Maximizing Power Transmission: V Belts vs. Synchronic Belts

Ed Hubble, Power Transmission Specialist, Van Meter Inc.

- *Ed started in the power transmission business in 1977. He has gained much experience over the years through courses including Dodge School of Power Transmission, Reliance School of Motors and Drives, Goodyear home study course for applying v-belts and cogged tooth belts, Boston home study for gearology, IDC Bulk material handling, Fafnir school for bearing application, Technical Associates Introduction to vibration analysis and root cause analysis and how to identify failure causes.*
- *He has worked with many customers over his 30 plus years, reducing energy costs through more energy efficient power train systems encompassing motors, gear reducers, couplings and belt and chain drives. He often gives presentation on motor training on what to look for when applying motors and how energy can be saved in particular applications.*

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Energy Savings in Belt Drives

Presenter

Ed Hubble

Power Transmission Specialist

Van Meter Industrial

Energy Savings in Belt Drives

- US Department of Energy has determined manufacturing operations in the US to spend $30 billion annually on electricity powering motor-driven systems
- There 40 million electric motors in operation
    - Consume 70% of all electricity used in plants
    - Not running at optimum efficiency
- Why does efficiency matter?
    - Efficiency is a measure of power loss associated with the motor, the bearings, and the drive
    - Loss of power = loss of $$
- 1/3 of electric motors in the industrial and commercial sectors use belt drives
    - If the efficiency of these systems were improved by a mere 5%, the plants would see tremendous energy savings
    - Synchronous belt drives

Maintenance of Belt Drives

- Saving Maintenance Expense & Downtime
- V-belt drives and synchronous belt drives demand approximately the same amount of time for installation
- Synchronous belts do no require a run-in procedure or retensioning
- V-belt is retensioned 24 hours after installation
    - 30 minute process:
        - Locking out the power
        - Removing the belt guard
        - Rensioning
        - Securing the belt guard
        - Resuming power
    - Not completing this can cause premature belt failure

Belt Efficiency Principles

Torque Loss

1. The thicker cross sections of V-Belts require more energy to bend than the thinner cross sections of synchronous belts
2. V-Belts transmit power through friction and energy is lost in the form of heat, because of the constant creep and slip of the belt relative to the sheave

Speed Loss

1. There is loss in the driven speed with the slip and creep
2. Synchronous belts don't have slip or creep because of the positive engagement with the sprockets

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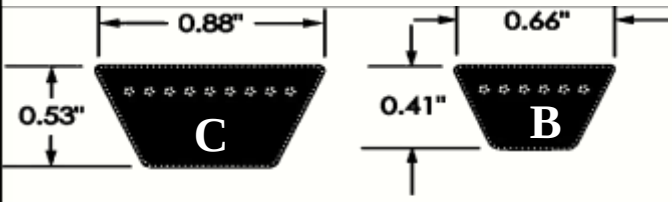
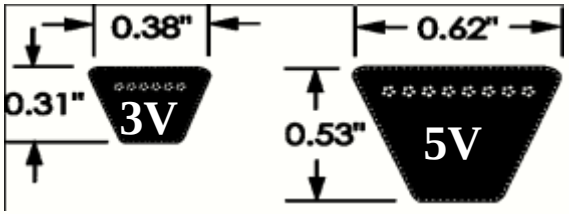
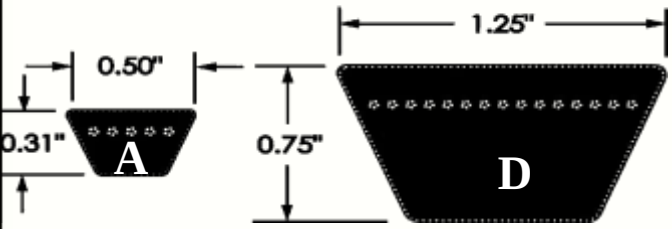
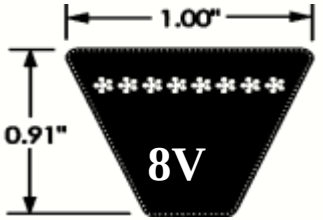
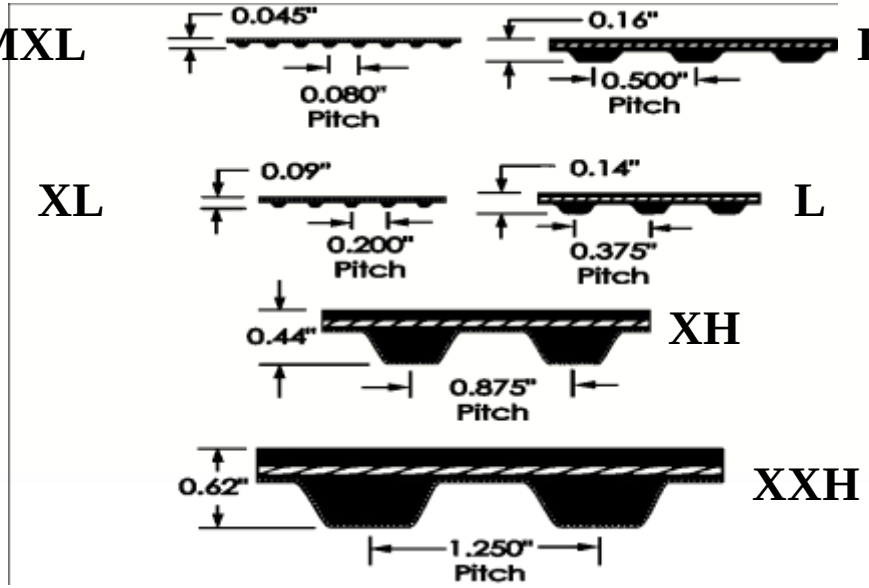
Belt Cross Sections





