Continuous Oil Purification in Critical Equipment. New Trends

Ing. Cristián Schmid
Lubritech Argentina SRL

Content

- Introduction
- Definition of Critical Equipment
- Life Extension Charts
- Different Maintenance Strategies for Critical Equipment
- Continuous Oil Purification Technologies
- Cases
- Recommendation and Conclusion

Reliability and Availability

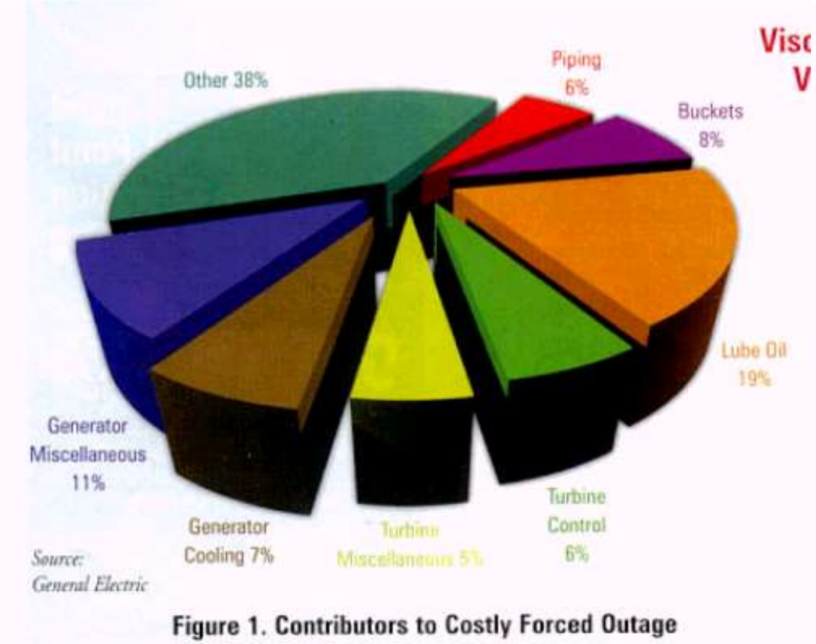
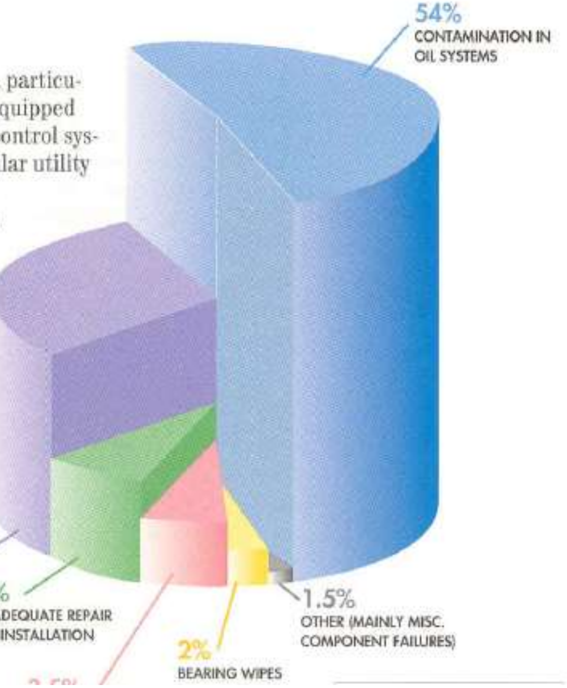


Figure 1. Contributors to Costly Forced Outage

For any power generation facility, the turbine is considered the lifeblood of the operation. Any problem requiring an unexpected shutdown of the main turbine is likely to cause a significant unplanned outage, potentially resulting in millions of dollars of downtime costs. According to a 1991 study by General Electric (GE), turbines contribute on average 20 percent of all forced outages in a conventional power plant. Among this 20 percent, GE noted that 19 percent of turbine/generator problems were associated with the lube oil system. For this reason, monitoring turbine oils has become commonplace in the power generation industry.



Lube Oil failures is the first cause of turbines unplanned outage (GE 1991)
Contamination in Oil System is the biggest contributor to bearing failures (EPRI 2000)

Definition of Critical Equipment

- Each User has its own definition.
- There are some similiar criterias for all them.
    - High environmental or safety impact
    - High production cost when Equipment isn't running.
    - High Maintenance Cost for repairing.

- Examples of Critical Equipment
    - Centrifugal Compressor in FCC Unit in Refineries.
    - Shoe Press in Pulp & Paper.
    - Gas Turbine in Cycle Combined Power Plant.

