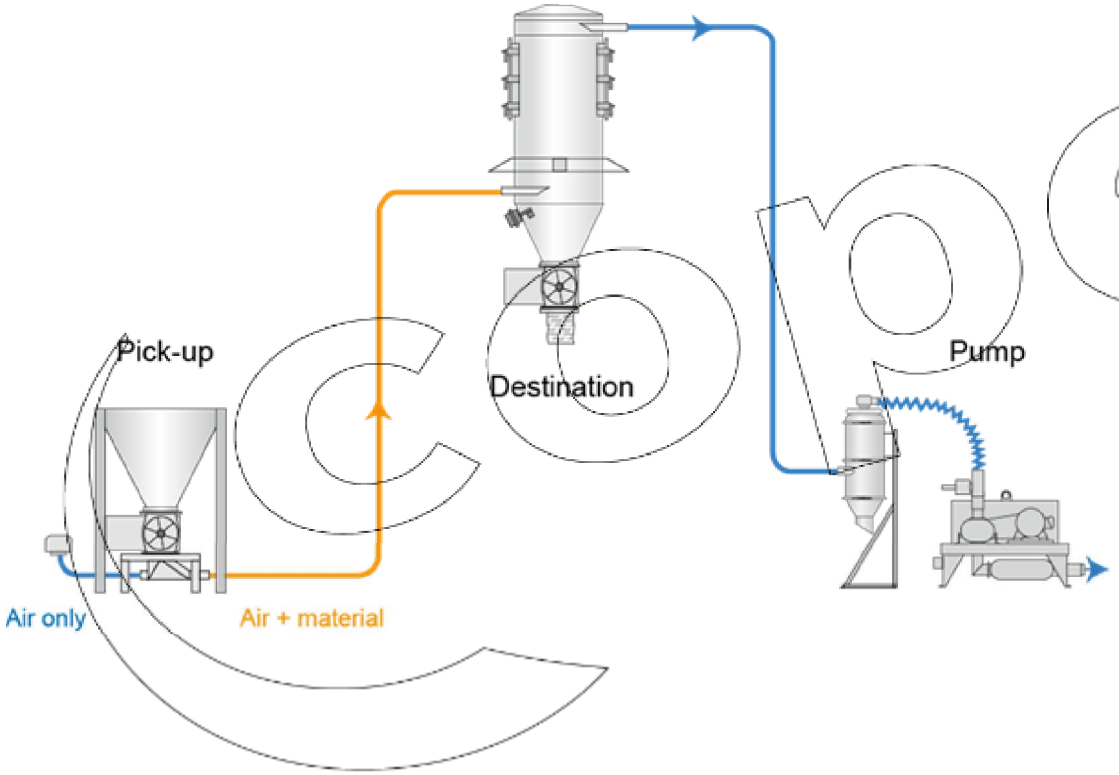


Conveying Gas

Too much gas can lead to:

- Added pressure drop
- Air separation issues
- Air to cloth ratio
- Can velocity
- Higher particle velocities
- Product degradation
- System component wear

Conveying Gas Volume in a Vacuum System

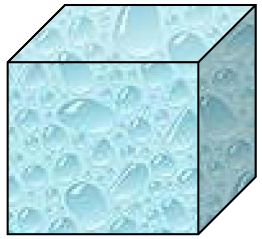


at Atmospheric Pressure

0 PSIG

0.075 lbs. of Air

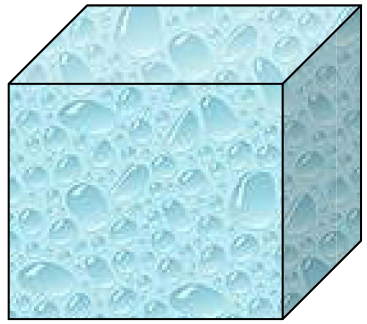
= 1 cu.ft.



