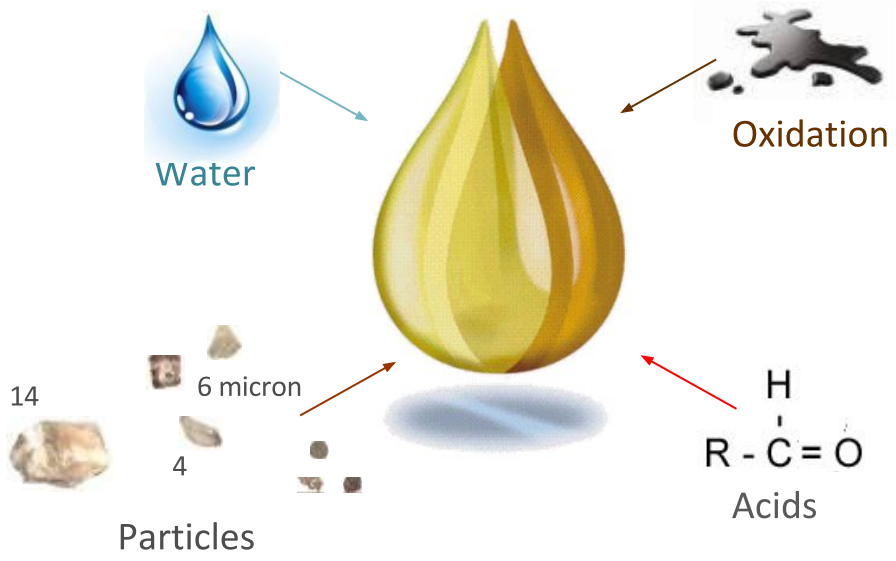
Reliability Increase of Steam & Gas Turbines

Presented by: Rick Klassen Klassen Specialty Hydraulics Inc. rick@klassenhydraulics.com

Main contaminants in oils …

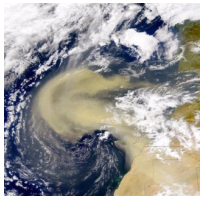


Causing many problems…

Air release
Corrosion
Oil film thickness
Temperature
Cavitation
Additive depletion
Turbine trips
wear
Demulsibility
Vibrations

Particles






Water



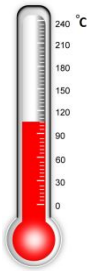
Impact of particles

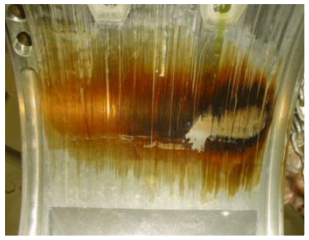
- Sand Blasting,
- Abrasive Wear,
- Fatique wear
- Oil oxidation

Impact of water

- Corrosion
- Cavitation and hydrogen-embrittlement
- Acids
- Bacteria, oil oxidation

Thermal

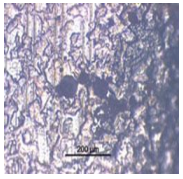




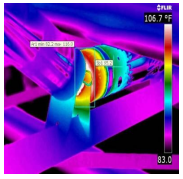
Chemical

O_2 O_2 O_2

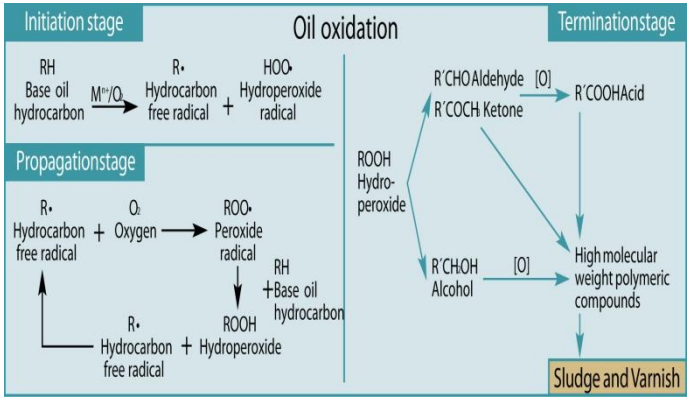
ESD



Micro Dieseling



Hot spots



Chemical & Thermal Oxidation

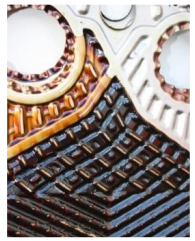
O_2 O_2 O_2

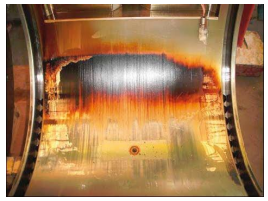
+

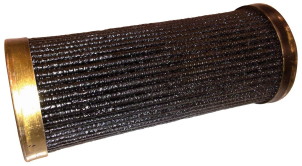
Cu Fe Si

Accelerators

Results in Sludge & Varnish







Oil film thickness

Temperature

Vibrations

Wear

Air release

Demulsibility

Additive depletion

Turbine trips

Blade stress

Acid Control

Acids in mineral oil can be removed with the removal of the oxidation products

For phosphate esters, this is different

Filtration of Turbine oils

Comments from the field

We had a turbine trip due to the hydraulic control system

We have vibration problems

We need 2 lifting pumps, it is supposed be only one

Our centrifuge was full of tar

We have to change inline filters more often

We have changed the oil and after 6 months we have problems again

Bearing temperatures are slowly increasing

All related to varnish and sludge...

how to remove and avoid it?

The development of the VRU

- **Depth Media: CCJensen was in 1953 one of the first companies that was able to remove insoluble and partly soluble oxidation products**

- **Electrostatic: A new principle of filtration, able to remove insoluble and partly soluble oxidation products**

- **Ion Exchange: CCJensen was able to also remove soluble oxidation products but the type of ion exchange media and efficiency depends on oil type, no indication when to change the media, minor water and particle removal**

- **Cool / Depth media: CCJensen intro 2010, developed the VRU to remove insoluble and soluble oxidation products independently of the oil type, insert change is based on pressure and inserts removes particles and water**

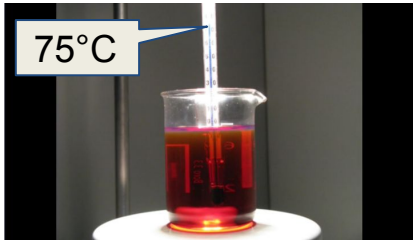
Old versus new filtration principle Installed at the same time on the same turbine

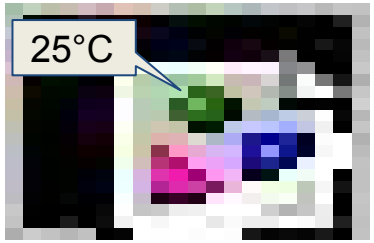
Old depth filtration technique

New depth filtration technique

How does the VRU work?

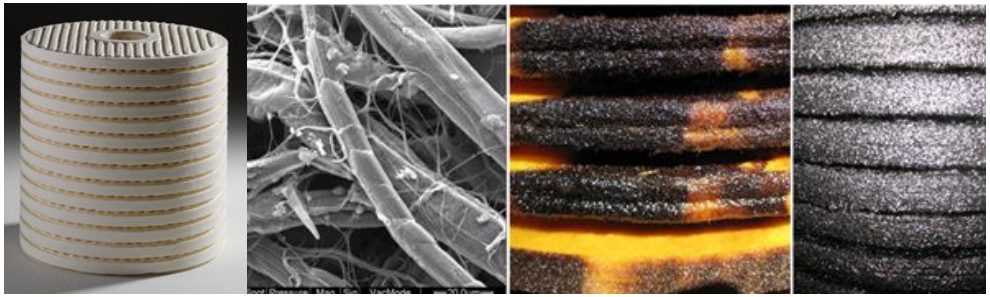
Make use of nature





When oil cools down, oxidation products comes out of solution and settles in your system

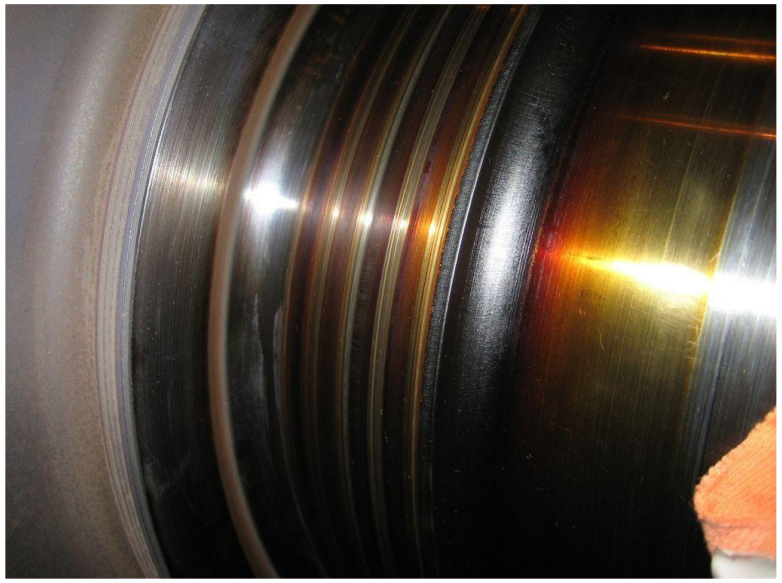
Cellulose is from nature, very polar towards oxidation products

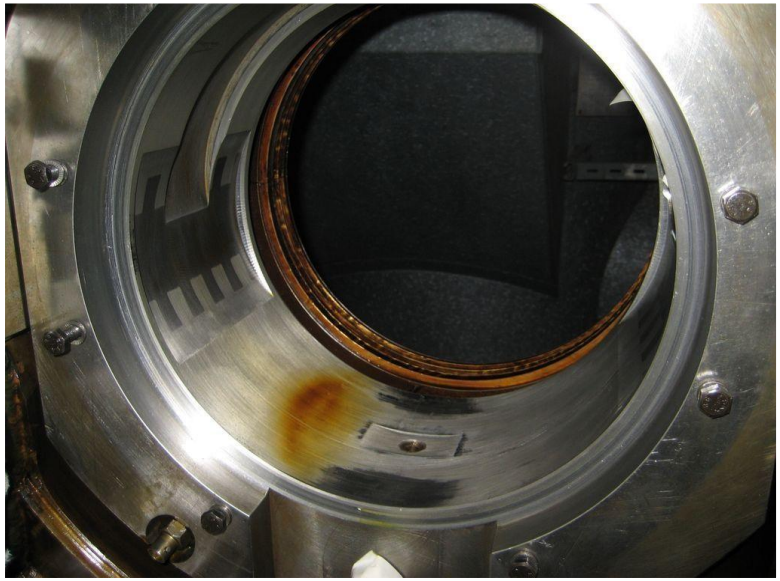


Field experiences

Siemens Gas Turbine test 2012 – 2013
Combined cycle at Göteborg Energi, Sweden

Varnish on turbine components





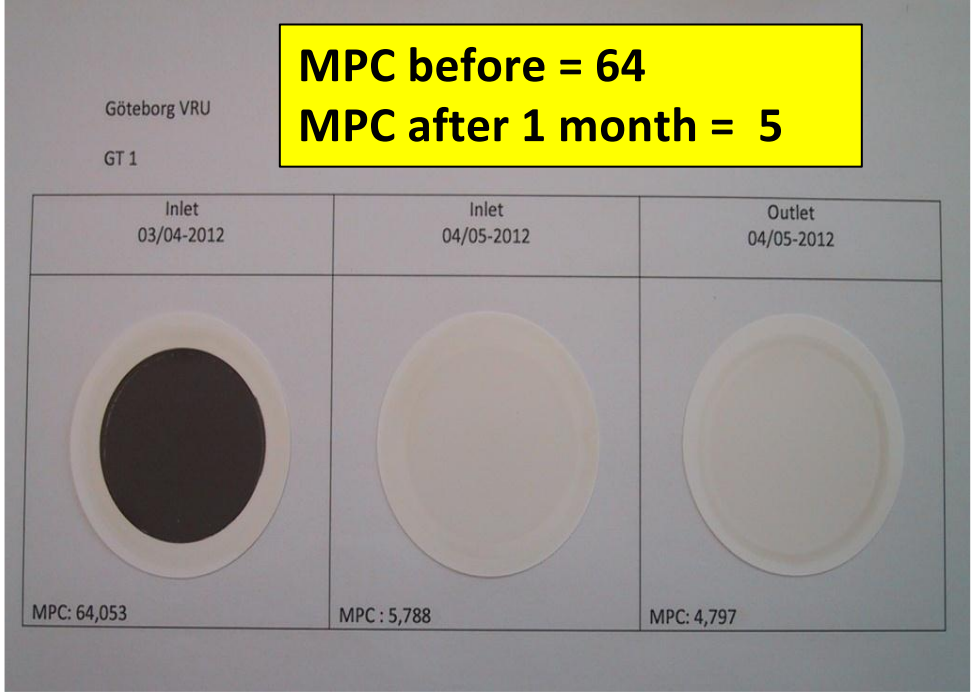
Target: MPC Value always < 15

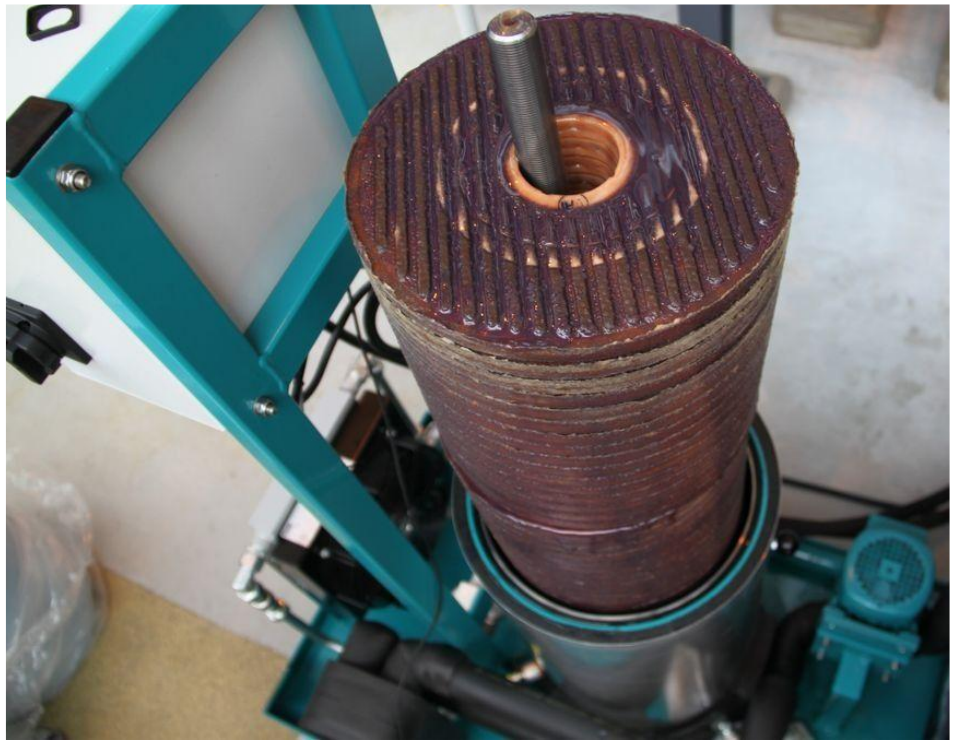
- MPC : > 60
- Load : base load, winter time
- Oil temp : 60-70°C
- Oil volume : 12,000 L
- Oil type : Shell Turbo CC 46