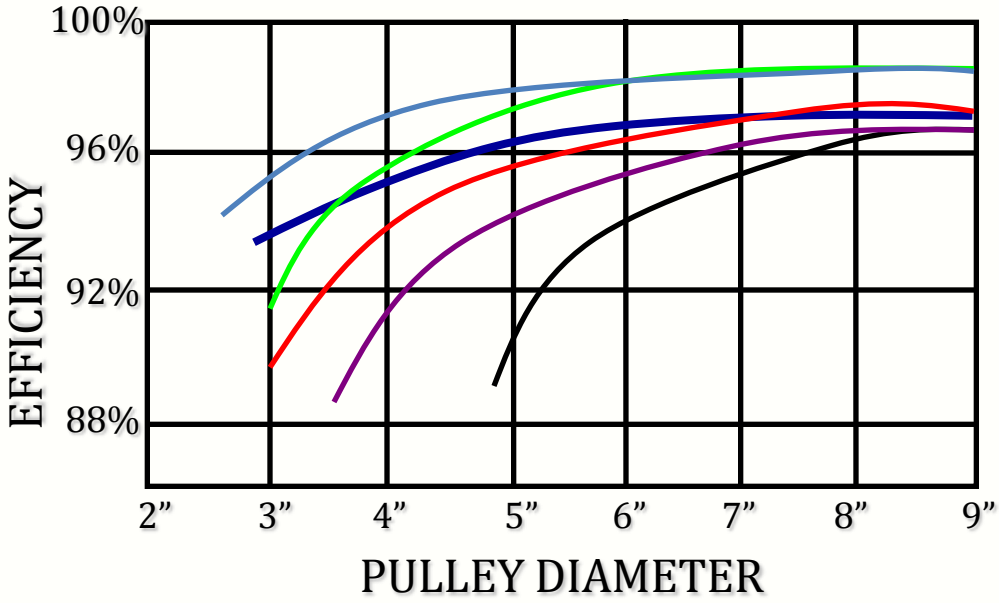






Drive Efficiency

- Synchronous belts usually represent the greatest efficiency
- The 3V narrow is most efficient "v" type belt
- Thinner cross section belts tend to indicate higher efficiency
- Use pulleys above the recommended minimum pulley diameter



