Troubleshooting Pneumatic Conveying Systems

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AGENDA

Part 1 – Dilute Phase System Troubleshooting

Part 2 – Dense Phase System Troubleshooting
PART 1
Dilute Phase System
Troubleshooting
What a Pneumatic Conveying System looks like when its working correctly
What a Pneumatic Conveying System looks like when its **not** working correctly
The 4 pieces that every dilute phase pneumatic conveying system has...
Blower Package

• The source of “power” in the system

• Blowers only provide 2 things:
  – The correct VOLUME of air needed
  – The PRESSURE required to generate the power needed
Convey Line

• The tie between point “A” and point “B”
Filter Receiver / Bin Vent

• End of the line where the air and material are separated

Filter Receivers/Bin Vents provide two things:
• A wide spot in the river
• A physical barrier to particulate from escaping the system
Rotary Valves / Airlock

- The “revolving door” of the system

Rotary Airlocks:
- Meters Product into or out of a pneumatic system
- Is the airlock in the system separating the pressure differential
- Not perfect at either, but the only thing that can do both at the same time
What can go wrong with each piece and what to look for
Blower Packages

• Represent about 1% of the problems in the field.
• Reality of Blower Packages: if they run for a week, they will run for the next 20 years
• Belts glaze and Belts break, but speeds should never change
• Pressure relief valves should never open
Blower Packages

Have one very important source of information that is the first place you should look at when troubleshooting:

This is your best indicator of what is going on inside the conveying system.
Pressure/Vacuum Gauge

• Gauge is “bouncing”
  – Early stages of rotary valve wear or velocity too low
  – Possible controls interaction

• Gauge is “higher than normal”
  – Convey line buildup
  – Bulk density of the material higher than normal

• Gauge is “lower than normal”
  – No feed into system
  – Bridging above feed source
Convey Lines

Represent about 5% of the problems in the field.

– Elbows:
  • The main wear point in a convey line
  • The ONLY place where convey lines “blow apart”

– Adding more line to a convey system will impact performance

– You can “feel” what is going on inside a convey line

– Diverter Valves
Convey Line - Issues

• Couplings and gaskets. Not as simple as you think
  – Vacuum gasket protectors
Convey Lines

• Product Build-up “hardening of the arteries”
Convey Lines

• Holes

- Obvious in a pressure system
- Little less in a vacuum system
Convey Lines

• Never Convey at a 45 degree angle up

• Horizontal conveying is “harder” than Vertical
Diverter Valves

- Internal Leaks can fill dead leg
Diverter Valves

• Better design
Filter Receivers / Bin Vents

- Represent about 5% of the problems in the field.
- They are not dust collectors
- “dirty bags” are not a bad thing
  - New bags have the worst efficiency they will ever have
Filter Receivers / Bin Vents

Have one very important source of information that is the first place you should look at when troubleshooting:

This is your best indicator of what is going on inside the filter. 0 – 6” is fine. Steady is great. Bouncing is bad...
Filter Receivers / Bin Vents

The timer board has many functions

- Controls the duration and delay of the cleaning pulses
- Displays the differential pressure across the bags (how dirty are the bags)
- Can be set for on-demand cleaning
- Has a dry contact switch for high pressure alarm
- Has a 4-20mA output for continuous monitoring
Filter Receivers / Bin Vents

Solenoids and Diaphragm valves

- Electrical signal opens the solenoid, letting the air off the back of the diaphragm
- causing it to release a pulse of compressed air down the inside of the filter bags
- Should sound like a rifle shot... not a “woosh” of air. You are snapping the bag clean not blowing it clean
Filter Receivers / Bin Vents

• Holes in bags
  – Along the wires of the cages
  – On the bottom of the bags

• Leaks (doors are the worst)
  – Pressure systems make a mess
  – Vacuum is hard to diagnose and find.
  – Very detrimental to system performance.

• Can Velocity and Interstitial Velocity
  – Separation is by gravity
Rotary Valves / Airlocks

Represent about “the rest”% of the problems in the field.

- Reality of Rotary Valves: They are a very precision device put into a rough environment.
Rotary Valves / Airlocks

Rotary Valves wear out.

• Leave our factory at 0.004” to 0.006” of tolerance
• Are considered “wore out” at 0.015”
• Wear is slow and internal
• Very hard to measure while installed
• It’s a complete business by itself
Rotary Valves / Airlocks

Rotary Valve wear is the hardest part of a pneumatic conveying system to diagnose

- There is nothing that can be done to a rotary valve to be able to measure or predict wear.
- All the wear is on the inside.
- “where is the wear”...not predictable or even.
- Can be a very slow process that takes years
  - “corporate memory”
Rotary Valves / Airlocks

