Guidelines for Improved

Foundry Operations

Little Known Facts About Successful Sand Handling
and
How You Can Slash Transporter Operating Costs By Up To 45%

Presented by:

Alb Klein Technology Group, Inc.
8275 Estates Parkway
Plain City, OH 43064-8408
Tel.: 614.873.8995 *** Fax 614.873.8996
http://www.albklein.com
e-mail: info@albkleinco.com

"Little Known Facts About Sand Handling That Can Slash Your Operating Costs by up to 45%"

Unique Air Conveyor System Shows You How It Can Be Done

Chris Doerschiag, P.E.

Pneumatic conveying systems in general can be divided into two broad categories. Dilute Phase conveying and Dense Phase conveying. Dilute Phase conveying works by vacuum or low pressure air of up to 20 psig and velocities in the pipe of 4000 FPM and higher, while Dense Phase works by medium pressure air of 10 - 60 psig and pipeline velocities of 2800 - 5000 FPM.

The PLUG FLO® system, which is an extension of the Dense Phase concept, works between 15 - 90 psig air pressure, can transfer sand at the low velocities of only 100 to 450 FPM and does it all with up to 45% less air. This means that sand velocity with a PLUG FLO" system can be as much as 6 to I 0 times. lower than in dilute and dense phase systems. Pipe line wear is drastically reduced, sand degradation practically eliminated and operating costs slashed to the bone.

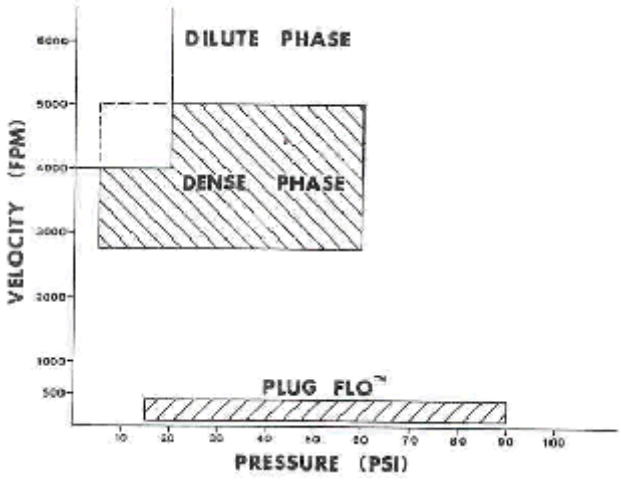


Fig.1 Types of Pneumatic Conveying Systems

The terms "dilute", "dense" and "plug" all refer to the material to air ratio (loading ratio) of the respective conveying system. Dilute Phase has the lowest and PLUG FLO® has the highest loading ratio. In a Dilute Phase system the loading ratio is only about 0.06 to 0.3 pounds of material per cubic foot of air. High velocity air is necessary to entrain the particles and while in suspension bounces them along the pipeline to the receiver. It's like a hurricane in a pipe and only powders and "soft" materials can survive such a trip. Dilute Phase is definitely not a good choice for moving sand pneumatically.

Most Dense Phase systems have a higher loading ratio of approximately 0.3 to 1 pound of material per cubic foot of air and require fluidization for transport. Before the material leaves the blow tank it has to be fluidized to "flow". Once in the pipeline it also has to be kept in fluidized suspension, which is accomplished by injecting additional air from a parallel pipeline thru boosters. This additional air, however, adds to the volume of air already in the pipe causing an even higher velocity and subsequent material degradation. If sand is transported in such a way the resulting abrasion can change the screen size by several points and wear out pipe prematurely.

Dilute Phase Dense Phase PLUG FLO®

Fig. 2 Material Distribution in the Pipe Line

For History Buffs

The first attempts of material handling by pushing solids thru a pipe line with compressed air was around 1853 when mail was rolled up in a small round cannister of approx. 3/4 inch diameter and blown 300 feet in a pipe line made from lead. This method of efficiently moving paperwork has in the meantime been expanded to the well known drive in stations at banks where all you hear is a "swooshhh" as your deposit slip is whisked to the bank teller.

Dilute Phase conveying systems date back to approx. 1888 when vacuum was used to unload ships loaded with grain.

From these humble beginnings air conveying was tried out in flour mills and cement plants where a lot of the basic design parameters for such systems were discovered and developed.

The big boost in pneumatic conveyor development and ifs application to a wide variety of industries, however, came during the Forties when the fledgling plastics industry took a more serious look at how best to transfer large volumes of granular materials, without contamination from ambient conditions.