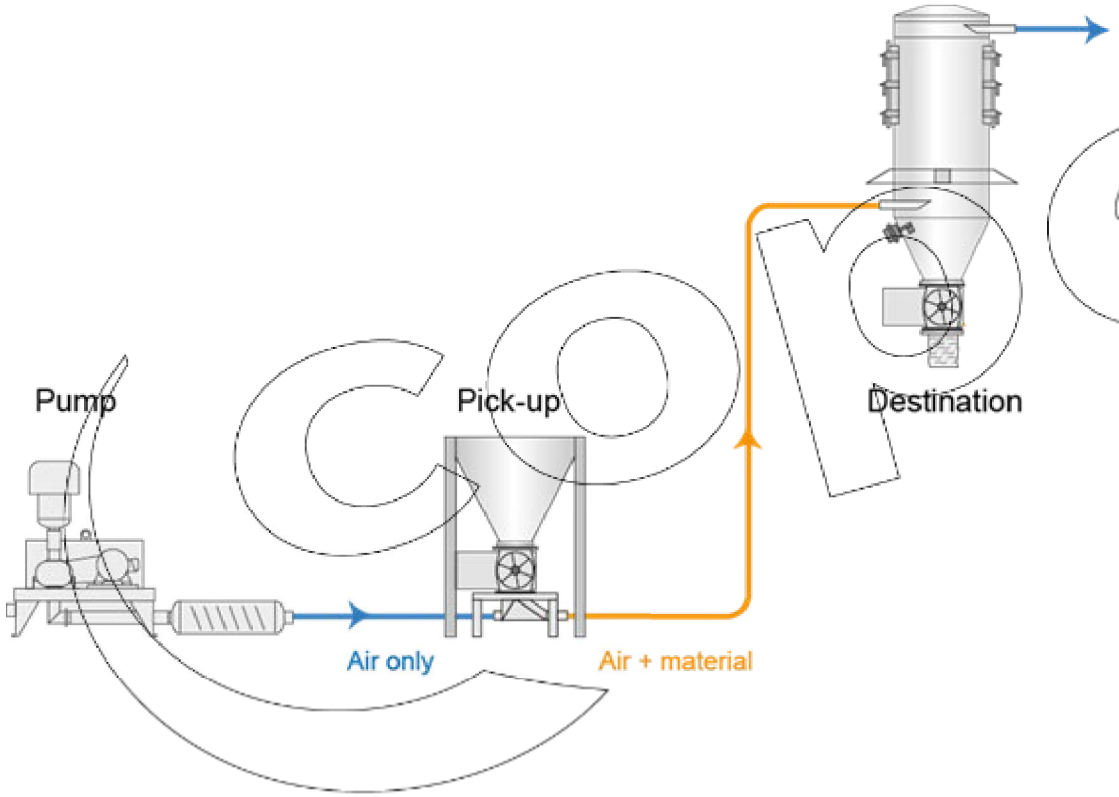
Vacuum

at 10” Hg = -5 PSIG

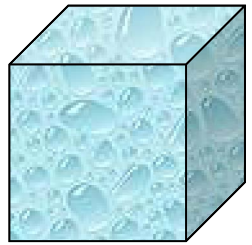
= 1.5 cu.ft.



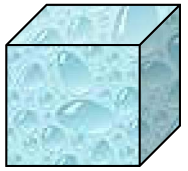
Conveying Gas Volume in a Pressure System



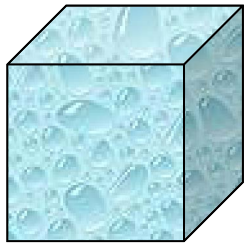
at Atmospheric Pressure
0 PSI
0.075 lbs. of Air
= 1 cu.ft.



Pressurized
at 10 PSI
= 0.6 cu.ft.



Not Pressurized
at 0 PSI
= 1 cu.ft.