C Classical

3V Narrow

5V Narrow

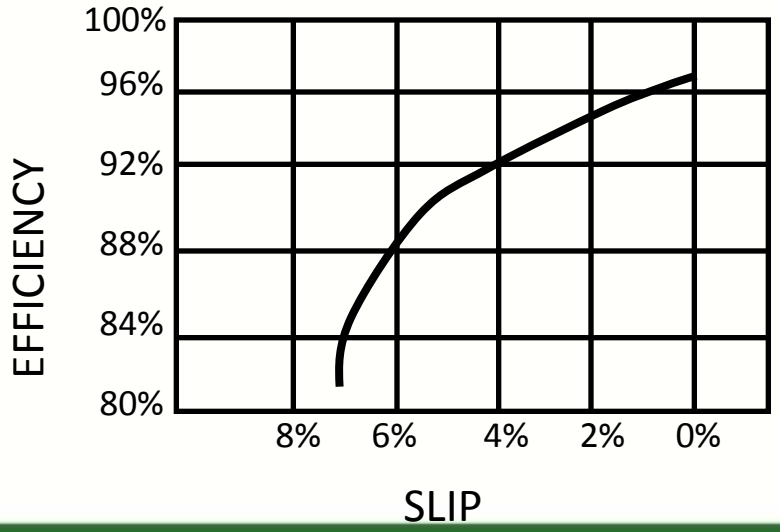
XH Positive Drive

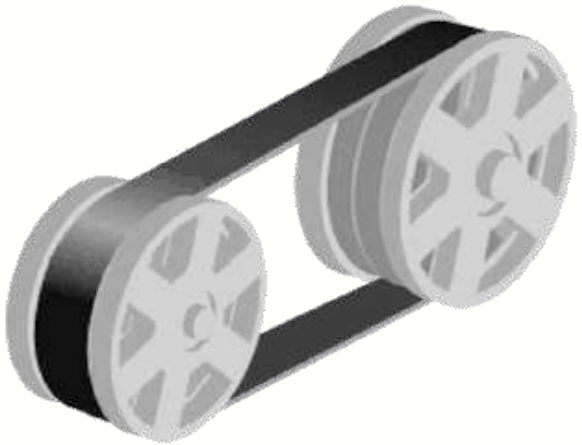
B Classical

H Positive Drive

Importance of Maintenance of V-Belt Drives

- Peak efficiency of V-Belts can be as high as 97% at time of installation
- Efficiency can drop as much as 15% if slippage occurs due to low tension
- Worn sheave grooves and sheave misalignment also contribute to slip decreasing efficiency
- A typical relationship between efficiency and slip is shown below





Belt Efficiency Principles

Synchronous belt drives are approximately 5% more efficient than V-Belt drives on average because:

1. They don't have speed loss due to creep and slip
2. There is less torque loss due to energy lost in bending and friction

Belt Efficiency Principles

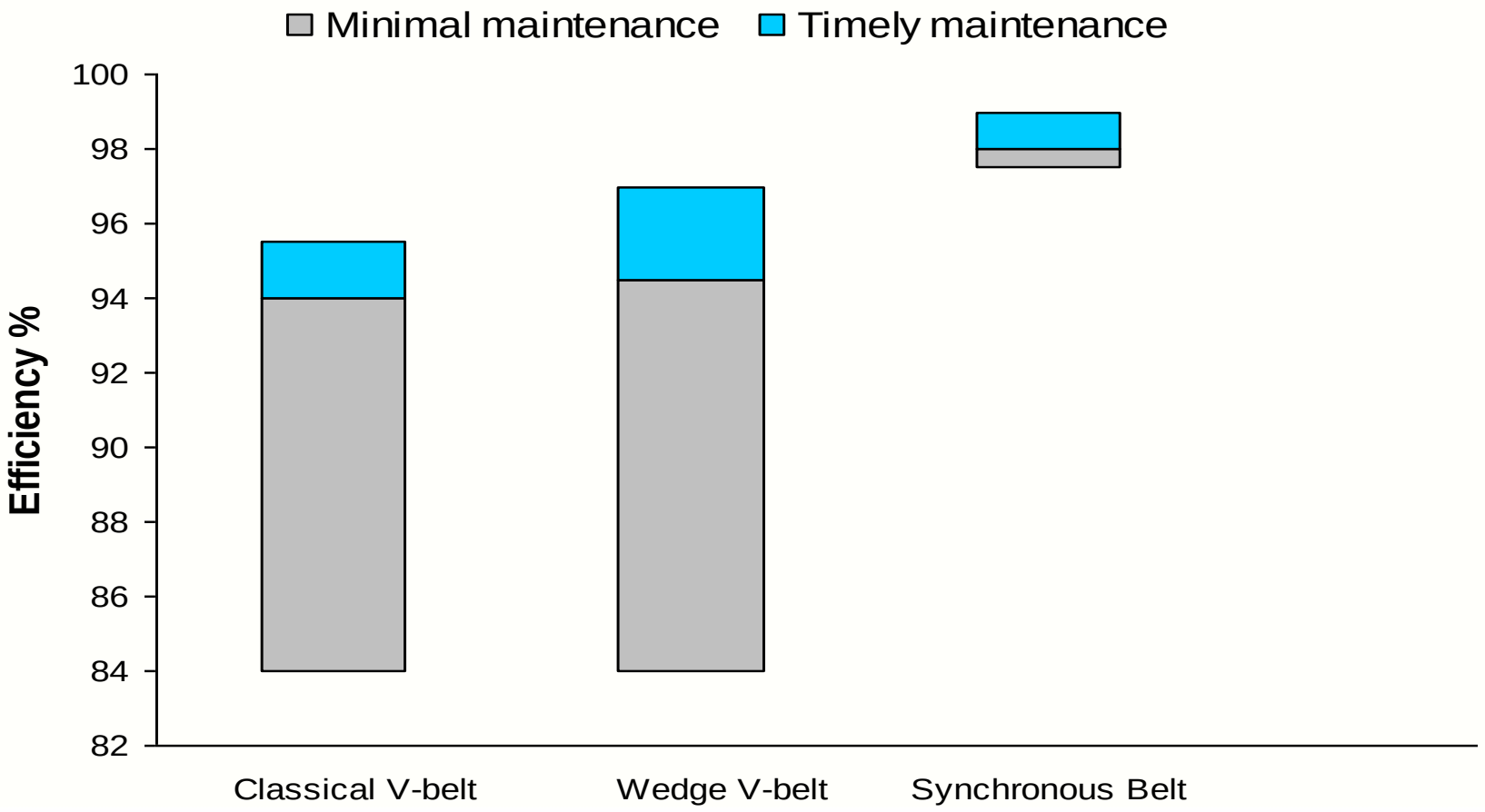
System should be designed for efficiency:

- Energy efficient motors
- Variable frequency drives

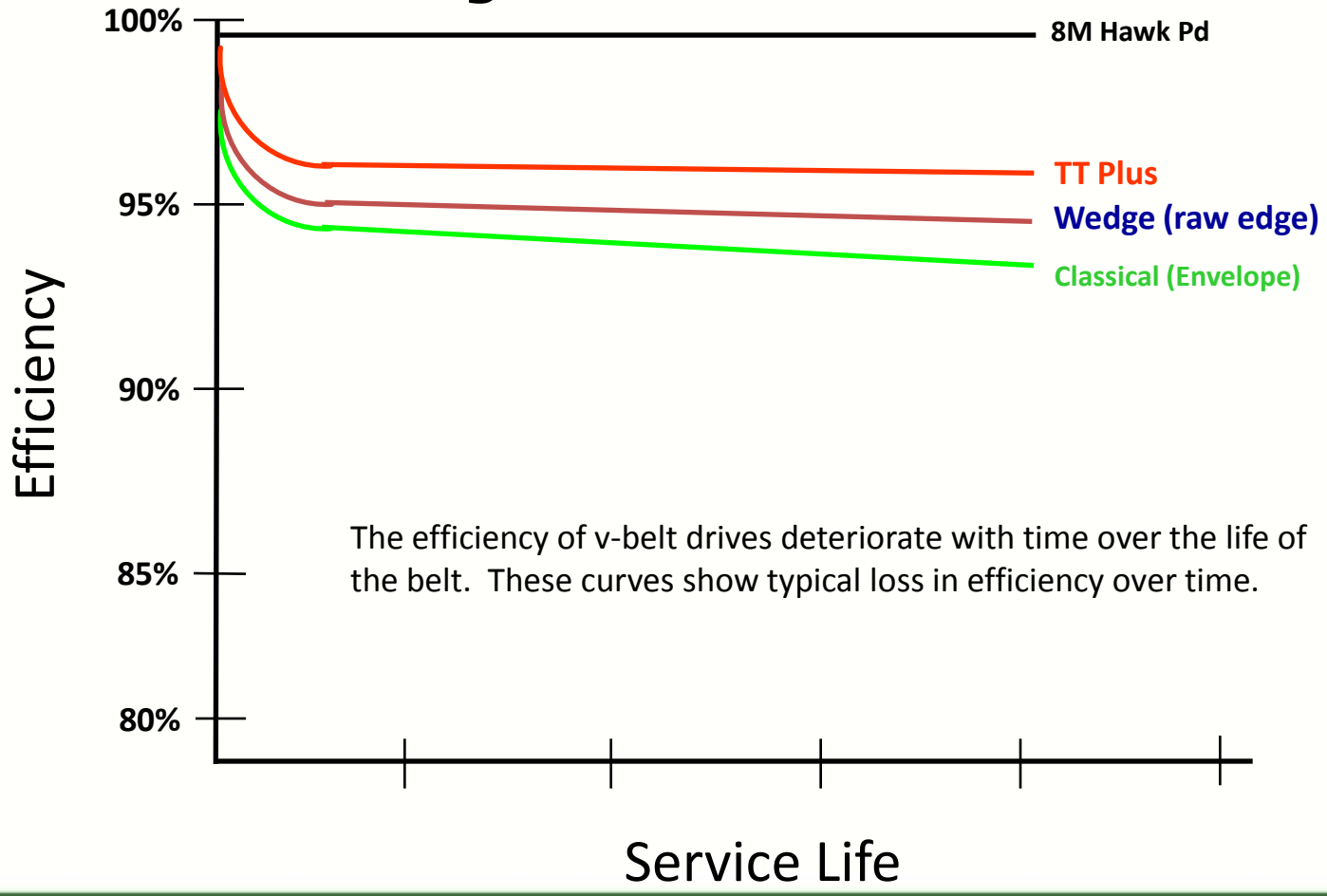
Design for requirements

- Measure speeds verify driven speed required
- Evaluate if application needs have changed

Higher Efficiency

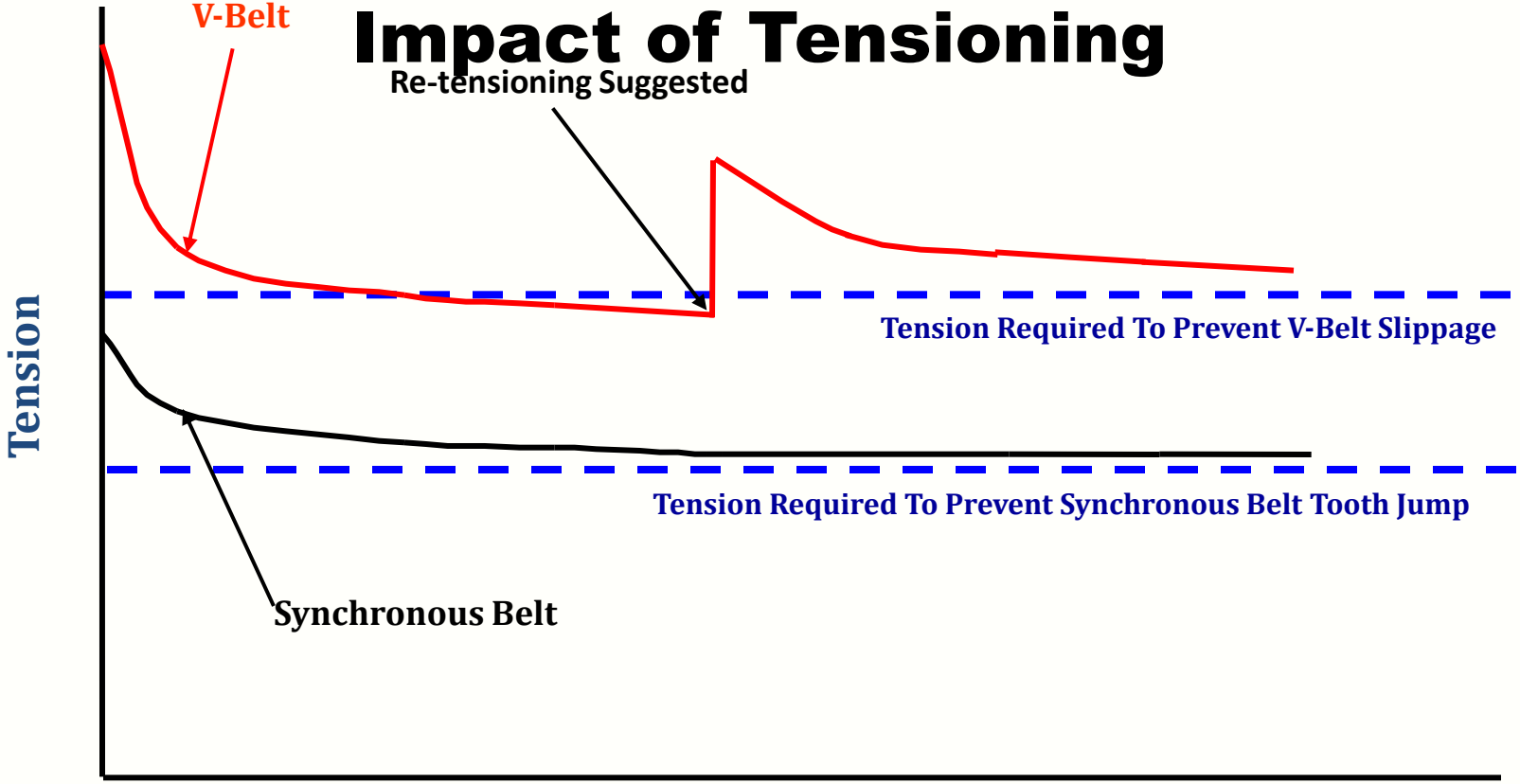


Drive Efficiency Relative to Service Life



V-Belts vs Synchronous Belts

Impact of Tensioning



V-Belt Retensioning

Common Sense Rules of V–Belt Tensioning

The ideal tension is the lowest tension at which the belt will not slip under peak load conditions.