Based on such experiences pneumatic conveying - both dilute phase and dense phase - gained in popularity until today when it has become a well known technology just waiting for the right applications.

Now, what works in one industry may not necessarily be applicable for another industry and when it comes to moving sand in a foundry these dilute and dense phase systems have simply been copied from other industries for foundry applications.

As experience has shown however, not necessarily the best solution!

Dilute and dense phase systems may be the solution for “soft" materials such as powders and fines that can withstand the high velocities in the pipeline without being destroyed in the process. But for foundry sand high velocity, fluidizing systems should not be used at all or only as a last resort if nothing else is economically feasible and sand degradation is ignored.

The PLUG FLO® System

The PLUG FLO® pneumatic conveying system is an extension of the dense phase concept and has been developed exclusively for moving dry foundry sand thru pipe lines efficiently and cheaply. Because of its success in foundries it has also found application in other industries for similar rugged, heavy duty applications.

Even though the PLUG FLO® system is only one of several types of air conveying systems available it offers considerable advantages for foundry sand applications when compared to the dilute and dense phase systems.

Advantages of the PLUG FLO® System:

What are the advantages of the PLUG FLO® system? Lets see:

First:
You don't need fluidization!
This means -
- 40% lower compressed air consumption;
- fewer parts to install and maintain;
- less compressor energy required;
- lower operating cost and
- Standard Schedule 40 Pipe is OK.
No need for heavy duty pipe.

Second:
You don't need boosters!
Again, this means -
- lower compressed air consumption and
- elimination of the extra booster piping and fittings;
- smaller dust collectors;
- reduced installation labor;
- fewer parts to install;
- minimal maintenance;
- a less complicated system.

Third:
Much lower velocities!
Translating into -
- Considerable less pipe line wear!
- fewer costly repairs and
- less waste of compressed air.
(Leaks in the pipeline waste a lot of compressed air)

Fourth:
Lower sand degradation because of lower velocities!
Resulting in -
- less dust generation;
- less waste material;
- savings in resin consumption; (excessive dust in the sand soaks up resin like crazy);
- more efficient operation;
- and improved house cleaning.

Are these benefits worth a closer look?

You decide!

How Does It Work?

(If you want to know the nitty-gritty technical details)

A pneumatic conveying system generally consists of a bulk material storage bin, a blow tank, a pipe line, one or more receiving bin(s) and controls. Since the equipment itself does not move - like a belt conveyor or elevator - the casual observer can not see anything happening and most of the time does not know (or care) what is really happening.

So let's examine what is going on. Let's take a look at the basics first because we can judge only by what we know and the devil is always in the detail.

Operation Of The PLUG FLO® System:

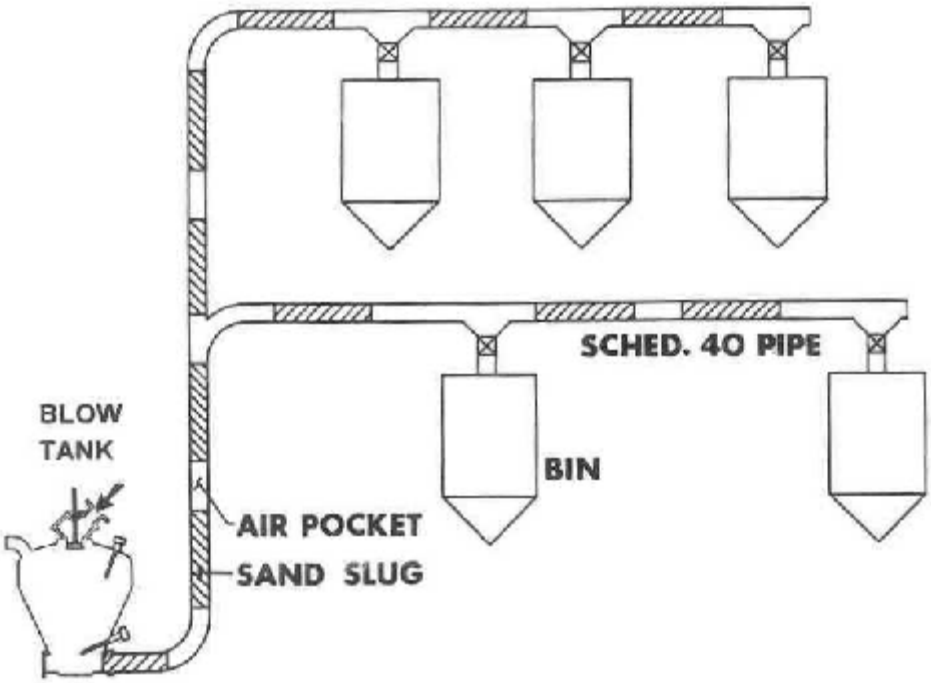
After filling the blow tank by gravity from a hopper or other bulk sand source the sand inlet valve is closed and the tank is pressurized with compressed air. By watching the pressure gage on the blow tank we can observe how the pressure in the blow tank builds up and once the required transport pressure has been reached - which can be as low as 15 - 20 psi, depending on system layout - the sand extrudes into the conveying pipeline in the form of slugs.

