WHAT DOES YOUR SHAFT COUPLING REALLY COST YOUR BUSINESS?

Shaft Alignment savings explained with TCAE ™ shaft couplings.

As many engineers know the reliability of a good pump, geartrain, or any other powertrain is only as good as the shaft coupling that drives it. Unless specified directly at the outset, many OEM machines are often purchased, unfortunately, with the most basic motor shaft coupling that have untimely let the system down due to failure or else burdened with lengthy maintenance schedules to keep the alignment in its critical state. Not only the expense, but the time required to perform accurate shaft alignment on rotating machines costs the plant enormously in lost production from downtime.

While the advent of modern laser alignment technology has enabled users to “plug and play” their instruments to achieve a quick result, just relying on a digital readout is a mistake as errors in reading sometimes occurs.

The requirement for shaft alignment can be categorised into two distinct areas:

1. Requirement for STATIC Shaft Alignment - the machine is stationary.
2. Requirement for DYNAMIC Shaft Alignment - machine is rotating.

Clearly most alignment methods can only focus on the first point –machine shafts can really just be aligned when stationary. It is here that every attempt is made to ensure coaxial alignment is achieved between the drive and driven shaft. This is usually done in both planes in line with the rotation axis with some high degree of tolerance. The precision for alignment varies for the type of coupling involved however since many couplings have some type of flexural element involved any deviation from “perfect” will result in some degree of side loading being induced to the shafts proportional to amount of tolerance offset. The detrimental effects of misalignment (no matter how small) will be seen over time in component wear (seals, bearings etc), additional power consumption and eventual failure.

The aspect of Dynamic Alignment is however a more important factor. Dynamic affects result from conditions including:

- initial torque energisation of a motor in a DOL configuration
- fluctuations in torque when a pump is loaded or unloaded
- torque changes when the gearbox of a rolling mill is loaded or unloaded with product
- thermal expansion from connected pipework to machines such as boiler feed pumps or turbines
- vibration from imbalance in pump impellers due to continual wear

Other significant factors can also cause things to go out of alignment - as simple as loose mounting bolts, flexible machine support bases and even corroded foundations all giving rise to the term “soft foot”. Almost no amount of STATIC alignment can solve the issue of soft foot as the connected machinery will flex the coupling to suit the loaded conditions.

Generally, it is hoped that these dynamic limits are of a low enough order that the coupling tolerance can accommodate the resulting flexure. BUT as mentioned above, the resulting flexure will place a burden in the form of side loading onto the connected shafts and create extra wear, consume additional power when the specified alignment tolerance is exceeded and can eventually cause premature failure of the drivetrain.

While most other coupling designers need to balance the flexural requirement within tight tolerances it still stands that precision alignment can be rarely achieved in an economical way when dynamics are present.

To overcome these real life “dynamic” conditions, the Thompson TCAE range of products have been designed to eliminate the need for precision alignment in the first place. Dubbed the “Alignment Eliminator Coupling”, the key feature of the TCAE series coupling is its unique double hinged mechanism that induces minimal radial load onto the connected shafts. In contrast flexible couplings of the elastomeric type produce side (radial) loads when

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the shafts are not perfectly aligned. Furthermore, the self-adjusting feature of the TCAE permit dynamic forces such as shock loads, thermal expansion, vibration and soft foot to be catered for without imposing damaging side loads on the shafts. The unique mechanism within the TCAE coupling transmits torque at constant velocity across a wide range of shaft angles and reduces imposed vibrations from rigidly mounted machines. With its expansive range of angular and axial movement capabilities (radially up to 5 degrees and axially up to +/- 15 mm for the smallest size) it also provides effortless installation with minimal downtime.

Additionally, the “out of sight – out of mind” ability of the TCAE coupling lends itself to applications that are often in remote and/or inaccessible places. Such examples include remote water feed pumps in mine sites or pumps or gearboxes situated in hazardous areas that may require difficult and elaborate entry permits to access that would ordinarily require routine coupling alignment activities to be performed. In these instances the “set and forget” nature of the TCAE coupling frees up the resources of the maintenance team for other more demanding duties.

Energy savings explained with TCAE ™ shaft couplings.