Air Volume and Velocity

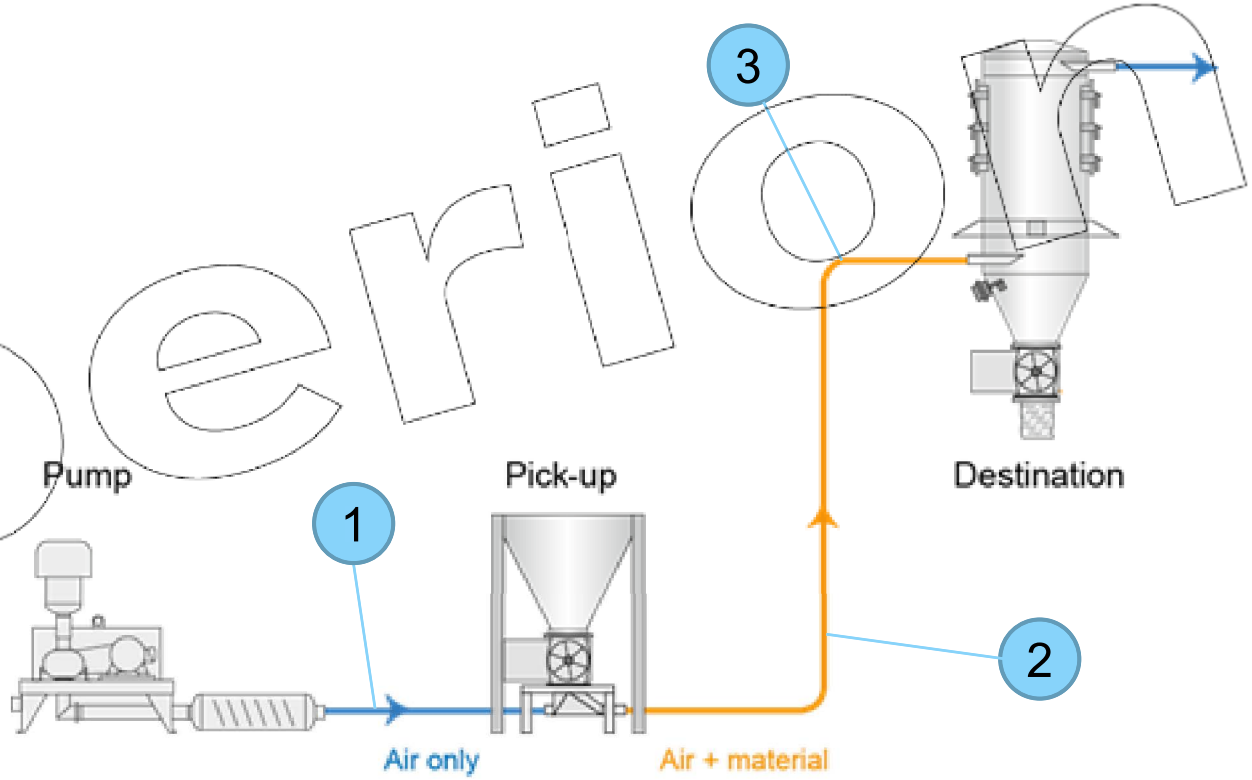
Boyle's Law:

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2} = \frac{P_3V_3}{T_3} = \frac{P_xV_x}{T_x}$$