Life Extension Charts

Asociación Argentina de Tribología

5th International Workshop of Tribology 2019

	20/17		19/16		18/15		17/14		16/13		15/12.		14/11.		13/10.		12/9.	
26/23	5	3	7	3.5	9	4	>10	5	>10	6	>10	7.5	>10	9	>10	>10	>10	>10
	4	2.5	4.5	3	6	3.5	6.5	4	7.5	5	8.5	6.5	10	7	>10	9	>10	10
25/22	4	2.5	5	3	7	3.5	9	4	>10	5	>10	6	>10	7	>10	9	>10	>10
	3	2	3.5	2.5	4.5	3	5	3.5	6.5	4	8	5	9	6	10	7.5	>10	9
24/21	3	2	4	2.5	6	3	7	4	9	5	>10	6	>10	7	>10	8	>10	10
	2.5	1.5	3	2	4	2.5	5	3	6.5	4	7.5	5	8.5	6	9.5	7	>10	8
23/20	2	1.5	3	2	4	2.5	5	3	7	3.5	9	4	>10	5	>10	6	>10	8
	1.7	1.3	2.3	1.5	3	2	3.7	2.5	5	3	6	3.5	7	4	8	5	10	6.5
22/19	1.6	1.3	2	1.6	3	2	4	2.5	5	3	7	3.5	8	4	>10	5	>10	6
	1.4	1.1	1.8	1.3	2.3	1.7	3	2	3.5	2.5	4.5	3	5.5	3.5	7	4	8	5
21/18	1.3	1.2	1.5	1.5	2	1.7	3	2	4	2.5	5	3	7	3.5	9	4	>10	5
	1.2	1.1	1.5	1.3	1.8	1.4	2.2	1.6	3	2	3.5	2.5	4.5	3	5	3.5	7	4
20/17			1.3	1.2	1.6	1.5	2	1.7	3	2	4	2.5	5	3	7	4	9	5
			1.2	1.05	1.5	1.3	1.8	1.4	2.3	1.7	3	2	3.5	2.5	5	3	6	4
19/16					1.3	1.2	1.6	1.5	2	1.7	3	2	4	2.5	5	3	7	4
					1.2	1.1	1.5	1.3	1.8	1.5	2.2	1.7	3	2	3.5	2.5	5	3.5
18/15							1.3	1.2	1.6	1.5	2	1.7	3	2	4	2.5	5	3
							1.2	1.1	1.5	1.3	1.8	1.5	2.3	1.7	3	2	3.5	2.5
17/14									1.3	1.2	1.6	1.5	2	1.7	3	2	4	2.5
									1.2	1.1	1.5	1.3	1.8	1.5	2.3	1.7	3	2
16/13											1.3	1.2	1.6	1.5	2	1.7	3	2
											1.2	1.1	1.5	1.3	1.8	1.5	2.3	1.8
15/12.													1.3	1.2	1.6	1.5	2	1.7
													1.2	1.1	1.5	1.4	1.8	1.5

Máquinas Hidráulicas y Motores

Rodamientos

By controlling the presence of particles in the Lubricatyng System; an increase of life in mechanical elements as journal bearings, rolling bearings and other is expected.

Source: noria

Life Extension Charts

New Moisture Level (ppm)

Current Moisture Level (ppm)	10,000		5,000		2,500		1,000		500		250		100	
	Rolling Element	Journal	Rolling Element	Journal	Rolling Element	Journal	Rolling Element	Journal	Rolling Element	Journal	Rolling Element	Journal	Rolling Element	Journal
50,000	2.3	1.6	3.3	1.9	4.8	2.3	7.8	2.9	11.2	3.5	16.2	4.3	26.2	5.5
25,000	1.6	1.3	2.3	1.6	3.3	1.9	5.4	2.4	7.8	2.9	11.2	3.5	18.2	4.6
10,000			1.4	1.2	2.0	1.5	3.3	1.9	4.8	2.3	6.9	2.8	11.2	3.5
5,000					1.4	1.2	2.3	1.6	3.3	1.9	4.8	2.3	7.8	2.9
2,500							1.6	1.3	2.3	1.6	3.3	1.9	5.4	2.4
1,000									1.4	1.2	2.0	1.5	3.3	1.9
500											1.4	1.2	2.3	1.6
250													1.5	1.3
100														

By controlling the presence of wáter in the Lubricatyng System; an increase of life in mechanical elements as journal bearings, rolling bearings and other is expected.