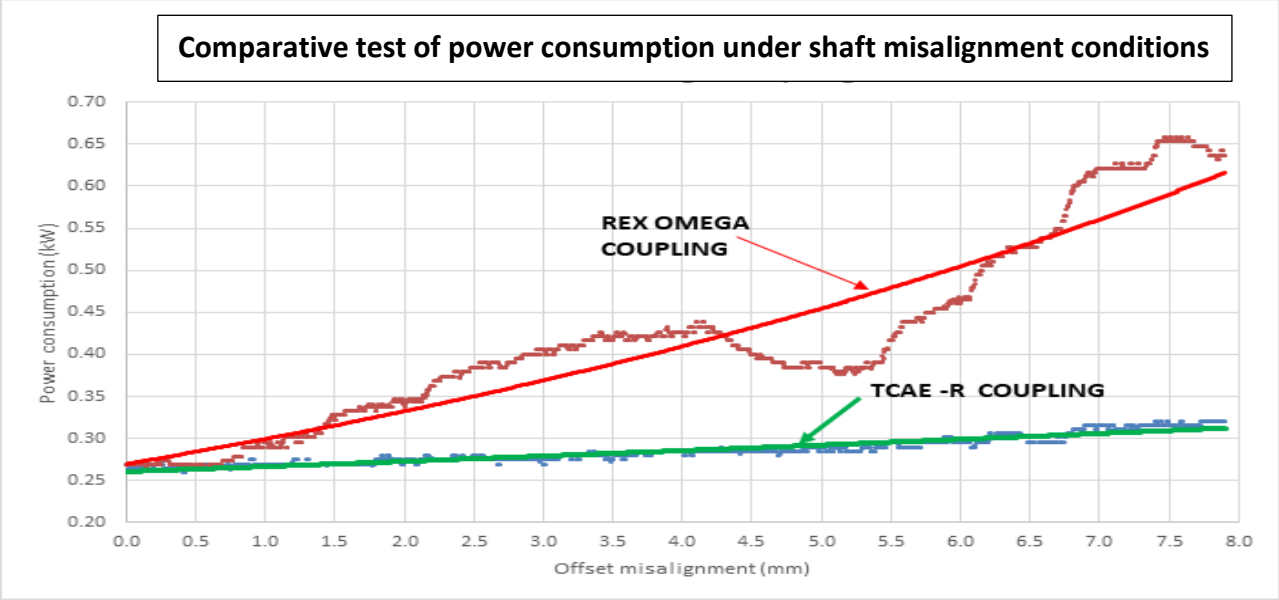
Tests have also been conducted to prove the energy saving potential of the TCAE compared to other flexural element couplings when various degrees of misalignment are created. The net result is the TCAE does provide a positive cost/benefit return for nearly every user.

Thompson Couplings produced a series of experiments to quantify this fact.

A 0.75kW , 4 pole , 3phase ,50Hz electric motor was coupled to a generator mounted on a sliding frame. An electric actuator controlled the relative position of the 2 shaft centrelines to produce an adjustable parallel offset condition.

A Thompson TCAE-R-2 coupling and a standard Rex Omega (30) elastomeric coupling were subjected to a series of tests by recording the power consumption of the driveline when the shaft centrelines were offset from 0 to 8mm. In angular terms this is a parallel offset of 5 degrees. Normally the Rex Omega coupling would not be subjected to such a high amount of flex however at the maximum recommended offset of 1/8” (3mm) allowed the power loss was very apparent.

In contrast the TCAE coupling maintained a slight rise in power consumption over the large offset distance due to small losses within the coupling as shown in the following graph of results.