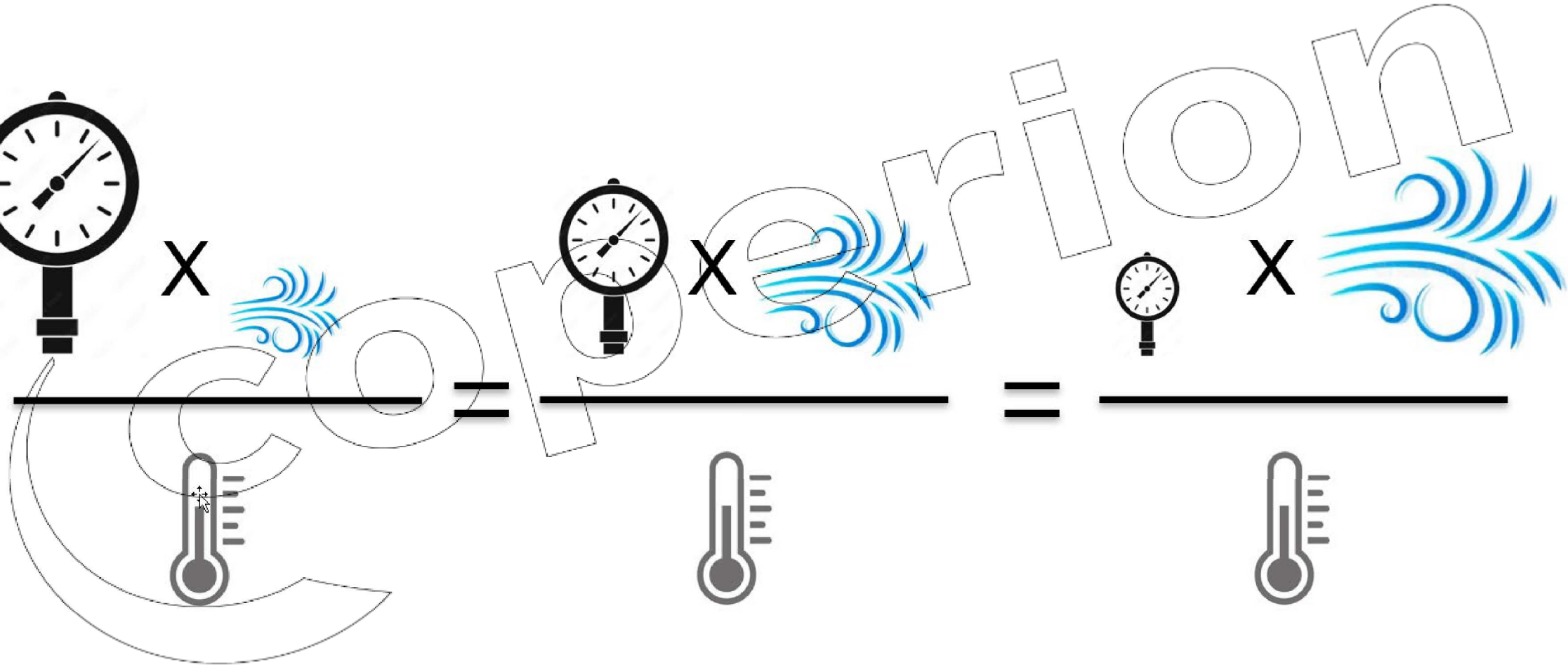
P = Pressure

V = Volume = (Velocity x Area)