Siemens is responsible for oil sampling, both parties do oil analyses

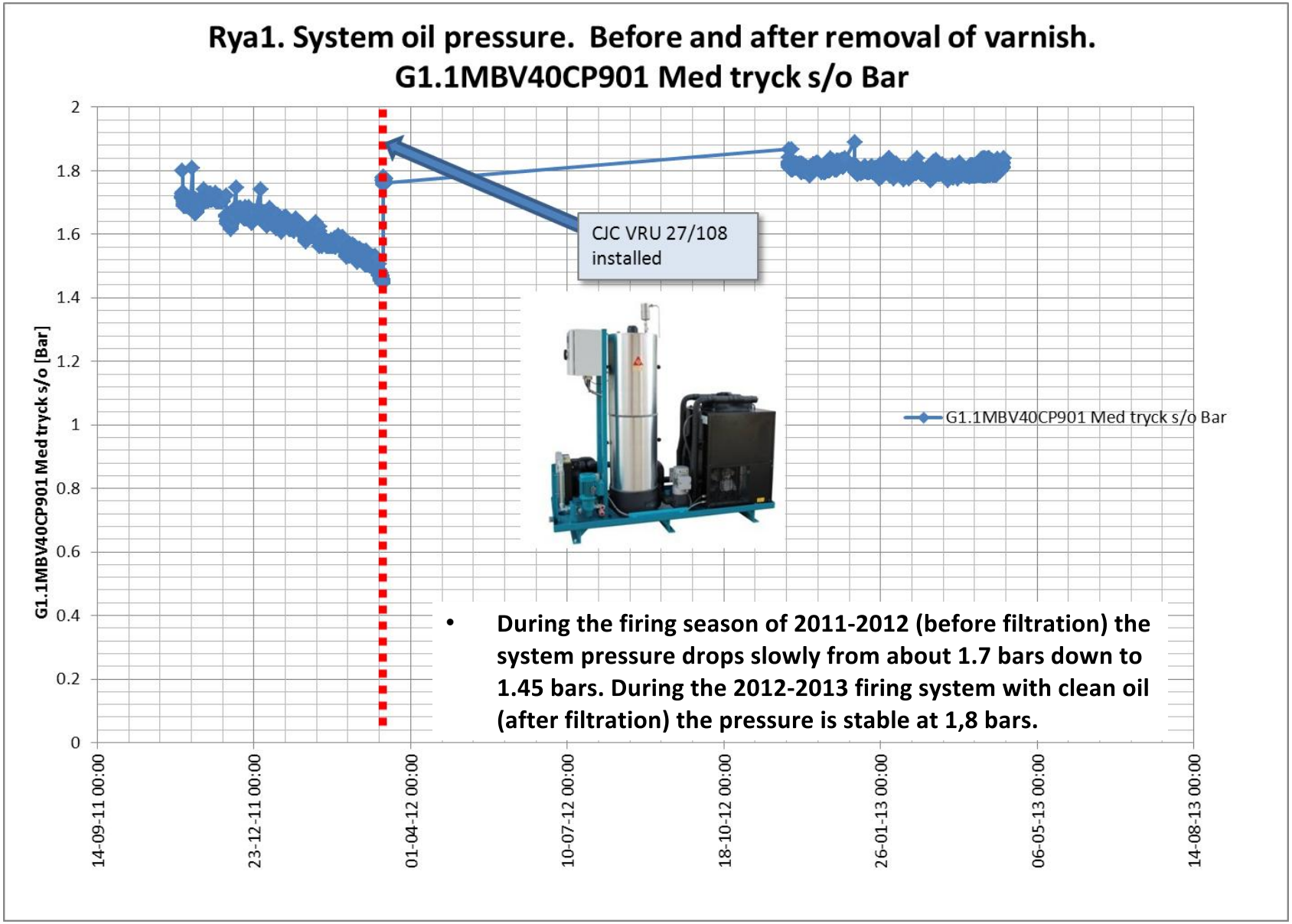
VRU at GT Rya 1 & 3


2012-03-15, Rya 1 start up

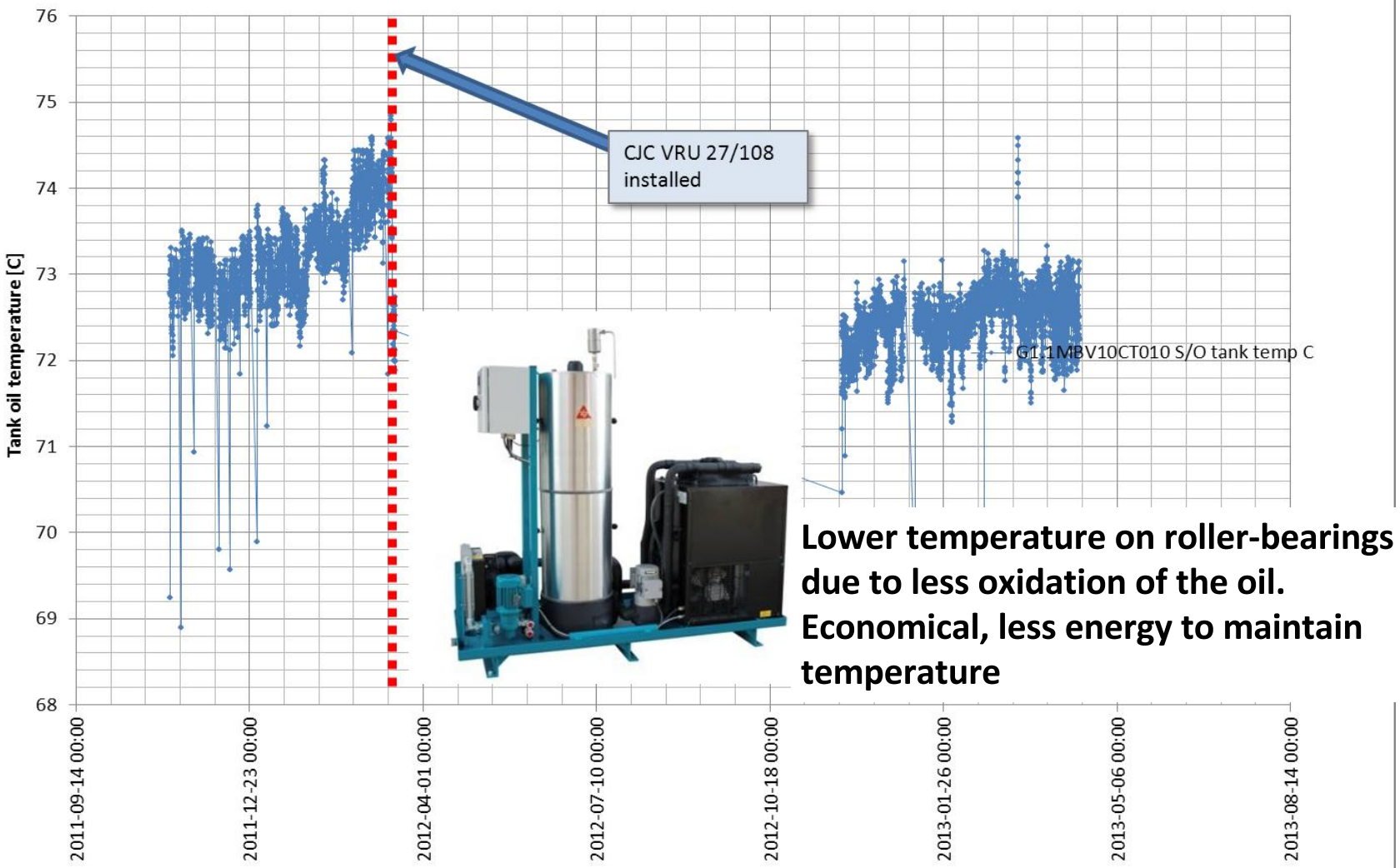

MPC before = 64
MPC after 1 month = 5
Göteborg VRU
GT 1
Inlet
03/04-2012
Inlet
04/05-2012
Outlet
04/05-2012
MPC: 64,053
MPC : 5,788
MPC: 4,797



