

ELECTRICAL ENERGY SAVINGS AVAILABLE FROM LOW PRESSURE PNEUMATIC CONVEYING SYSTEMS

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There is a new method for finding potential energy savings in low pressure pneumatic conveying systems. Experience in providing services to wood product manufacturers suggests that low pressure pneumatic conveying system fans are often operated at speeds well in excess of the speed required to provide effective particle capture and conveying. By making small speed adjustments it is possible to effect significant power and energy savings.

Discussion

The fan (affinity) laws describe relationships between fan power, fan speed, and system pressure. Small changes in speed relate to large changes in power since there is a cubic relationship between those two parameters. A speed change from 100% to 80% results in a decrease in power required of almost 48%. The suggested work is expected to result in implementing fan speed reductions of up to 20%. Reductions in fan speed for fixed speed fan applications will result in immediate energy savings. The magnitude of the savings can be reliably predicted before-hand and accurately verified afterward.

In order for pneumatic conveying systems to function properly it is necessary to adhere to certain criteria.¹

- Bulk density of the material conveyed must be recognized. Most millwork plants deal with dry wood in the form of sawdust and shavings. The bulk density of this material is in the range of 24 lb/ft³.
- Pick-up nozzles need air moving at about 3,500 feet per minute (fpm) in order to entrain particles. The shape of most pick-up hardware in the plant is an open circular duct either four or six inches in diameter. Negative static pressure required at this configuration of duct opening to establish an air

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See Ammerman Company Inc., Fan Design & Application Handbook, Undated, Page 55, Figure 92. Values for conveying velocities of various materials are presented as are values of suction (negative static pressure) required to pick-up various materials.

velocity of 3,500 fpm is 2.5 inches of w.c.

- Within the conveying ducts the air velocity needs to be maintained at a minimum of 3,500 fpm.
- The pneumatic conveying systems that are under study are defined as low pressure systems (up to 18 inch water column (w.c.) static pressure).
- Typical material loading is assumed to be in the range of $0.02 \text{ lb}_{\text{material}}/\text{lb}_{\text{air}}$. (A 15,000 cfm fan system could transport 22.5 $\text{lb}_{\text{material}}$ per minute. With this value of material loading, the mixture of air and material can be treated as if the load were exclusively air.
- The engineers recognize that on occasion large pieces of woody material enter the conveying system. When velocities are reduced, the larger pieces may drop out of the air stream. Plugging of a conveying pipe is generally caused by a collection of the larger pieces of material. It may be necessary to increase the pneumatic conveying system inspection program so that plug-ups are avoided.

Field Work

An adjustable speed drive controller (ASD) with a capacity to operate motors up to 200 hp in size, will be utilized to determine whether the present fan speed is higher than need be. An ASD can be temporarily used in place of the existing motor starter. The ASD is used as a test device to allow an existing conveying fan to be operated at any suitable slower speed. Once an appropriate slower speed is determined, the ASD is removed from the control circuit and the motor is returned to the control of the existing motor starter. The desired speed change is made permanent through the use of sheave changes on the motor or fan or in some case on both devices.

Field Analysis

Fan/motor systems that exhibit promising energy savings characteristics will be reviewed in conjunction with local operating personnel. The review will include a rank ordering of the systems to be considered based on electric load size and other criteria yet to be established. A list of system to be evaluated will result.

On a one-at-a-time basis, the ASD control will be temporarily installed in place of the existing motor starter. Once in place and in successful operation, the fan speed will be reduced from present speed. Observation of static pressures at the pick-up points will enable the engineers to establish reasonable speed reduction objectives for each system.

The first speed reduction will typically be half of the expected reduction available from the velocity analysis. When it appears to the engineers that there are no adverse effects, the speed will be further reduced. Each time a speed reduction is made, the system will be allowed to operate at a reduced speed for a reasonable length of time. Typically, the overall magnitude of speed adjustments is expected to be a maximum of 20%.

During each increment of speed reduction, the entire system will be observed. Any adverse effects resulting from the speed reduction will be noted. Adverse effects that are

expected to occur will probably be one, two, or all of the following, although there may be some unexpected adverse actions as well:

- a. Woody materials generated at cutter-heads may not be completely picked-up in an air stream.
- b. Suspended materials may fall-out of suspension in collector ducts.
- c. Suspended materials may collect at elbows and at other transitions.
- d. Cyclone action may suffer and collector efficiency drop.

A service provider will look to plant personnel for assistance in identifying "adverse effects". For each new speed the service provider's engineers will make and record the speed adjustment, take system measurements, and observe the effects of the speed change. When, in the judgement of the plant personnel, adverse actions become intolerable, the low speed limit will have been exceeded. The fan system speed will need to be increased up to the last acceptable level and fixed at that speed.

Once a new fan speed is targeted as the desired speed, the adjustable speed drive control will be set to maintain that speed. The fan will operate at that level for a representative period of time so that the system experiences a range of plant operations. If no adverse effects occur during the test period, the new speed will be considered acceptable and steps will be taken to make this speed permanent.

Motor and fan shaft sheaves will be sized to result in achieving the desired fan speed. The variable speed drive controller will be removed from service and the across-the-line motor starter will be returned to service. Local plant personnel will mount proper sheaves on the respective shafts. The fan will be operated permanently at the new speed.

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