

Reprint

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Techwise

Solution Found for

Hydraulic Servo Valve Sticking on Small Nuovo Pignone Gas Turbines by GE Service at YALE New Haven Power Plant

Abstract

ISOPur Fluid Technologies solves the Moog servo valve varnish problem on low pressure hydraulic, Nuovo Pignone gas turbine fuel control. Using the lubrication sump Mobil DTE Light for the hydraulic controls is common in smaller gas turbines. Operating conditions can cause servo sticking and forced outages when fine particles combine to produce deposits.

The MAG / ISOPur purification systems are putting an end to this problem with Balanced Charge Agglomeration (BCA) Technology purifying the lube / hydraulic oil at a New Haven Connecticut University.

by Gerald Munson and
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ISOPur Fluid Technologies

Equipment

A new Haven Connecticut University operates three Nuovo Pignone PGT-5M Turbines fueled on natural gas. Each gas turbine drives a 6.2-megawatt synchronous generator.

“ Failure of one of nine fuel servo valves every two months was unsettling, and the frequency of failure was increasing.”

Designation	Model	Serial	Type	Output
Gas TG#1	PGT 5M	05815	Dual Fuel Ind. Gas Turbine	6.2 MW
Gas TG#2	PGT 5M	05681	Dual Fuel Ind. Gas Turbine	6.2 MW
Gas TG#3	PGT 5M	G06083	Dual Fuel Ind. Gas Turbine	6.2 MW
Gen #1	TWAC	961075-05	Synchronous Generator	
Gen #2	TWAC	961075-06	Synchronous Generator	
Gen #3	TWAC	961075-04	Synchronous Generator	

Each gas turbine contains a single lube oil sump (Mobil DTE Light) which is used to lubricate the Gas Turbine (28 PSI), lubricate the generator, (28 PSI) and supply hydraulic power (1000 PSI) to the Moog 770 series electro-hydraulic servo valves that control the gas turbine and fuel flow.



Problem

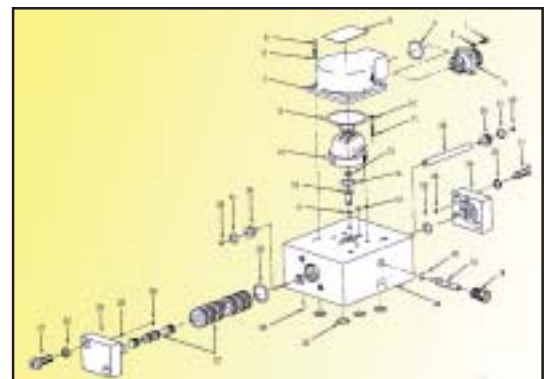
This PGT-5M turbine configuration utilizes a combined lubricant/hydraulic system using Mobil DTE Light for lubrication and hydraulic service.

of nine fuel servo valves every two months was unsettling and the frequency of failure was increasing.

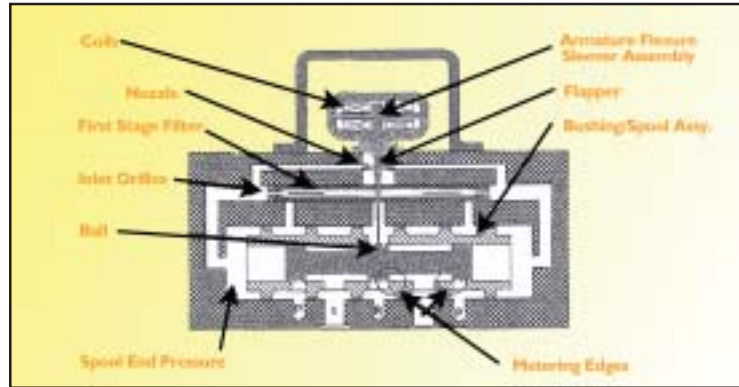
One consequence of this configuration is the in-service dual Moog Model 770 electro-hydraulic servo valves experienced increasing failures related to contamination varnish and erosion. Failure of one

Moog Servo Detail

The Moog valve is essentially an electric current to fluid flow transducer. The



force of a small solenoid is amplified by hydraulic pressure to provide precise control. The valve comprises a tremendous number of parts, most of which fit together with only a few microns clearance. The valve spool, null bushing and bore must be perfectly aligned matched sets with no interference to provide precision translation of milliamps of current into smooth proportional valve motion. Any interference restriction or imbalance will insert a discontinuity between the control signal and output destroying precise regulation. Flow is controlled from 1.0 GPM to Zero and zero to 1.0 GPM, all at 1200 PSI.