Control system oil pressure

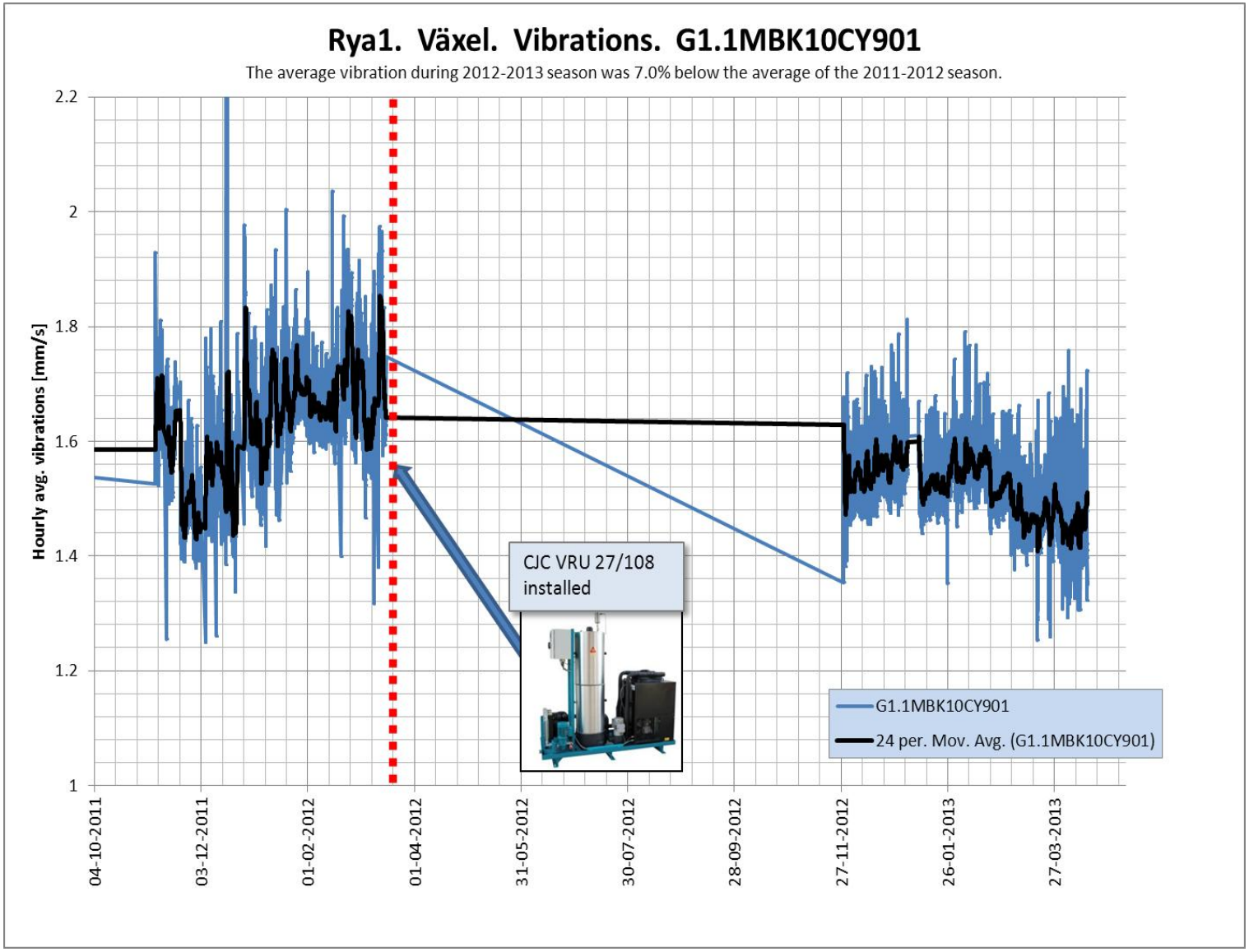


Tank oil temperature



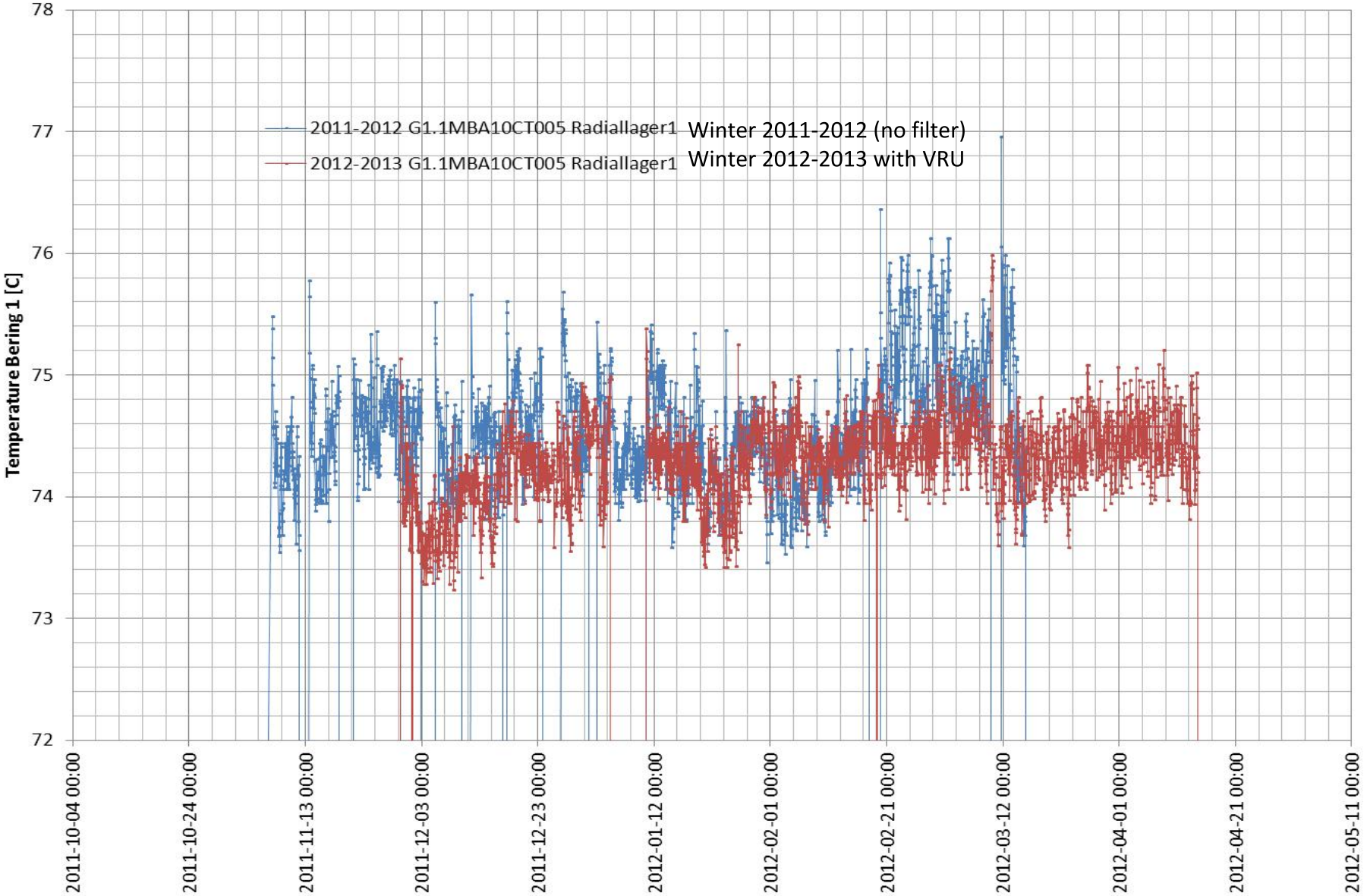
Lower temperature on roller-bearings due to less oxidation of the oil. Economical, less energy to maintain temperature

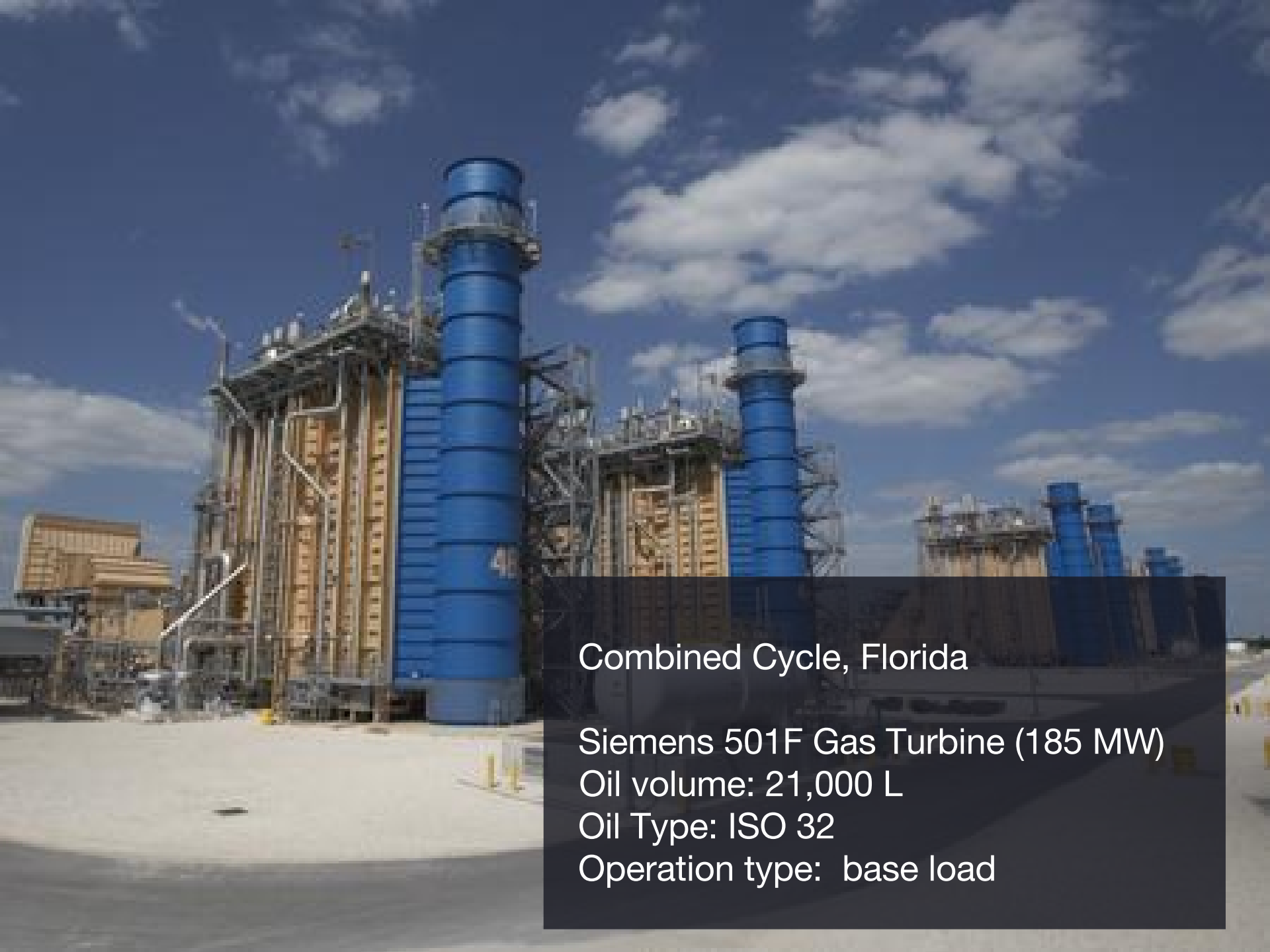
Control system vibrations



Rya1. Temperature Radial bearing 1

(Data superimposed on same graph)




Combined Cycle, Florida
Siemens 501F Gas Turbine (185 MW)
Oil volume: 21,000 L
Oil Type: ISO 32
Operation type: base load


VRU
Varnish
Removal
Unit

Varnish Single-Pass Removal with VRU on Siemens 501F, case: Florida

Date: 10/11/2012

Lab #: 904550

MPC VALUE: 54

L	a	b
54	0	9

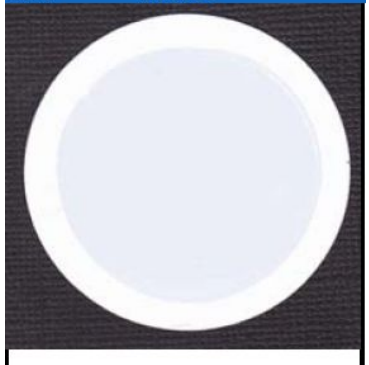
904550

UC VALUE: 3

Lab #:	904550
Particle Count (pore blockage)	13/11/7
Particle Count (optical)	21/19/14

Date: 10/11/2012

Lab #: 904551



MPC VALUE: 5

L	a	b
15	-3	-4

904551

UC VALUE: 1

Lab #:	904551
Particle Count (pore blockage)	15/14/10
Particle Count (optical)	14/12/9

Varnish Trendline with VRU on Siemens 501F, case: Florida

Date:	01/17/2013	12/5/2012	10/11/2012
Lab #:	937125	921848	904550

MPC VALUE: (4)			MPC VALUE: 26			MPC VALUE: 54		
L	a	b	L	a	b	L	a	b
11	-10	-1	25	0	8	54	0	9

Membrane Patch Colorimetry Results:

The MPC color value of 12 is below the alarm limit of 23 and is considered normal.

Varnish Trendline with VRU on Siemens 501F, case: Florida

01/17/2013	12/05/2012	10/11/2012
937125	921848	904550
		
UC VALUE: **1**	***UC VALUE:*** **1**	***UC VALUE:*** **3**

VRU – Nuclear Power Plant
Alstom Steam Turbine
Oil volume = 50,000L Total Preslia 32

The results

LABORELEC
GDF SUEZ
Electricity, Grids and End-Use

Contaminatie	VRU INSTALLED		INSERT REPLACED	INSERT REPLACED	VRU STOPPED FORGOT INSERT CHANGE	INSERT REPLACED	
Referentie LABORELEC	1304.0468	1305.0399	1307.0897	1309.0440	1312.0420	1405.0293	1407.0794	1410.0673
Datum staalname	15/04/2013	13/05/2013	15/07/2013	11/09/2013	22/11/2013	07/05/2014	31/07/2014	20/10/2014
Membrane Patch Colorimetry ASTM D7843	29	20	46	14	5	5	25	13

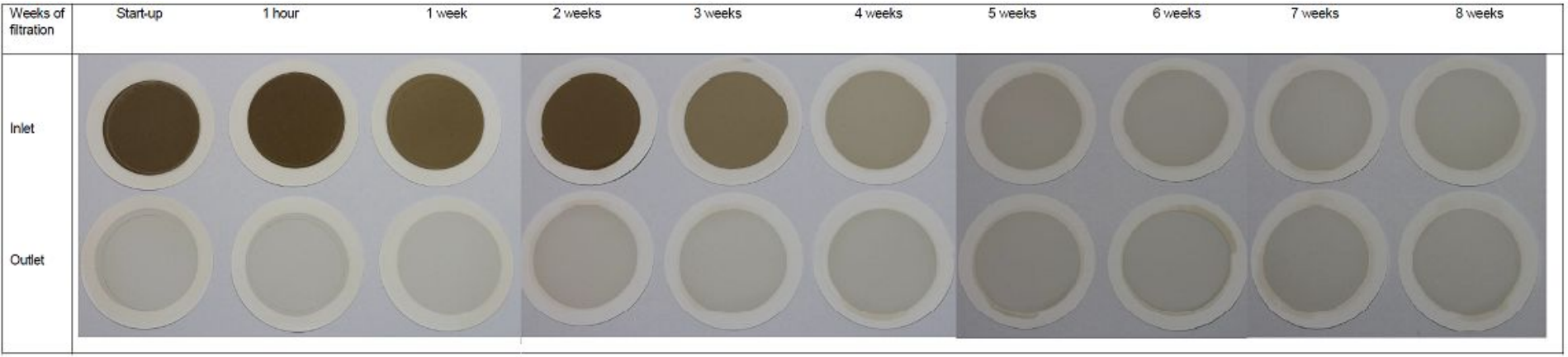

Electrabel Doel 2, 2x VRU27/108 for turbine oil

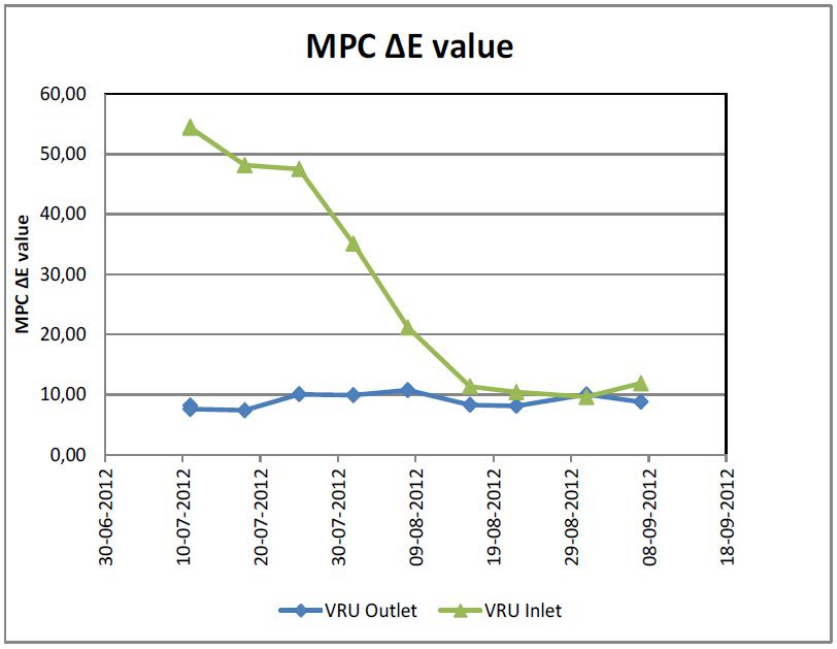
Electrabel
GDF SUEZ

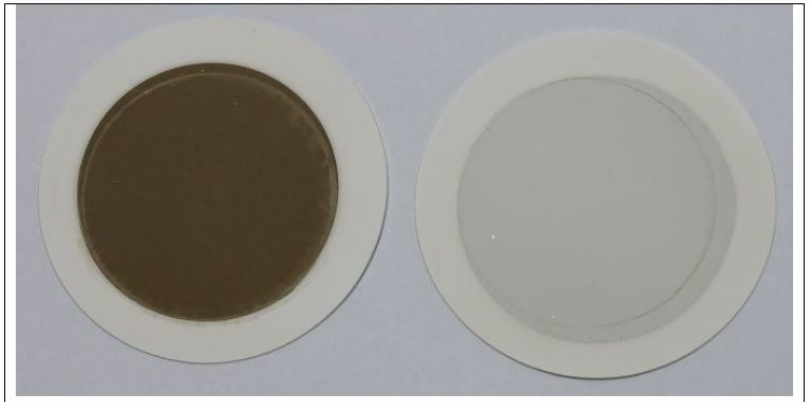
VRU - Varnish Removal Unit on
Siemens Steam Turbine (HP/MP K30-25-2, LP N30-2X10)
13,000 liter ESSO ET EP 32


