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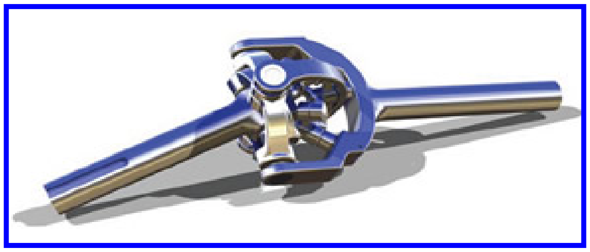
Thompson Constant Velocity Coupling

Preliminary performance report



Objective:

To study the transmission response of THOMPSON coupling to various load related driving unit's (in this case a hydraulic pump) input rotational speed and vibration amplitudes, and its comparison with standard coupling through preliminary vibration data measurements.

To study and prepare procedures and types of measurements required for future online performance data acquisition and analysis.

Measurements

Snap shot simultaneous Tri-axial measurements were recorded on the drive train as follows:

1) Driving component – Hydraulic Pump – Horizontal, Vertical and Axial planes

2) Transmission system (coupling) - both the drive and non drive ends of the coupling arrangement - Horizontal, Vertical and Axial planes – Radial, Tangential and Axial-Vertical directions

3) Measurements were recorded under varying loading of – no load, 25% load, 50% load and full load

4) The driving and transmission units were inclined horizontally at 15^0 to the driven unit (fly wheel).

Observations during measurements

1) The driving hydraulic pump loads are varied to record measurements under different loads.

2) The standard coupling reached a temperature reading of 98^0 C under no load test case and failed at (the) start of 50% load test case with (the) temperature reaching 298^0 C. Whereas Thompson coupling maintained a steady temperature with the top reading of 32^0 C at full load.

Abstract

The preliminary analyses of snapshot vibration spectra indicates that the Thompson constant velocity coupling has demonstrated its speciality and unique feature of absorbing very high input amplitudes from the driving unit, without generating frictional forces, and it does not raise the operating shaft or coupling temperatures. This should result in reduced maintenance, reduction of catastrophic failures and machine breakdowns. Due to its geometry of construction it seems to maintain constant velocity and dramatically reduces unbalanced forces that tend to disturb the operating vibration signature of any drive train. It has shown the capability to convert tangential forces into useful radial forces, so that its output rotational velocity is maintained at the desired speed. The kinematics of the coupling seems to be adequately considered during its invention. This is confirmed by nil meshing amplitude of the coupling components as well as its capacity to control the phase differences in all planes, such that the output radial forces are maintained steady and constant. The inventors do have a highly enhanced product for both simple and complex machines.

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Spectral, time signal and orbits analyses

The driving units (hydraulic pumps) for both the test jigs, one each for the standard coupling and the Thompson coupling have high operating amplitudes with the test jig for the Thompson coupling nearly twice. This is further compounded by induced dynamic imbalance in the driven unit (fly wheel) and the predominant overtones of the input high amplitudes. Therefore analysis and comparisons of the performance of the coupling is complex.

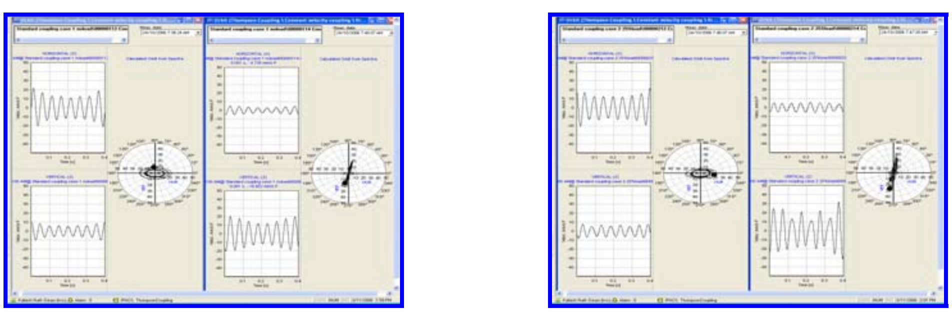
This report contains a few of the spectral data analysed in the time signals and orbits including the generated phases in all the planes as well as radial/ tangential interactions of the coupling and its components (Thompson coupling) to determine and understand the performance under various differing loading cases of no load, 25% load, 50% load and full load.

Proposed future online data measurements would provide the possibility for an in-depth analysis of operating parameters including high start up torque dissipation by Thompson coupling.

