3 - AR No. 4 - Replace Belts with Notched V-Belts

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Recommendation

Replace Standard V-belts with notched V-belts on all motors in Plywood 1 and 2. This will reduce current motor energy consumption by approximately 2%.This will generate savings of $67,164, with no implementation cost and an immediate payback.

Annual Savings Summary

Source	*Quantity*	*Units*	*Cost Savings*
Electrical Consumption	1,101,045	kWh (site)	$67,164
Electrical Demand	1,888	kW Months / yr	$0
Total	**3,758**	**MMBtu**	**$67,164**

Implementation Cost Summary

Description	*Cost*	*Payback (yrs)*
Implementation Cost	$0	0.0

Facility Background

The facility uses motors to power almost every operation within the Plywood 1 and 2. Belted motors could be found through all of the processes within the facility. The facility provided motor and belt lists to analysts to aid in calculating potential energy savings available by switching from V-belts to notched V-belts.

Technology Background

A notched v-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.

Proposal

Replace the current V-belts with notched V-belts incrementally as belts require replacement. This will save 1,101,045 kWh annually, resulting in an annual cost savings of $67,164, with no payback.

Notes

Analysts assumed that the the longer life of notched V-belts will offset the additional cost associated with these belts. This results in no additional cost associated with installing notched V-belts to replace v-belts when they wear out, yielding an immediate payback. No energy incentives apply to this recommendation.

Like standard V-belts, notched V-belts require periodic re-tensioning to maintain their efficiency. 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 belts, as savings would be reduced by the increased cost of replacing notched V-belts.

Analysts were unable to count every belt within the two buildings, but the facility provided belt and motor lists. Analysts considered both to complete the analysis for the energy savings. The savings are based on changing V-belts in the facility to notched v-belts. The actual savings could change depending on the implementation rate of the notched V-belts.

Belt Replacement Inventory (Rf. 1)

Description	Qty	Horsepower Rated	Horsepower Total	Operational Months	Operation Hours	Load	Total Current Demand	Total Current Energy
	(n)(Rf. 1)	(HP_R)(Rf. 1)	(HP_T)(Eq. 1)	(t_m)(N. 1)	(t_h)(N. 2)	(LF)(N. 3)	(D_i)(Eq. 2)	(E_i)(Eq. 3)
		(hp)	(hp)	(months)			(kW-mo.)	(kWh)
Ply. 1 5 Hp	37	5	185	12	7,000	70%	1,159	676,249
Ply. 1 7.5 Hp	25	8	188	12	7,000	70%	1,175	685,388
Ply. 1 10 Hp	31	10	310	12	7,000	70%	1,943	1,133,174
Ply. 1 15 Hp	12	15	180	12	7,000	70%	1,128	657,972
Ply. 1 20 Hp	23	20	460	12	7,000	70%	2,883	1,681,484
Ply. 1 25 Hp	19	25	475	12	7,000	70%	2,977	1,736,315
Ply. 1 30 Hp	14	30	420	12	7,000	70%	2,632	1,535,268
Ply. 1 40 Hp	33	40	1,320	12	7,000	70%	8,272	4,825,128
Ply. 1 50 Hp	7	50	350	12	7,000	70%	2,193	1,279,390
Ply. 1 75 Hp	11	75	825	12	7,000	70%	5,170	3,015,705
Ply. 1 100 Hp	23	100	2,300	12	7,000	70%	14,413	8,407,420
Ply. 1 125 Hp	3	125	375	12	7,000	70%	2,350	1,370,775
Ply. 1 150 Hp	1	150	150	12	7,000	70%	940	548,310
Ply. 1 200 Hp	3	200	600	12	7,000	70%	3,760	2,193,240
Ply. 1 350 Hp	1	250	250	12	7,000	70%	1,567	913,850
Ply. 1 600 Hp	1	600	600	12	7,000	70%	3,760	2,193,240
Ply. 2 5 Hp	41	5	205	12	7,000	70%	1,285	749,357
Ply. 2 7.5 Hp	4	8	30	12	7,000	70%	188	109,662
Ply. 2 10 Hp	24	10	240	12	7,000	70%	1,504	877,296
Ply. 2 15 Hp	6	15	90	12	7,000	70%	564	328,986
Ply. 2 20 Hp	2	20	40	12	7,000	70%	251	146,216
Ply. 2 25 Hp	22	25	550	12	7,000	70%	3,447	2,010,470
Ply. 2 30 Hp	4	30	120	12	7,000	70%	752	438,648
Ply. 2 40 Hp	6	40	240	12	7,000	70%	1,504	877,296
Ply. 2 50 Hp	7	50	350	12	7,000	70%	2,193	1,279,390
Ply. 2 60 Hp	3	60	180	12	7,000	70%	1,128	657,972
Ply. 2 75 Hp	15	75	1,125	12	7,000	70%	7,050	4,112,325
Ply. 2 100 Hp	15	100	1,500	12	7,000	70%	9,400	5,483,100
Ply. 2 125 Hp	2	125	250	12	7,000	70%	1,567	913,850
Ply. 2 200 Hp	2	200	400	12	7,000	70%	2,507	1,462,160
Totals	**397**		**14,308**				**89,657**	**52,299,636**