Source: noria

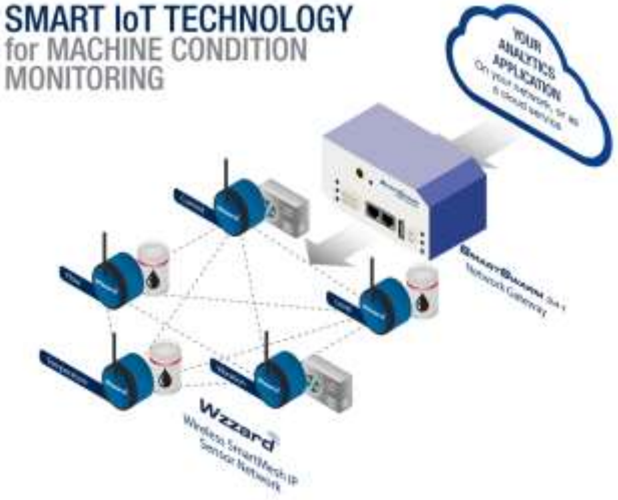
Maintenance Strategies related with Lubrication

MAYO		JUNIO		JULIO		AGOSTO		SEPTIEMBRE	
DIARIO		DIARIO		DIARIO		DIARIO		DIARIO	
Jun 01		Jul 01		Jul 31		Sep1		Sep30	
May-11		Jun-11		Jul-02		Ago-04		Sep-01	5
		Jun-23		Jul-07		Ago-10		Sep-14	1
		Jun-24		Jul-08		Ago-11		Sep-17	72
		Jun-25		Jul-09				Sep-22	5
		Jun-26						Sep-23	10
		Jun-30							
DIARIO		DIARIO		DIARIO		DIARIO		DIARIO	
Jun 01		Jul 01		Jul 31		Sep1		Sep30	
Sep-30		Jun-11						Sep-24	10
DIARIO		DIARIO		DIARIO		DIARIO		DIARIO	
Jun 01		Jul 01		Jul 31		Sep1		Sep30	
								Sep-14	6

- Planned Maintenance '70-'90
  - Lubricant Change by time.
  - Contamination in Lubricant can decrease the life of lubricant.
  - No bigger actions around control of contamination.
- Condition-based Maintenance '2000
  - Lubricant Change by condition.
  - Contamination in Lubricants can affect life of mechanical elements.
  - Proactive actions to avoid contamination of lubricants.

Maintenance Strategies related with Lubrication

- New Trends



  - Looking for increasing of Planned Turnaround Frequencies (from 5 up to 8 years).
  - On-line condition monitoring (sensors).
  - Focus on permanent oil purification. Proactive instead Preventive or Corrective.

  IIoT, AI and Big Data.

Oil Purifiers

Manpower required

Medium-High efficiency

- Centrifuge (w)
- Vacuum Units (w&p)