Tabulation of amplitudes & phases of the Thompson Coupling Component meshing

Loading cases		**no load**		**25% load**		**50% load**		**100% load**	
		in	out	in	out	in	out	in	out
Velocity mm/sec	**H**	**0.95**	**0**	**0.27**	**0**	**5.10**	**3.56**	**6.63**	**0**
	V	**2.81**	**0**	**0.80**	**0**	**11.96**	**2.19**	**9.00**	**0**
	A	**0.95**	**0**	**0.13**	**0**	**4.57**	**7.4**	**5.21**	**0.38**
Phases in degrees	**H**	**49**	**90**	**90**	**-90**	**100**	**-9**	**-121**	**-90**
	V	**174**	**180**	**54**	**180**	**-119**	**45**	**43**	**0**
	A	**123**	**90**	**154**	**135**	**159**	**19**	**-56**	**-72**
Velocity mm/sec	**R**	**0.77**	**0**	**0**	**0**	**3.15**	**0.65**	**0.23**	**0.30**
	T	**2.79**	**0**	**0.07**	**0**	**11.47**	**5.81**	**0.93**	**3.55**
	A/V	**1.59**	**0**	**0**	**0**	**4.99**	**0.65**	**0.93**	**0**
Phases in degrees	**R**	**-32**	**-90**	**90**	**-90**	**126**	**180**	**0**	**-45**
	T	**98**	**180**	**-153**	**45**	**-96**	**41**	**-29**	**45**
	A/V	**-138**	**-90**	**45**	**-90**	**29**	**26**	**-79**	**-90**

H = Horizontal, V = Vertical, A = Axial, R = Radial, T = Tangential, A/V = Axial/ Vertical



Standard coupling drive end and non-drive end orbits no load and 25% load cases respectively

The above shown orbits of the standard coupling do not transmit the input orbits to the output orbits in the same mode (both the loading cases) and tend to loose consistency, resulting in transmission losses and high frictional forces being generated.

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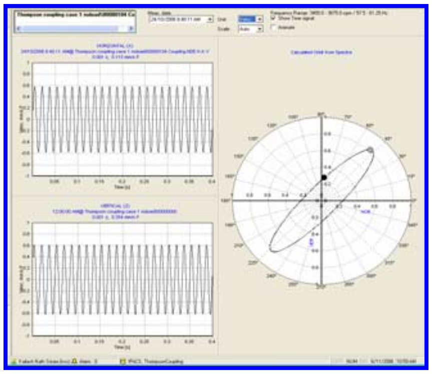
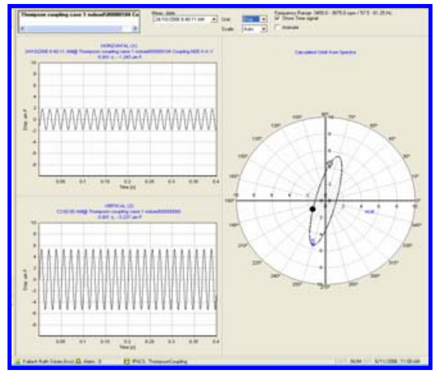
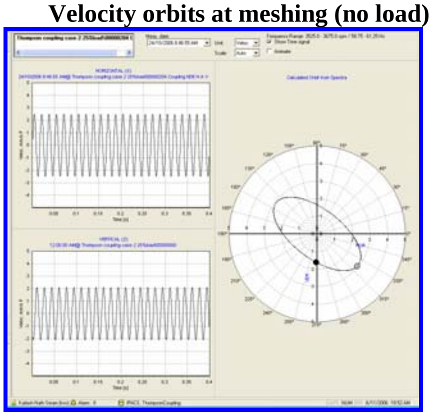
Whereas the following output orbit modes of the Thompson coupling component meshing under various loading cases seem to be inducing radial movements



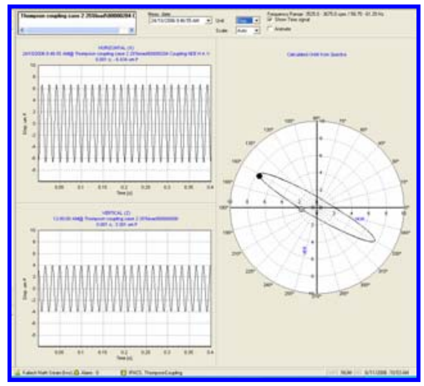
Velocity orbits at meshing (no load)



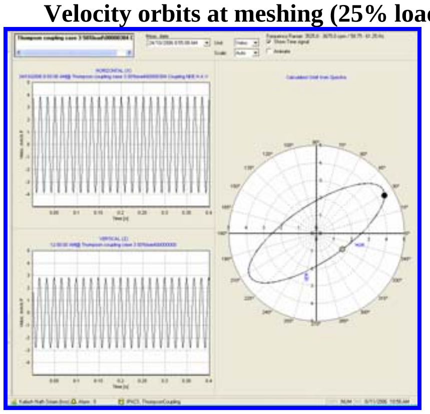
Displacement orbits at meshing (no load)