Note that the valve is worn out on only one side
Rotary Valves / Airlocks

Note that the valve is wore out on only one side

Minimal to No Wear  Severe Wear
Rotary Valves / Airlocks

Product Buildup also causes issues.
Rotary Valves / Airlocks

What you can see with rotary valve wear

– Rate has dropped in the system
  • Blow by air increase causing fill efficiency to go down
– Frequency of line plugging going up
– Blower Pressure “bouncing”
SUMMARY – Dilute Phase Troubleshooting
Remember 3 things

• There are 4 main components
• Start with the Rotary Valves
• Determine the frequency of the problem
PART 2
Dense Phase System Troubleshooting
The 4 pieces that every dense phase pneumatic conveying system has...
Air Compressor

• The source of “power” in the system

• Air Compressors tend to fall into 2 categories:
  – Dedicated to and only for the Dense Phase system
  – Part of the plant air system
Convey Line

- The tie between point “A” and point “B”
- Usually pipe not tube
Filter Receiver / Bin Vent

- End of the line where the air and material are separated

Filter Receivers/Bin Vents provide two things:
- A wide spot in the river
- A physical barrier to particulate from escaping the system
ASME Code Pressure Vessel

Pressure Vessels:
• Normally rated to 100 PSIG
• Top or Bottom Discharge
• Normally cycle about 10-13 times per hour
What can go wrong with each piece and what to look for...
Air Compressor

• The source of “power” in the system

• Air Compressors tend to fall into 2 categories:
  – Dedicated to and only for the Dense Phase system
  – Part of the plant air system
Air Compressors

• Oil- Compressed air generates oil mist
  – Oil/Mist separator
Air Compressors

• Water- Compressed air generates a lot of water
  – Desiccant drier
  – Refrigerant drier
Air Compressors

- Accumulator
  - Storage of Compressed Air
  - Should always pump back up to full pressure prior to next convey cycle
  - Keeps the pressure constant on the system air volume controls
Convey Line

- The tie between point “A” and point “B”
- Usually pipe not tube
Convey Lines - Ditto Dilute
Phase issues except:

Pipe not tube

– Due to compressed air codes, usually Schedule 40 or 80 pipe

– Couplings are made for pipe.
You can feel what is going on inside the pipe. Great way to “see” what is going on.
Convey Lines- Boosters

- Used to “stir up” materials that have de-aerated or have become solid plugs.
  - Normally just prior to an elbow
Convey Lines - Elbow Support

- Dense phase slugs have mass...
- Big lines = large slugs = large forces pushing line in direction of travel
- Amplified by materials that tend to de-aerate
Diverter Valves

• Divert Angle and slugs of material
Diverter Valves

- Better design
What is Dilute Phase or Dense Phase Conveying?

• They are different modes of how the material being conveyed flows through a convey line.

• It is 100% the Material not the equipment that determines the difference.
Dilute Phase VS Dense Phase

Dense Phase  Dilute Phase
3 MPH          40 MPH
Dilute Phase VS Dense Phase

40 MPH
Dilute Phase VS Dense Phase

3 MPH
Filter Receiver / Bin Vent

• Exactly the same filters as used on Dilute Phase Systems
Filter Receivers / Bin Vents

- Dense Phase air volumes change
  - Zero flow....vessel filling
  - Average flow....vessel conveying
  - Peak flow....vessel blowdown

- DP reading are going to fluctuate

- Alarm setpoints are almost impossible to set
ASME Code Pressure Vessel

Pressure Vessels:
• Normally rated to 100 PSIG
• Top or Bottom Discharge
• Normally cycle about 10-13 times per hour
Pressure Vessel

Where the “magic” is

• Black Box of Magic
  – Air Control
    » CFM constant
    » PSIG constant
Dense Phase Cycle
Normal

< Time >

- Material
- Airflow
- Pressure
Pressure Vessel

Two Reasons for Dense Phase

- Abrasive material
  Sand, Cement, alumina, perlite ore

- Friable material
  Popcorn, glass spheres, sugar
Pressure Vessel

- For a material to work well in a dense phase system, it has to be either:

  - Permeable.....air can get through it
    - (Popcorn, plastic pellets,sand)

  - Fluidizable....air turns it to “water”
    - (talc, cement, clay)

- Air is always moving down the line through the material...if not....you have a plug
Dense Phase Cycle

Plugged line

< Time >

- Material
- Airflow
- Pressure
Pressure Vessel

- Bottom Discharge

- More common and simpler design. But only work on materials that flow without a lot of assistance out of a hopper
Pressure Vessel

- Top Discharge
- Highly fluidizable powders that tend to flush down the line if you used bottom discharge
- Fluidizing disk can be a high maintenance item
Pressure Vessel – Mark your gauges and lock out your “tweekers”
Dense Phase Problems

Most dense phase problems are in two areas:

– The material has changed

– “Tweekers” increasing the airflow in a system
Questions?

Dense Phase
Troubleshooting
Troubleshooting Pneumatic Conveying Material Handling Systems

We are in **booth #211** if you have more questions...