22/8/2012

The results







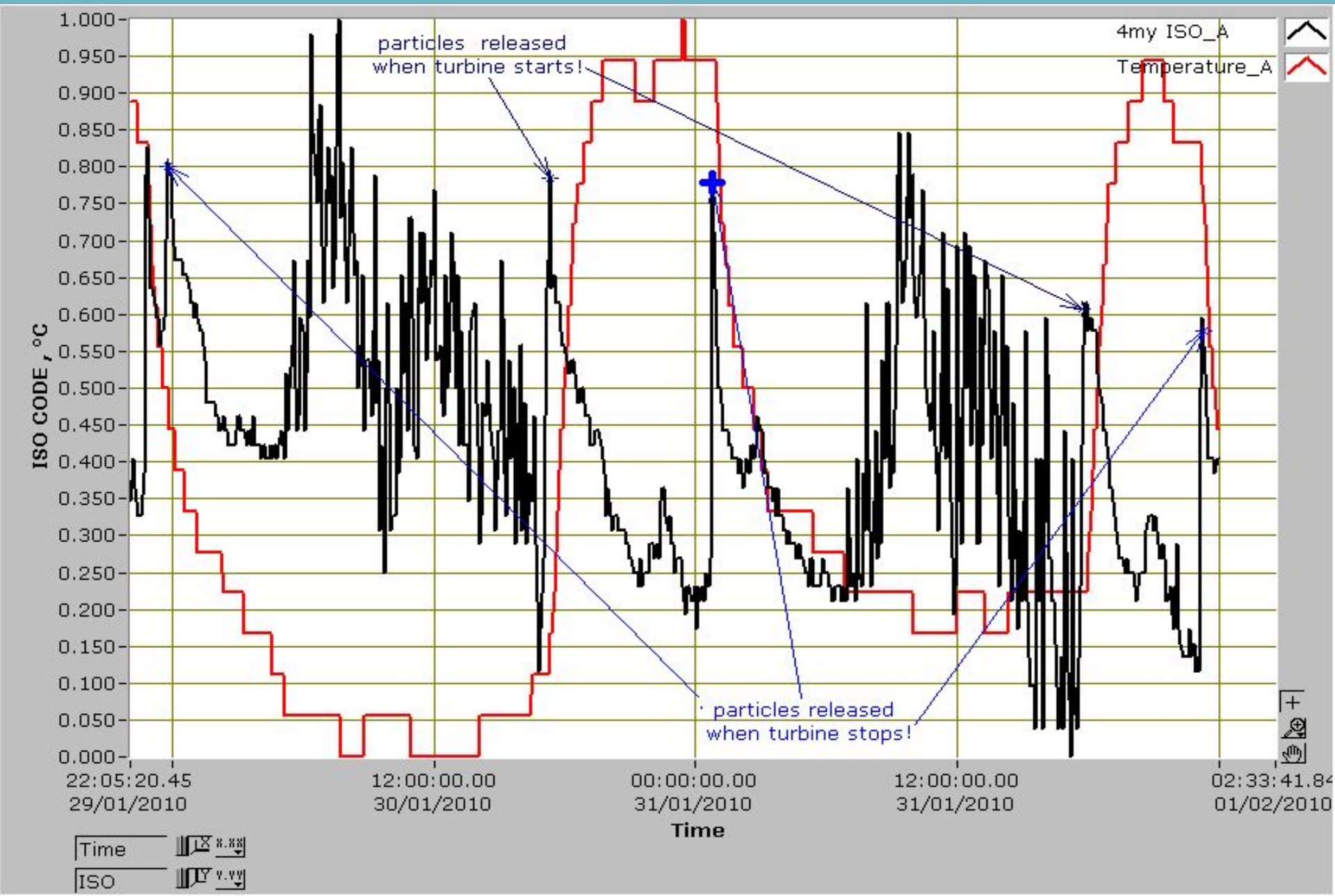
0.45 µm nitro-cellulose membrane.

Oil before VRU filtration	Oil after VRU filtration
MPC ΔE value: 54.448	MPC ΔE value: 8.177

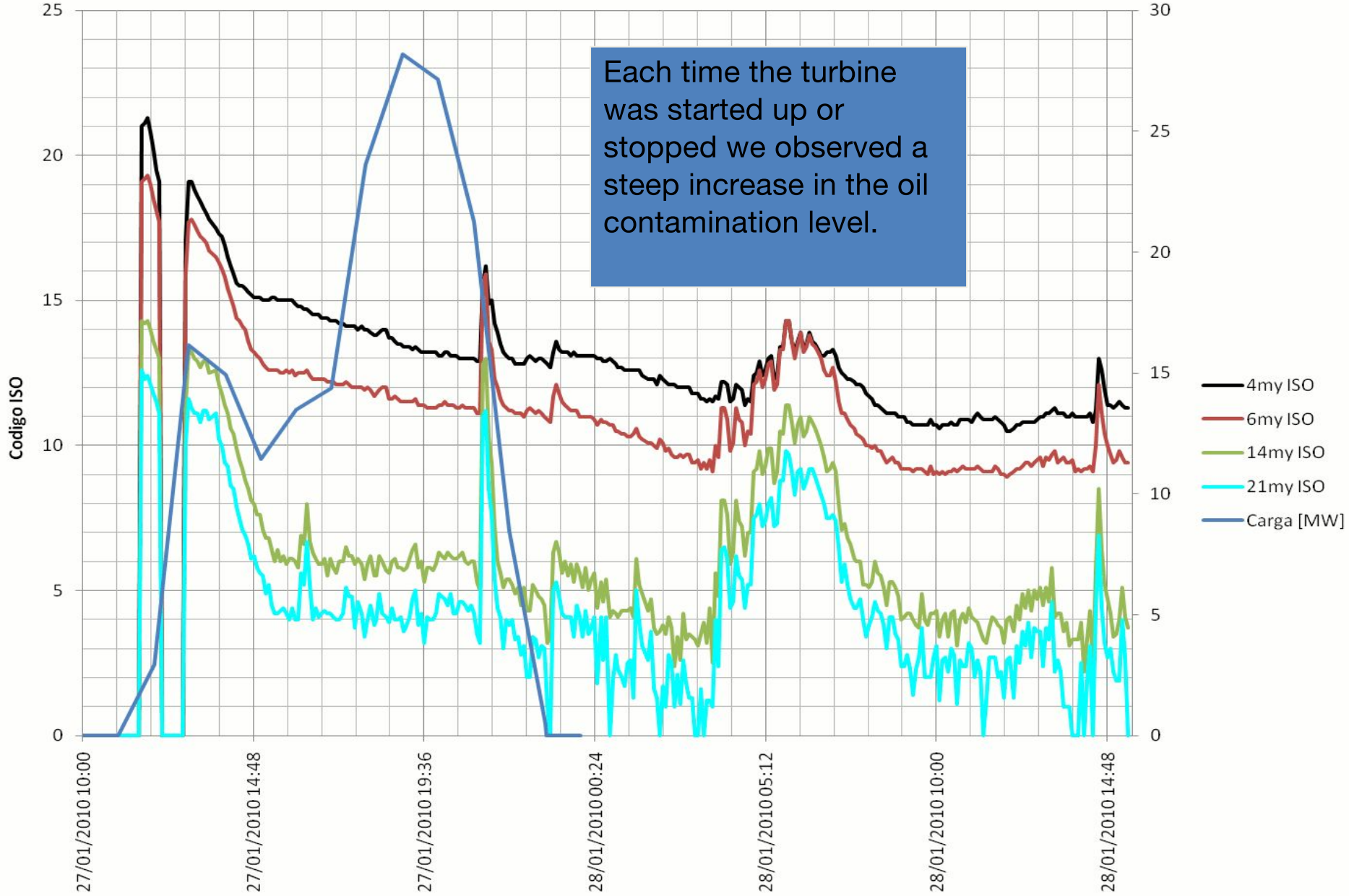
Where did the varnish go?

Other parameters are improving too !

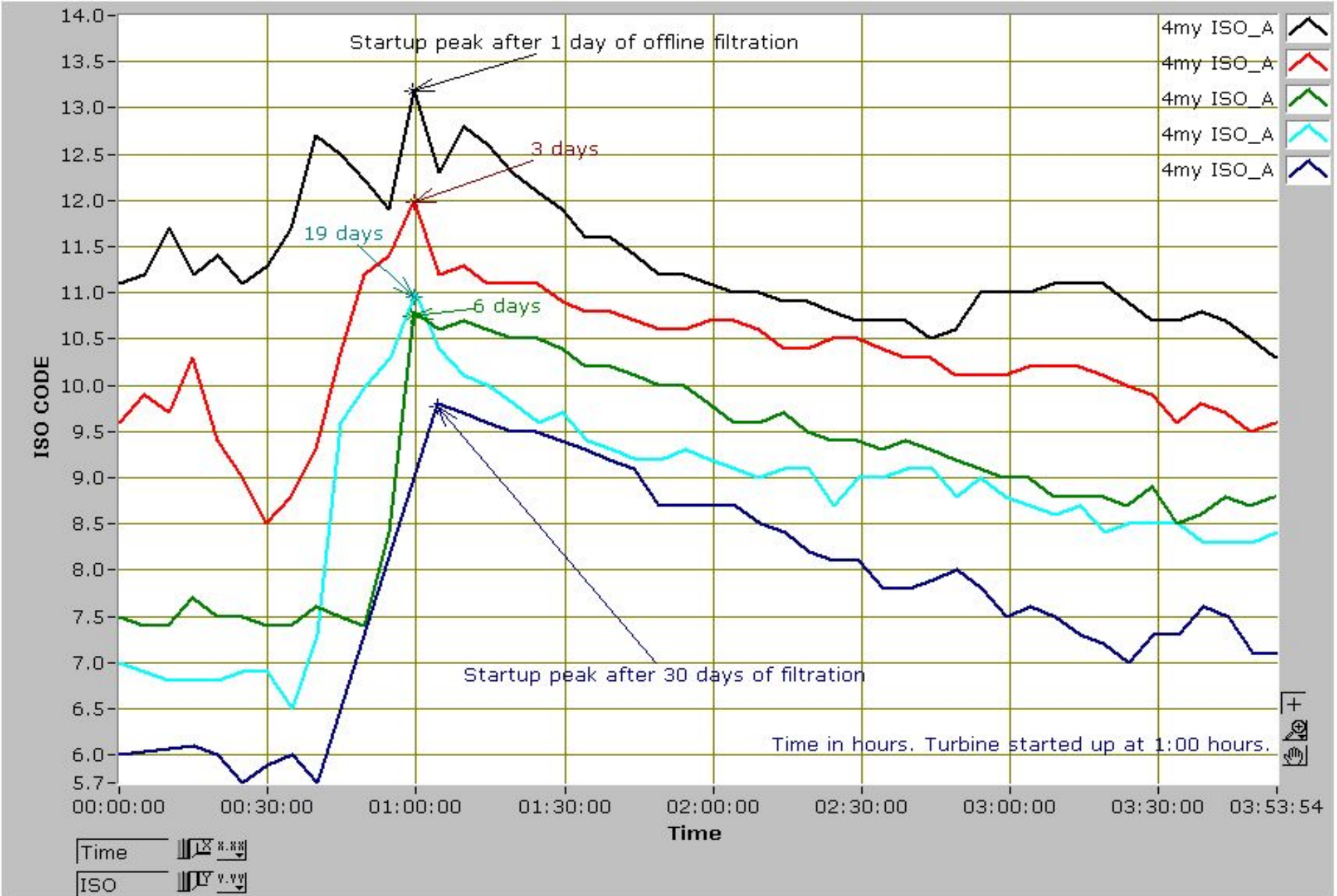
The particles



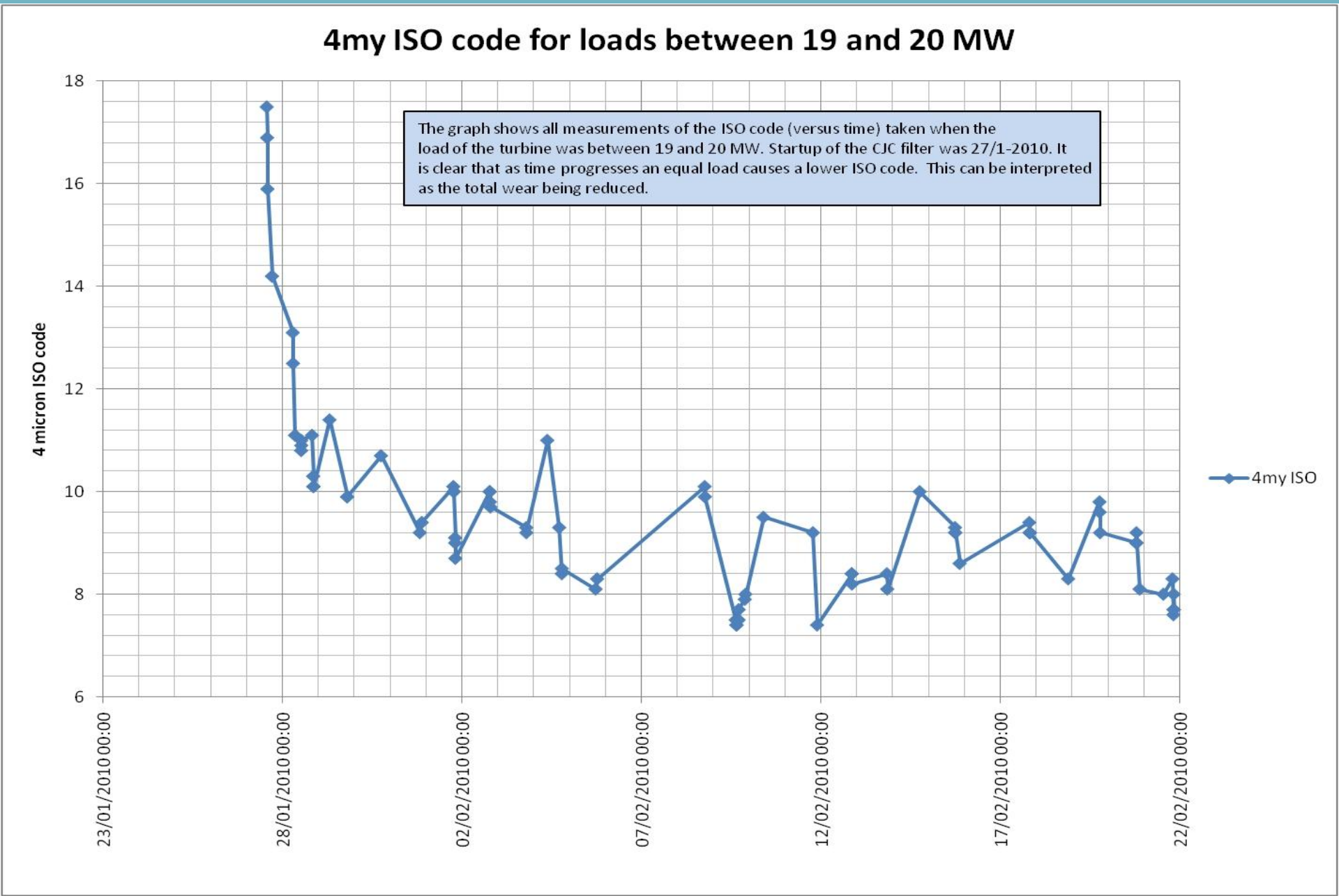
The particles



The particles



The particles



And nano particles?