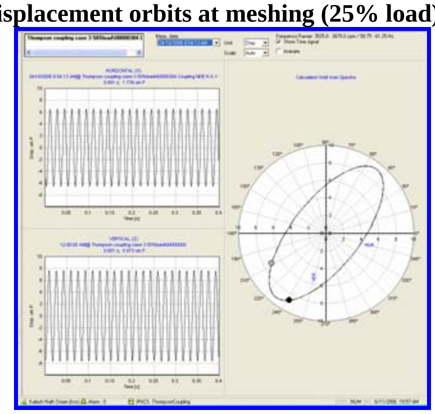
Velocity orbits at meshing (25% load)



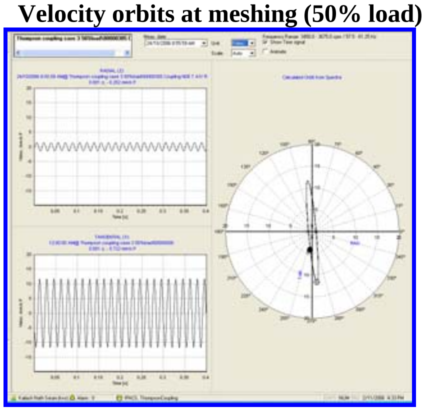
Displacement orbits at meshing (25% load)



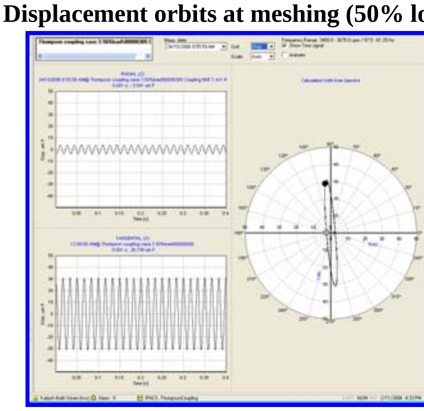
Velocity orbits at meshing (50% load)



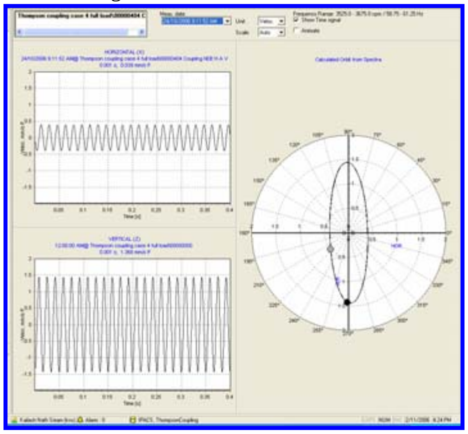
Displacement orbits at meshing (50% load)



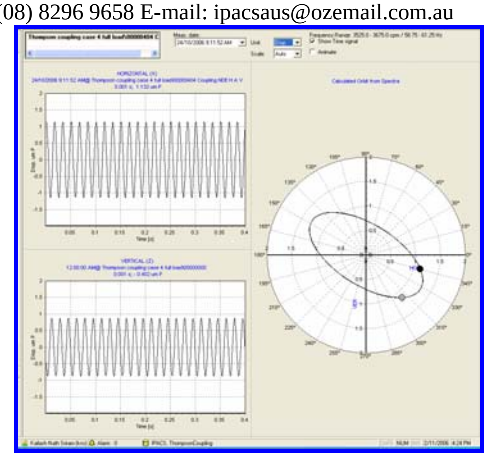
Radial/ tangential velocity orbits (50% load)



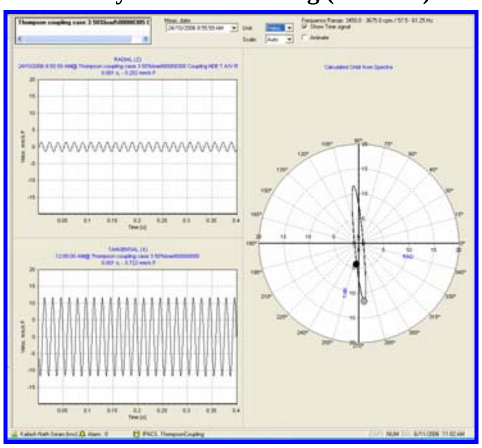
Radial/ tangential displacement orbits (50% load)



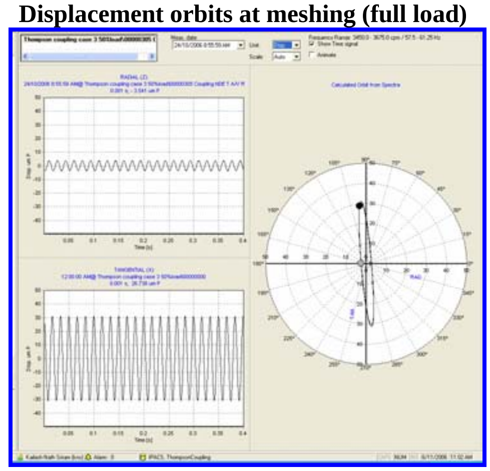
Velocity orbits at meshing (full load)



