BASIC SYSTEM CONCEPTS

The following illustrations depict basic principles of different common types of pneumatic conveyors:

1. **Dilute Phase Pressure conveying**. Probably one of the most commonly used concepts for conveying of bulk solids.

   a. Advantages:
      - Competitive cost
      - Simple to operate
      - Reasonable headroom required at feed point
      - More efficient than vacuum
      - Ideal for single source – multiple destination system layout

   b. Disadvantages
      - Not suited for abrasive applications
      - Not well suited for fragile materials
      - Not suited for heavy density materials

2. **Dilute Phase Vacuum conveying**.

   a. Advantages:
      - Minimal headroom at feed point
      - Ideal for conveying from multiple sources to a single destination
      - Good for toxic products or where external leaks can not be tolerated
      - Good for materials that tend to pack or compress under pressure (e.g. fibrous mat'ls.)

   b. Disadvantages
      - Not suited for abrasive applications
      - Not well suited for fragile materials
      - Least efficient type of pneumatic conveyor due to thin (low-density) air
      - Not ideally suited for long distances or high capacities

3. **Dilute Phase Pressure Screw conveying**. This is the "Fuller-Kinyon" principle, whereby the compression of the material itself in the zone of the reduced-pitch screw flighting, creates an "airlock", thus preventing back-feeding. Should the screw become empty, the check valve closes and allows the line to purge out.

a. Advantages:
- Eliminates the need of rotary airlock for abrasive materials
- Relatively high tonnage, long distances
- Low headroom requirements compared to a transporter
- Good for semi-abrasive powders such as cement & limestone

b. Disadvantages
- High capitol cost and operating cost
- Not well suited for fragile materials

4. **Dense Phase Blow-Pot conveying**. Early technology in dense phase

a. Advantages:
- Eliminates the need of rotary airlock for abrasive materials
- Relatively high tonnage
- Usually smaller pipe dia. and filter size than dilute phase

b. Disadvantages
- Not suited for long distances
- Not well suited for fragile materials
- High pressure requirements resulting in high velocities

5. **Semi-Dense Phase Blow-Pot, Fluidized Bottom w/ Top discharge**

a. Advantages:
- Used for fluidizable powders that need aeration to discharge from vessel
- Requires somewhat less headroom than bottom discharge
- Can achieve very high capacities when used with a pre-pressurizing (discharge) valve

b. Disadvantages
- Not suited for non-fluidizable products
- Not well suited for large, or variable particle size
- Less efficient than blow-pot, (Requires more air = higher velocities)

6. **Semi-Dense Phase Blow-Pot, Fluidized Bottom w/ Bottom discharge**

a. Advantages:
   - Used for fluidizable powders that need aeration to discharge from vessel
   - Used for cohesive or difficult to flow powders such as TiO_2
   - Can achieve very high capacities when used with a pre-pressurizing (discharge) valve

b. Disadvantages
   - Not suited for non-fluidizable products
   - Not well suited for large, or variable particle size
   - Less efficient than blow-pot, (Requires more air = higher velocities)

7. **Dense Phase Transporter with Air Assist (Booster) Technology**

a. Advantages:
   - Allows for much longer distances
   - Much more efficient than "Blow-Pots"
   - Lower velocities, - Ideal for fragile or abrasive materials
   - Can handle most types of materials, except large particle size (1" and greater)
   - Can stop/start system with a full line.

b. Disadvantages
   - Transport vessel requires substantial head-room as compared to dilute phase.
   - Greater expense than blow-pot system with out air assist technology.