AR No. 4 - Analysis

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General Data

Utility Data

Incremental Energy Cost	(IC_E)	*$0.06100*	/kWh	**(Rf. 2)**
Incremental Demand Cost	(IC_D)	*$0.00*	/kW·mo.	**(Rf. 2)**

Drive Replacement and Efficiency

Current Belt Drive

Type		*Standard V-Belts*		**(N. 4)**
Efficiency	(η_C)	*93.0%*		**(Rf. 3)**

Proposed Belt Drive

Type		*Notched V-Belts*		
Efficiency	(η_P)	*95.0%*		**(Rf. 3)**

Energy Analysis

Current Conditions

Demand	(D_C)	*89,657*	kW·mo	**(Eq. 4)**
Energy	(E_C)	*52,299,636*	kWh	**(Eq. 5)**

Proposed Conditions

Demand	(D_P)	*87,769*	kW·mo	**(Eq. 6)**
Energy	(E_P)	*51,198,591*	kWh	**(Eq. 7)**

Savings

Demand	(D_S)	*1,888*	kW·mo	**(Eq. 8)**
Energy	(E_S)	*1,101,045*	kWh	**(Eq. 9)**

Cost Savings

Demand	(S_D)	*$0*	/yr	**(Eq. 10, N. 4)**
Energy	(S_E)	*$67,164*	/yr	**(Eq. 11)**

Economic Results

Annual Cost Savings	(S)	*$67,164*	/yr	**(Eq. 12)**
Implementation Cost	(C_I)	*$0*		**(N. 4)**
Simple Payback	(t_{PB})	*0.0*	years	**(Eq. 13)**

Notes

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

N. 2) Information obtained by analysts during the facility assessment.

N. 3) Analyst's assumption based on average load factors for industrial motors.

N. 4) There are no demand savings because the power house utility analysis did not include demand charges.

N. 5) Additional cost of notched V-beltsis assumed to be offset by longer lifetime.

Equations

Data Preparation

Eq. 1) Total Horsepower (HP_T)

$$n \times HP_R$$

Eq. 2) Total Current Demand (D_i)

$$HP_T \times t_m \times LF \times \left(\frac{0.746\ \text{kW}}{1\ \text{hp}}\right)$$

Eq. 3) Total Current Energy (E_i)

$$HP_T \times n \times t_h \times LF \times \left(\frac{0.746\ \text{kW}}{1\ \text{hp}}\right)$$

Analysis Calculations

Eq. 4) Current Demand (D_C)

$$\sum D_i$$

Eq. 5) Current Energy (E_C)

$$\sum E_i$$

Eq. 6) Proposed Demand (D_P)

$$D_C \times \left(\frac{\eta_C}{\eta_P}\right)$$

Eq. 7) Proposed Energy (E_P)

$$E_C \times \left(\frac{\eta_C}{\eta_P}\right)$$

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 (S_D)

$$D_S \times IC_D$$

Eq. 11) Energy Cost Savings (S_E)

$$E_S \times IC_E$$

Eq. 12) Annual Cost Savings (S)

$$S_D + S_E$$

Eq. 13) Simple Payback (t_{PB})

$$\frac{C_I}{S}$$

References

Rf. 1) Quantity and rated horsepower was found in documents provided by facility personnel.

Rf. 2) Developed in the Utility Analysis located in the Site Data section of this report.

Rf. 3) Nominal drive efficiencies from USDOE Motor Tip Sheet #3. http://www.nrel.gov/docs/fy00osti/27833.pdf