Check the belt tension frequently during the first 24-48 hours of run-in operation.

Do not over tension belts. Doing so will shorten belt and bearing life.

Keep belts free from foreign materials that may cause slippage.

Inspect the V-drive periodically. Re-tension the belts if they are slipping.

Maintain sheave alignment with a strong straight-edge tool while tensioning V-belts.

Belt Efficiency Principles

Energy Savings Estimates:

1. Annual Energy Cost ($) = Motor HP x Hours/Year x 0.746 kW/HP x Cost ($) per kWh
2. Annual Energy Savings = Annual Energy Cost ($) x Efficiency Improvement
3. Assume on average, Efficiency Improvement = 5%
4. Payback Period = Cost of New Drive / Annual Energy Savings

Belt Efficiency Principles

Case Study: Washington State University Fan Drive

Fan Details:

1. Motor: 60 HP, 1750 rpm
2. Energy Cost = $0.06/kWh
3. Operates 168 hours/week and 52 weeks/year (168 x 52 = 8736 hours/year)

Belt Efficiency Principles

Case Study: Washington State University Fan Drive

Energy Savings Example:

Annual Energy Cost ($) =

60 HP x 8736 Hours/Year x 0.746 kW/HP x $0.06 per kWh = $23461

Annual Energy Savings =

$23461 x 0.05 = $1173 (assume Efficiency Improvement = 5%)

Belt Efficiency Principles

Case Study: Washington State University Fan Drive

Existing V-Belt Drive:

Belt: 5-C112 (112" Length)

Driver Sheave: 955C (9.9" OD)

Driven Sheave: 1105C (11.4" OD)

Center Distance: 41.4"

Hub Load: 1122 lbs

Power Rating: 105 hp

Purposed Eagle Pd Drive:

Belt: B-2800 (110" Length)

Driver Sprocket: B-48S (8.4" OD)

Driven Sprocket: B-56S (9.8" OD)

Center Distance: 40.8"

Hub Load: 589 lbs

Power Rating: 119 hp

Belt Efficiency Principles

Case Study: Washington State University Fan Drive

Existing V-Belt Drive:

– Drive rpm 1638

– Driven rpm 1418

– Motor Amps 51.7

– Motor KW 29.8

Purposed Eagle Pd Drive:

– Drive rpm 1654

– Driven rpm 1418

– Motor Amps 49.8

– Motor KW 28.8

The percent energy savings = (29.8 – 28.8)/28.8 x 100 = 3.5%

Energy Savings = $250/year*

* The calculation was made by McKinstry Energy Company. The actual energy cost ($ per kWh) and hours per year operation that were used in the calculation are unknown.

The Following Calculations are based on 24/7/365 .06KW Cost Savings Based on First Year Only

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25HP 1750RPM TO 875RPM $760.00 saved