T = Temperature

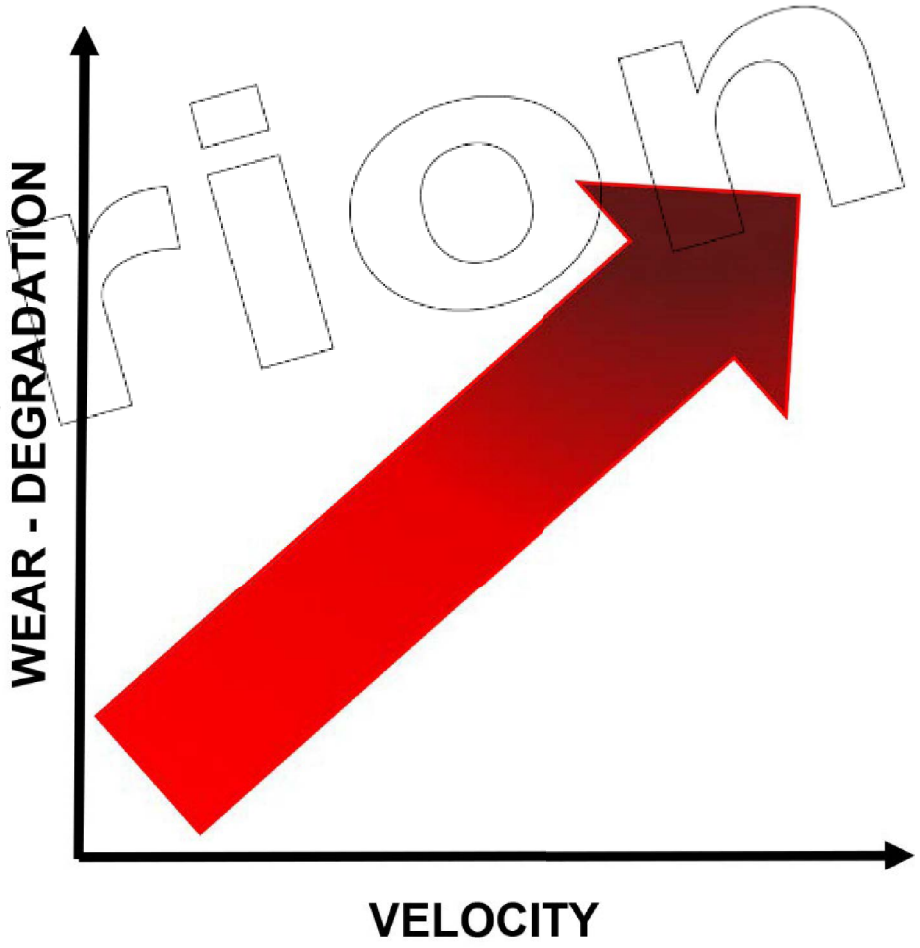


Compressible Gas Changes in Flow

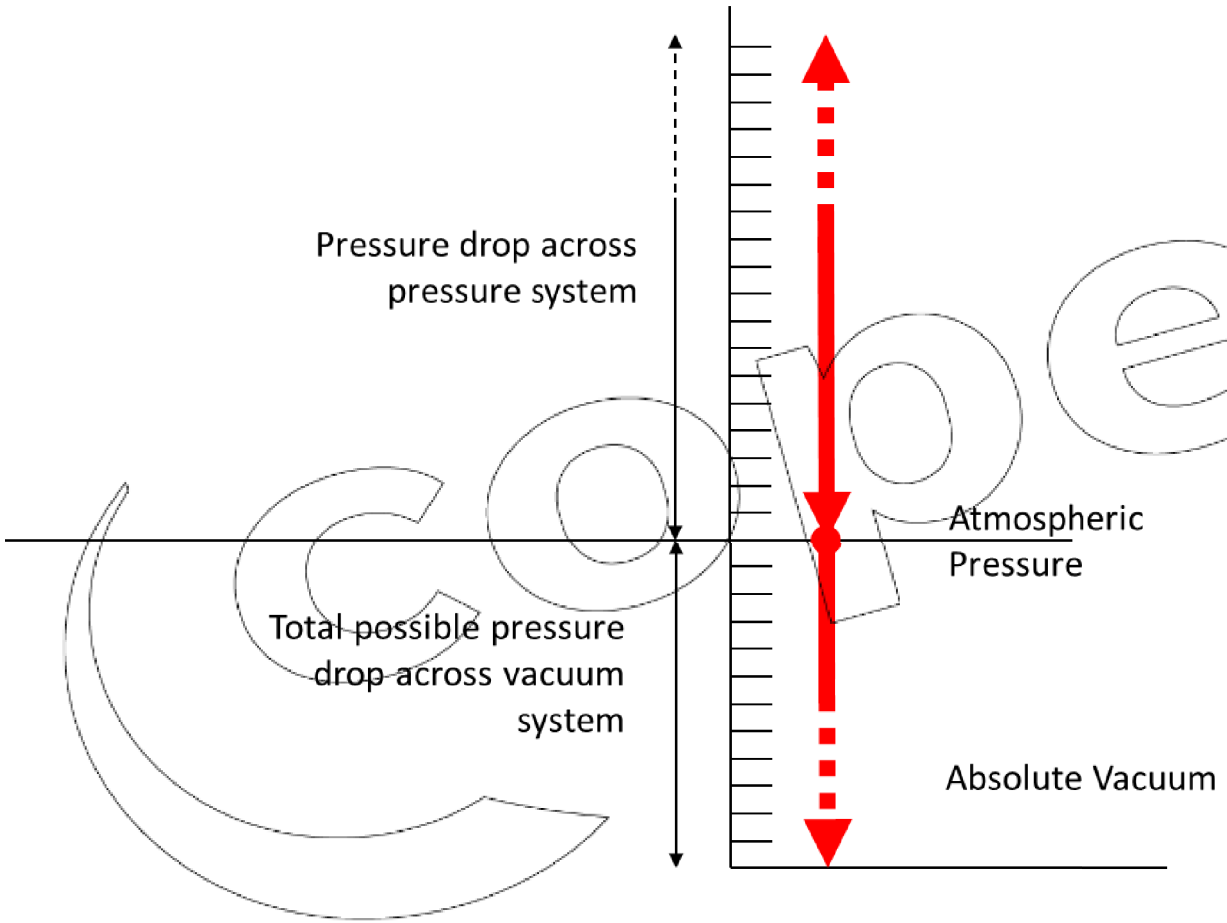


Velocity

- Making sure the material moves at the correct speed is critical for good system performance
- Material moving too slow will fall out of suspension and could cause the system to plug
- Material moving to fast can cause product degradation and wear on the system components

