AR No. 1

Separate Dust Collection Systems

Recommended Action

Dust collection for the door manufacturing operation and laminating operation are currently handled through a common baghouse filter. Combined airflow from both operations is contributing to high filtration velocity and inefficient bag cleaning, resulting in excessive pressure drop through the filter. Installing a smaller baghouse dedicated to the laminating system will reduce fan operating power by 17% and decrease electric utility costs by 26%.

Assessment Recommendation Summary			
Energy 10^6 Btu	Cost Savings	Implementation Cost	Payback (Years)
1,524	$23,700	$62,500	2.6

Background

Particulate control is an important part of many industries. Whether a control device is installed to meet regulatory requirements or to reclaim valuable material, particulate control systems have become standard equipment for many manufacturers. Due to better than 99% removal efficiency and relatively low capital cost, the most popular means of controlling particulate emissions in the manufacturing sector is baghouse or fabric filtration.

Effective filtration through baghouses can require significant energy costs. This is typically a result of high flow resistance to air movement through a thick cake of filtered dust and supporting fabric. Therefore, operation and maintenance practices must focus on minimizing flow resistance across the filter. This is accomplished by designing the system to avoid excessive filtration velocity, commonly called Air-to-Cloth Ratio.

Your facility currently uses a single baghouse to collect wood dust produced in sanding and cutting operations. The system was originally designed to handle a maximum of 66,000 cfm of dust-laden air. Due to equipment additions, the system is currently operating at an airflow rate of approximately 75,000 cfm and a pressure drop of 10 inches of water (in. H_2O). When operated under design conditions, the anticipated pressure drop across the filter would be between 4-6 in. H_2O.

The door and lamination plants each use a dedicated fan for dust collection. Both fans operate in parallel to blow into the single baghouse. Although both plants have different operating hours, both fans are operating for the same amount of time. Current operation conditions, as measured during our visit, are summarized for both systems in Fan Operation Summary - Current Conditions table. Details on motor measurements can also be found in Appendix A.

Anticipated Savings

Savings will result through a reduction in power needed to overcome the high pressure drop through the current baghouse. In addition, separating systems will allow the fan for the lamination plant to operate fewer hours, reducing total energy consumption.

Based on information supplied by plant management, airflow requirement for the lamination dust collection system is 21,000 cfm, with the remaining 54,000 cfm needed for the door plant. A proposal has been made to install a new baghouse to accommodate the 21,000 cfm airflow from the lamination plant. The new baghouse will have 10 ft long bags with a total cloth area of 3,018 ft^2. This yields an average filtration velocity of approximately 7.0 ft/min. Under normal operation, we believe 6 in. H_2O pressure drop will be reasonable for this system.

Pressure drop across fabric filters is proportional to filtration velocity, which is a function of flow rate. Separating dust collection for the door and lamination plants will reduce airflow through the current baghouse and, therefore, will reduce fan energy needed to overcome filter resistance.

Pressure drop across a baghouse filter (ΔP_f) is related to the combined resistance of the fabric filter media and residual dust cake (R_f) , volumetric airflow (Q) and total cloth area (A_c). This relationship is expressed as:

$$\Delta P_f = (Q \times R_f) \div A_c$$

Assuming filter resistance will remain relatively constant when systems are separated, change in system pressure due to reduced airflow can be predicted with the following formula.

$$\Delta P_{f2} = \Delta P_{f1} \times (Q_2 \div Q_1)$$

From the preceding relationship, reducing airflow through the current baghouse from 75,000 cfm to 54,000 cfm will reduce average pressure drop across the filter from an estimated 10 in. H_2O to approximately 7 in. H_2O. Changes in filter pressure drop will have a proportional effect on fan input power by reducing total system pressure.

Resulting changes in total system pressure and fan power are summarized in the Fan Operation Summary - Separate Systems table on the following page.

Fan Operation Summary - Current Conditions

System	Total ΔP* in. H_2O	Filter ΔP in. H_2O	Ductwork ΔP in. H_2O	Motor Hp	Efficiency		Measured Power		Operating Hours	Energy (kWh)
					Motor	Fan	(BHP)	(kW)		
Door Plant	21.5	10.0	11.5	250	94%	73%	242	191	4,800	917,760
Lamination Plant	21.5	10.0	11.5	200	94%	73%	127	101	4,800	484,800
Combined	21.5	10.0	11.5	450			368	292		1,402,560

**Total pressure estimated based on complexity of ductwork.*

Fan Operation Summary - Separate Systems

System	Total ΔP in. H_2O	Filter ΔP in. H_2O	Ductwork ΔP in. H_2O	Flow Rate cfm	Efficiency		Calculated Power		Operating Hours	Energy (kWh)
					Motor	Fan	(BHP)	(kW)		
Door Plant	18.7	7.2	11.5	54,000	94%	73%	218	173	4,800	829,973
Lamination Plant	17.5	6.0	11.5	21,000	94%	73%	79	63	2,000	125,856
Total				75,000			297	236		955,829

BHP = Brake horsepower
= Calculated or Measured Power x Motor Efficiency ÷ 0.746

Energy = Power x Fan Operating Hour

The relationship between fan power (P), flow rate and system pressure is expressed as:

$$P = (0.0001175 \times Q \times \Delta P_T) \div (\eta_f \times \eta_m)$$

where,

η_f = Fan efficiency
η_m = Motor Efficiency
ΔP_T = Total System Pressure
= $\Delta P_f + \Delta P_{Ductwork}$

Power savings (PS) is the difference between current combined fan power of 292 kW and anticipated total power of 236 kW for fans operating in separate systems. Likewise, energy savings (ES) is the difference in combined energy from both tables. Demand cost ($D) and energy cost ($E) savings are calculated based on respective incremental rates, as shown below.

$D = PS x $4.94/kW-mo x 12 mo/yr
= (292 kW - 236 kW) x $4.94/kW-mo x 12 mo/yr
= $3,300

$E = ES x $0.04557 /kWh
= (1,402,560 kWh - 955,829 kWh) x $0.04577/ kWh
= $20,400

Total savings are summarized in the following table.

Savings Summary				
Source	Quantity	Units	Energy 10^6 Btu	Cost $
Electric Energy	446,731	kWh	1,524	$ 20,400
Power Demand	56	kW		$ 3,300
Total			1,524	$ 23,700

Implementation Cost

Based on vendor quote, the installed cost for the proposed baghouse is $50,000. The cost of sensors and controls for the new system is anticipated to be $10,000 and additional ductwork estimated at approximately $2,500. Installation of a new baghouse is anticipated to be $62,500, which will be paid for by savings in 2.8 years.