Depending on the particle size distribution of the sand, the pipe diameter, internal pipe wall roughness, operating pressure and other factors, slugs formed at the blow tank outlet vary in length from approx. 4 feet to 10 feet. When the appropriate length of the slug has been reached sand flow momentarily stops and compressed air rushes into the pipe right behind the slug until the next slug forms and so on. The slugs, driven by the force of the expanding compressed air move along the pipeline until discharged into the receiving bin at the other end of the line. The receiving bin separates the sand from the conveying air. The sand collects in the bin while the dust laden air is ducted to a dust collector for cleaning before discharge to the atmosphere.

During this entire process the sand is NOT fluidized by air. NOT in the blow tank before being extruded into the piping and NOT in the pipeline during transport. This automatically means less air consumption. Also, there are NO BOOSTERS required to help push the sand. Another saving of air consumption when compared to many dilute and dense phase systems. The only motive power is the compressed air injected at the blow tank.

Slugs in the real world are made up of a compressed mass of sand grains of various sizes, which makes the slugs porous - a key factor in the PLUG FLO® system. The compressed air in the pipeline not only pushes against the nearest slug face but penetrates the porous slug and fills the spaces between the slugs.

Operation Of The PLUG FLO® System:



PLUG FLO® TRANSPORTER

Fig. 3 Typical PLUG FLO® Sand Transporter System Layout

When the blow tank is empty, indicated by a level probe near the tank outlet, it is depressurized by venting to atmosphere, and refilled with sand for another cycle. As the blow tank is depressurized the entire pipeline is also depressurized and the flow of sand stops. In the horizontal pipe sections the slugs simply come to rest wherever they are. In the vertical pipe section the slugs settle in the lower section of the riser. At the beginning of the next cycle, compressed air again fills the blow tank and rushes thru the porous slugs of sand until the entire pipeline is pressurized and the slugs start moving again. The sand column in the riser also separates into slugs which are being pushed along by the expanding air.

The driving force of the PLUG FLO® system is the static pressure of the compressed air behind the slug of sand in the pipeline. The slug of sand is pushed by the compressed air like a piston in a cylinder.

For slug movement to take place the force generated by the compressed air acting on the rear face of the slug must be greater than the resistance caused by the weight of the slug plus the friction generated by the sand rubbing against the pipe wall. The total force acting on the slug is, therefore, proportional to the pressure of the compressed air.

As the compressed air in the pipeline rushes toward the open discharge at the receiving bin end the initial static pressure decreases. In doing so, however, the actual air volume expands resulting in increased speed. This is the reason for the increase in sand velocity from approx. 100 feet per minute at the blow tank discharge to 450 feet per minute at the receiving bin, a distance nearly 330 feet away.

The unique features of the PLUG FLO® system make it possible to move sand thru pipelines with practically no degradation. What's more, with the lower transport velocities pipe wear is drastically reduced. Some installations have been operating on a daily basis for over five years without significant pipe wear.

What To Look For?

Hints for improved installation and operation

Whenever dry and granular materials such as sand are handled in bulk volume PLUG FLO® air conveying should be considered. This includes all sand handling systems such as the raw sand supply and distribution for core making and molding systems, reclaimed sand and shell sand. For powders and other fines such as bond materials, iron oxide, etc. fluidizing, dense phase systems should be considered.

Part of the analysis should always include a particle size distribution check of the material. If a material is made up of a mixture of ingredients with different bulk densities and a large range of particle sizes, air conveying may not even be a choice at all. If in doubt, check with the material vendor or conveying system supplier.

The materials should always be dry and free flowing. If larger, hard lumps of material are present a screen should be installed upstream of the blow tank. System capacity is also influenced by the dust and moisture content of the material. The higher the dust and moisture content, the lower the flowability and / or capacity.