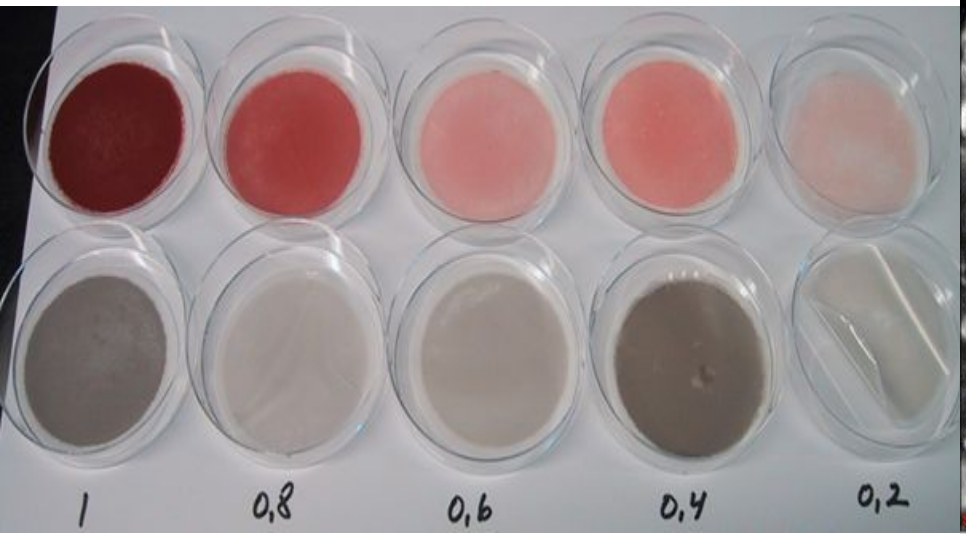
Particle Distribution µm

Top Row: Red Iron Oxide Test Dust

Bottom Row: Actual particles from gear oil

ISO 4406 4, 6, 14 µm

What do we prefer?



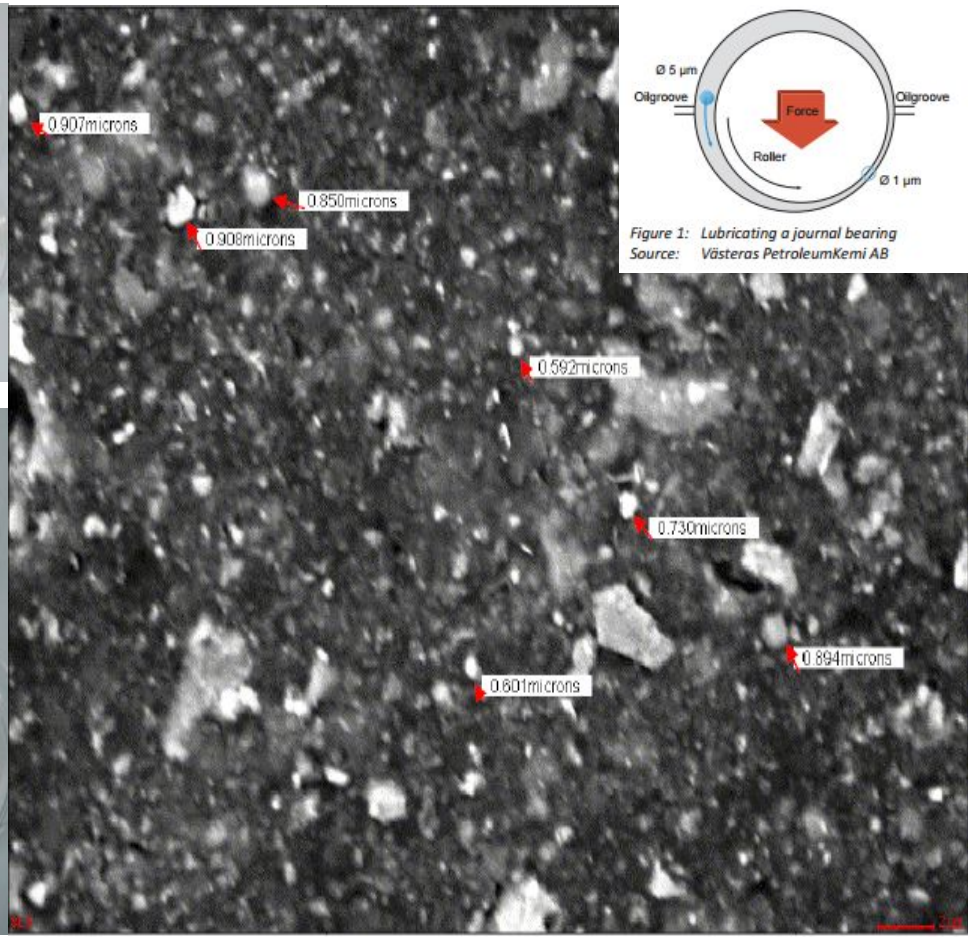


Figure 1: Lubricating a journal bearing
Source: Västeras PetroleumKemi AB

Foam & Air release

Foam field test

Use clean sample bottle and shake

- No foam, it might be a mechanical aeration
- Foam, possibly caused by contamination

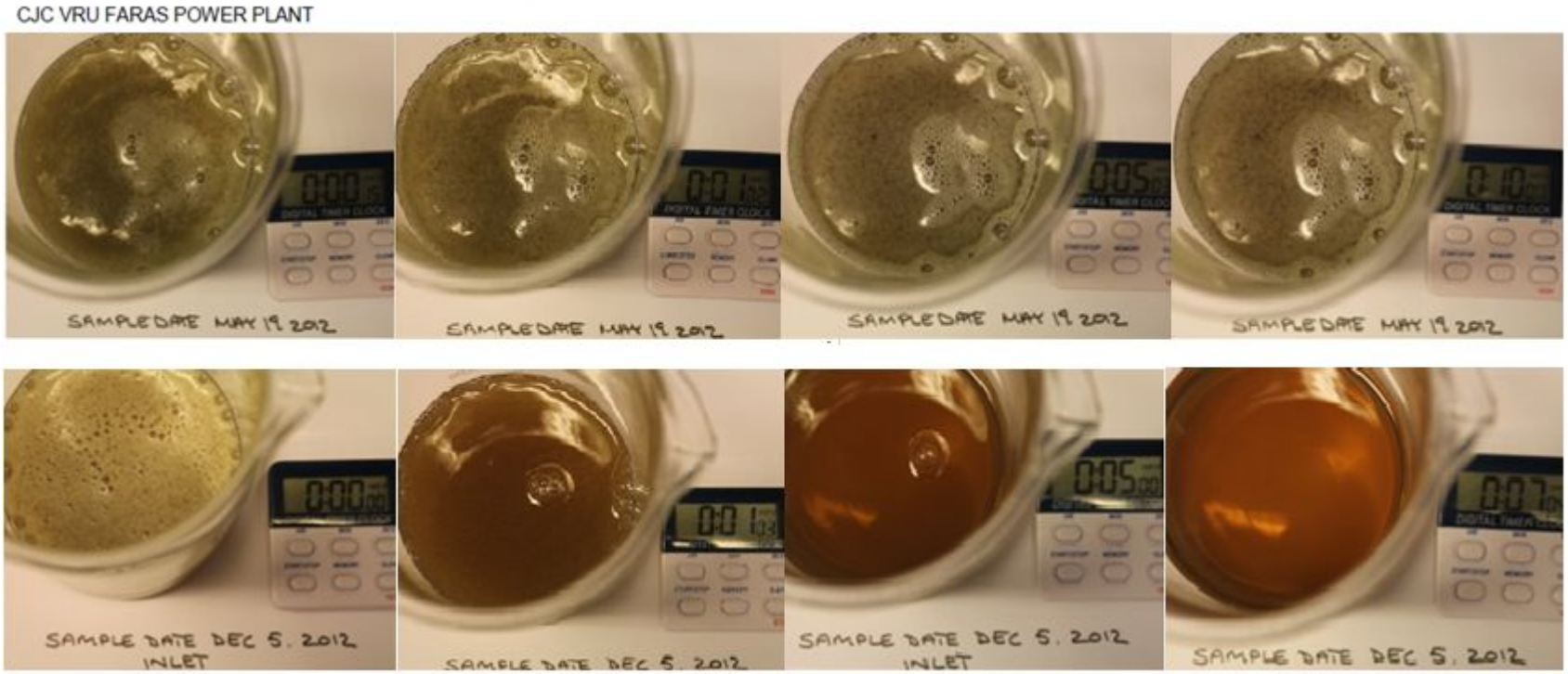
Contaminations

- Water: reduces the surface tension, leading to air entrainment and foam.
  e.g. more foam may be generated in the presence of water, but foam is less stable and will dissipate faster.
- Oxidation by-products
- Additive breakdown
- Particle contamination (act as seeds on which bubbles grow)
- Antifoam additives may be attracted to particle surface, reducing the effectiveness in the bulk oil.

Foam & Air release

Before filtration

After filtration



Effects of Air Entrainment

- Pump cavitation
- Vibration
- Oil oxidation
- Component wear due to reduced lubricant viscosity
- 1% air may trip low oil pressure switches
- Centrifugal pumps require <1% air to maintain suction

Air release and particle improvement gives a better hydrogen control in the generator, so does demulsibility

Demulsibility

VRU on steam turbine

- Power plant : Electrabel Knippegroen, Belgium
- Turbine type : Siemens SST5-5000
- Oil type : Shell Turbo T32
- Oil volume : 15.000L
- Oil temp : 60°C-62°C

Previous unit disconnected by customer

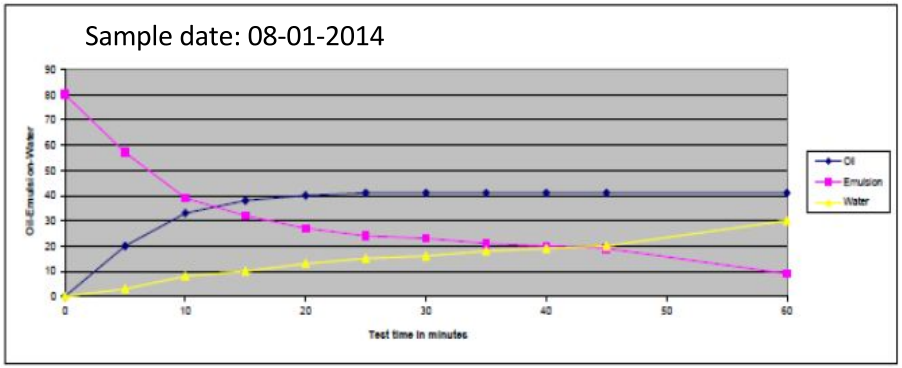
MPC value: 28,3
Suction from tank
08-01-2014

MPC value: 5,0
Suction from tank
11-01-2014

MPC value: 4,1
Suction from tank
22-04-2014

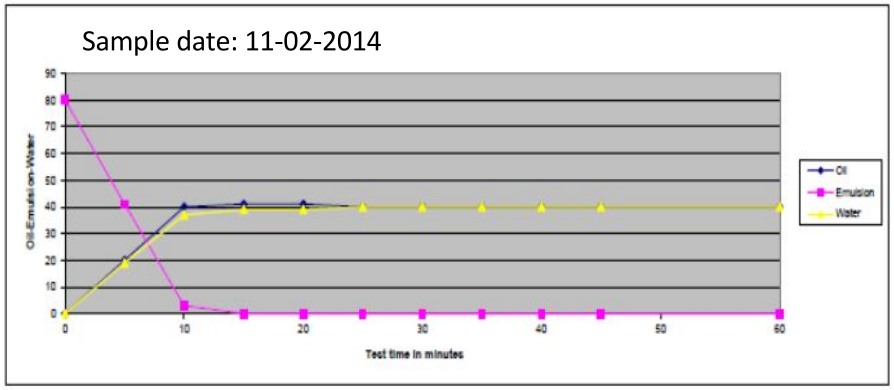
Remarkable improvement on demulsibility

Sample date: 08-01-2014



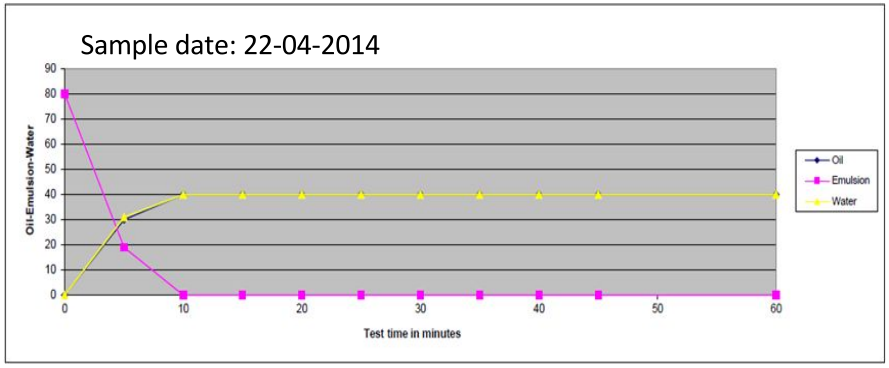
Time in minutes.	0	5	10	15	20	25	30	35	40	45	60
Oil phase in ml.	0	20	33	38	40	41	41	41	41	41	41
Emulsion phase in ml.	80	57	39	32	27	24	23	21	20	19	9
Water phase in ml.	0	3	8	10	13	15	16	18	19	20	30

