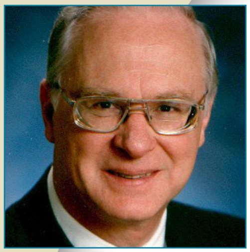
Better Sand Reduces Defects



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Article Takeaways:

1. The difference between Dilute and Dense Phase in Conveying and sand impact
2. Where sand degradation occurs prior to production
3. How to reduce sand velocities to reduce defects and operating costs

Conducting a survey among foundry management would no doubt discover a common goal of satisfying the customers' expectations with a quality product. In other words, castings that meet specifications and will not turn into problems later during the machining or assembly process into the final products. Stated simply castings without defects.

Castings without defects are the result of meeting quality control requirements with certain procedures in place which are strictly adhered to.

Studying Defects Prevention we can find a number of definitions which all contribute to the desired outcome and can point us in the right direction.

How do you define Defects Prevention? Let's see who says what:

- Corrective and Preventive actions (Galin); or
- The activities involved in identifying defects or potential defects and preventing them from being introduced into a product (Zahran); or
- A program focusing on those process areas that are the greatest sources of trouble whether methods, technology, procedures or training (Humphrey); or

As summarized by the world famous quality guru Dr. W. Edwards Deming:

- It's what is needed in improvement of the process, by reduction of variation or by change of level or both. Study of the sources of product, upstream, gives powerful leverage on improvement.

Sources and causes of defects in the final casting vary all over the map but for the sake of simplicity today we will limit our discussion to sand because "Sand Matters!" Of course discovering a defect is only the beginning of the process with the next step being what to do about it. You can simply accept the fact that you are faced with a defect, try to repair it and continue production without consideration of cost, or you can spend time and effort to discover the root cause and work on eliminating it, which may require a more detailed analysis of the entire process including the production equipment.

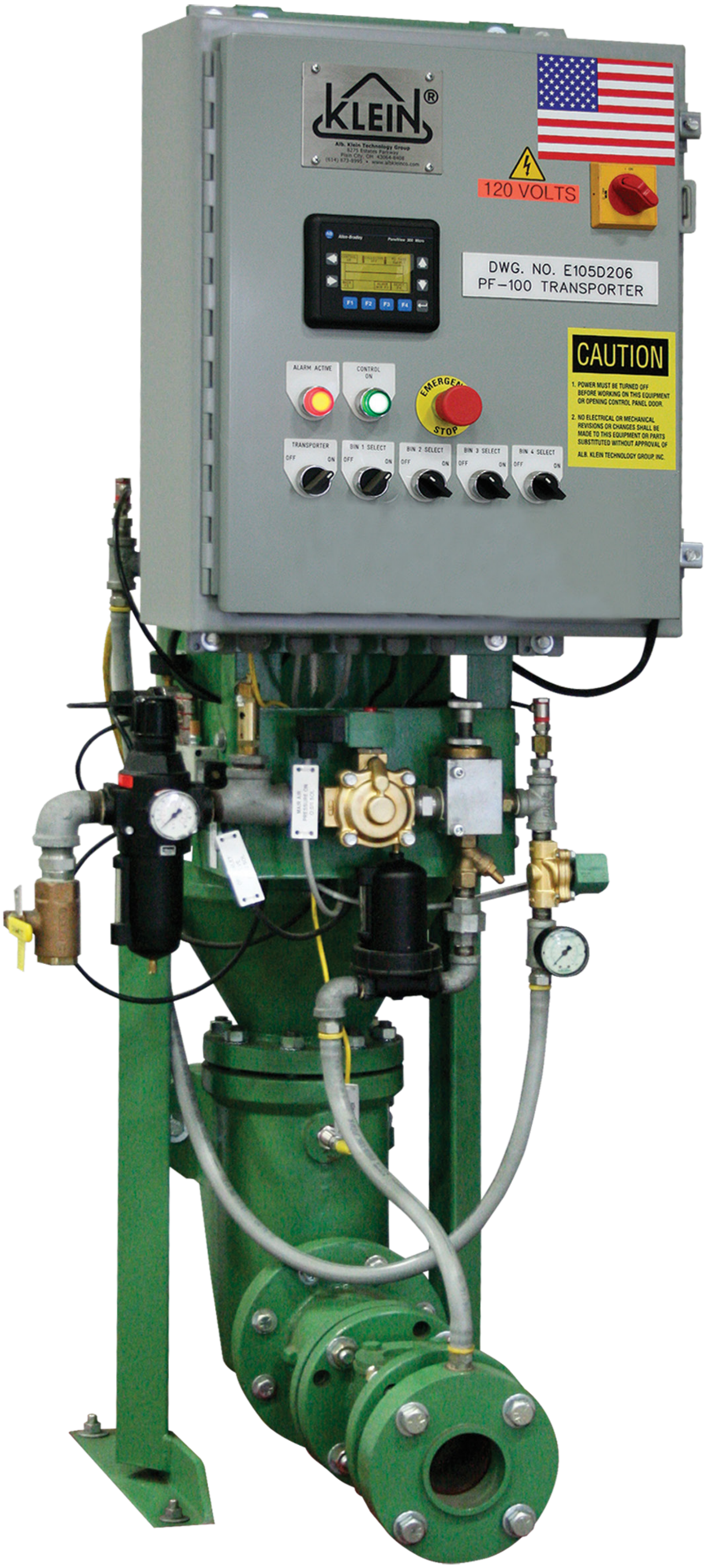
Some time ago a foundry reported a caved-in roof over the pouring area as a result of about 15 tons of collected sand dropping from a leak in the sand conveying pipeline running above the roof. When maintenance checked out the situation it was found that the core room operators occasionally experienced sand shortages but did not think any more of it. Recognizing that something was different from normal operations would be the first step in working on preventing the defect but considering the options of fixing or eliminating the defect should have been the next step. The "fix" selected was to plug the leaky pipeline by welding a patch plate over the leak and no further analysis was attempted. A more desirable and effective process would have been to question why did the pipeline develop a leak? Could it be that the layout of the piping run needed improvement? Could it be that the air pressure and volume settings of the pneumatic conveying system were adjusted incorrectly? Could it be that the capacity of the system required to provide sufficient sand to the core room was increased from the original design tonnage?