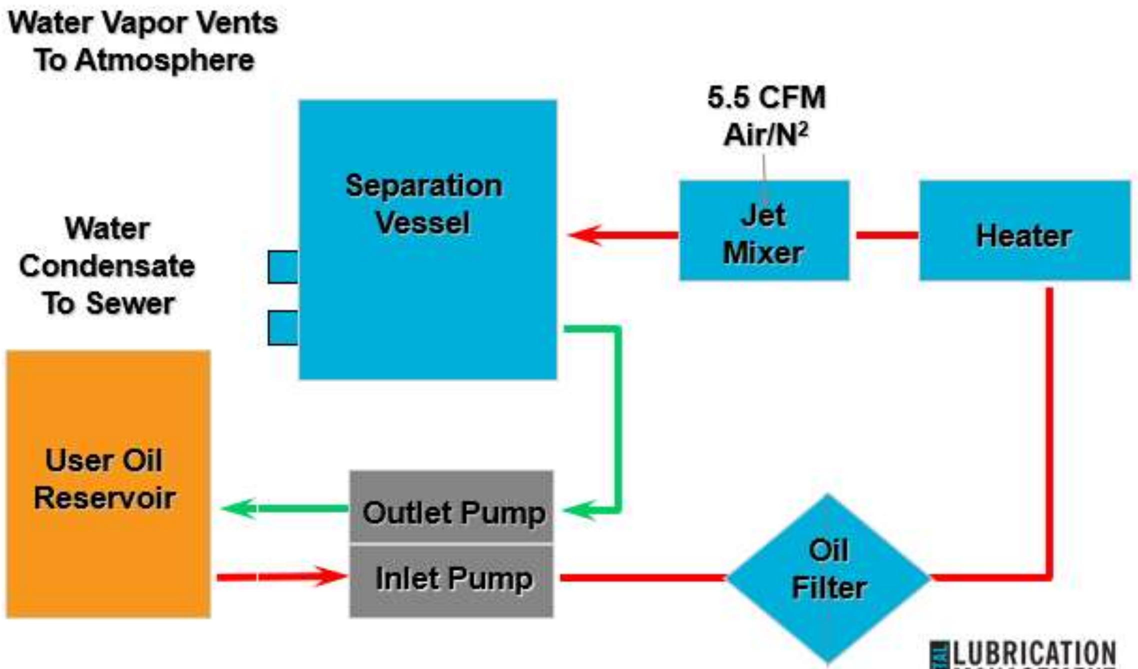
Autonomus 24x7 Oil Purifiers

High efficiency

- **Thermojet**. Air Stripping Technology (w, p&g)
- **ISOPur**. Balance Charge Aglommeration Technology (v)

Oil Purifiers

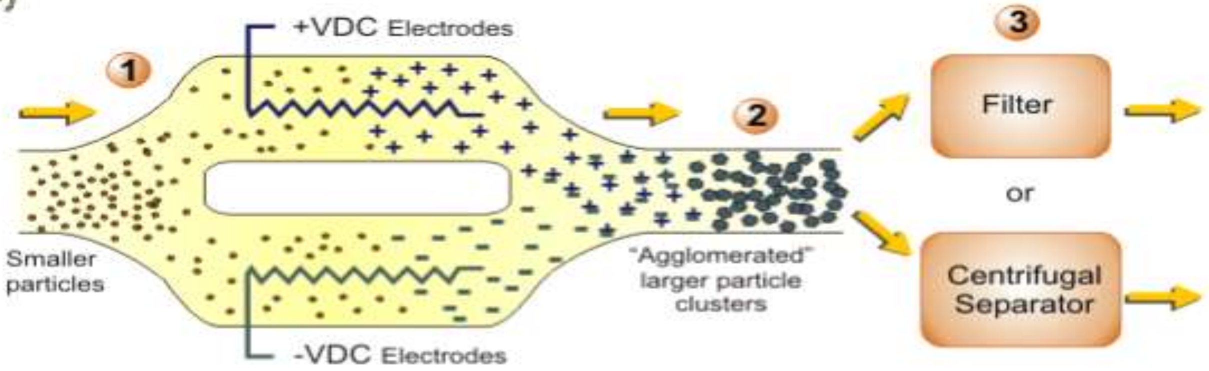
Thermojet



LUBRICATION MANAGEMENT

Plug & Play

ISOPur



1. Particles are passed across high-voltage electrodes, inducing a charge on the particles (+) and (-) in separate paths.
2. Oppositely charged particles are mixed and are attracted to each other, forming larger particle clusters.
3. Particle clusters are more efficiently filtered or removed by centrifugal separators.

Oil Purifiers

Permanent Oil Purifiers are specified by End Users or recommended by OEM's.

Thermojet: Repsol, Petrobras, PEMEX, Elliot, GE among others for Critical Turbomachinery in Refineries.

ISOPur: GE for Gas Turbines.

	Código doc:	Especificación de Diseño:		
REPSOL	ED-K-04.00-01	SISTEMAS DE ACEITE DE LUBRICACIÓN, CIERRE, CONTROL Y AUXILIARES		
Dirección de Ingeniería	Dirección Técnica	COMPRESORES Y MÁQUINAS	JUNIO-2004	Página 6 de 11