Belt Type	Belt part number:	DriveR diameter or teeth number [Inch]	DriveN diameter or teeth number [Inch]	DriveR / DriveN bushing	DriveN speed [revs/min]	Center distance [Inch]	Belt speed [ft/min]	Actual service factor	Noise level [dB(A)]	Overall width [Inch]	Overall length [Inch]	Annual energy used	Drive costs index
Falcon HTC	8GTR 2240 21	56	112	TL2012/TL3020	875.0	30.74	2572	2.4	75	2.01	39.10	10030	1.50
Falcon HTC	8GTR 2000 21	45	90	TL2012/TL3020	875.0	28.65	2067	1.8	74	2.01	35.36	10098	1.28
Falcon HTC	8GTR 2000 36	40	80	TL2012/TL3020	875.0	29.85	1837	2.6	81	2.01	35.81	10206	1.52
HY-T Plus	3 - B94	7.40	15.40	SK/SK	862.3	29.72	3580	1.6	N/A	2.53	41.40	10712	1.26
HY-T Plus	2 - B96	8.00	16.00	SK/SK	893.7	29.78	3854	1.2	N/A	2.03	42.06	10712	1.11
HY-T Plus	3 - B96	8.00	16.00	SK/SK	894.8	29.78	3854	1.8	N/A	2.53	42.06	10712	1.32
HY-T Plus	2 - B118	12.40	25.00	SK/SF	880.2	29.86	5870	1.8	N/A	2.06	48.83	10712	1.95
HY-T Plus	3 - B90	6.80	13.60	SD/SK	898.2	29.68	3305	1.4	N/A	2.53	40.16	10715	1.08
HY-T Plus	3 - B90	6.60	13.60	SD/SK	873.2	29.83	3213	1.4	N/A	2.53	40.20	10719	1.07
HY-T Plus	3 - B90	6.40	13.60	SD/SK	848.2	29.98	3121	1.3	N/A	2.53	40.25	10724	1.06
HY-T Plus	3 - B87	6.00	12.40	SD/SK	873.0	29.78	2938	1.2	N/A	2.53	39.25	10741	1.00
HY-T Plus	4 - B87	6.00	12.40	SD/SK	873.7	29.78	2938	1.6	N/A	3.25	39.25	10741	1.20
HY-T Wedge	2 - 5V950	7.10	14.00	SK/SF	883.1	30.73	3253	1.3	N/A	2.00	41.28	10759	1.61
HY-T Wedge	2 - 5V950	7.50	15.00	SK/SF	870.9	29.59	3436	1.4	N/A	2.00	40.84	10759	1.63
HY-T Wedge	2 - 5V1000	8.00	16.00	SK/SF	871.1	30.89	3665	1.6	N/A	2.00	42.89	10759	1.70
HY-T Wedge	2 - 5V1060	9.25	18.70	SK/SF	862.3	30.68	4238	2.0	N/A	2.00	44.66	10759	1.95
HY-T Wedge	2 - 5V1120	10.90	21.20	SK/SF	896.9	30.35	4994	2.4	N/A	2.00	46.40	10759	2.39
HY-T Wedge	2 - 5V1180	11.80	23.60	SK/E	872.4	30.63	5406	2.7	N/A	2.63	48.33	10759	2.76
HY-T Wedge	2 - 5V1250	14.00	28.00	SF/E	872.8	28.65	6414	3.1	N/A	2.63	49.65	10759	3.15
HY-T Plus	4 - B84	5.40	11.00	SD/SK	888.9	29.89	2663	1.3	N/A	3.25	38.36	10790	1.11

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50HP at 1750RPM to 875RPM
$1,273 Saved

Belt Type	Belt part number:	DriveR diameter or teeth number [Inch]	DriveN diameter or teeth number [Inch]	DriveR / DriveN bushing	DriveN speed [revs/min]	Center distance [Inch]	Belt speed [ft/min]	Actual service factor	Noise level [dB(A)]	Overall width [Inch]	Overall length [Inch]	Annual energy used	Drive costs index
Falcon HTC	14GTR 2380 20	40	80	TL2517/TL3020	875.0	30.11	3215	1.7	74	2.01	40.53	20236	1.41
Falcon HTC	14GTR 2520 20	44	90	TL3020/TL3020	855.6	30.88	3537	2.0	75	2.01	42.52	20249	1.50
Falcon HTC	14GTR 2800 20	56	112	TL3020/TL3020	875.0	31.59	4501	2.6	77	2.01	46.21	20276	1.68
Falcon HTC	14GTR 2240 37	36	72	TL2517/TL3020	875.0	29.04	2894	2.8	80	2.01	38.40	20282	1.83
Falcon HTC	14GTR 2240 37	36	72	SF/TL3020	875.0	29.04	2894	2.8	80	2.31	38.40	20282	1.90
Falcon HTC	14GTR 3136 20	72	140	TL3020/TL3020	900.0	31.96	5787	3.5	80	2.01	50.45	20297	2.26
HY-T Plus	5 - B94	7.40	15.40	SF/SF	861.9	29.72	3580	1.3	N/A	4.00	41.40	21424	1.16
HY-T Plus	4 - B96	8.00	16.00	SK/SF	893.7	29.78	3854	1.2	N/A	3.25	42.06	21424	1.00
HY-T Plus	5 - B96	8.00	16.00	SF/SF	894.3	29.78	3854	1.5	N/A	4.00	42.06	21424	1.23
HY-T Plus	3 - B118	12.40	25.00	SK/SF	879.4	29.86	5870	1.4	N/A	2.53	48.83	21424	1.45
HY-T Plus	5 - B90	6.80	13.60	SK/SF	897.6	29.68	3305	1.2	N/A	4.00	40.16	21430	1.03
HY-T Plus	6 - B90	6.80	13.60	SK/SF	898.2	29.68	3305	1.4	N/A	4.75	40.16	21430	1.18
HY-T Plus	5 - B90	6.60	13.60	SK/SF	872.7	29.83	3213	1.1	N/A	4.00	40.20	21438	1.02
HY-T Plus	6 - B90	6.60	13.60	SK/SF	873.2	29.83	3213	1.4	N/A	4.75	40.20	21438	1.17
HY-T Plus	6 - B90	6.40	13.60	SK/SF	848.2	29.98	3121	1.3	N/A	4.75	40.25	21448	1.16
HY-T Wedge	4 - 5V950	7.10	14.00	SF/E	883.1	30.73	3253	1.3	N/A	3.16	41.28	21519	1.44
HY-T Wedge	4 - 5V950	7.50	15.00	SF/E	870.9	29.59	3436	1.4	N/A	3.16	40.84	21519	1.52
HY-T Wedge	3 - 5V1000	8.00	16.00	SF/E	869.9	30.89	3665	1.2	N/A	2.63	42.89	21519	1.35
HY-T Wedge	3 - 5V1060	9.25	18.70	SF/E	861.2	30.68	4238	1.5	N/A	2.63	44.66	21519	1.50
HY-T Wedge	2 - 5V1120	10.90	21.20	SK/SF	893.9	30.35	4994	1.2	N/A	2.00	46.40	21519	1.51
HY-T Wedge	2 - 5V1180	11.80	23.60	SK/E	869.8	30.63	5406	1.3	N/A	2.63	48.33	21519	1.74
HY-T Wedge	2 - 5V1250	14.00	28.00	SF/E	870.6	28.65	6414	1.5	N/A	2.63	49.65	21519	1.99