Short of reviewing all the applicable reasons for the defect the patched pipeline will probably hold up for a time and then develop another leak and then we are back to "repair and go on."

Every foundry has to move tremendous amounts of sand as part of the daily operations and to handle such amounts effectively can sometimes grow into an ongoing major material handling battle. Belt conveyors and elevators have been used many times to transfer sand but today pneumatic conveyors are probably widely accepted as a more practical means to distribute sand in the foundry. Depending on what type of pneumatic conveying system is used can have a great influence on the quality of sand delivered to the production line when considering sand grain degradation, dust generation and life expectancy of the piping.

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

Sand grain degradation in the piping caused by excessive velocities in the piping results in more dust or higher AFS numbers for the sand which in turn, if not separated prior to binder coating, requires higher amounts of resin for chemically bonded sands and the subsequent effects of higher resin percentage on mold/core performance in the casting process. Similarly the higher velocities also cause increased wear of the pipeline and



bends with resultant increased downtimes and maintenance costs. A typical example is the filling of sand silos from bulk delivery trucks. Every foundry is familiar with the associated problems of such systems, mainly due to the delivery in dilute phase (low air pressure but very high velocity), which definitely is not recommended for sand.

Recalling another pneumatic sand conveying project, shortly after the brand new installation was completed and production started frantic telephone calls from the customer reported that after just a few days of operation the pipeline developed several leaks and sand was being sprayed all over the production equipment in the foundry. Of course, the first impulse question was "how can that be?" As it turned out the customer installed all the sand piping runs but pressing production requirements did not allow the additional time to also install and connect the transporter pressure vessel to push the sand through the pipeline. Instead the sand delivery truck was connected directly to the sand piping and sand was blown directly from the sand truck to the receiving hoppers in the plant. Since all sand trucks unload and deliver sand in dilute phase it quickly became clear that the much higher velocities of the truck delivery system far exceeded the design capacity of the piping system causing pipeline leaks already after a very short time.

