

## Ask Joe! Column

### How to Get a Pneumatic Conveying Pipeline to Handle More

Guest article by Jack D. Hilbert, Pneumatic Conveying Consultants



Process lines are often asked to produce more material with existing equipment. The limitation in achieving this goal is often not the specific process itself but auxiliary equipment and components upstream and / or downstream of the process.

Pneumatic conveying systems often are used to transport materials directly into process lines or staging areas where blending, mixing, pre-conditioning takes place prior to the actual process. Downstream of the process, pneumatic conveying is often used to transport products to the next stage of their production or to storage for subsequent packaging and distribution.

The pneumatic system has four basic components; air supply, line charger, pipeline and product receiver. Each area in itself is a topic for discussion.

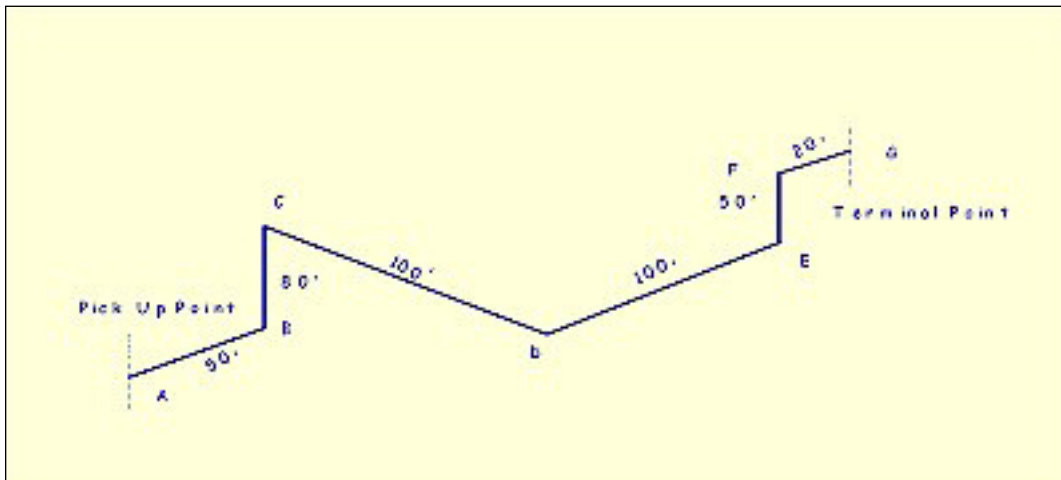
#### Conveying Pipeline Example

We'll take a specific sample case and look at some options for the conveying pipeline. We'll focus on the practical and real world issues rather than spend time on extensive theoretical analyses.

There are a few basic pneumatic relationships which you may have learned in the past but are worth mentioning as we will refer to them during our analysis;

- Conveying capacity is inversely proportional to conveying distance
- Conveying pressure is directly proportional to conveying distance
- The relationship between pressure (P) and volume (V) are constant between any two points in a system.

Figure 1. Pneumatic Conveying System Diagram



Let's assume the problem at hand is a dilute phase pressure conveying system, handling a product with the following characteristics and a pipe layout as shown in the diagram (Figure 1);

- Particle size ~ 1/8", Loose bulk density ~ 35 pcf
- System Capacity = 30,000 pounds per hour
- Conveying Line = 6" diameter; 270 ft. horizontal, 130 ft. vertical with (5) x 90 degree bends
- Plant is at sea level location, material is at ambient temperature
- Existing blower duty is 1,200 ICFM at 11 psig.

Our example continues by considering the affect of a production capacity increase which will increase our conveying rates to 35,000 pounds per hour.

The primary consideration for the conveying line is to find a way to handle the increased capacity with the minimal amount of increase in conveying line pressure. While this may seem like a formidable task at first, recall one of our basic relationships that conveying line pressure is directly proportional to line length.

When we refer to line length, what we actually mean is equivalent line length which not only takes into account the summation of horizontal runs and vertical runs, but the number of bends in the system as well.

If we can find a way to reduce the equivalent length of pipe, we can effectively reduce the pressure differential required to move the material through the line. This represents two possibilities;

1. Move the same amount of material at a lower pressure drop or,
2. Move more material at the same pressure drop before the equivalent length change was made.