If supply air pressure drops below design conditions, capacity will decrease and may even stop if below a certain value. When distributing sand to the core room the transport air should be free of any moisture. Moisture in the sand causes problems with some binder systems (especially cold box) which are not compatible with external moisture and will result in scrap cores.

Air flow to the blow tank should always be adjusted to the minimum necessary to keep the system operating properly. Check the manufacturer's operating manual for recommended settings. Excessive air flow in a PLUG FLO® system can cause just as much damage as a dilute phase system. Turning up the air flow does not always give higher throughput. In fact it may cause just the opposite and result in high shock waves in the pipe line, damage to pipe supports, premature pipe wear and degradation of the sand.

All pipe connections must be tight and pressure tested. Leaky pipe joints change the system design conditions and may stop sand flow completely.

When properly designed the ran and size of the pipe line is matched to the required system performance. Changing pipe diameter or layout of an existing pipe run may have unexpected results. As a rule of thumb pneumatic conveying can be expressed as a ratio of capacity to a given length of run. The shorter the run the higher the capacity. This means if the system is designed for 10 tons per hour at 250 feet, extending the run to 300 feet will correspondingly reduce the capacity.

When considering the pipe line layout vertical runs should always be located within the first one-third of the run length. Pipe runs should be laid out with minimum change in direction and have a maximum of straight sections. Pipe bends and risers near the end of a line should be avoided.

Minimize the number of bends in the pipe line. A maximum of three bends will satisfy most installations. The fewer the number of bends the better will be the conveying capacity.

Receiving bins should have plenty of "disengaging" height. The force of the compressed air and of the sand slug entering the receiver is considerable and must be allowed to dissipate. If not properly sized the turbulence generated will push a lot of good sand into the dust collection system.

Once a new system has been placed into operation and works satisfactorily, keep a record of the operating parameters and if something should go wrong at a later date - maybe because someone changed the settings, you can cross check operating data and make necessary corrections to the system.

Conclusion

Pneumatic conveying, when chosen and operated correctly can have a profound impact on material handling in your foundry. Your correct choice can eliminate or reduce potential problems with dust collection and maintenance of conventional material handling systems. Therefore, investing some time and effort to evaluate key factors of the various options will result in

better decisions and fewer headaches down the road.

There is additional technical data available going into more detail of the PLUG FLO® System, it's features and operations. The collected data is backed up by actual installations in many foundries. But whether or not you are interested in understanding all the details of why the PLUG FLO® system is the way to go, if you have sand to be transferred in your foundry and want to look into slashing your transporter operating costs by up to 45%, reduce. pipe wear and sand degradation, you should definitely investigate the PLUG FLO® system now.

There is a special "do-it-yourself' Transporter Selection Kit available upon request, which makes choosing the right system as easy as possible. Take advantage of this program now. All you do is fill in the blanks on a data sheet for your particular installation and make your selection from a chart. And you can do it right where you are, without the pressure and hassle of an outside salesperson. For your copy of the **SP25 Technical Report** or the **PLUG FLO® Selection Kit** and answers to any questions you may have, contact the author. Don't delay. Every day you procrastinate may cost you dearly in lost profits.

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The Klein Company Commitment

The Alb. Klein Technology Group of Plain City, Ohio provides system engineering, equipment, parts and service to the foundry industry.

Striving to help our customers remain competitive and profitable we specialize in foundry sand processing and related areas and work closely with our customers to meet their requirements and specifications. Scope of supply may range from a single piece of equipment to complete engineering and plants, including:

- ✔ Klein PLUG FLO© Sand Transporter
- ✔ Klein FKS Fluidized Bad Sand Heater/Cooler/Sifter
- ✔ Klein KU Gravity Sand Heater/Cooler
- ✔ Klein Vibratory Core Sand Mixer
- ✔ Klein STATORMIX™ Core Sand Mixer
- ✔ Klein BMP Precision Liquid Metering Pumps
- ✔ Klein CERAFUME™ High Temperature Gas Filtration
- ✔ LIPPKE™ Green Sand Moisture Control
- ✔ Klein Rail Vehicle Sanding System

By investing considerable sums of money and talent into the company's own research and development activities for over two generations now, Klein constantly strives for technological advances and leadership in this field. Klein's goal always has been to develop and gather the best available technology so that our customers are assured state of the art equipment and systems. Perhaps this is one of the reasons why today Klein equipment can be found in most industrialized countries of the world operating, successfully every day.

Alb Klein Technology Group, Inc.,
8275 Estates Parkway,
Plain City, OH 43064-8408
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