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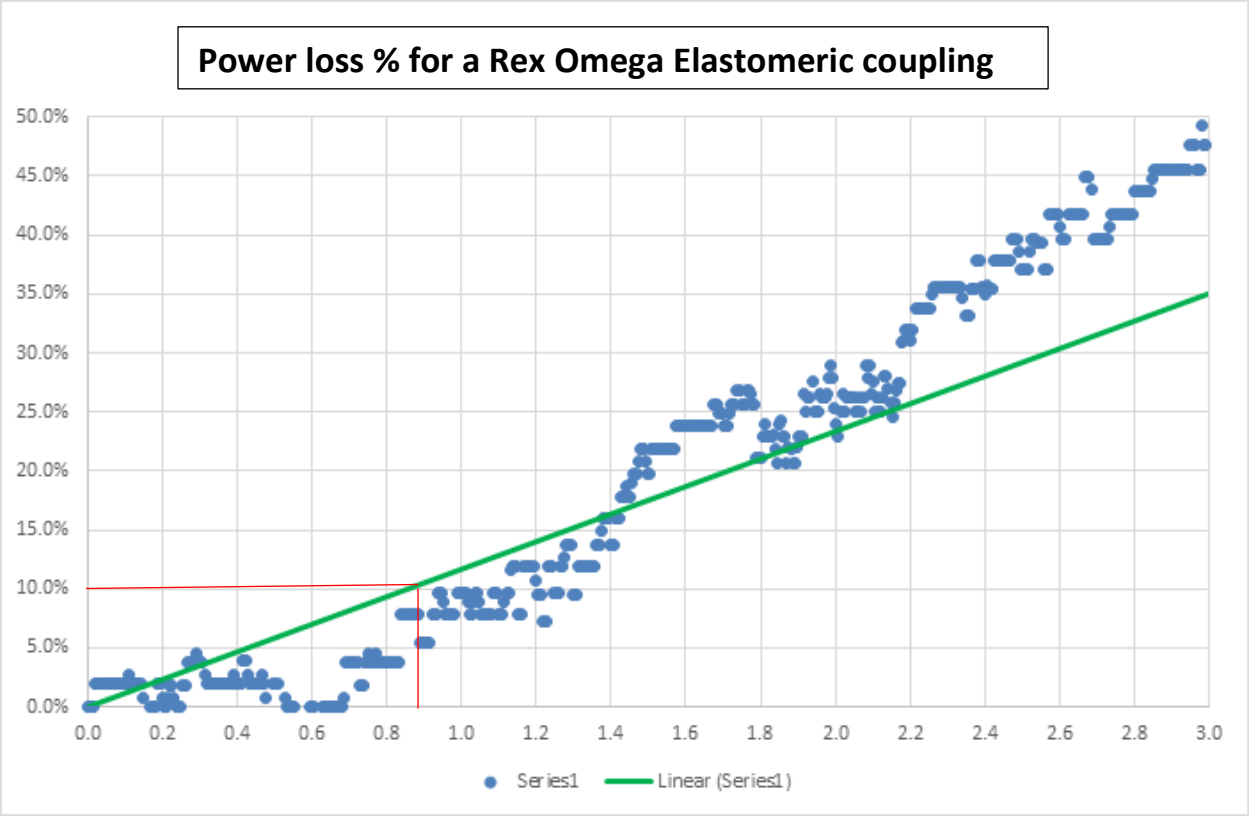
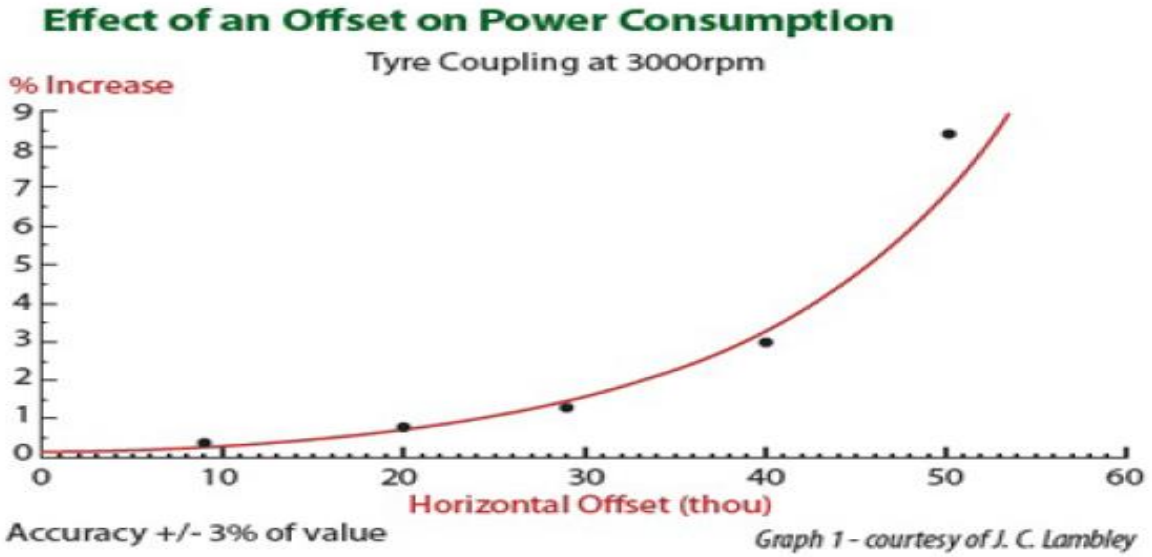
When the results were converted to an energy loss percentage within the normal range of allowable alignment for the Omega coupling the energy loss was apparent. Moreover at a relatively minimal offset of 0.9mm (0.035”) for this type of coupling losses of 10% energy can be observed.