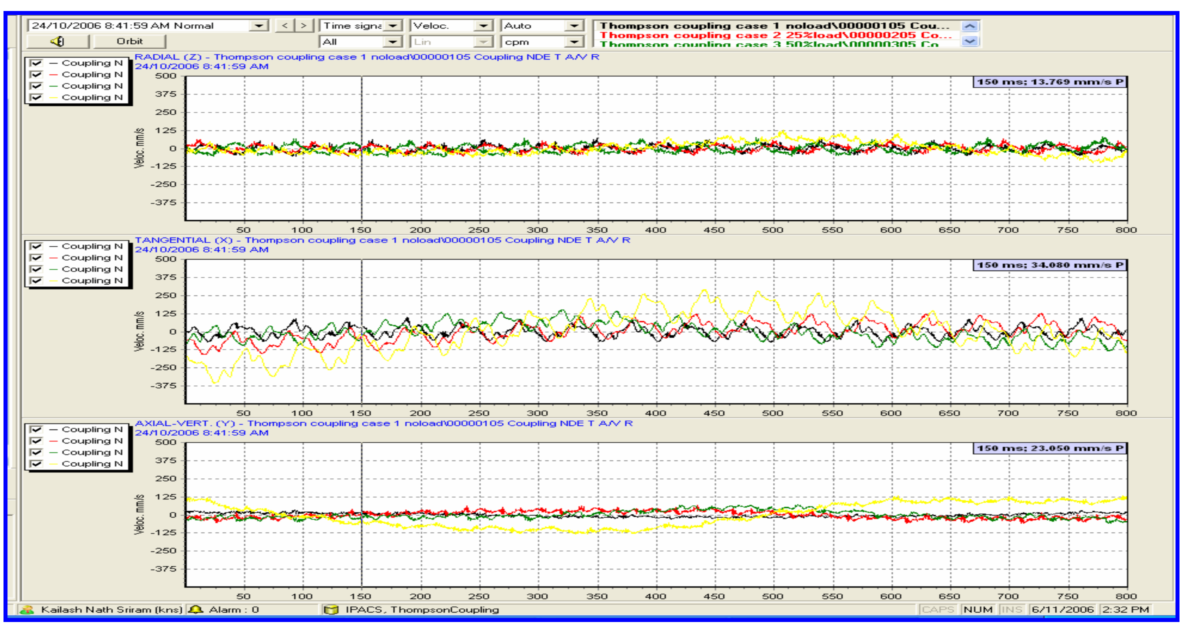
Displacement orbits at meshing (full load)



Radial/ tangential velocity orbits (full load)



Radial/ tangential displacement orbits (full load)



Velocity time signals (all load cases) showing steady radial movements (first row) with tangential movements (second row) influenced by dynamic imbalance of the drive train and the coupling tends to change these into radial movements without increasing Axial/ vertical (third row) unbalanced forces.