TIL 1528-3
GE ENERGY SERVICES TECHNOLOGY
CUSTOMER TECHNOLOGY SERVICES
18 NOVEMBER 2005

Compliance Category - O
Timing Code 7

TECHNICAL INFORMATION LETTER

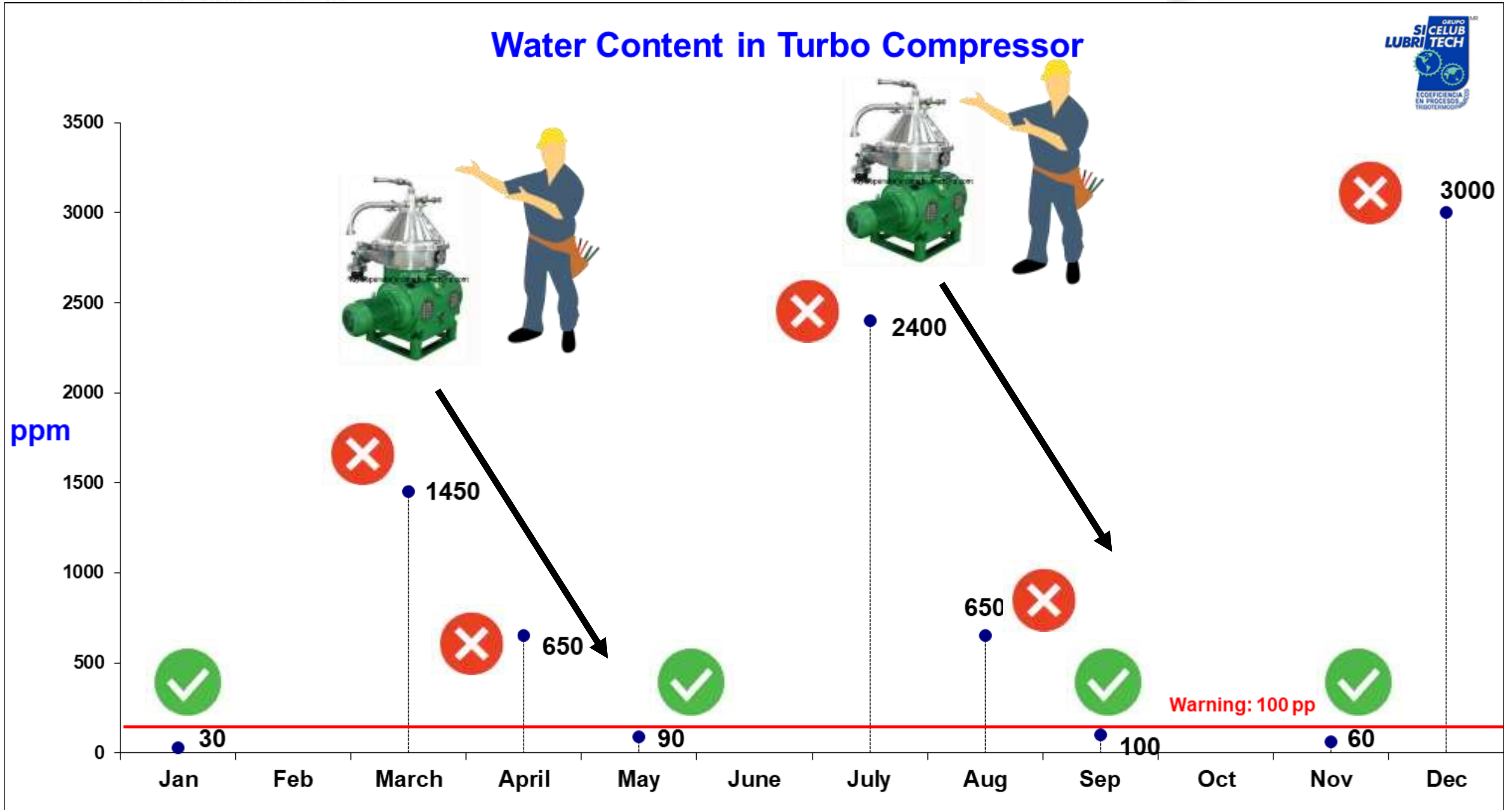
LUBE OIL VARNISHING

APPLICATION
This TIL applies to all heavy-duty gas turbines

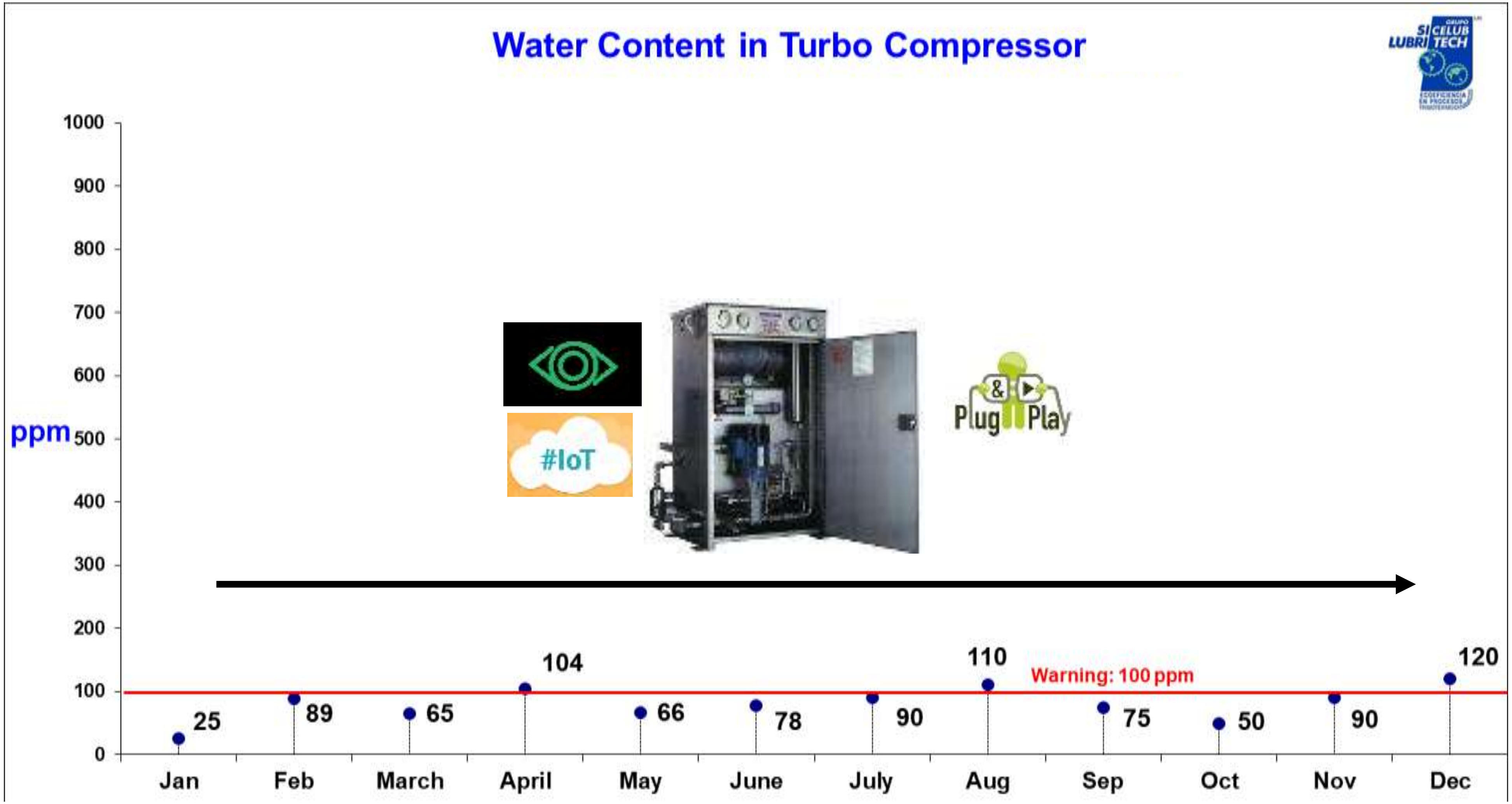
PURPOSE
This TIL is to provide customers with information regarding the formation of varnish or lacquers within the lube oil system, their effects and information regarding mitigation technologies. Please note that this information represents the current information gathered to date.

GE has performed extensive studies to validate the use of Balanced Charge Agglomeration technology. A recent test on seven 7FA+e turbines with this technology installed was run for 75 days while performing routine colorimetric sampling. The results of this test can be seen in Figure 3. Note that the results for two turbines are shown. The other five have been removed for clarity. All turbines exhibited similar results.

