Recommendation

We recommend replacing the radial blade with a higher efficiency radial-tip fan blade in the manufacturing dust collection system. We estimate fan efficiency can be improved from the current average of 50% to a reasonable average of 70%, reducing fan operation costs by 29%.

<table>
<thead>
<tr>
<th>Source</th>
<th>Quantity</th>
<th>Units</th>
<th>Cost Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical Consumption</td>
<td>2,857</td>
<td>kWh (site)</td>
<td>$143</td>
</tr>
<tr>
<td>Electrical Demand</td>
<td>11</td>
<td>kW Months / yr</td>
<td>$686</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>9.8</strong></td>
<td><strong>MMBtu</strong></td>
<td><strong>$829</strong></td>
</tr>
</tbody>
</table>

Assessment Recommendation Cost Summary

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost</th>
<th>Payback</th>
</tr>
</thead>
<tbody>
<tr>
<td>Implementation Cost</td>
<td>$2,400</td>
<td>2.9</td>
</tr>
</tbody>
</table>

Facility Background

The facility currently uses radial fan blades on the dust collection fan. During the site assessment, plant personnel informed us that the fan is a material handling fan. Motor and fan nameplate information was collected during the site assessment by energy analysts. A power quality analyzer was used to collect live power readings of the motor under typical loading conditions. A manometer was used to collect various pressure readings on either side of the fan during typical loading conditions. Motor and fan data are summarized in the following Motor Analysis Tool (MAT) and Fan Efficiency Analysis Tool (FEAT) pages.

Technology Background

Dust collection systems can be arranged in either “material-handling” or “clean-side” configurations. Material-handling fans operate with particulates flowing through the fans and use positive pressure to push the material down stream. Clean-side fans operate down stream of the bag house where no particulates flow. They use negative pressure to pull particles from the plant into a bag house.

Material-handling fans are typically centrifugal fans in which air enters the fan axially and leaves radially. Centrifugal fans operate from a combination of centrifugal forces and angular deflection of the airflow by the blades. Centrifugal fans normally produce higher static pressure than axial-flow fans of the same wheel diameter and rotational speed. The wheel is known as the impeller or rotor, which contains a back plate, shroud, and blades. Material-handling fans are used to move air containing dust and granular materials from wood and metal working operations through ducts to cyclones or bag houses. These fans can handle high temperatures (up to 800 °F), corrosive fumes and abrasive materials from cutting or grinding operations.
There are six types of centrifugal fan blades commonly used in dust collection systems. These blade types, efficiencies and characteristics are listed below.

- **Radial Blade**
  - Static efficiency to 60%
  - High tip speed capabilities
  - Reasonable running clearances
  - Best for erosive or sticky particulate

- **Backward Inclined**
  - Static efficiency to 80%
  - Low-Medium tip speed capabilities

- **Radial Tip**
  - Static efficiency to 70%
  - Medium-High tip speed capabilities
  - Good for high particulate airstream

- **Backward Curved**
  - Static efficiency to 83%
  - Medium-High tip speed capabilities
  - Clean or dirty airstreams.
  - Solid one-piece blade design

- **Forward Curved (Sirocco)**
  - Static efficiency to 65%
  - Smallest diameter wheel for a given pressure requirement
  - High volume capability
  - Often used for high temps

- **Backward Inclined**
  - Static efficiency to 83%
  - Medium-High tip speed capabilities
  - Clean or dirty airstreams.
  - Solid one-piece blade design

Radial type blades are most commonly used in industrial “material-handling” applications. Other types of blade configurations are prone to clogging and/or damage when material is passed through the fan. However the radial type blades have comparatively low efficiencies due to non-tangential flow conditions at the blades leading edge.

**Proposal**

We recommend replacing the radial blade with a higher efficiency radial-tip fan blade in the manufacturing dust collection system. Improved aerodynamics will enable the fan to move air more efficiently, reducing the power required from the fan motor, thus reducing associated annual energy consumption by 29%.

If the previously mentioned actions are taken, they will save 2,857 kWh annually and result in an annual cost savings of $829 for a net payback of 2.9 years after an implementation cost of $2,400.
Replacing fan blades often times provides a safer, and more enjoyable working environment for employees. Newer balanced fans are typically quieter and will help protect hearing and causes less fatigue and stress on employees. This may reduce the need for heavy duty ear protection and improve communication between employees.

Replacing fan blades often times reduces maintenance issues. Newer balanced fans vibrate less reducing bearing problems, stress cracking in duct work, while also reducing or eliminating the need for silencers.

Notes
Data Collected

**Motor Data**
- Current Energy Consumption: 10,000 kWh/yr. (Eq. 1)
- Current Power Draw: 40.0 kW (Ref. 1)
- Current Operation Months: 12 mo./yr.

**Fan Data**
- Current Fan Blade Type: Radial
- Current Fan Efficiency: 50.0% (Ref. 2)

**Utility Data**
- Incremental Energy Cost: $0.05000/kWh (Ref. 3)
- Incremental Demand Cost: $5.00/kW-mo. (Ref. 3)

Assumptions

**Proposed Fan Data**
- Proposed Fan Blade Type: Radial-Tip
- Proposed Fan Efficiency: 70.0% (Ref. 4)

Energy Savings Analysis

**Proposed Energy Consumption**
- Proposed Energy Consumption: 7,143 kWh/yr. (Eq. 1)
- Proposed Power Draw: 29 kW (Eq. 2)

**Energy Savings**
- Energy Savings: 2,857 kWh/yr. (Eq. 3)
- Power Draw Reduction: 11 kW (Eq. 4)

**Cost Savings**
- Energy Cost Savings: $143 (Eq. 5)
- Power Cost Savings: $686 (Eq. 6)

Implementation Cost Analysis

**Material Costs**
- Radial-Tip Fan Cost: $2,000 (Ref. 5)

**Labor Costs**
- Labor Rate: $50/hour (N. 1)
- Installation Time: 8.0 hours (N. 1)

Economic Results
- Cost Savings: $829/yr. (Eq. 7)
- Implementation Costs: $2,400 (Eq. 8)
- Payback: 2.9 yrs.

Equations

1. Proposed Energy Usage ($E_P$) = $E_C \times \frac{\eta_C}{\eta_P}$ (Eq. 1)
2. Proposed Power Draw ($P_P$) = $P_C \times \frac{\eta_C}{\eta_P}$ (Eq. 2)
3. Energy Savings ($E_S$) = $E_C - E_P$ (Eq. 3)
4. Power Draw Reduction ($P_R$) = $P_C \times IC_D \times t_M$ (Eq. 4)
5. Energy Cost Savings ($C_E$) = $E_S \times IC_E$ (Eq. 5)
6. Power Cost Savings ($C_P$) = $P_R \times IC_E \times t_M$ (Eq. 6)
7. Cost Savings ($C_S$) = $C_E + C_P$ (Eq. 6)
8. Implementation Costs ($C_I$) = $C_M + (C_{LR} \times t_I)$ (Eq. 7)

References

1. Developed in the previous Motor Analysis Tool (MAT) pages.
2. Developed in the previous Fan Efficiency Analysis Tool (FEAT) pages.
3. Developed in the Utility Analysis of the Site Data section.
4. Developed using the FSAT (Fan System Assessment Tool) software developed by the Air Movement and Control Association (AMCA) and the Oak Ridge National Laboratory for the U.S. Department of Energy’s Industries of the Future program.

Notes

N. 1) Energy analysts estimated material and labor costs as well as labor time. Labor rates are for facility personnel to replace fan wheels.