8. **Air Assist (Booster) Operating Principle**

Given the old principle of Physics, in order for any work to be accomplished, the energy **source** must be at least slightly greater than the **resistance**.

a. In the case of the top illustration of this page, if we assume a given distance of a hundred feet, and the **resistance** to transport “x” tph over this distance in a given diameter pipe is – say 100 psig. In other words, it would take at least 101 psig of air pressure to move this mass if all the energy were put into the top of the transport vessel. The only other option would be to increase the line diameter in order to reduce resistance. There are several disadvantages to this system:

- Most air compressors are limited to 100-120 psig of compression
- Air compressed to 100 psig is = to about 1/6th of its free-air volume. So if you were to require a system to operate at 100 psig, whatever velocity would be required at the beginning to cause the material to move would expand to 6.7 x this speed at the terminal end. (e.g.; A pick-up velocity of 2,000 fpm would equal a terminal velocity of 13,400 fpm) This extremely excessive and would cause severe and dangerous “pounding” in the convey line. Thus, the necessity for low-velocity, -gentle-handling system for abrasive or friable materials is not accomplished.
- The “fix” would be a larger pipe which equates to more air and less efficiency.

b. In the bottom illustration of this page, if we divide the 100 ft. long system into (5) “work zones” by installing (4) air assists, this theoretically divides the resistance by “5”, or 100 psig/5 = 20 psig resistance. So, we now have a 20 psig operating system because we are by-passing the air and injecting it at strategic locations in the system, thus reducing **resistance**.

There are many advantages to this system:

- Substantial decrease in system conveying velocity
- Higher solids-to-air ratios
- Lower energy requirements
- The ability to stop and restart with the line full. (In this case, each Air Assist has only to do 20 feet of work)
- All above results in much more gentle handling of fragile or abrasive materials

The above example is obviously a theoretic illustration only as there are many other factors which contribute system pressure drops (resistance), such as pipe bends, vertical risers vs. horizontal runs, distance between bends, etc. but the described example is what the Air Assists do contribute to the system design.

We frequently demonstrate to our customers when they are visiting our test lab, what effect there is on the system operation and energy consumption with the Air Assists on vs. off, as well as the ability to start a full pipe of material.

The following illustrations depict various technologies provided by *NOL-TEC*:

9. ***NOL-TEC*** **Dense Phase Batch conveying**. Basic dense phase air assist-type system.

    a. Advantages:
    - Competitively priced
    - High tonnage
    - Relatively long distances

    b. Disadvantages
    - "Blow-down" surge at the end of each cycle results in high instantaneous velocity – not suited for abrasive or fragile materials

10. ***NOL-TEC*** **Dense Phase Non-Purge conveying**. Pipeline remains full between batch re-fill.

    a. Advantages:
    - Excellent for very fragile and very abrasive products
    - High tonnage
    - Long distances

    b. Disadvantages
    - Slightly higher cost than "purge-type" system due to additional valving and controls
    - Not recommended for cohesive materials which may be difficult to re-start in a full line.

11. ***NOL-TEC* Dense Phase Continuous conveying**. Uses two transporter which alternate their filling and blowing cycles.

   a. Advantages:
      - Good for high tonnages over long distances – (no dead time consumed in de-pressurizing and re-pressurizing line.)
      - Good for fragile and abrasive materials providing virtually no pressure change surges

   b. Disadvantages
      - Quite expensive since all major components of the system are doubled
      - Requires significant elevation due to side-by-side filling or with over-under transporter arrangement

12. ***NOL-TEC* Dense Phase Vacuum conveying**. Where vacuum conveying is required with fragile or abrasive materials.

   a. Advantages:
      - Low velocities as with pressure dense systems
      - Good where low-profile feed is required such as railcar unloading or from low discharge silos

   b. Disadvantages
      - Not as efficient as pressure dense phase systems
      - Limited in pressure differential
      - Rather limited in distance

13. ***NOL-TEC* *"Slow-Flow"* Dense Phase Airlock Continuous conveying**. Fairly new technology for continuous conveying of fragile powders.

   a. Advantages:
      - Low elevation requirements
      - High tonnage
      - Relatively long distances
      - Continuous conveying
      - Air Assists can be added for long powder systems
      - Good for plastic pellet conveying
      - Usually higher capacity than comparable line dia. in pressure dilute phase

   b. Disadvantages
      - Not recommended for abrasive materials

Other useful information:

Air Cycle Calculation: Defines the difference between "Surge" air and "Average" air, and depicts an example of how they are calculated.

Testing Sieve Reference Chart: Depicts comparison and visual example of different units of particle size measurement.

Sea Level Conditions vs. High Altitude: Depicts a physical comparison of a given volume of air at sea level vs. high altitude (Denver, CO)