Sample date: 11-02-2014



Time in minutes.	0	5	10	15	20	25	30	35	40	45	60
Oil phase in ml.	0	20	40	41	41	40	40	40	40	40	40
Emulsion phase in ml.	80	41	3	0	0	0	0	0	0	0	0
Water phase in ml.	0	19	37	39	39	40	40	40	40	40	40

Sample date: 22-04-2014



Time in minutes.	0	5	10	15	20	25	30	35	40	45	60
Oil phase in ml.	0	30	40	40	40	40	40	40	40	40	40
Emulsion phase in ml.	80	19	0	0	0	0	0	0	0	0	0
Water phase in ml.	0	31	40	40	40	40	40	40	40	40	40

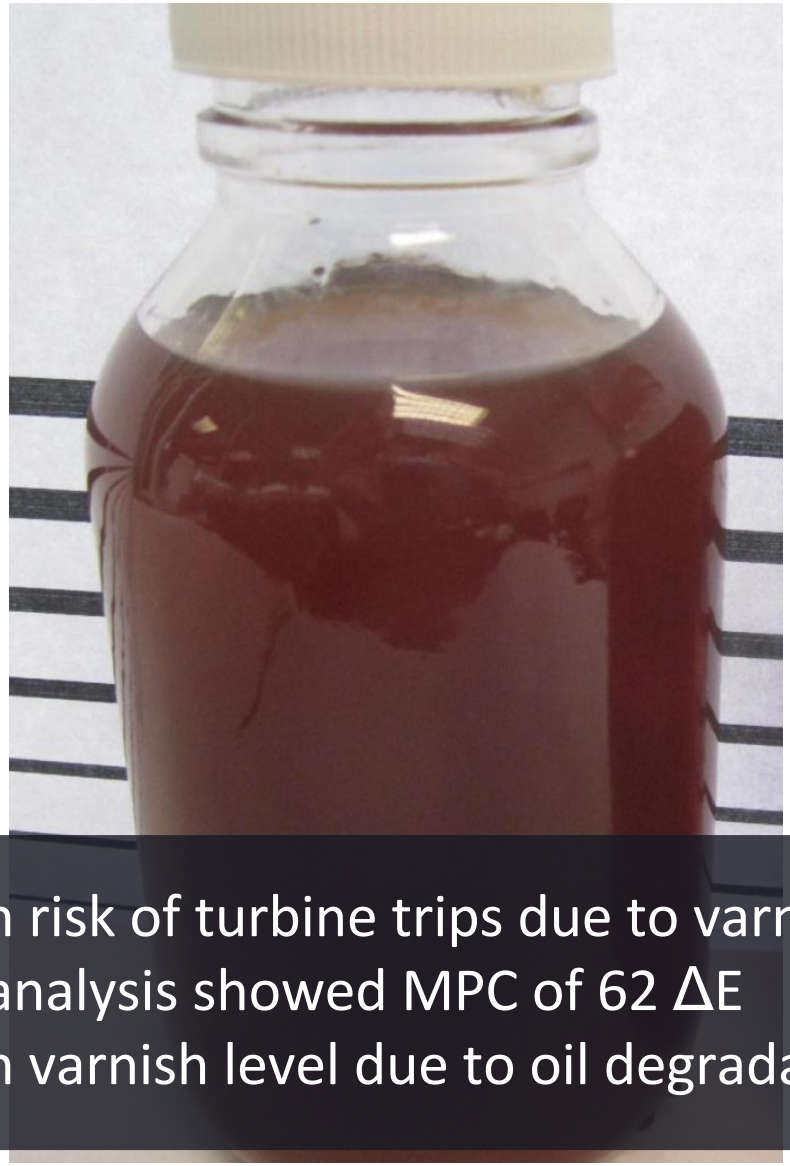
Four Contaminations...

Particles Water Oxidation Acid

...One Solution

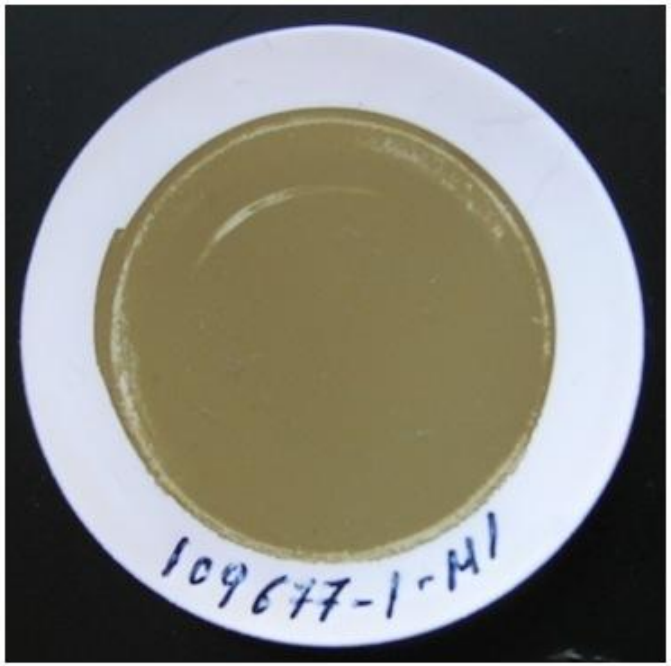
VRU - Varnish Removal Unit on
GE 9FA (250 MW) – 26,000 liters Shell Turbo CC 32 at
Iberdrola Tarragona Power, (BASF), Tarragona, Spain

The Problem



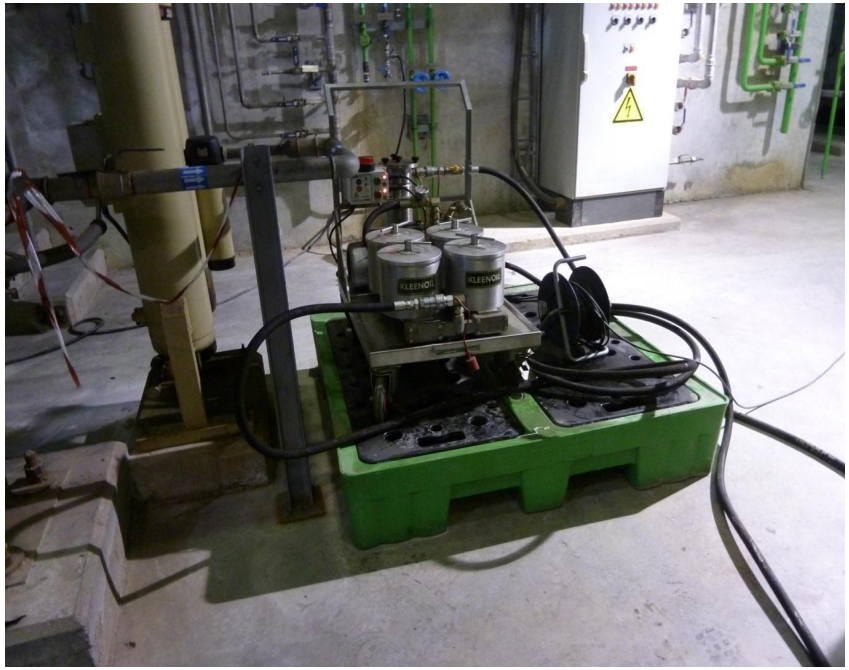
High risk of turbine trips due to varnish.
Oil analysis showed MPC of 62 ΔE
High varnish level due to oil degradation.

109677-1-M1



MPC=62	ISO 23/23/18

In the past



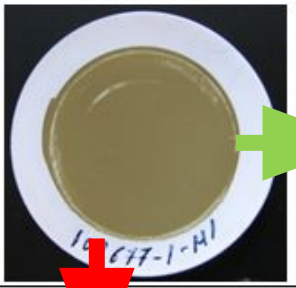
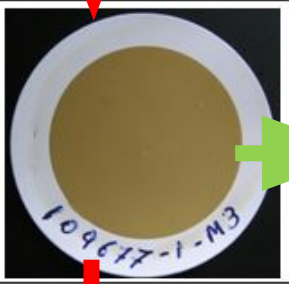
Different technologies were used:

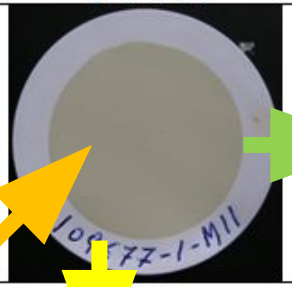
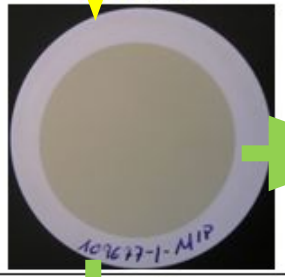
Electrostatic – Ion-Exchange – Normal Depth Filtration - . . . .

None could lower the MPC at high oil temperatures below 15.

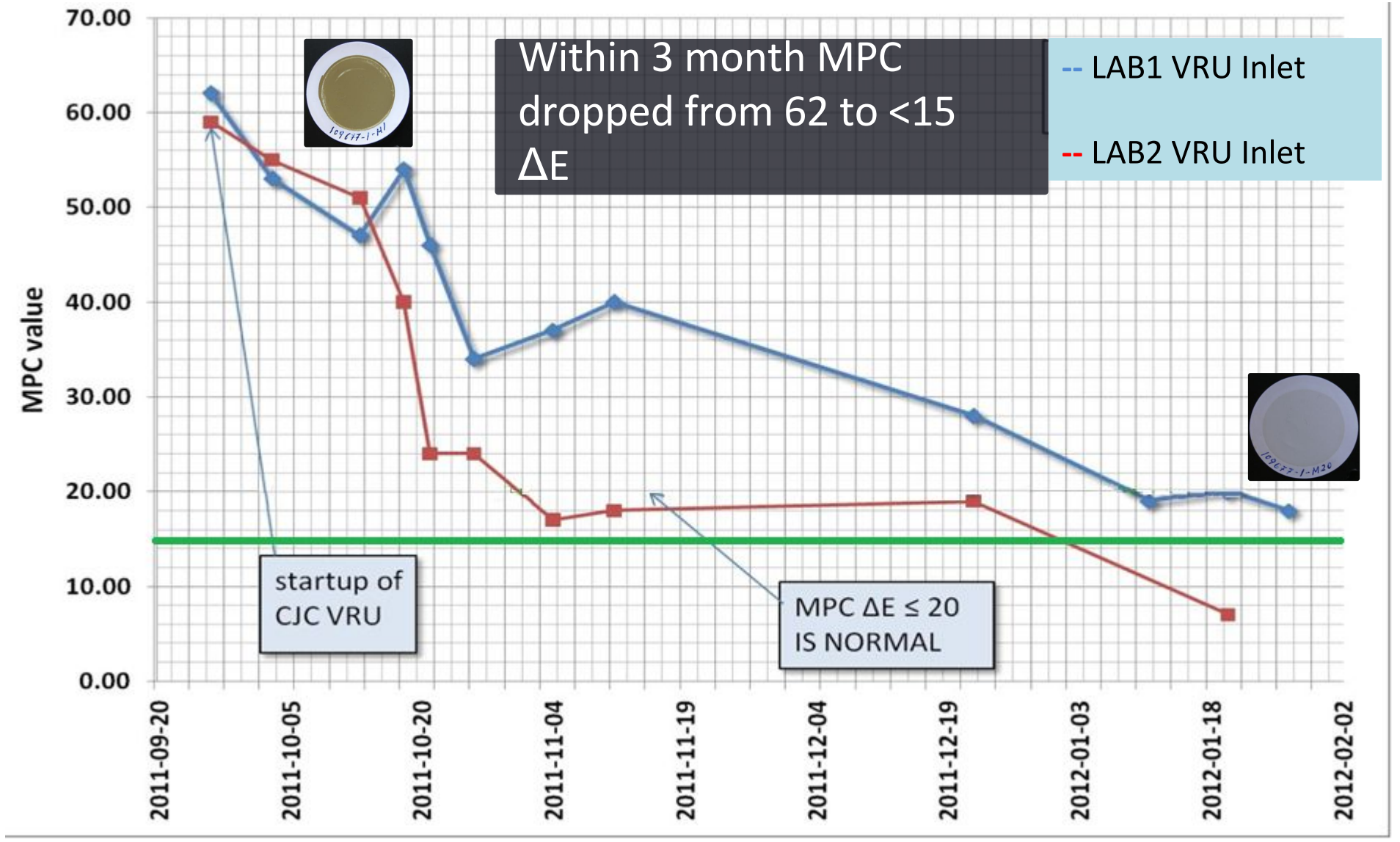
The Solution:
VRU - Varnish Removal Unit → Efficient varnish removal.
The VRU first treats the oil, making the varnish precipitate and come out of solution to be then adsorbed by the cellulose fibers of the VRi - Varnish Removal insert

The results

PRUEBA ELIMINACIÓN		VRU INLET	VRU OUTLET
FECHA	HORAS /DÍAS		
26/09/11	1 / 0	109677-1-M1  MPC=62	109677-1-M2  MPC=25
03/10/2011	120 / 5	9677-1-M3  PC=53	109677-1-M4  MPC=16
13/10/2011	240 / 10	9677-1-M5  MPC=47	109677 -M6  MPC=18

PRUEBA ELIMINACIÓN		VRU INLET	VRU OUTLET
FECHA	HORAS /DÍAS		
26/10/2011	551 / 23	109677-1-M11  PC=34	109677-1-M12  MPC=15
2/12/2011		677-1-M18  C=28	109677-1-M19  MPC=15
11/01/2012		77-1-M20  MPC=19	109677-1-M21  MPC=15

The results


70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
MPC value
2011-09-20
2011-10-05
2011-10-20
2011-11-04
2011-11-19
2011-12-04
2011-12-19
2012-01-03
2012-01-18
2012-02-02
Within 3 month MPC dropped from 62 to <15 ΔE
-- LAB1 VRU Inlet
-- LAB2 VRU Inlet
startup of CJC VRU
MPC ΔE ≤ 20 IS NORMAL