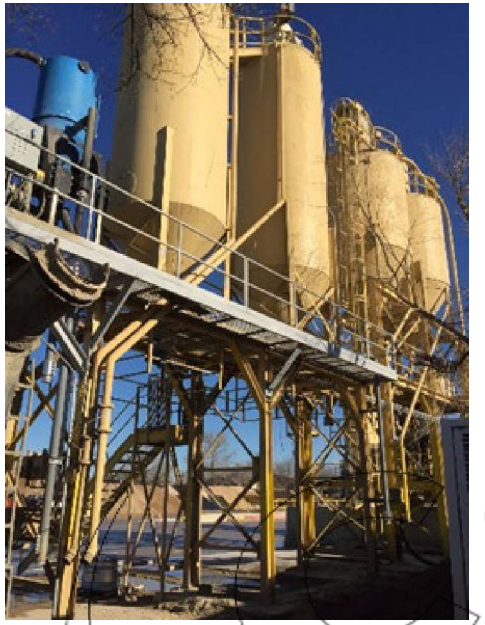


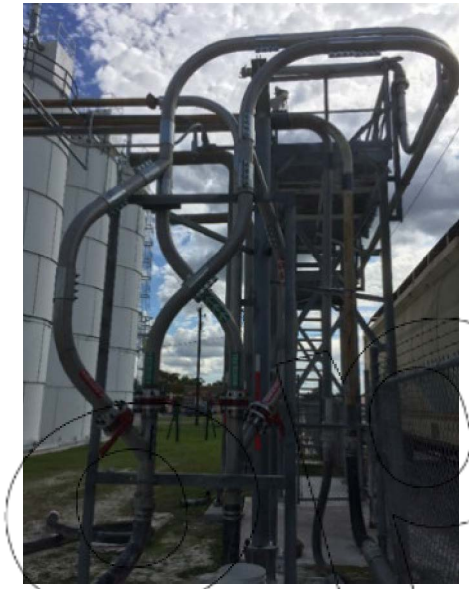
Pressure Drop



Pressure Drop

What increases pressure drop?





- Pipe Layout –
  - Shortest route
  - Back-to-back elbows
  - Inclined lines
  - Excessive hose
- Dirty / clogged filters
- Undersized filters
- Material build up
- Worn out equipment = Leaks
- Material-to-air-ratio