Contamination Issues

A Service Bulletin from United Servo focuses on contamination control issues with:

- the inlet orifice
- the filter
- the nozzles
- the flapper
- the ball
- the bushing
- the spool
- the metering edges

Any contamination at these locations is an immediate malfunction.

Solution

The provision of a separate hydraulic fluid system is an expensive alternative to eliminate

The three turbine units were connected to the flushing taps on the Lube/Hydraulic reservoir to provide the oil treatment. Following installation, several rapid changes of the filter elements were required during the clean-up phase to remove the residual debris from the system. After five months, the servo failure frequency is steadily decreasing and complete cessation of this failure mode is expected before next summer.

Test Results

Installation of the ISOPur model 50 fluid purification systems on the three Nuovo Pignone PGT5 gas turbines produced an immediate and continuing positive effect not only on the MOOG Servo valves but also on the entire turbine Lube Oil system. The data and graph that

. . . Provision of a separate hydraulic fluid system would be an expensive alternative to eliminate contamination and varnish buildup

. . . instead, GE Services

. . . decided to install three ISOPur 50 Fluid Purification Systems.

follows show dramatic reduction in large and small particulate contamination in the oil. In addition, the physical condition of the fluid continues to improve as indicated by

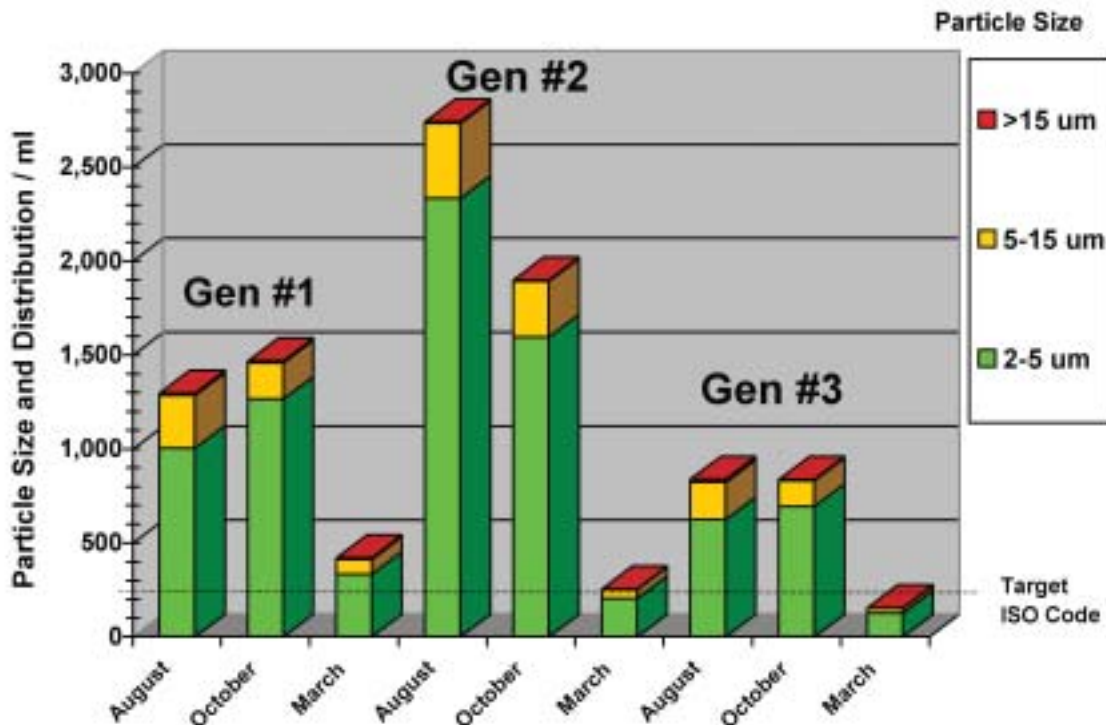
a return to normalization of all of the relevant oil parameters (by FTIR). Reduction of the water content to impressively low levels on an ongoing basis will ensure

stable and beneficial performance from the lubricant.

