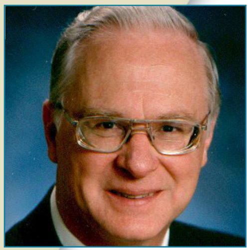
Maintenance and Troubleshooting of Pneumatic Conveying Systems for Sand in a Foundry



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Article Takeaways:
1. Troubleshooting Guide
2. Difference between Dilute Phase and Dense Phase conveying.

No doubt, minimizing maintenance costs ranks near the top priority when planning new foundry equipment investments. Maintenance is an integral function of the foundry equipment; therefore, the foundry engineer can greatly influence and predict such costs at the time a particular piece of equipment is selected. The more that is known about how a system functions (and the various factors influencing its operation), before the final decision to made to purchase is made, the better the chances of controlling future maintenance costs and loss of production.

Typical cases where this specifically applies are in the pneumatic conveying systems for transferring sand in a foundry. Often these systems are tucked away in a corner or the basement of the plant and the only time attention is paid to its operation is when the system has stopped to operate. Ideally decisions to purchase should be based on understanding the difference in possible maintenance requirements for each option.

Pneumatic conveying systems can generally be divided into two broad categories. Dilute Phase and Dense Phase conveying. Dilute Phase conveying works by vacuum or low pressure air of up to 20 psig and velocities in the pipeline of 4,000 FPM and higher, while Dense Phase works by medium pressure air of 10 – 90 psig and pipeline velocities of 450 – 2,500 FPM.

The concept of dilute and dense phase systems in pneumatic conveying goes back 130 years. However, what works in one industry may not necessarily be applicable for another industry and when it comes to moving sand in a foundry, dilute and dense phase systems have simply been copied from other industries for foundry applications. As experience has shown, however, that these are not necessarily the best solutions!

The terms “dilute” and “dense” refer to the material to air ratio (loading ratio) of the respective conveying system. 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 some require boosters for transport. This additional air, however, adds to the volume of air already in the pipe causing higher velocity and subsequent sand 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 and dense phase systems with higher material velocities may be the solution for “soft” materials such as powders and fines that can withstand the higher velocities in the pipeline without being destroyed in the process. But for foundry sand high velocity, fluidizing systems should only be used as a last resort if nothing else is economically feasible and sand degradation is ignored.

To take advantage of a combination of factors which make the pneumatic conveying of dry sand in a foundry efficient and economical, a Dense Phase system, operating at the lowest practical velocity but higher pressures would be preferred.

Because of the much lower velocity, pipeline wear is drastically reduced, sand degradation practically eliminated, and operating and maintenance costs are slashed to the bone. Therefore, these systems are now the preferred choice for foundries.

But just like a race car, if you expect top performance you have to keep it properly tuned. Even the best Dense Phase system performs as designed, only if installed correctly and periodically monitored.

Since the main adjustments in any pneumatic sand conveying system are sand feed rate, air pressure and air volume, it is quite possible to convert a Dense Phase system, perhaps unknowingly, into a Dilute Phase system, with all its disadvantages, by simply ignoring the correct settings.

Preventive maintenance needs to be taken into consideration during the system design stage to prevent situations where frequent maintenance becomes necessary.

Hints for improved installation, operation and maintenance

Part of the system analysis should always include a particle size distribution check of the sand. For sand contaminated with excessive fines or dust, air conveying may not even be a choice at all.

The sand should always be dry and free flowing. If debris is present a screen must be installed upstream of the blow tank. System capacity is also influenced by the moisture content of the sand. The higher the moisture content, the lower the flowability and/or capacity.

When distributing sand to the core room, the transport air should be free of any moisture to prevent problems with binder systems which are not compatible with external moisture and will result in scrap cores.

Air flow should be adjusted to the minimum necessary to keep the system operating properly during startup. Excessive air flow in a Dense Phase 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 pipeline, 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 run and size of the pipeline is matched to the required system performance. Therefore, if a system is designed for 10 tons per hour at 250 feet, extending the run to 300 feet will correspondingly reduce the capacity.