Cases



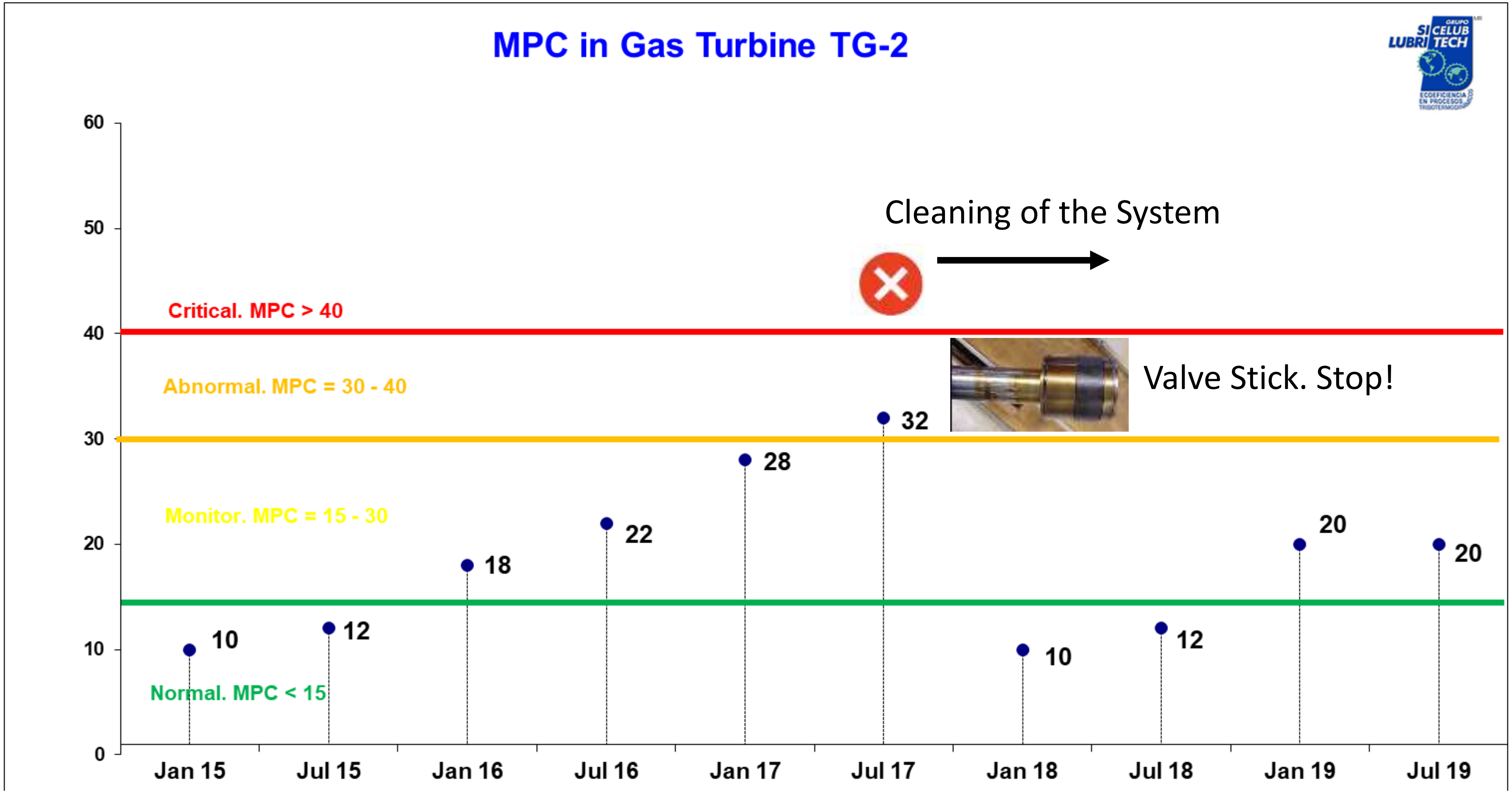
- Turbocompresor in Refinery.
- Oil Analysis every two months.
- Intermitent Oil Purifier Application (33% of time).
- Average ppm of water around 1,000 ppm.