Let's look at two possible ways of reducing equivalent pipe length.

### Line Routing Optimization

Shortening the conveying line may seem so obvious to everyone yet it is one of the techniques least utilized in actual practice. It seems that system designers often envision the pipe as having to follow building walls, staircases, roof lines, etc. and use esthetics as the driving consideration. Many times, this results in considerable more straight pipe and many more elbows than necessary – all which add to the total equivalent length of the convey line.

Let's take a look at our example. In the sketch presented earlier, look at the line segment C-D-E. If we were able to change the pipe such that we ran directly from C to E, we can eliminate approximately 59 feet of horizontal pipe and (1) elbow.

The table represents the blower duty requirements for the original as well as the modified condition.

<b>Blower Duty</b>	<b>With Segment C-D-E Installed</b>	<b>With Only Segment C-E Installed</b>
ICFM	1,200 cfm	1,100 cfm
Discharge Pressure	11 psig	9 psig
BHP	79 hp	62 hp
Conveying Rate = 30,000 pounds per hour		

Remembering that capacity is proportional to line pressure, since we have reduced line pressures by 19%, we should be able to handle a capacity increase, from the pipeline perspective, of 19%. In this example, the

capacity increase from 30,000 to 35,000 pounds per hour represents roughly a 16% increase. By just making the piping change to reduce the length as shown we should be able to handle the change of capacity.

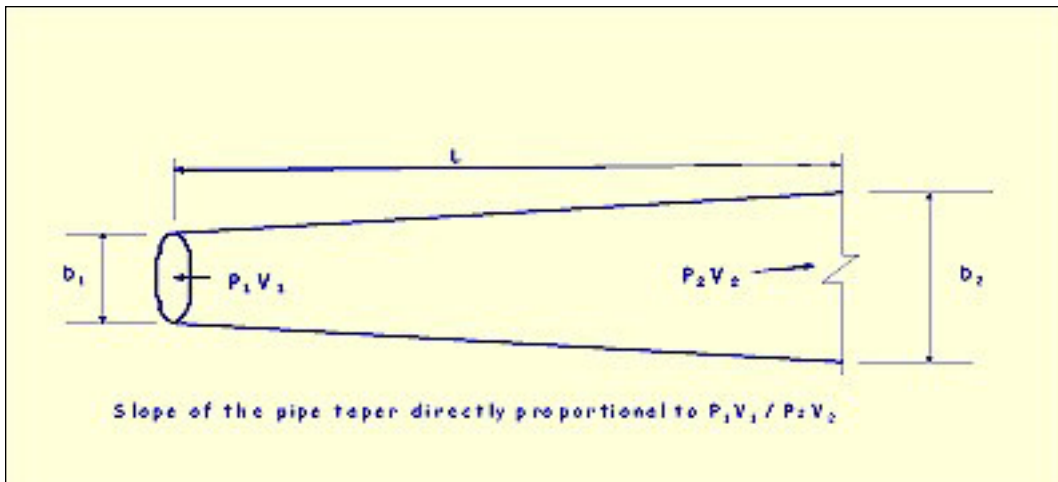
## Line Stepping

Another pipe line technique available is what we call "line stepping". Before we proceed with that thought, let's go back to our favorite relationships for a moment.

We know that as the pressure decreases along the line from the pick-up point to the discharge, the air volume expands and therefore if the pipe is a constant diameter, the velocity has to be continually increasing. With that thought, we can say that in an ideal world, if we could have a pipe line which is tapered, and that taper was at the same rate as the pressure ~ volume relationship is changing; we could effectively keep velocity as a constant.