Pipe runs should be laid out with a minimum of bends (pipe bends and risers near the end of a line to be avoided).

The entire pipeline must be rigidly anchored and supported so that it cannot sway or move during operation. Rod-type pipe hangers are not permitted. Unlike air, gas or water pipelines, sand pipelines are affected by impact loads of sand slugs which causes vibrations and movement of the pipeline unless it is properly anchored.

All pipe sections and pipe bends should be connected with special flanged joints only. Butt welding of pipe sections, instead of flanged connections, should not be attempted because the welds of the pipe joints protruding inside the pipe promote local wear and quickly cause leaks in the sand pipe.

Once a new system has been placed into operation and works, keep a record of the operating parameters. And later if something goes wrong , you can cross check operating data and make necessary corrections to the system.

Recommended Inspection And Maintenance Procedures

1. To avoid damage, all wear parts (those in contact with the sand) must be checked regularly, and if required, replaced.
2. Maintenance intervals will be determined by usage of the transporter. To keep track of maintenance intervals, a batch counter should be furnished in the control panel.

At a minimum, the following items should be checked at regular intervals of 40,000 cycles: main seal, inlet cone, vent cone, vent cap, discharge flap, seal ring, and leaf spring. Note, different designs have different wear parts.

3. To inspect the wear parts, all air pressure to the transporter must first be turned off, locked-out, and drained.
4. During normal operation the main seal of the transporter blow tank will wear, and therefore, must be checked at certain intervals for wear or cracks by observing the inlet cone through the inlet housing sight glass lens. During a transporter cycle, watch for escaping air around the main seal. (If not available on a particular brand, the valve should be disassembled and checked carefully.)
5. Check for problems with the Air Spring by inflating the Air Spring and checking for leaks. If air leaks are detected replace the Air Spring. Should the Air Spring hesitate to complete its stroke check for external dam age to the air controls. If not equipped with an air spring, check whatever device operates the main inlet valve.

Conclusion

Pneumatic conveying, when chosen and operated correctly can have a profound impact on sand handling in your foundry. The correct choice can eliminate or reduce potential problems with dust collection. Excessive fines generation, and maintenance. 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.

Trouble Shooting Guide

Condition	Possible Cause
Receiving bin not being filled when empty.	Transporter is not ON.
	Transporter is in fault condition.
	PLC is not in run mode.
	Bin level probe defective.
	Level probe cable damaged.
	Level probe out of calibration.
	Pinch valve not opening (in multi-bin systems).
	Bin fill selector switch is in the off position (in multi-bin systems).

Sand fill time too long.	Fill time timer needs adjusted. Wet sand. No sand in supply bin. Sand inlet blocked. Vessel not vented. Open/Close inlet valve solenoid not working. Quick exhaust valve not opening.
Transport time too long.	Insufficient air pressure. Inlet cone not closed. Vent cone not closed. Air spring not inflated. Leaking main seal. Leaking vent seal. Discharge flap proximity switch defective. Air flow control valve not adjusted properly. Discharge flap leaf spring broken. Leaks in transport pipe. Transport pipe blocked. Excessive dust in sand. Receiving bin level probe not reading full. Pinch valve not open. More than one pinch valve open (in multi-bin systems).
Transport cycle ends prematurely.	High blow time alarm set too low. Discharge flap proximity switch defective. Blow tank pressure on solenoid not open. Main air valve solenoid not open.
Capacity decreases.	Main air supply pressure changed. Wet sand. Dirt build up on orifice ring. Main air supply filter plugged. Worn vent cone or vent cap. Flow control valve setting changed. Main air valve solenoid not open. Lumps or debris in sand supply: (Inlet valve cone cannot close tightly causing air leaks). Worn discharge flap or damaged discharge nozzle.
Transporter delivers product to more than one bin during a single blow (for multi-bin systems).	No air pressure at fill valve. Air pressure at fill valve set to low. Fill valve solenoid Spool is in vent position. Damaged fill valve sleeve (replace).

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