The results are not unique and have been previously replicated by others including JC Lambley formerly of ICI Chemicals as shown below:



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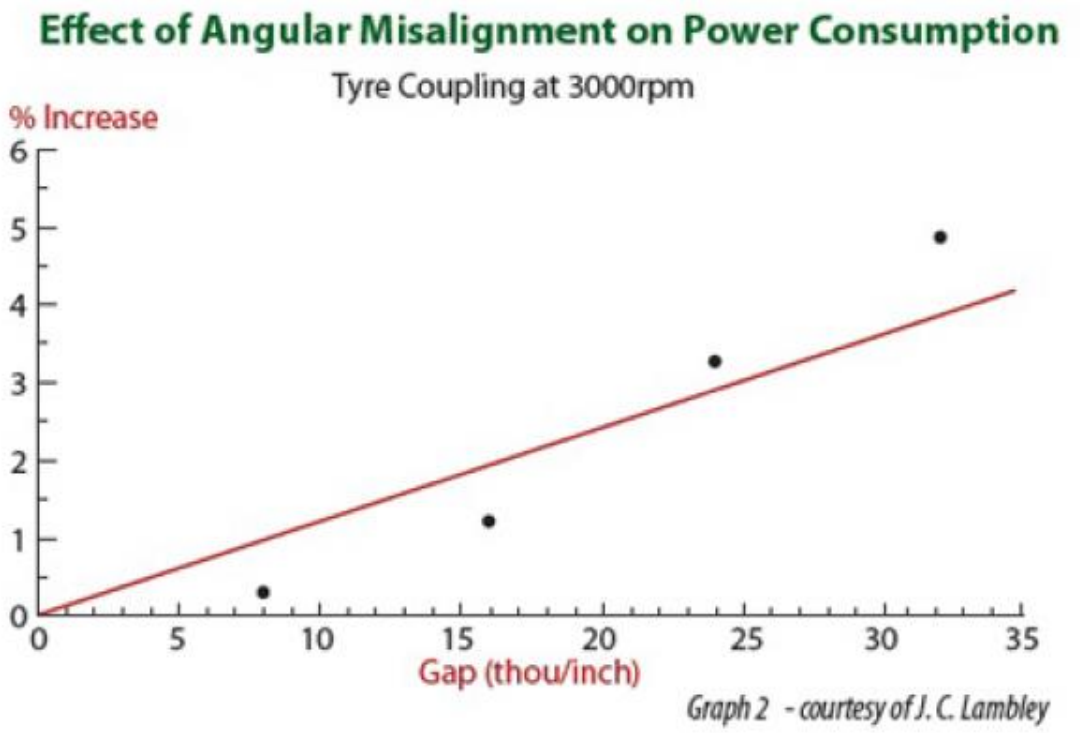

The TCAE coupling provides significant cost advantages in terms of energy savings and total cost of ownership through reduced power consumption, elimination of shaft alignments services, reduced wear on connected bearings and seals etc.

Production savings explained with TCAE ™ shaft couplings.

To demonstrate the effectiveness of the TCAE coupling in operation a number of case studies are presented from the company's wide customer base. The following table shows just some of the many individual applications that the TCAE coupling has helped to solve compared to other traditional shaft couplings:

SEE NEXT PAGE FOR EXAMPLES

(Presented by David Farrell (B.E. Mech (Hons)) - Chief Engineer, Thompson Couplings Ltd.)