Test Parameter	Turbine Gen #1			Turbine Gen #2			Turbine Gen #3			New Oil	
	Date	8/20/02	10/10/02	3/13/03	8/20/02	10/10/02	3/13/03	8/20/02	10/10/02		3/13/03
Oxidation		0.01	0.01		0.01	0.01		0.25	0.01		0.02
Sulfation		0.02	0.01		0.01	0.01		0.25	0.01		0.03
Nitration		0.03	0.01		0.03	0.01		0.12	0.01		0.03
H ₂ O %		0.04	0.05		0.04	0.05		0.04	0.05		0.04
KF H ₂ O	168	75	<25	230	51	<25	196	25	<25		25
TAN	0.16	0.48	0.07	0.08	0.44	0.19	0.05	0.46	0.18		0.46
Viscosity	33.2	34.0	33.3	32.1	33.0	33.5	32.4	32.0	32.5		33.0
ISO Code	17/15/12	18/15/11	13/14/10	19/16/10	18/15/10	15/13/9	17/15/11	17/14/11	14/12/8		18/17/13
>2	1217	1470	421	2741	1900	255	839	838	155		
>5	293	205	88	406	304	50	214	143	28		
>15	13	12	8	8	7	3	16	7	2		
Iron	2	0	0	0	0	1	0		1		
Phos.	97	69	68	126	98	93	98	70*	70		85
Zinc	24	29	45	22	36	37	6	9*	10		75

*Hydraulic Leak detected into Lube oil sump / Correct leak & bleed & feed to correct

Gas Turbine Lube Oil Particle Count History





varnish and debris removed from the hydraulic system the connection from the brain to the muscle is secure and reliable.

Experience with these turbines for several years prior to the ISOPur Installation had demonstrated one servo valve failure every two months, due to deposits. The plant service engineer noted, "Operation since July has been nearly trouble free. We are quite pleased at this point, but the one year trouble free point will be the proof of this system."

Increasing demands for speed, response and precision will force the continuing upgrade of these critical electromechanical control components. As performance requirements increase and physical clearances become smaller, the severity of contamination issues will continue to increase. Fine filters cannot eliminate the varnish and pre-varnish components that are easily removed with ISOPur purification.

Continuation

Continuing oil and system analysis will permit the confirmation that the ISOPur BCA process is a cost-effective solution for these servo valve applications. The service manager is very pleased with operation to date and will proclaim the program a complete success when a year of no problems is in the logbook. Review of past repair records indicate classic varnish and debris issues with the servo filter, orifice, flapper, bushing, and spool. Since these gas turbines were not overhauled at the start of the

Conclusion

Computer controlled electro-hydraulic servo valves are the nerve fiber that connects the computer brain to the hydraulic muscle in

machinery. The "Balanced Charge Agglomeration" Process seems to be scrubbing the remaining contamination from the system as indicated by oil test values returning to the new oil standards. With all

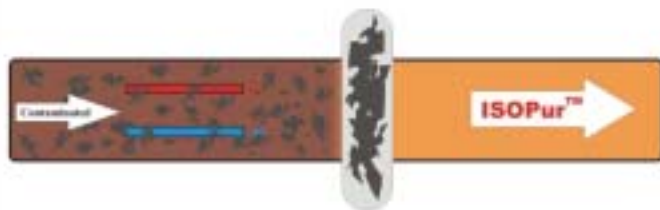
demonstration it is expected that some issues will remain until all contamination is purged from the systems. Decreasing severity and frequency of problems indicate strong progress. Oil quality issues are being monitored at the same time and indicate steady improvement. In

addition, the equipment operators report less stress.

For additional information contact G. L. Munson or C. W. Mitchell - (860) 571-8590.

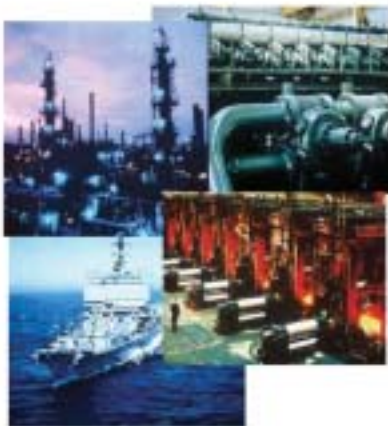
Six Years Without an Oil Change and Oil Remains Cleaner Than New.

ISOPur Fluid Technologies Presents Balanced Charge AgglomerationSM



- Cleans fluids down to a submicron level of ultra-purity
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- Extends equipment life
- Extends fluid life

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information:
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Our Customers Speak for Themselves:

"During my 15 year history at the power house, we averaged one oil-related outage every 18 months on one of the four steam turbines here. Since the ISOPurTM units were installed six years ago, we have had no oil-related issues whatsoever. The resulting savings in the expense and overhaul budgets over the five-year cycle is between \$260,000 and \$300,000. This does not include the incremental savings from not having to purchase power during the forced outages."

- Engineer in a major U.S. Pharmaceutical company



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