Recommendation

INSERT RECOMMENDED ACTIONS HERE. The use of notched v-belts will reduce motor energy use by 2.1% on average through improved transmission efficiency. This is achieved by reducing losses due to bending, friction, slip between the belt and the sheave, and stretching of the belt over time.

### Annual Savings Summary

<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>40,779</td>
<td>kWh (site)</td>
<td>$2,039</td>
</tr>
<tr>
<td>Electrical Demand</td>
<td>114</td>
<td>kW Months / yr</td>
<td>$572</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td></td>
<td>$0</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td></td>
<td>$0</td>
</tr>
<tr>
<td>Total</td>
<td>139</td>
<td>MMBtu</td>
<td>$2,611</td>
</tr>
</tbody>
</table>

### Implementation Cost Summary

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost</th>
<th>Payback (yrs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Implementation Cost</td>
<td>$0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

Facility Background

This paragraph should fully describe the system so that anyone who hasn't been to the facility can still understand it. Include a description of the system, operating procedures/conditions, why saving is available, how data was collected, what tools were used, and any other pertinent information.

Technology Background

High torque, or synchronous, drive belts are similar in appearance to automotive engine timing belts. The teeth and grooves of the belt and sheave system are designed to fit together tightly preventing slip and reducing friction. Loss in motor speed and efficiency occurs when a standard V-belt slips within the groove of the sheave. The friction between the standard V-belt and sheave generates heat within the belt, resulting in energy loss and shortening of belt life. V-belts often call for more tension than HTD belts, adding to friction and wear in bearings. Manufacturers estimate that HTD belts can improve efficiency by approximately 4% to 8% over standard V-belts. An average efficiency improvement of 5% is used in this analysis. Additional advantages include improved operation in oily and wet environments, and reduced maintenance.

HTD belts are not recommended in applications where belt slip under duress is desired. Conveyor systems are an example of an application where notched or standard V-belts are desirable instead of HTD belts. If the conveyor were to jam, a V-belt will slip and fail before damage is caused to the conveyor.
A notched belt reduces slip and allows the belt to bend around sheaves with less energy loss. Reduction in output speed and efficiency occurs when a standard V-belt slips within the groove of the sheave. Efficiency improvements have been found to range from 1% to 3%. An average efficiency improvement of 2% over standard V-belts is used in this analysis. Friction between the standard V-belt and sheave generates heat within the belt, resulting in an energy loss and shortened belt life. Notched V-belts can last twice as long as standard V-belts but have shorter lives in abrasive environments where contaminants can become trapped between the belt and the sheave. Notched V-belts may be used with existing V-belt pulleys but typically cost 20-30% more.

Proposal

INSERT PROPOSAL STATEMENT HERE. These actions will save 40,779 kWh annually, resulting in an annual cost savings of $2,611, with a net payback period of 0.0 years after an implementation cost of $.

Notes

With less belt friction and slippage, motor applications may operate at slightly higher speeds. While a fan impeller's faster speed would move more air, for example, the fan motor's electrical draw would increase to the third power according to a fan affinity law. Continuously running equipment could nullify some of the potential savings. This can be accounted for by reducing the pulley ratios when new HTD sheaves are purchased.

HTD belts produce more noise than notched or standard V-belts because air is trapped between the fast-moving belt and toothed sheaves. For the relatively low horsepower levels of the selected motors, this added noise may not be objectionable.

An alternative to HTD belts are notched V-belts. Notched V-belts may be used for applications that cannot accept new pulleys, or where slippage during overload needs to be provided. Notched V-belts are regular V-belts with cuts manufactured in the inner surface. These cuts reduce the friction associated with a belt's flexing during use. Notched belts permit just a 1% to 3% energy savings over standard V-belts.

In general, we assume that the additional cost of the notched V-belts will be offset by a longer lifetime. Thus, there is no cost associated with installing notched V-belts to replace old belts when they wear out, yielding an immediate payback. No energy incentives apply to this recommendation.