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100HP at 1750RPM to 875RPM
$2,565.00 Saved

Belt Type	Belt part number:	DriveR diameter or teeth number [Inch]	DriveN diameter or teeth number [Inch]	DriveR / DriveN bushing	DriveN speed [revs/min]	Center distance [Inch]	Belt speed [ft/min]	Actual service factor	Noise level [dB(A)]	Overall width [Inch]	Overall length [Inch]	Annual energy used	Drive costs index
Falcon HTC	14GTR 3136 20	72	140	TL3020/TL3020	900.0	31.96	5787	1.7	80	2.01	50.45	40472	1.04
Falcon HTC	14GTR 2800 37	56	112	TL3020/TL3535	875.0	31.59	4501	2.4	84	3.50	46.21	40539	1.10
HY-T Plus	6 - B118	12.40	25.00	SF/E	879.4	29.86	5870	1.4	N/A	4.75	48.83	42849	1.02
HY-T Wedge	6 - 5V1000	8.00	16.00	E/F	869.9	30.89	3665	1.2	N/A	4.63	42.89	43037	1.04
HY-T Wedge	5 - 5V1060	9.25	18.70	E/F	860.4	30.88	4238	1.2	N/A	3.75	44.88	43037	1.01
HY-T Wedge	4 - 5V1120	10.90	21.20	E/E	893.9	30.35	4994	1.2	N/A	3.16	46.40	43037	1.00
HY-T Wedge	4 - 5V1180	11.80	23.60	E/F	869.8	30.63	5406	1.3	N/A	3.63	48.33	43037	1.11
HY-T Wedge	3 - 5V1250	14.00	28.00	E/E	869.1	28.65	6414	1.2	N/A	2.63	49.65	43037	1.05
HY-T Wedge	4 - 5V1250	14.00	28.00	E/F	870.6	28.65	6414	1.5	N/A	3.63	49.65	43037	1.26

200HP at 1750RPM to 875RPM
$6,932.00 Saved

Belt Type	Belt part number:	DriveR diameter or teeth number [Inch]	DriveN diameter or teeth number [Inch]	DriveR / DriveN bushing	DriveN speed [revs/min]	Center distance [Inch]	Belt speed [ft/min]	Actual service factor	Noise level [dB(A)]	Overall width [Inch]	Overall length [Inch]	Annual energy used	Drive costs index
Falcon HTC	14GTR 3138 68	72	140	TL3535/TL4040	900.0	31.96	5787	2.9	90	4.02	50.45	81143	1.21
HY-T Wedge	6 - 5V1250	14.00	28.00	F/J	869.1	28.85	6414	1.2	N/A	4.63	49.85	86075	1.00
HY-T Wedge	7 - 5V1250	14.00	28.00	F/J	870.0	28.85	6414	1.4	N/A	5.13	49.85	86075	1.20

Custom rebates can be applied for. Contact your local power supplier for details.