New VRi´s before use

VRi´s - after 5 days operation

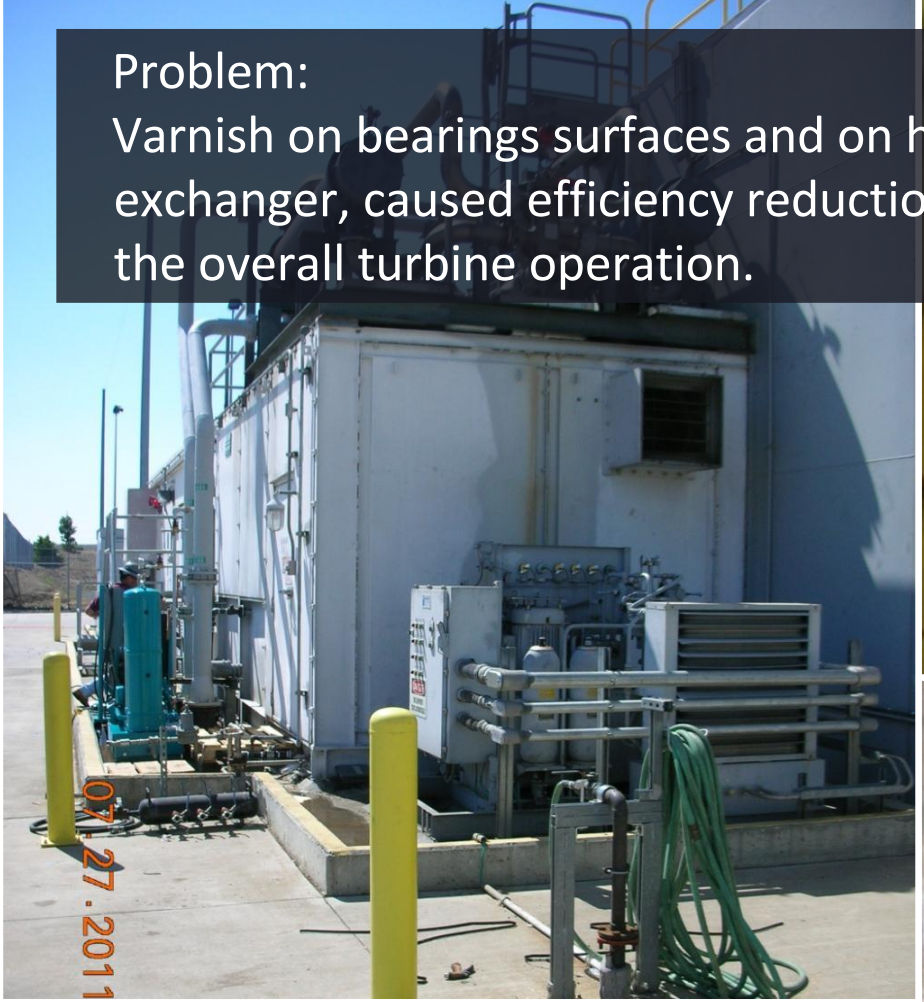
A happy CJC guy

An even happier customer

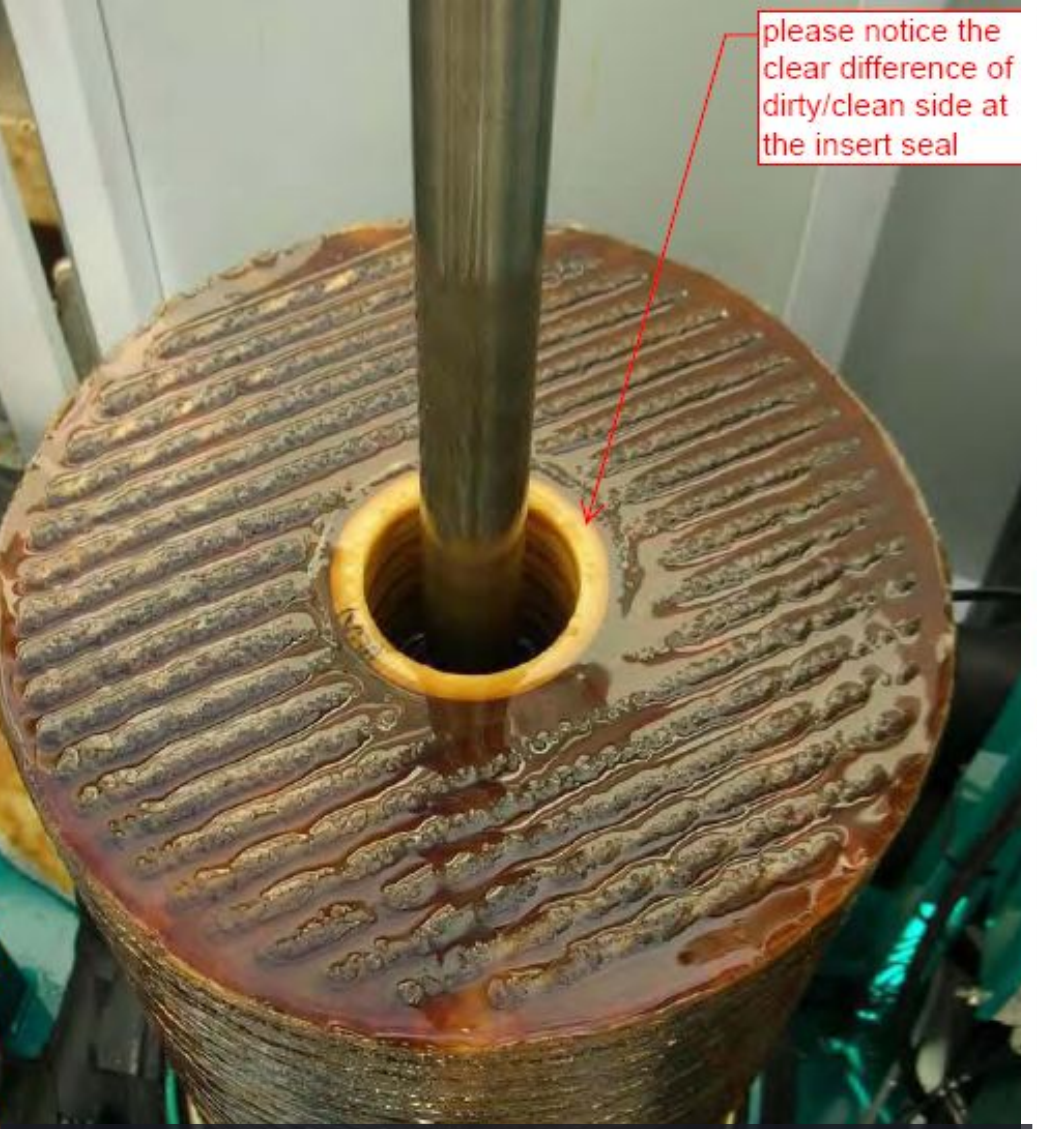
Calpine Delta Energy Center, Pittsburg, CA

Siemens 501F Gas Turbine (185 MW)
Oil volume: 21,000 L
Oil Type: Shell Turbo T 32

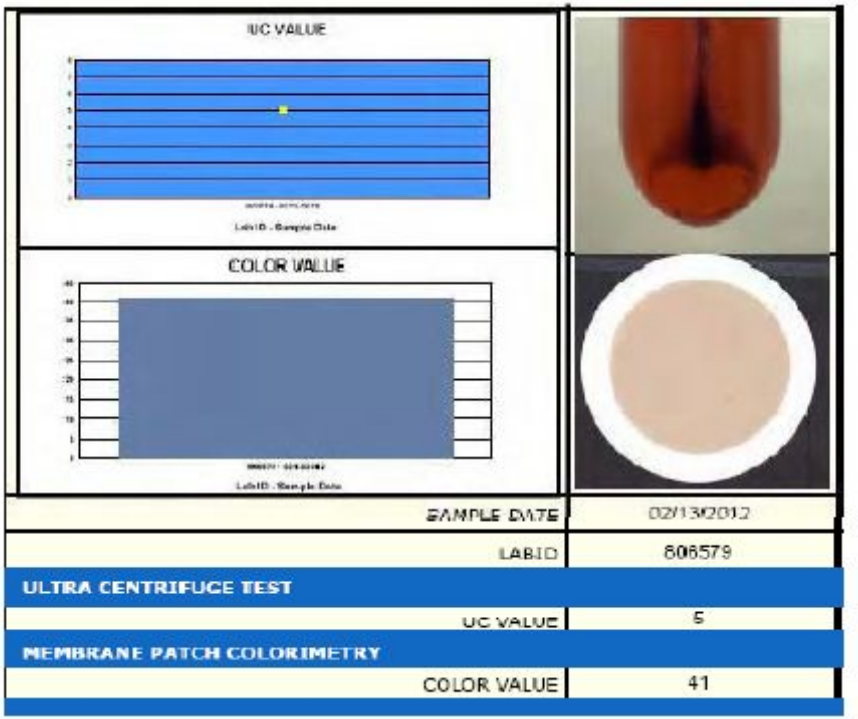
Problem:
Varnish on bearings surfaces and on heat exchanger, caused efficiency reduction of the overall turbine operation.

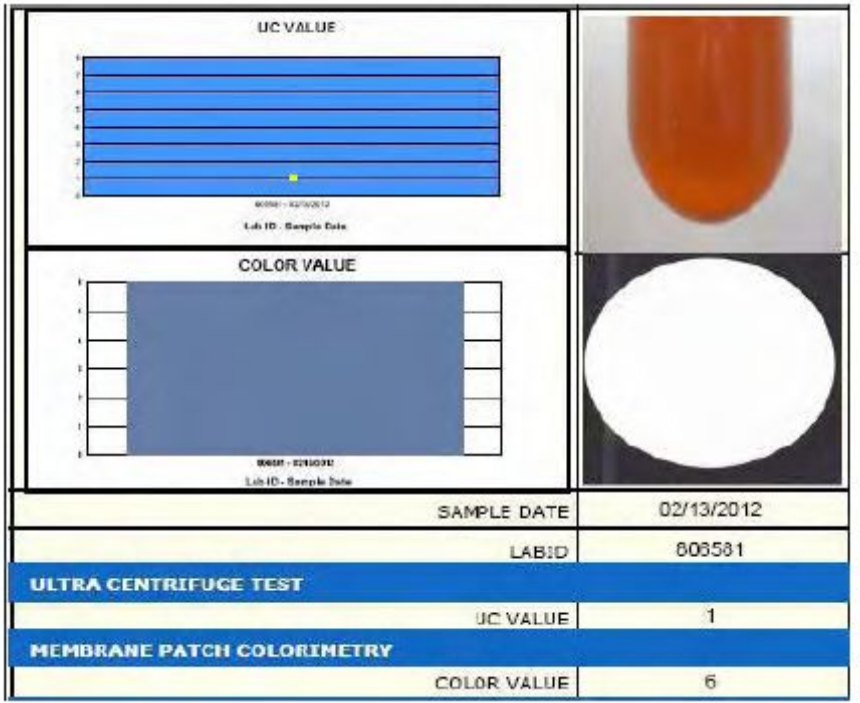


Solution:
VRU – Varnish Removal Unit,
outdoor version

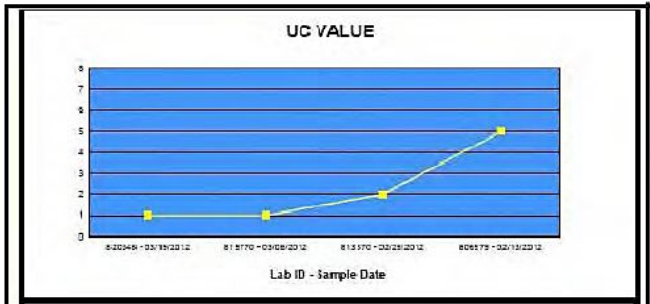


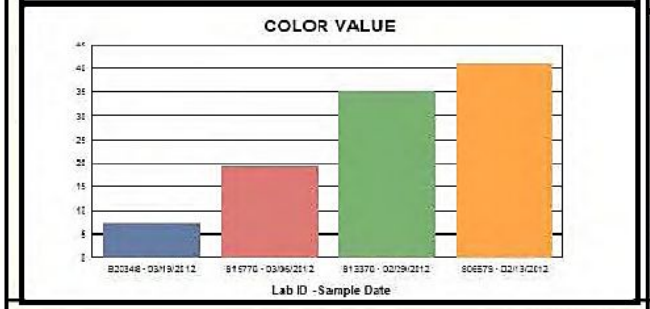
Results:
Immediate drop (inlet vs. outlet) from
UC 5 to 1
MPC 41 to 6

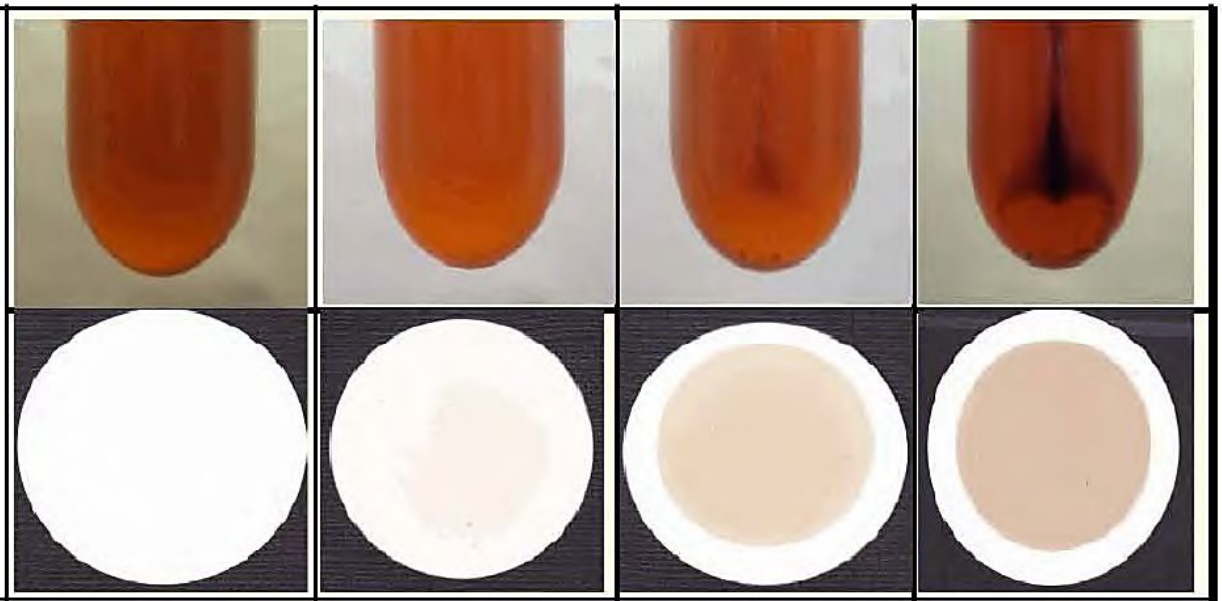




The results







SAMPLE DATE	03/19/2012	03/06/2012	02/29/2012	02/13/2012
LABID	820348	815770	813370	806579
ULTRA CENTRIFUGE TEST				
UC VALUE	1	1	2	5
MEMBRANE PATCH COLORIMETRY				
COLOR VALUE	7	19	35	41
PHYSICAL PROPERTIES				
ACID NUMBER mg KOH/g	0.06	0.06	0.06	0.08
KARL FISCHER WATER ppm	20	10	20	30

Partner ship with OEM's

POWER

[redacted]

www.power.alstom.com

ALSTOM

Februar 04, 2013

C.C.JENSEN BENELUX BV
George J.T. Janssen
Global Segment Manager Power
Marconistraat 7
2809 PH Gouda
Netherlands

Acceptance of VRU for Lube Oil treatment on Alstom Turbines

Dear Mr. Janssen

We herewith confirm that your product VRU 27/108 may be used for the permanent treatment of the lube and control oils on all Alstom Gas and Steam Turbines. Connected to the oil reservoir in "kidney loop" mode it can be operated without limitation with the turbine in operation or shut down.