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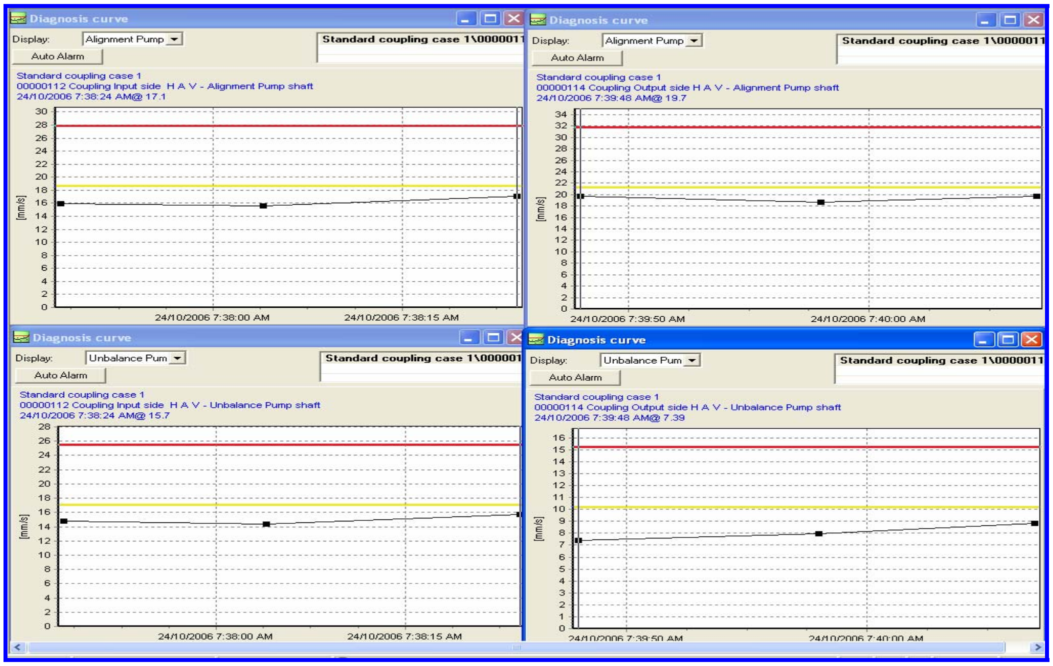
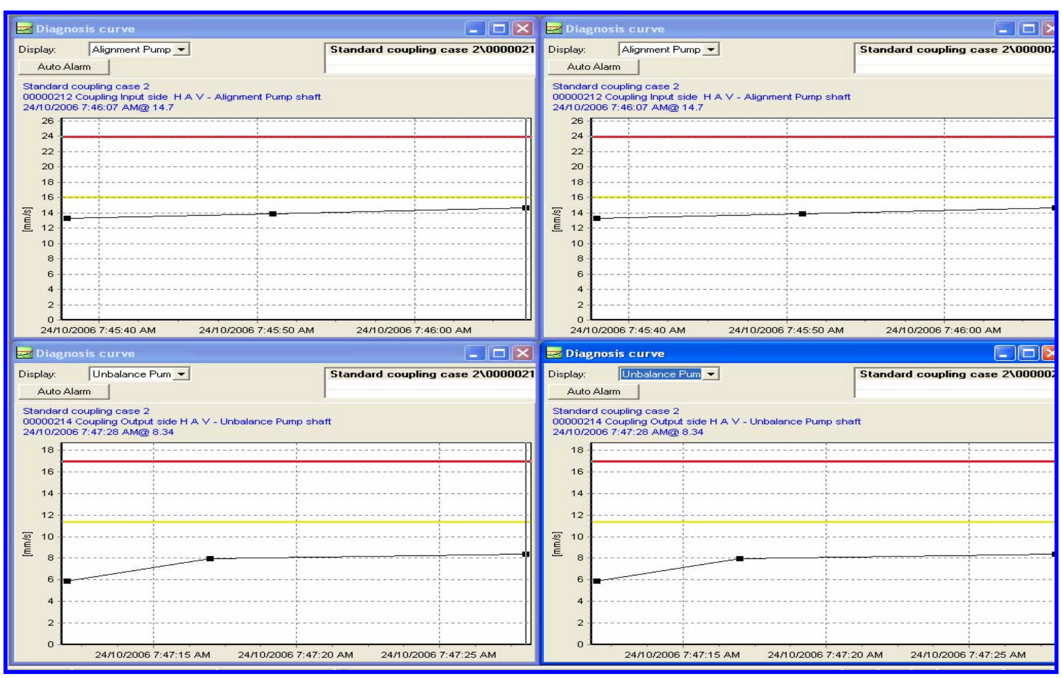
Comparison of transmission of the simulated fault diagnostics

The input amplitudes being high the spectra has been analysed for a few basic fault diagnostics to understand the behaviour and onward fault transmission of the two types of couplings. Following are a few comparisons between the **input** and the **output** sides of the couplings to study if the driving unit's faults are transmitted with the **same, increased or reduced intensities** to the driven units.





Standard coupling Misalignment and Imbalance Input / Output - no load (1st fig.) & 25% loading cases (2nd Fig.)
Transmits increased misalignments and imbalances

