Better Plants
U.S. DEPARTMENT OF ENERGY

Motor System *Info Card*

Top 5 Energy Conservation Measures

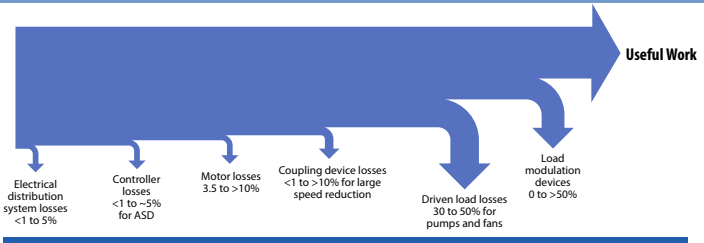
1. Turn off motors when not in use
2. Replace standard V-belts with notched or synchronous belt drives
3. Replace standard efficient motors with energy efficient/premium efficient motors
4. Mitigate voltage unbalance
5. Improve power factor

Annual Energy Savings for Premium vs Standard Efficiency Motors

Motor Horse-power	Standard Efficiency		Premium Efficiency		Annual Cost Savings
	Motor Efficiency	Annual Energy Cost	Motor Efficiency	Annual Energy Cost	
10	86.7	$6,884	91.7	$6,508	$375
25	89.9	$16,596	93.6	$15,940	$656
50	91.6	$32,576	94.5	$31,577	$1,000
100	92.2	$64,729	95.4	$62,558	$2,171
200	93.3	$127,931	96.2	$124,075	$3,857

Note: Based on a 1,800 RPM TEFC motor in operation 8,000 hours per year (hrs/year) at 75% load at an electrical rate of $0.1/kWh.

Typical Motor System Losses



Rules of Thumb: Replace Instead of Rewind If…

- Motors are standard and easy to purchase
- The process down time will be significantly reduced
- Motor power is less than 50 hp
- The cost of rewinding exceeds 60% of the price of a new motor

Motor Formulas

$$P(kW,estimated) = \frac{Rated\ Horsepower \times 0.746 \times \%\ Motor\ Load}{Motor\ Efficiency}$$

$$P(kW,measured,3\text{-}phase) = \frac{Amp \times Vol \times \sqrt{3} \times Power\ Factor}{1000}$$

$$Horsepower = \frac{Torque(ft \cdot lb) \times RPM}{5252}$$

$$Synchronous\ Speed = \frac{120 \times Frequency\ (Hz)}{Number\ of\ Poles}$$

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WATER POWER TECHNOLOGIES OFFICE

Motor System *Info Card*

Unit Conversions

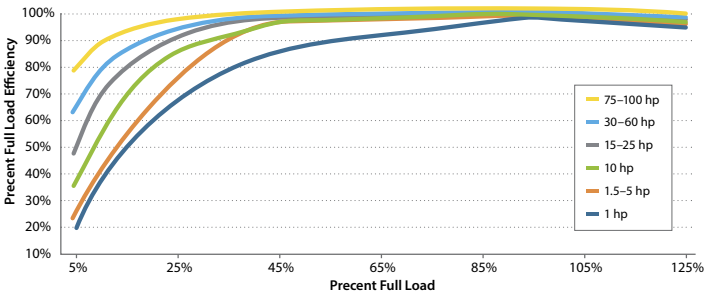
1 hp = 745.5 W = 550 lb • ft/s

1 kW = 1.341 hp = 738 lb • ft/s

Adjustable Speed Drive Part-Load Efficiency

Variable Drive hp Rating	Efficiency (%) Load, Percent of Drive Rated Power Output					
	12.5	25	45	50	75	100
5	80	88	91	92	94	95
10	83	90	93	94	95	96
50	86	92	95	95	96	97
100	89	94	95	96	97	97
200	81	95	96	96	97	97

Motor Part Load Efficiency



Shaft Alignment Tolerances for Direct-Coupled Shafts

Motor Speed (RPM)	Parallel Offset (mils) Short Flex Couplings		Angular Misalignment (mils per inch) Spacer Couplings	
	Excellent	Acceptable	Excellent	Acceptable
900	3.0	6.0	1.2	2.0
1,200	2.5	4.0	0.9	1.5
1,800	2.0	3.0	0.6	1.0
3,600	1.0	1.5	0.3	0.5

Source: Alan Luedeking, Ludeca, Inc. "Shaft versus Foot Alignment Tolerances: A Critique of the Various Approaches," 2008.

Resources

1. Improving Motor and Drive System Performance: A Sourcebook for Industry by US Department of Energy
2. Motor Tip Sheets by US Department of Energy
3. Premium Efficiency Motor Selection and Application Guide - A Handbook for Industry. Washington D.C, US Department of Energy
4. EASA Standard AR100-2015: Recommended practice for the repair of rotating electrical apparatus by Electrical Apparatus Service Association, Inc.