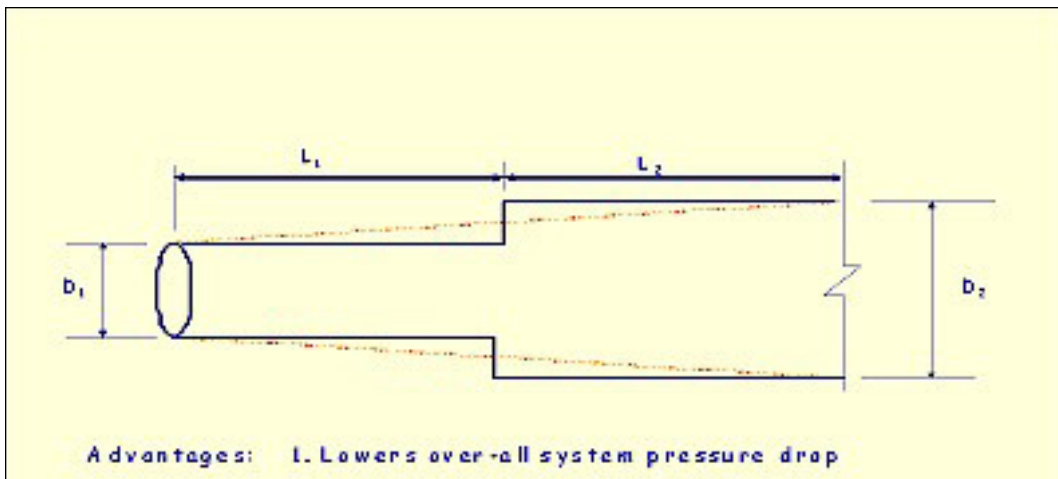
The following diagram reflects this train of thought (Figure 2);

Figure 2. Pressure - Volume Relationship in a Tapered Line



Tapered pipes are not readily available so as an alternative, we can accomplish the goal from above by using the concept of "line stepping" to increase the pipe diameter with the next size of commercially available pipe. This concept is as shown below (Figure 3);

Figure 3. Line Stepping



Line stepping is an effective way to reduce conveying line pressure which can allow for the handling of incremental capacity. The location of the step must be selected which will still provide adequate conveying

velocity in the pipe line. If a system is extremely long, multiple step points can be used. In the actual system, the increase in diameter would be accomplished via a smooth transition piece.

Let's now take our sample problem and consider two situations;

1. Keep the original pipe line geometry and step the line from 6" to 8" at Point "E" and,
2. Change the line by using segment C-E in lieu of C-D-E but include stepping at Point "E" as well.

The table below is similar to that presented earlier when we evaluated the use of a shorter line but now we can see the results of adding line stepping as well.

<b>Blower Duty</b>	<b>With Segment C-D-E</b>	<b>With Only Segment C-E</b>	<b>With Segment C-D-E &amp; Line Stepping</b>	<b>With Segment C-E &amp; Line Stepping</b>
ICFM	1,300 cfm	1,200 cfm	1,260 cfm	1,150 cfm
Discharge Pressure	13 psig	11 psig	12 psig	10 psig
BHP	102 hp	79 hp	92 hp	71 hp
Rate = 35,000 pounds per hour				

## Summary

In this discussion, we have seen how a relatively easy modification to an existing pneumatic pipeline can provide a means of handling higher conveying rates or how an existing system can be made to operate with lower energy requirements.

Before spending money to purchase a new conveying system to handle higher rates, take a look at the existing system and evaluate what incremental capacity increases can be achieved through the systematic process of de-bottlenecking the existing equipment first.

Remember to always evaluate what affect a change to any one of the four basic parts of a pneumatic system has on the others before implementing the change. In subsequent articles, we will look at the other basic components in light of the same example problem.

## Comments, Suggestions and More!

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## About our Author

Mr. Hilbert received his BS in Mechanical Engineering and MS Engineering Science degree from Penn State University. Since 1980 he has been a registered Professional Engineer in state of Pennsylvania.

Jack has over 32 years of professional experience in bulk material handling systems and environmental products. He also has authored numerous technical papers on various subjects relating to bulk material handling systems. Formerly with Fuller Bulk Handling Corp., Jack is now with Pneumatic Conveying Consultants.

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**Welcome to Ask Joe!**, a monthly column by our resident materials handling guru, Joe Marinelli of Solids Handling Technologies. Joe addresses the issues that bug you the most. And Joe knows!! Formerly with Jenike & Johanson, Solids Flow and Peabody TecTank, Joe is an expert on materials handling.

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Guest articles for the **Ask Joe!** Column are always welcome, for more information please contact Joe Marinelli directly at his email address: [joe@solidshandlingtech.com](mailto:joe@solidshandlingtech.com).

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