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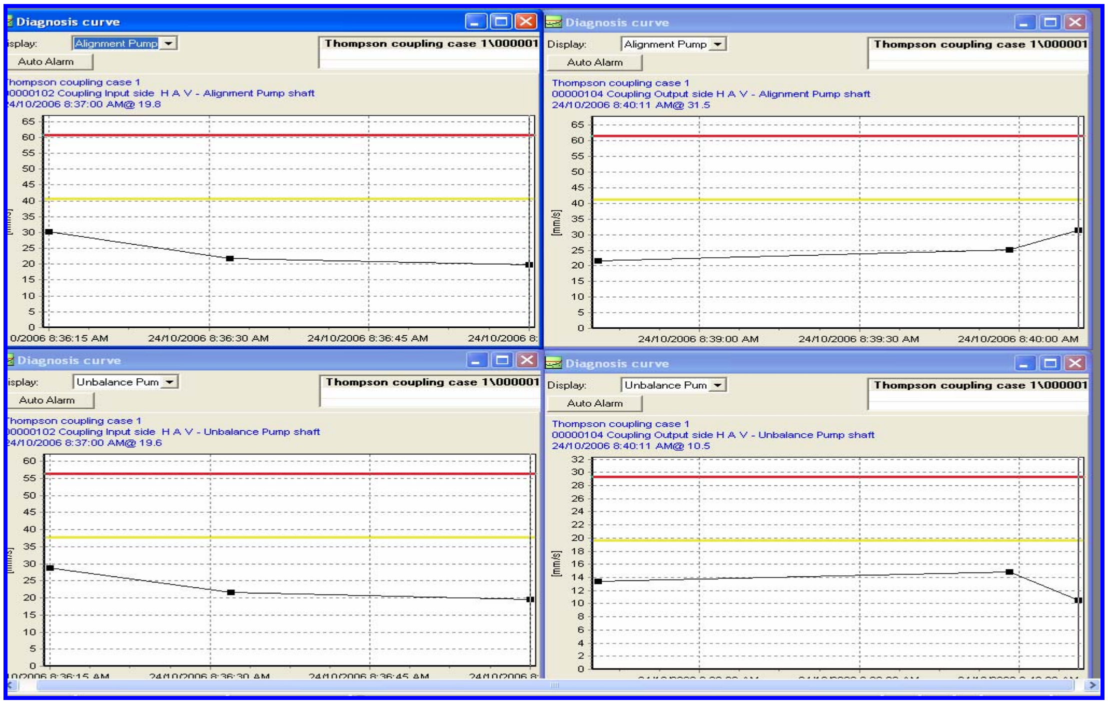
