Save Energy!







Eliminate Misalignment and "Right-Size" Your Pumps

Causes, Effects and New "Out-of-the-Box" Solutions







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Save Energy!

Eliminate Misalignment and "Right-Size" Your Pumps

Causes, Effects and New "Out-of-the-Box" Solutions

- Introduction
- Misalignment Overview
 - What is misalignment, and how is it measured?
 - Causes & effects of misalignment
- Getting and Staying Aligned
 - Technologies used to set alignment
 - Common reasons alignment is ignored
 - Existing flexible couplings and their limitations
 - Example of vibration at various levels of misalignment

• Flux Drive SmartCOUPLING

- Magnetic coupling description and history
- Flux Drive technology
- Alignment benefits
- Energy benefits
- Case study: Veolia Environnement, Stickney, IL WWTP

Flux Drive founded by Chip Corbin – Marine Engineer

- SUNY Maritime College
- US Naval Officer 1980s

BACKGROUND

- 1988: Founds Impact Engineering Inc.
 - Vibration mitigation and preventive maintenance services on ocean-going vessels
 - Expert alignment and balancing services
 - Chip (and team) still provides vibration services to the U.S. Navy, including highly classified vessels and global shipping lines
- 2007: Flux Drive founded.
 - Products designed to:
 - 1. Save energy
 - 2. Provide alignment and vibration mitigation benefits
 - 3. Survive and be serviceable at sea

Brief Misalignment Overview

What is Shaft Alignment?

Positioning of two or more machines so that their rotating shaft center lines are collinear at the coupling under operating conditions

Types of Misalignment

Angularity Calculations

(.075 - .045) / 6 = 5 mils/inch of angularity

Typical Alignment Standards

RPM	Offset (mils)		Angle (mils)		
	Excellent	Good	Excellent	Good	
600	5.0	9.0	10.0	15.0	
900	3.0	6.0	7.0	10.0	
1200	2.5	4.0	5.0	8.0	
1800	2.0	3.0	3.0	5.0	
3600	1.0	1.5	2.0	3.0	
7200	0.5	1.0	1.0	2.0	

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Causes of Misalignment

- Inaccurate assembly or installation of components
 - Improper shimming
 - Post-installation torque on system from pipefitting, etc.
- Thermal growth from hot processes
- Distortion of supports due to torque
- Other equipment or base anomalies
 - Soft foot

CAUSES

Improper shimming

Thermal growth in hot processes

Effects of Misalignment: <u>HEAT</u>

- EFECTS
- Metal is under constant stress
 - Similar to bending a wire repeatedly
 - Flexible elements reduce, but that doesn't eliminate heat build-up
- Heat transfers into bearings
 - Damages grease and reduces bearing life

at the coupling

at the bearings

Effects of Misalignment: VIBRATION

Vibration damage

FFECTS

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- Bearings fail more rapidly
- Seals deteriorate and leak
- Shafts weaken over extended period
- Vibration Characteristics
 - Typical frequencies at 1x and/or 2x shaft speed (SS)
 - High vibration amplitudes in the radial and/or axial directions
 - May amplify natural frequencies in resonant structures
 - Other vibration from the coupling due to wear/lock-up conditions
 - Possible 180-degree phase shift across the coupling

Sample Vibration Spectrum

Getting and Staying Aligned

Why Perform Shaft Alignment?

Reduces:

ALIGNED

- Vibration and noise
- Bearing, coupling and seal wear/damage
- Maintenance costs and downtime

Save maintenance dollars (\$\$) Save fuel/operating cost (\$\$)

Alignment Alternatives

OVERVIEW

Manual	Instrumented	Invisible	2nd Generation	
Alignment	Alignment	Laser	Visible Laser	
• Eyeball it	 Reverse Dial Rim & Face Graph Paper for calculations Dial Indicator to check for soft foot 	 No more sag Able to span longer couplings Automatic Calculation/No More Graph Paper 	 Visible Beam Span up to 30' Soft Foot Check Live Move 	
Method:	Method:	Method:	Method:	
• Straight Edge	• 3 or 4 points	• 3 or 4 points	• 3 or 4 point	

Why is Alignment Often Ignored?