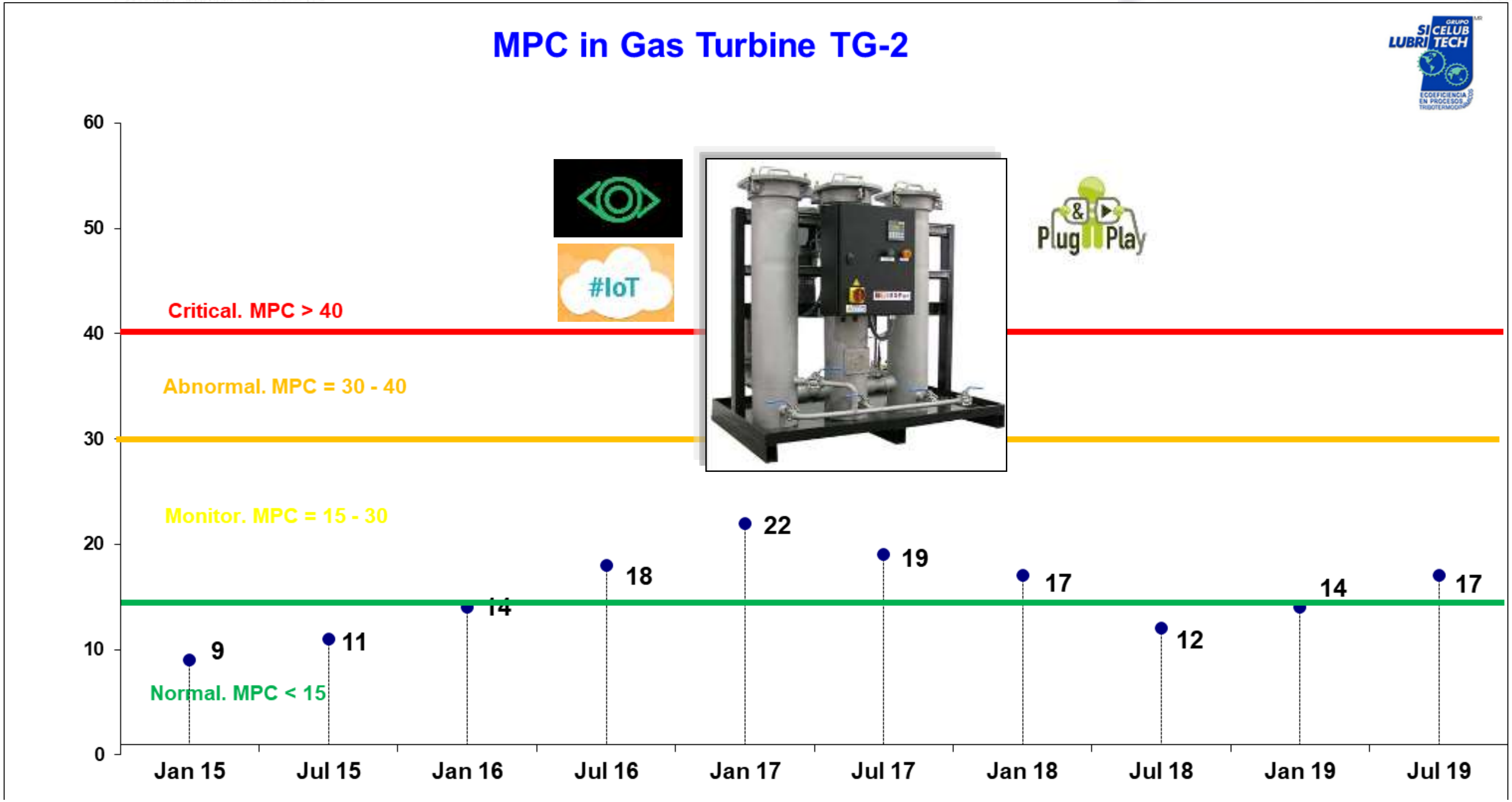
- On Line Oil Analysis.
- Permanent Oil Purifier Application (100%).
- Average ppm of water around 100.

Current Moisture Level (ppm)	New Moisture Level (ppm): 10,000		5,000		2,500		1,000		500		250		100	
	Rolling Element	Journal	Rolling Element	Journal	Rolling Element	Journal	Rolling Element	Journal	Rolling Element	Journal	Rolling Element	Journal	Rolling Element	Journal
50,000	2.3	1.6	3.3	1.9	4.8	2.3	7.8	2.9	11.2	3.5	16.2	4.3	26.2	5.5
25,000	1.6	1.3	2.3	1.6	3.3	1.9	5.4	2.4	7.8	2.9	11.2	3.5	18.2	4.6
10,000			1.4	1.2	2.0	1.5	3.3	1.9	4.8	2.3	6.9	2.8	11.2	3.5
5,000					1.4	1.2	2.3	1.6	3.3	1.9	4.8	2.3	7.8	2.9
2,500							1.6	1.3	2.3	1.6	3.3	1.9	5.4	2.4
1,000									1.4	1.2	2.0	1.5	3.3	1.9
500											1.4	1.2	2.3	1.6
250													1.5	1.3
100														

Increase of life in journal bearings of 90%



- Gas Turbine in Power Gen.
- Oil Analysis every six months.
- No Action until MPC is higher tan 30.
- Valve stick occurrence.
- Unplanned turnaround and performing of cleaning. Uptime 90%.



- Permanent Oil Purifier Application (100%).
- No Varnish events.
- No Unplanned Turnaround. Uptime 100%

Recommendation

- Use permanent Oil Purifiers for removing water, particles, gases and varnish in Critical Equipment. Operate 24x7.

- Add on-line condition monitoring devices to get more data around contamination presence and act quickly.

Conclusion

- New Operation requirements, require more Reliability and Availability in Critical Equipment.
- Tribology or Lubrication Engineering Best Practices need to be spread and applied in Industry.
- Strategy of On Line Monitoring and 24x7 Oil Purification are good tools for increasing Reliability in Mechanical Elements of critical Equipment in Refineries, Power Gen Plants, Off-Shore Platforms, etc.

¿Questions?