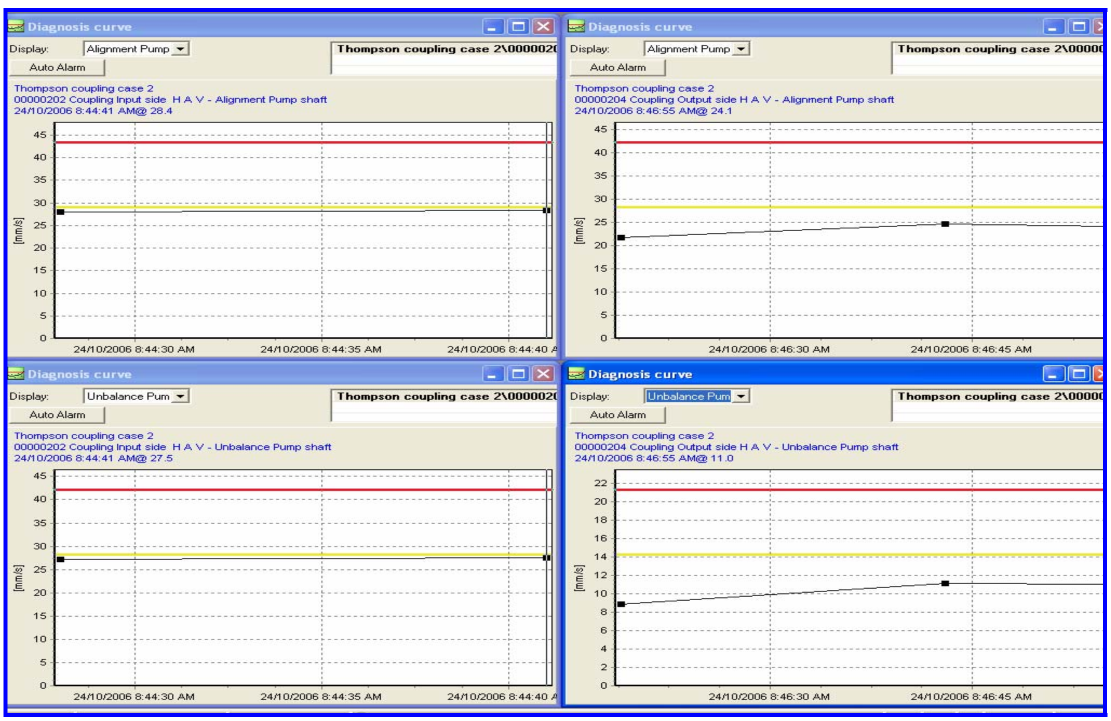
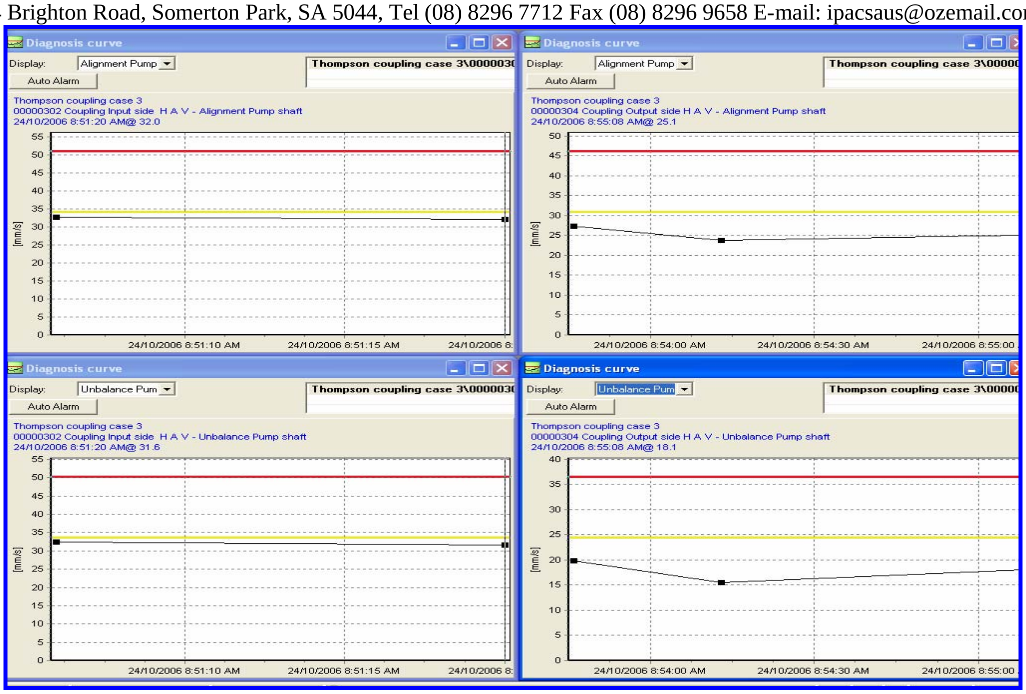
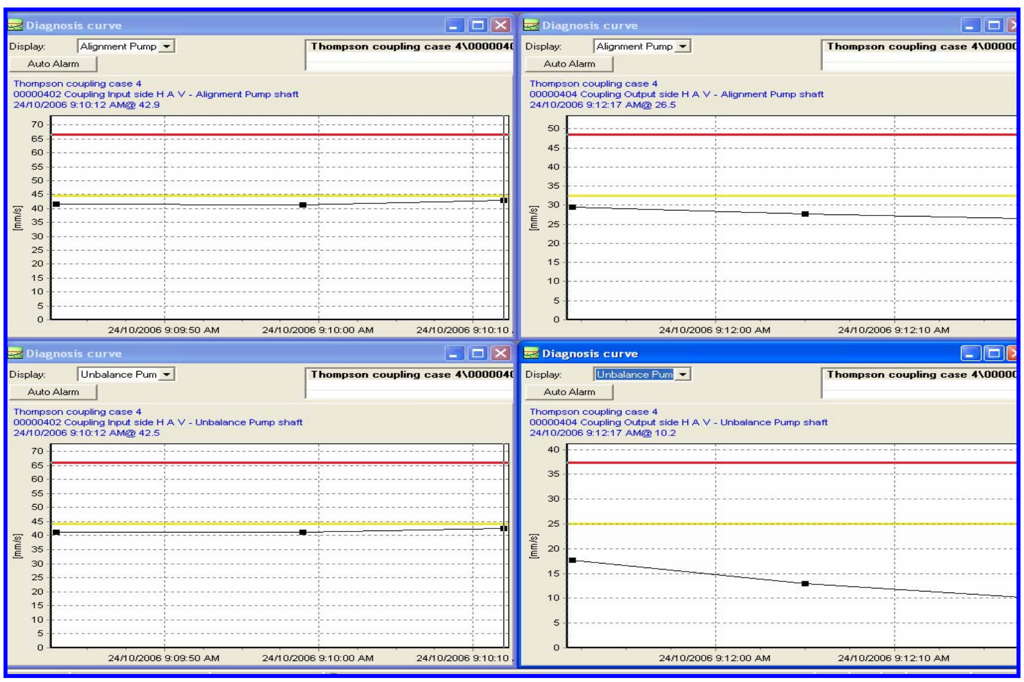