- Benefits are not known
- Present alignment methods are thought to be adequate
- Precision equipment/procedures not available
- Precision equipment too expensive
- Skilled/trained personnel not available

Accommodating Misalignment: Flexible Couplings and Their Function

- Transmit torque and speed (power)
- Accommodate limited misalignment between the driver and driven load
- Accommodate limited misalignment during temperature transients
- Compensate for end movement and axial growth

SOLUTIONS

Toothed Elastomeric Insert Coupling

Gear Coupling

Grid Coupling

Elastomeric ring

Disc Pack Coupling

Flex Coupling Limitations: Cause of Failures

- Excessive misalignment/improper assembly
 - Improper coupling selection or installation
 - Undersizing coupling for torque requirement
 - Not laser-aligning or thinking coupling doesn't require it
 - Lack of PM (lubrication) or wrong type
 - Grid/gear type couplings require regular maintenance
 - Age

SS

SOLUTIO

Inserts are designed for obsolescence

Flexible Coupling Performance Example: Grid Coupling on 40hp 1800 rpm Pump

Motor: Laser-aligned to coupling tolerance

Flexible Coupling Performance Example: Grid Coupling

Pump: Laser-aligned to coupling tolerance

ISO 10816 Chart

Vibration Severity R	ange Limits (Velocity) Vibration Severity Ranges for Ma	chines Belonging	to:				
From ISO 2372								
In/Sec (PK)	MM/Sec (RMS)	Class I	Class II	Class III	Class IV			
		< 15 KW	15 – 75 KW	>75 KW	>75 KW			
0.015	0.28	A	A	A	A			
0.025	0.45				(Good)			
0.039	0.71	В						
0.062	1.12		В					
0.099	1.8	C		В				
0.154	2.8		С		В			
0.248	4.5	D		С	(Allowable)			
0.392	7.1		D		С			
0.617	11.2			D	(Tolerable)			
0.993	18				D			
1.54	28				(Not Permissable)			
2.48	45							
3.94	71							
A: Good								
B: Allowable								
C: Tolerable								
D: Not Permissible								
Suggested Classifications:								
Class I: Small (up to 15kW) machines and subassemblies of larger machines.								
Class II: Medium size (15kW to 75kW) machines without special foundations, or machines up to 300kW rigidly mounted on special foundations.								
Class III: Large rotating machines rigidly mounted on foundations which are stiff in the direction of vibration measurement.								
Class IV: Large rotating machines mounted on foundations which are flexible in the direction of vibration measurement.								
Legend:								
Green: Good								
Vollow: Worning								

Flux Drive SmartCOUPLINGs (FSC)

The Modern Magnetic Alignment Solution

Magnetic Couplings – The Modern Alternative

All magnetic couplings provide benefits that no other technology can:

- 100 percent isolation of motor from load via air gap
 - Eliminates all potential for vibration transfer
 - Provides load seizure protection (no broken shafts)
- Misalignment accommodation
 - 0.100" or more due to wide air gap
- Cushioned start

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TECHNOLO

Magnetic Coupling Background

- "Eddy current" couplings debuted in late 1990s
 - Rare earth permanent magnet advances made them feasible
- Limitations relegated Eddy current couplings to niche markets
 - Eddy current design is relatively weak, requiring coupling oversizing
 - Oversized coupling larger in diameter than motor

LECHNOLOGY

- Expensive due to use of copper bonding technique
- No inherent ability to reduced load speed
- Load seizures lead to overheating and coupling damage

Magnetic *Sealing* Technology

- Not the same as a magnetic coupling
- "Mag drive" pumps utilize opposing magnets for <u>synchronous</u> torque transfer
- Benefits

LECHNOLOGY

- Excellent sealing technology no leaks!
- Breaks away on load seizure to protect shafts/impellers
- Limitations
 - No cushioned starting
 - Not intended for alignment correction between motor/load
 - No load speed control for energy savings

Flux Drive SmartCOUPLING Technology

Second-generation magnetic coupling design

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ECHNOLO

- Based on proven induction rotor/motor principles
- Cushioned start and energy savings (a Flux Drive exclusive)
- Rising torque curve for wide range of applications

Inline Flux Drive SmartCOUPLING

LECHNOLOGY

Alignment Benefits

Allows axial elongation (thermal growth)

Alignment Benefits

Accepts angular and parallel misalignment

Magnetism balances for consistent torque transfer

Parallel offset in any direction up to 0.090"

Alignment Benefits

- No touching parts
 - No transmission of vibration
 - No laser alignment needed
 - Never wears out!