Like standard V-belts, notched belts require periodic re-tensioning to maintain their efficiency. These calculations were done with very general assumptions based on conversations with plant personnel and general observations. Actual savings for implementation will depend on the number and size of belt driven motors. Notched V-belts should not be used on motors that cause excessive wear on the current belt as savings would be reduced by the increased replacement costs of notched V-belts.
References

Put any additional references here.
# High Torque Drive Implementation Cost

## Fixed Costs

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fixed Cost</td>
<td>$400/motor</td>
</tr>
<tr>
<td>Number of Motors</td>
<td>30 motors</td>
</tr>
<tr>
<td>Total Fixed Cost</td>
<td>$12,000</td>
</tr>
</tbody>
</table>

## Variable Costs

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable Cost</td>
<td>$15/hp</td>
</tr>
<tr>
<td>Total Rated Horsepower</td>
<td>640 hp</td>
</tr>
<tr>
<td>Total Variable Cost</td>
<td>$9,600</td>
</tr>
</tbody>
</table>

## Total

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Implementation Cost</td>
<td>$21,600</td>
</tr>
</tbody>
</table>

## Equations

- **Eq. 1)** Total Fixed Cost ($C_{FT}$)
  \[ C_{FT} = C_F \times n \]
  (N. 1)

- **Eq. 2)** Total Variable Cost ($C_{VT}$)
  \[ C_{VT} = C_V \times HP_T \]
  (Rf. 1)

- **Eq. 3)** Total Implementation Cost ($C_I$)
  \[ C_I = C_{FT} + C_{VT} \]

## Notes

N. 1) A high torque drive system cost is based on motor horsepower and drive ratios between the motor and load. Using manufacturers' information, we have used the highest cost of each horsepower range and a variety of drive ratios to estimate associated costs. Additional labor associated with installing HTD sheaves is included in this total, which assumes implementation is delayed until the existing belts require replacement.

## References

Rf. 1) Developed in Belt Replacement Inventory table on the following page.
<table>
<thead>
<tr>
<th>Description</th>
<th>Qty</th>
<th>Rated (HP)</th>
<th>Total (HP)</th>
<th>Operational</th>
<th>Total Current</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>(hp)</td>
<td>(hp)</td>
<td>Months</td>
<td>Power (kW)</td>
</tr>
<tr>
<td>Boiler FD Fan</td>
<td>1</td>
<td>15.0</td>
<td>15.0</td>
<td>12</td>
<td>11.3</td>
</tr>
<tr>
<td>MH Blower 1</td>
<td>1</td>
<td>75.0</td>
<td>75.0</td>
<td>12</td>
<td>57.6</td>
</tr>
<tr>
<td>MH Blower 2</td>
<td>1</td>
<td>100.0</td>
<td>100.0</td>
<td>12</td>
<td>79.3</td>
</tr>
<tr>
<td>MH Blower 3</td>
<td>1</td>
<td>150.0</td>
<td>150.0</td>
<td>12</td>
<td>116.2</td>
</tr>
<tr>
<td>MH Blower 4</td>
<td>1</td>
<td>75.0</td>
<td>75.0</td>
<td>12</td>
<td>55.9</td>
</tr>
<tr>
<td>Dry Kiln Fans</td>
<td>20</td>
<td>7.5</td>
<td>150.0</td>
<td>12</td>
<td>86.8</td>
</tr>
<tr>
<td>Roof Exhaust Fan</td>
<td>5</td>
<td>15.0</td>
<td>75.0</td>
<td>12</td>
<td>46.1</td>
</tr>
<tr>
<td>Totals</td>
<td>30</td>
<td>640.0</td>
<td>5,438</td>
<td></td>
<td>5,438</td>
</tr>
</tbody>
</table>
**Notes**

N. 1) Number of months motor operates annually for demand savings calculations.

N. 2) Total motor power and energy. Individual motor power and energy can be found in the Motor Inventory in the Site Data section.