To put up with the heavy wear properties of sand it is usually only transported by using pressure vessels whose sizes are matched to the conveying capacities. The prevalent thinking is that high conveying capacities require large pressure vessels in order that the frequency of actuation of the different components in the system are not too high and they, therefore, have sufficient service life.

In these systems the sand is pushed through the conveying pipeline in slugs which are formed in accordance with the frictional relationship between the sand and the wall of the conveying pipe and the permeability of the sand, without any mechanical assistance in the pressure vessel itself.

These conveyors are costly to manufacture and incorporate relatively many components and the electrical controls are also costly. The normally used level probes, functioning as capacitive switches, can cause malfunctioning when there are fluctuations in the sand moisture content and temperature.

Defects prevention, relative to sand and the resulting quality of castings, has therefore become a popular topic and was the driving force to conduct sufficient research and development of appropriate equipment to prevent certain sand related casting problems. What would it mean to foundries if the casting defects caused by poor sand qualities could be reduced or eliminated? What would it mean to have a reliable sand transfer system and reduced maintenance costs?

True to the various definitions of defects prevention mentioned above it was soon realized that a totally different approach to the elimination of the problems of current sand transfer systems was necessary rather than build on existing technology. The driving force for the development of a better and more efficient sand transfer system was to eliminate the inherent defects of the "old systems" and provide a system that can be "install and forget."

To start, an investigation of different sizes of pressure vessels or blow tanks was initiated which showed that small units with a fast sequence of operation and short cycle times not only offered advantages with respect to size and cost but also with respect to energy requirements. A new conveying system was subsequently developed, as an extension of the Dense Phase concept, operating between 15-90 psig air pressure, sand velocities in the pipeline of only 100 to 450 FPM and using up to 45 percent less compressed air than conventional Dense Phase systems. This meant that sand velocities in the piping were as much as 6 to 10 times lower than in conventional Dilute and Dense Phase systems, pipeline wear was drastically reduced, sand degradation practically eliminated and operating costs slashed to the bone.

A major difference between the newly developed conveying system and the conventional conveying systems was the reduction in cycle time for the batch operation. Because of the comparatively large size of the pressure vessels of conventional systems a complete cycle included the approximately 90 seconds fill time required to refill the pressure vessel with sand which took up a large portion of the overall cycle and temporarily stopped the flow of sand in the pipeline. The newly developed conveying system utilized a much smaller pressure vessel with a total cycle time for fill and blow of only about 14 seconds, resulting in an almost continuous flow of sand into the pipeline. The required individual cycle functions were also simplified so that fewer control components are needed resulting in additional cost savings.

The advantages of a pneumatic sand conveying system with proper defects prevention built-in:

1. 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
   - Standard Schedule 40 pipe can be used
   - No need for heavy duty pipe
2. 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

	BEFORE TEST					AFTER TEST				
SIEVE	1	2	3	4	5	1	2	3	4	5
30	0.2	0.2	0.2	0.2	0.1	0.2	0.2	0.2	0.4	0.2
40	27.3	27.3	27.1	27.7	27.7	28.2	28.3	28.2	27.9	29.1
50	31.9	31.9	32.2	32.3	32.5	31.9	32.0	31.8	31.7	32.1
70	30.6	30.7	30.6	30.3	31.1	30.3	30.3	30.4	29.7	29.3
100	9.8	9.8	9.7	9.4	9.4	0.1	9.0	9.1	9.3	8.8
140	0.2	0.1	0.2	0.1	0.2	0.3	0.2	0.3	0.9	0.5
200	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
270	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pan	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AFS	43.4	43.9	43.3	43.1	43.2	43.1	43.0	43.1	43.5	42.9

3. Much lower velocities! Translating into:
   - considerable less pipeline wear!
   - fewer costly repairs
   - less waste of compressed air; (leaks in the pipe line waste a lot of compressed air);
4. 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
   - improved house cleaning

And what can we expect regarding sand quality with a system designed to prevent problems because of sand defects? To determine the feasibility of such a system a number of tests were performed to assure consistency of results. Shown below is typical test data and proof that recognizing problems in a process or equipment and systematic follow-up to eliminate defects is realistic and brings desired results.

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