TECHNOLOGY

Flexible Coupling Performance Example SmartCOUPLING on 40hp pump @ 1800rpm

Motor: Laser-aligned for comparison purposes

FLUXDRIVE

ENERGY EFFICIENCY MADE EASY

Flexible Coupling Performance Example SmartCOUPLING:

Pump: Laser-aligned for comparison purposes

Flexible Coupling Performance Example SmartCOUPLING:

Motor: Multiple spectrums at various levels of misalignment

Flexible Coupling Performance Example SmartCOUPLING:

Pump: Multiple spectrums at various levels of misalignment

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Flux Drive SmartCOUPLINGs (FSC)

Energy-Saving Benefits!

An optimist will tell you the glass is half-full; the pessimist, half-empty. The engineer will wonder why the glass was designed with 100 percent excess capacity!

Wasted Energy In Motor-Driven Systems

- Excess Capacity Margin (ECM) built into most pump/fan systems
 - Engineers size systems for future demand/safety factor
 - Systems commissioned and run with some level of ECM
 - Adjustable speed devices can **RIGHT SIZE** the pump!
- Savings on centrifugal loads follows laws of affinity

BLEM

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Exponential savings with speed reduction

Theoretical power based on Laws of Affinity.

Energy Savings on Centrifugal Loads

TECHNOLOGY

Closed Air Gap = Max Speed

Open Air Gap = Reduced Speed

- Savings achieved by adjusting air gap ('SmartPOWER' reduction)
 - Benefits from Affinity Laws
 - 5% less speed = ~10% less power
 - 10% less speed = ~20% less power
 - Example: 100kW Electric Motor, \$0.10 cents/kWh, full time operation = \$87,600 per year in energy cost
 - Gap 1: \$8,760 Savings
 - Gap 2: \$17,520 savings
 - Max Gap: Up to \$65,000 savings!

Payback ROI often less than 2 years

Cushioned Start Benefits

- Motor disconnected from load at start-up
- Magnetism is created by speed differential coupling sides
- Locked rotor amps dramatically reduced

FITS

Ζ

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- Typically current spikes to 6-7x running amps
- Flux Drive limits to 1.5x running amps
- May reduce utility demand charges
- Torsional shock decreased
 - Reduces shaft/coupling damage
 - Protects gearboxes from lash

POWER (kW)

Other SmartCOUPLING Benefits

- Out of the box "drop in" replacement of existing flexible couplings
 - Shaft spacers available for wide DBSE
- No laser alignment required "eyeball" install
 - Minimum 100-mil air gap on all sides up to 310 mil with air gap spacers
- Installation in less than 1 hour
 - Simple split hubs pre-bored to customer specs
- Easy switch between full and reduced speed operation as needed
 - Never permanently trim an impeller again!
- Available in belt-pulley model as well!

Flux Drive Adjustable Speed Drives

- Mechanical soft start
- Dynamic speed control for changing processes
 - Linear actuator connects to facility control system
 - Control between 30 percent & full speed
- Load seizure protection
- Reliability in difficult environments
- Not susceptible to power quality issues
- Extremely durable

PRODUCTS

- Outlast connected equipment
- Available in inline and belt-pulley models

FLUXDRIVE ENERGY EFFICIENCY MADE EASY

STUD CASE

VEOLIA Stickney WWTP, Chicago, IL ENVIRONNEMENT

Hot Oil Pumps – Sludge Drying

Problem:

- Four 125hp KSB hot oil pumps
- Pumps aligned when cold but grew out of alignment when hot
 - ~35 mils vertical growth
 - ~40 mils axial growth
- Seals failing approximately every six months due to vibration from misalignment
- High maintenance expense plus hazardous conditions from leaking oil

Stickney WWTP, Chicago, IL IRONNEMENT

Solution:

STUD

CASE

VEOLIA

- 125hp SmartCOUPLING (FSC-5)
- Drop-in solution replaces existing coupling
 - 1" shaft spacer used to span DBSE

Results:

- Significant reduction in vibration
 - Below 0.05 in/sec compared to 0.25 in/sec prior to installation
- FSC insulates motor from pump heat
- \$1,500 annual energy savings per pump

After the webinar ...

WHITEPAPERS

• "IDENTIFYING AND CORRECTING MISALIGNMENT WITH THE FLUX DRIVE SmartCOUPLING"

http://www.fluxdrive.com/docs/VibrationWhitepaper.pdf

 "ELIMINATING EXCESS CAPACITY MARGIN FOR ENERGY AND COST SAVINGS"

http://www.fluxdrive.com/docs/ECMWhitepaper.pdf

VIDEOS

http://www.fluxdrive.com/videos

To contact our speaker after this webinar: Matt Carlson | VP Sales & Marketing | Flux Drive Inc. mcarlson@fluxdrive.com | 1-800-236-3581

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