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Type and company location	Application	Power/Speed conditions	Existing Problem	TCAE Solution
Gold Mining dump truck PTO drive - Indonesia	Coupling required at diesel engine Power take off to drive hydraulic pump	100kW, 2300rpm max diesel drive	Restricted engine compartment room meant direct coupling of the pump within standard coupling angular tolerances was not possible	TCAE-R-2 was installed with a shaft angle of 5 degrees allowing the pump to be situated unobstructed. The constant velocity nature of the coupling meant the pump operation remained smooth with no induced vibration from the coupling.
Water pumps for a large pulp and paper making plant – Sydney, Australia	Couplings required to operate in various sized water and slurry pumps	Various sized ranging from 11 kW, 1440rpm to 110kW, 1440rpm	Corrosive nature of the plant room has caused the concrete plinths used to mount the motor-pump bases to crumble. Significant downtime results from the requirement to constantly laser align the existing couplings under these “soft-foot” conditions	Various sized TCAE-R series couplings have now replaced the many existing pump couplings and have operated for many years without the need for any alignment. Furthermore the life of the pump seals has increased due to elimination of damaging side loads on the shafts from misalignment
Paper roll winder drives for a large paper making plant - Indonesia	Coupling connects DC motor to roll winder	180kW, 920 rpm	The existing gear coupling of the paper winder shaft required continual re-alignment due to the shock loads imposed under controlled deceleration and stopping	TCAE-R-7 was installed with an integral disc brake to control the deceleration and emergency stopping of the paper roll.
Suction press pump driveshafts for a large paper making plant - Indonesia	Long driveshaft (3 mtrs) connects motor to pump	185kW, 2100 rpm	Existing gear coupling regularly fails due to misalignment conditions	A Long series TCAE-L-7 installed to connect the motor gearbox to the suction pump
Roughing mill runout table driveshafts for a large steel plant - UK	Long bank of conveyor drive rolls feed hot steel slab through roughing mill	85kW, 579 rpm	Current cardan universal driveshafts produce continual torsional vibration affecting slab quality. Also couplings fail prematurely due to reversing nature of drive	A customised TCAE-V-7 was installed with standard DIN flanges to mount to the existing shaft flanges. The constant velocity nature produces relative vibration free motion to the conveyor

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Roller/Straightener driveshafts for a large steel rolling mill - Italy	Steel coil straightening machine with individual driving rollers	2,5kW 120 rpm	Existing special gear couplings fail regularly and require constant oil feed lubrication due to speed and angle	A customised high angle version of the TCHA-SD-8 coupling driveshaft was used to connect the gearbox output shafts to the individual spindle rollers at an angle up to 12 degs
Large, Vertical driveshaft for a high torque aviation test rig - Spain	Brand new test equipment being constructed by OEM	5,000 kW, 230rpm to 500 rpm	Requirement for a true constant velocity driveshaft able to handle high torque load, axially compress/expand and articulate angularly while under load	A 3 metre long customised TCAE-V-14 driveshaft was designed and installed to connect a gearbox to provide true constant velocity to a rotor mast with a varying shaft angle up to 3,1 degrees. The vertical operation of the shaft required a customised thrust bearing arrangement to support the vertical load as well as high torque.
Large air compressor drive coupling for an aluminium plant - USA	Direct coupled motor to compressor drive	2,250HP, 225 rpm	Existing Falk gear couplings are unable to handle the alignment conditions required in this specific installation	TCAE-S-11 couplings installed at close DBSE (220mm)
Dosing pump drive coupling for a large soft drink manufacturer - Ireland	Coupling connection to an axial pump	37kW, 1440rpm and 5,5kW 1440rpm	Acidic environment causes the existing Omega elastomeric couplings to fail regularly	TCAE-V-0 and TCAE-V-1 couplings installed with Nitrile rubber boot
Trimmer/Chopper drive for a large aluminium coil processing line - USA	Drive coupling with high angle requirement within a process line	300kW, 350rpm	Existing cv joints installed were unable to handle the continual articulating angle and speed without being destroyed prematurely	TCAE-V-9 couplings installed operating at 6 degree angle while running at 350rpm
Hot oil process pump in a large oil refinery - Netherlands	Hot oil process pump in part of the refinery operation	45kW, 1460 rpm requiring ATEX approval	Centrifugal pump for hot oil at 280C regularly requires constant alignment due to thermal expansion of the pump	TCAE-R-2 with ATEX certification installed which has sufficient axial expansion and angular articulation to cope with the pump temperature

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Large axial fan driveshaft for tempering furnace- Italy	Hot air blower driveshaft	400kW, 990 rpm length 3mtrs, operating at 100degs C	Current gear flex couplings not able to handle the excessive angular misalignment when exposed to the hot air of the fan	TCAE-L-5 driveshaft installed to cope with the thermal expansion of the hot air without affecting performance
Coal Stacker reclaimer conveyor driveshaft for a large steelworks - Australia	Belt conveyor head drive roller connected to gearbox	110kW, 94 rpm	Existing gear couplings are unable to handle continual misalignment due to flexure in the stacker structure and are regularly failing	Customised TCAE-L-10 driveshaft with 2 piece shaft passing through conveyor boom. Each shaft requires angular misalignment capability due to flex in structure