**References**

Rf. 1) Quantity, rated horsepower, total current power, and total current energy developed in the Motor Inventory pages found in the Site Data section of this report.
### General Data

#### Utility Data
- Incremental Energy Cost: \((IC_E)\) \$0.0500/kWh
- Incremental Demand Cost: \((IC_D)\) \$5.00/kW-mo.

### Drive Replacement and Efficiency

#### Current Belt Drive
- Current Type (1st): Standard V-Belts
- Current Efficiency (1st): \(\eta_{C,1}\) 93.0%
- Current Type (2nd): N/A
- Current Efficiency (2nd): \(\eta_{C,2}\) 0.0%

#### Replacement
- Replacement Fraction (1st): \(\chi_1\) 100.0%
- Replacement Fraction (2nd): \(\chi_2\)

#### Weighted Efficiency
- Average Current Efficiency: \(\eta_C\) 93.0%

#### Proposed Belt Drive
- Proposed Type: Notched V-Belts
- Proposed Efficiency: \(\eta_{P}\) 95.0%

### Energy Analysis

#### Current Conditions
- Current Demand: \((D_C)\) 5,438 kW-mo.
- Current Energy: \((E_C)\) 1,937,023 kWh

#### Proposed Conditions
- Proposed Demand: \((D_{P})\) 5,324 kW-mo.
- Proposed Energy: \((E_{P})\) 1,896,244 kWh

#### Savings
- Demand Savings: \((D_S)\) 114 kW-mo.
- Energy Savings: \((E_S)\) 40,779 kWh

#### Cost Savings
- Demand Cost Savings: \((S_{D})\) \$572/yr
- Energy Cost Savings: \((S_{E})\) \$2,039/yr

### Equations

#### Table Calculations
- Eq. 1) Total Horsepower \((W_P)\): \(n \times HP_R\)
- Eq. 2) Total Current Demand \((D_i)\): \(P_i \times t_m\)

#### Analysis Calculations
- Eq. 3) Average Current Efficiency \((\eta_C)\): \(\frac{X_1 \times \eta_{C,1} + X_2 \times \eta_{C,2}}{X_1 + X_2}\)
- Eq. 4) Current Demand \((D_C)\): \((X_1 + X_2) \times \sum D_i\)
- Eq. 5) Current Energy \((E_C)\): \((X_1 + X_2) \times \sum E_i\)
- Eq. 6) Proposed Demand \((D_{P})\): \(D_C \times \frac{\eta_C}{\eta_P}\)
- Eq. 7) Proposed Energy \((E_{P})\): \(E_C \times \frac{\eta_C}{\eta_P}\)
- Eq. 8) Demand Savings \((D_S)\): \(D_C - D_{P}\)
- Eq. 9) Energy Savings \((E_S)\): \(E_C - E_{P}\)
- Eq. 10) Demand Cost Savings \((C_{SD})\): \(D_S \times IC_D\)
- Eq. 11) Energy Cost Savings \((C_{SE})\): \(E_S \times IC_E\)
- Eq. 12) Annual Cost Savings \((C_S)\): \(S_D + S_E\)
- Eq. 13) Simple Payback \((t_{PB})\): \(\frac{C_L}{S}\)

### References
- Rf. 2) Developed in the Utility Analysis located in the Site Data section.

### Notes
- N. 1) Current belt type of selected motors on Belt Replacement Inventory, found on the previous page. A second belt type is chosen when combinations of standard and notched belts are installed on selected motors found in the Belt Replacement Inventory.
- N. 2) Percent of motor energy and demand corresponding to the selected belt type.
### Economic Results

<table>
<thead>
<tr>
<th>Description</th>
<th>Symbol</th>
<th>Value</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Cost Savings</td>
<td>( (S) )</td>
<td>$2,611 $/year</td>
<td>(Eq. 12)</td>
</tr>
<tr>
<td>Implementation Cost</td>
<td>( (C_I) )</td>
<td>$0</td>
<td>(Rf. 4) or (N. 3)</td>
</tr>
<tr>
<td>Simple Payback</td>
<td>( (t_{PB}) )</td>
<td>0.0 years</td>
<td>(Eq. 13)</td>
</tr>
</tbody>
</table>

### Notes

N. 3) Additional Cost of notched V-belts offset by longer lifetime.

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### References

Rf. 4) Developed in the Data Preparation section for this recommendation.