Thompson coupling Misalignment and Imbalance Input / Output - no load (1st fig.) & 25% loading cases (2nd Fig.)
Transmits decreased misalignments and absorbs part of imbalances





Thompson coupling Misalignment and Imbalance Input / Output – 50% loads (1st fig.) & Full load cases (2nd Fig.)
Transmits decreased misalignments and absorbs part of imbalances

Inference

Both the standard and Thompson coupling were tested with an induced 15^0 geometrical misalignment in the horizontal plane. The standard coupling tended to transmit both the misalignment and the unbalanced forces increasing in the scaled values and resulted in a catastrophic failure.

Thompson coupling on the other hand tended to reduce adverse effects of the misalignment and seems to absorb some of the unbalanced forces. This would dramatically reduce catastrophic failures and extend the useful life of machines with considerable reduction in maintenance activities.

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Tabulation of overall/ operating speed (1200 RPM - 20Hz) amplitudes for both types of couplings under varying loading cases

Measurement types		Standard coupling no load		Thompson coupling no load		Standard coupling 25% load		Thompson coupling 25% load		Standard coupling 50% load		Thompson coupling 50% load		Standard coupling 100% load		Thompson coupling 100% load	
Pump	H total/ run speed	16.38	*14.63*	33.37	*36.35*	15.29	*12.16*	32.41	*34.28*	17.19	*13.68*	36.34	*41.95*	Failed	*Failed*	38.27	*44.25*
	V total/ run speed	11.66	*9.57*	13.69	*9.37*	12.91	*10.13*	13.17	*4.90*	17.07	*13.68*	12.77	*10.55*	Failed	*Failed*	13.70	*10.37*
	A total/ run speed	7.02	*5.96*	9.12	*8.49*	7.34	*4.39*	12.88	*13.00*	9.70	*6.71*	15.00	*16.36*	Failed	*Failed*	9.72	*9.57*
Coupling Input side	H total/ run speed	17.35	*16.99*	36.82	*34.62*	17.76	*14.72*	31.87	*31.53*	Failed	*Failed*	33.44	*37.61*	Failed	*Failed*	45.52	*49.53*
	V total/ run speed	9.23	*7.17*	16.69	*11.7*	7.77	*5.89*	16.76	*8.36*	Failed	*Failed*	15.57	*6.27*	Failed	*Failed*	12.43	*6.00*
	A total/ run speed	6.82	*6.42*	8.98	*6.08*	5.96	*5.89*	11.86	*10.64*	Failed	*Failed*	12.83	*12.57*	Failed	*Failed*	15.68	*9.01*
Coupling Input side	R total/ run speed	9.32	*9.63*	9.80	*6.90*	8.88	*7.42*	11.77	*11.30*	Failed	*Failed*	10.64	*11.14*	Failed	*Failed*	9.85	*8.48*
	T total/ run speed	10.50	*9.07*	17.45	*8.54*	9.32	*6.57*	17.17	*7.53*	Failed	*Failed*	20.60	*15.20*	Failed	*Failed*	22.49	*16.55*
	A/V total/ run speed	9.25	*8.79*	17.14	*11.00*	9.76	*8.77*	16.71	*16.65*	Failed	*Failed*	18.87	*20.01*	Failed	*Failed*	22.94	*23.41*
Coupling Output side	H total/ run speed	5.70	*5.98*	8.68	*5.40*	7.35	*7.48*	10.28	*8.22*	Failed	*Failed*	10.57	*11.16*	Failed	*Failed*	7.15	*7.67*
	V total/ run speed	19.57	*21.68*	24.59	*15.49*	26.55	*22.43*	27.16	*26.31*	Failed	*Failed*	22.16	*23.02*	Failed	*Failed*	30.24	*30.00*
	A total/ run speed	10.33	*8.97*	19.20	*10.04*	9.23	*6.23*	14.18	*10.69*	Failed	*Failed*	24.03	*21.63*	Failed	*Failed*	20.41	*13.95*
Coupling Output side	R total/ run speed	14.12	*13.98*	20.87	*9.64*	14.28	*9.87*	18.69	*17.94*	Failed	*Failed*	20.78	*22.29*	Failed	*Failed*	19.31	*16.01*
	T total/ run speed	16.71	*13.98*	33.65	*16.07*	16.39	*11.51*	47.27	*44.85*	Failed	*Failed*	41.08	*41.54*	Failed	*Failed*	53.29	*46.51*
	A/V total/ run speed	6.47	*3.81*	12.21	*4.29*	7.08	*0.00*	7.89	*1.00*	Failed	*Failed*	13.74	*12.16*	Failed	*Failed*	9.86	*6.10*

H = Horizontal, V = Vertical, A = Axial, R = Radial, T = Tangential, A/V = Axial/ Vertical

All amplitudes are mms/ sec and above table show both the overall spectral amplitudes and those at the driving pump speed of 1200 RPM (20 Hz) *in italics.*

The input amplitudes from the Hydraulic pump to the Thompson Coupling are nearly twice those of the standard coupling. In spite of these higher values the Thompson Coupling has clearly demonstrated its capacity to withstand and absorb these high amplitudes without generating any frictional forces. It is not adversely disturbed (reduction/elimination of catastrophic failures), and maintains steady transmission by converting the unbalanced forces from the high amplitudes into radial rotating kinematics.