System Guidelines for Dilute Phase

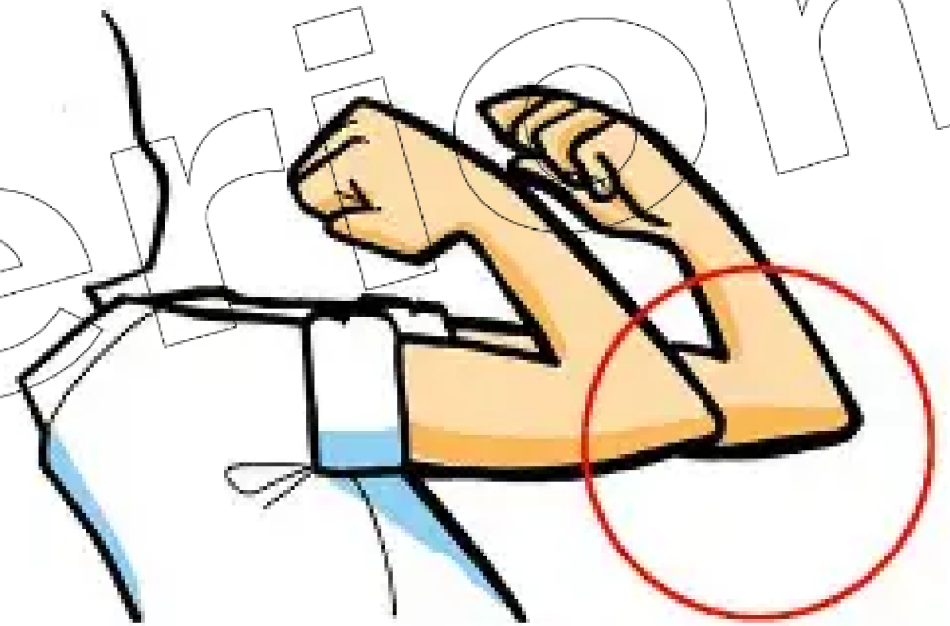
- Keep pipe routing as short as possible
- Use as few elbows as possible
- Keep flexible hose lengths as short as possible
- Provide a 3-meter acceleration zone, after the pick up point to the first elbow
- The conveying line should be installed horizontally or vertically
- Do not angle the conveying line upwards, especially for materials that do not fluidize easily
- Avoid back-to-back elbows
- Material in the line will fall at the end of each draw cycle, which is a problem with sticky powders - Purge the line at the end of each cycle by adding a feeding valve or a purge valve
- Isolate when 3 or more feeding rotary valves are on a common line

FUN FACT

A straight, clean 100-foot run of pipe might seem easy, but the friction it generates means your blower is working hard. To move the same amount of material at the same velocity over **200-feet**, you don't need a blower that's twice as powerful — you need one that's closer to **three times as powerful** to overcome the extra system resistance.

FUN FACT

Every single 90-degree elbow in your pipe layout costs your system the equivalent of adding **25 to 50 feet of straight pipe** in terms of pressure drop and wear. If you have five unnecessary elbows, you're effectively forcing your blower to pump air through an extra 250-feet of hidden pipeline, just to get that material around a few corners.



FUN FACT

A single, tiny pinhole leak in a positive pressure dilute phase line — the size of a paperclip — can result in the loss of enough air volume over a year to **inflate over 10,000 standard party balloons**. That's pure, wasted energy that's not being used to move your product.

FUN FACT

"In a typical dilute phase system, particles can reach speeds up to **100-feet per second** inside the pipe. That's roughly the speed of a cheetah running through your plant—which sounds fast, but it's exactly why friable (delicate) materials often arrive at the end of the line looking like they just went through a tiny, high-speed tumble dryer!“

FUN FACT

"If your separator filters are operating at just **5% inefficiency** due to moisture or caking, the resulting pressure drop is enough to require your blower to work **15% harder** just to maintain the same airflow. It's like trying to drink a thick milkshake through a coffee stirrer — the system is fighting itself every second.

FUN FACT

Coperion process equipment is so common in the plastics industry that if you pick up almost any consumer plastic — from the dashboard of your car to the colorful LEGO bricks your kids play with, or the thin film wrapping your food — there's a very high probability that the highly customized polymer compound inside that product was conveyed, measured, mixed, blended, and processed by a Coperion process before it was molded into its final shape.