We are running long term tests with various products. The VRU of C.C.Jensen has shown the best results in removing varnish precursors, continuously keeping the varnish potential at very low level (MPC < 10) and keeping the oxidation in the oil very low.
In addition the use of the VRU has shown to improve the air release property of the lube oil, probably a result of the lower number of fine particles due to the continuous fine filtration.
There have been no negative effects on the oil additives.

We recommend the continuous use of VRUs on Gas Turbine lube/control oils to avoid malfunctions on hydraulic devices and to extend the service life of the oil fillings.

Kind Regards

MITSUBISHI POWER SYSTEMS

CJC Fixed installed on MHI control oil systems in the US

SIEMENS Siemens Industrial Turbomachinery

Dokumentnummer [redacted] Utgåva B

Godkänd av 2013-05-03
Dokumentslag Teknisk rapport
Sekretessklass [redacted]
Datum 2013-04-05
Sida 1 (12)
Utfärdare Mikael Jonsson
Ordernummer
Decimalnummer
UPS/HG
Till [redacted]
Tjänsteställe REK
Kopia till REK
Enbart sida 1 RE

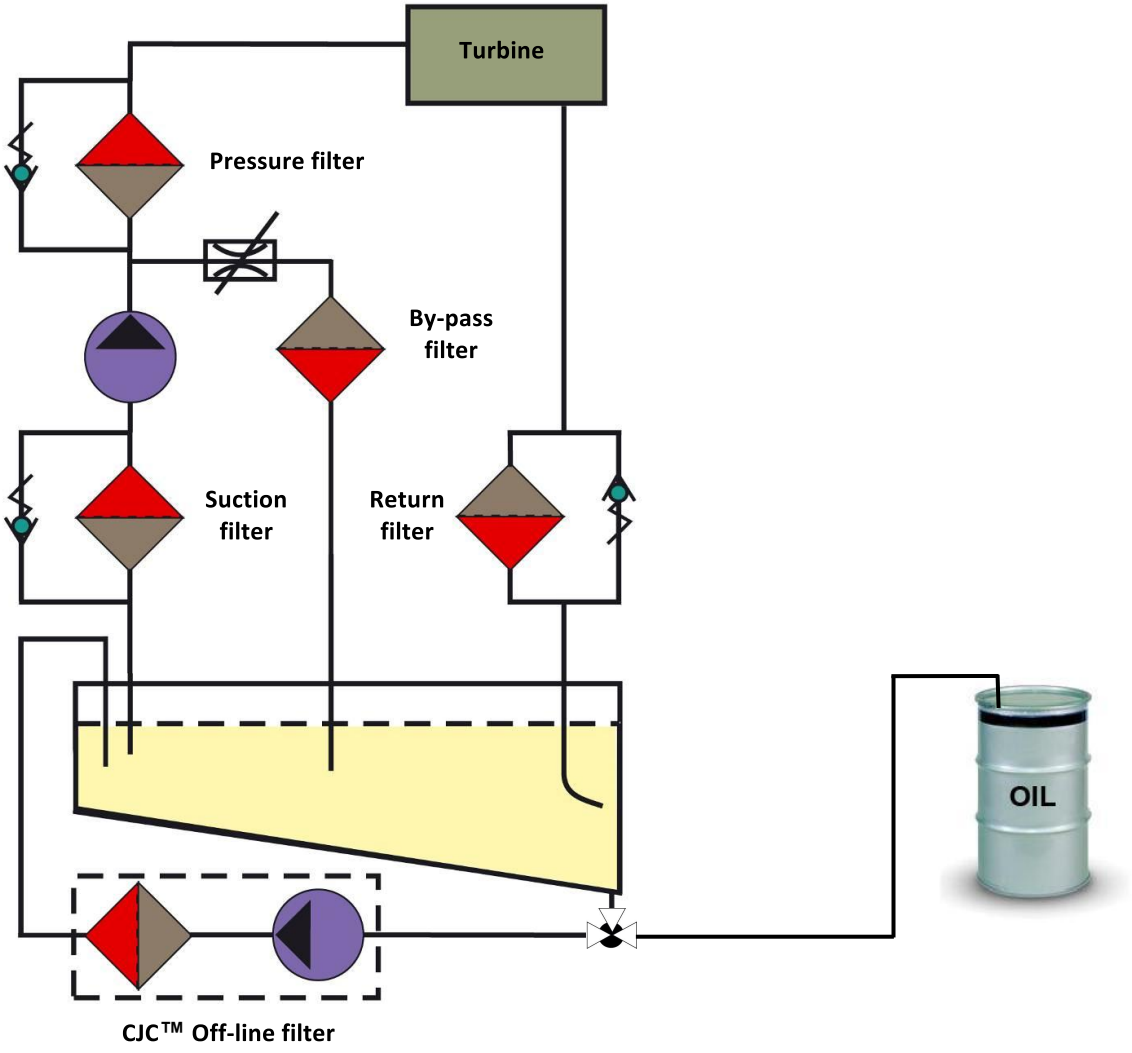
Test av smörjoljerening för SGT-800 på Rya Kraftvärmeverk 2012-2013

Sammanfattning
I samband med upptäckten av höga halter av oxidationsprodukt

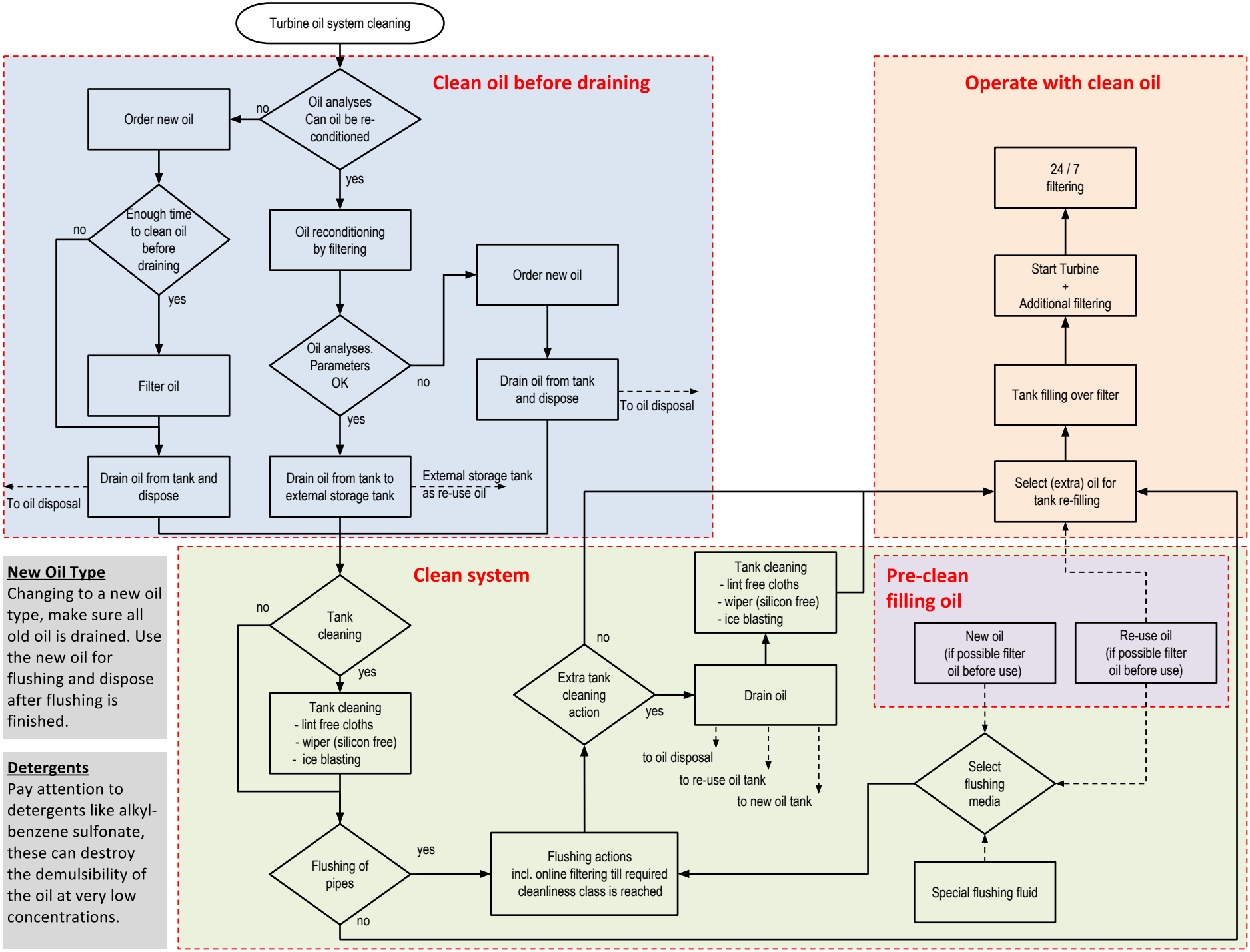
GE Energy

Filter positions in an oil system

Filter positions in an oil system



System Flushing
&
Tank Cleaning


Turbine oil system cleaning
Clean oil before draining
Oil analyses Can oil be re-conditioned
no
Order new oil
yes
Oil reconditioning by filtering
Enough time to clean oil before draining
no
yes
Filter oil
Oil analyses. Parameters OK
no
Order new oil
yes
Drain oil from tank and dispose
To oil disposal
Drain oil from tank to external storage tank
External storage tank as re-use oil
Drain oil from tank and dispose
To oil disposal
Operate with clean oil
24 / 7 filtering
Start Turbine + Additional filtering
Tank filling over filter
Select (extra) oil for tank re-filling
Clean system
Tank cleaning
no
yes
Tank cleaning
- lint free cloths
- wiper (silicon free)
- ice blasting
Flushing of pipes
yes
no
Flushing actions incl. online filtering till required cleanliness class is reached
Extra tank cleaning action
no
yes
Tank cleaning
- lint free cloths
- wiper (silicon free)
- ice blasting
Drain oil
to oil disposal
to re-use oil tank
to new oil tank
Pre-clean filling oil
New oil (if possible filter oil before use)
Re-use oil (if possible filter oil before use)
Select flushing media
Special flushing fluid
New Oil Type
Changing to a new oil type, make sure all old oil is drained. Use the new oil for flushing and dispose after flushing is finished.
Detergents
Pay attention to detergents like alkyl-benzene sulfonate, these can destroy the demulsibility of the oil at very low concentrations.

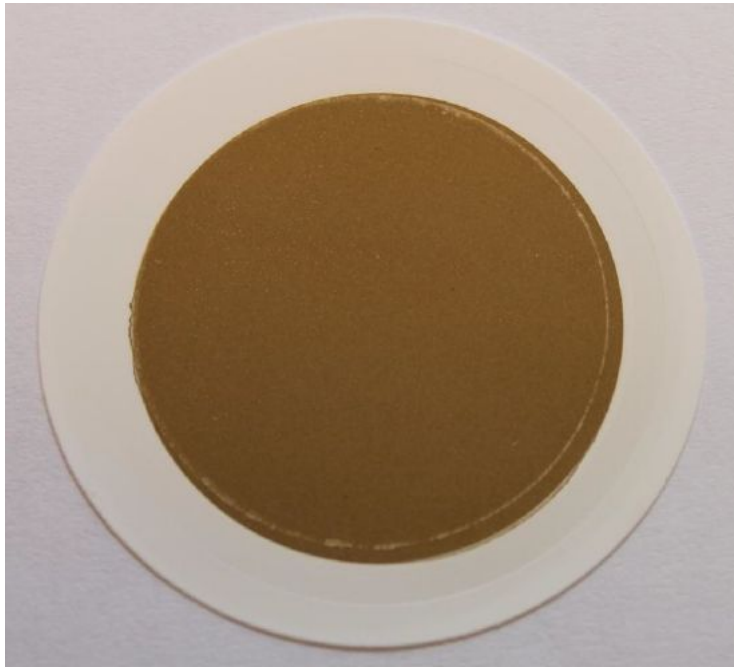
Field example: Power Station Salzburg, Austria

Problem:
Sticking valves during startup after summer period

Alstom GT8C2
Oil Type: Shell Turbo CC46, 30,000 liter
MPC level: 55

Salzburg AG Varnish on valves

Salzburg AG Start-up



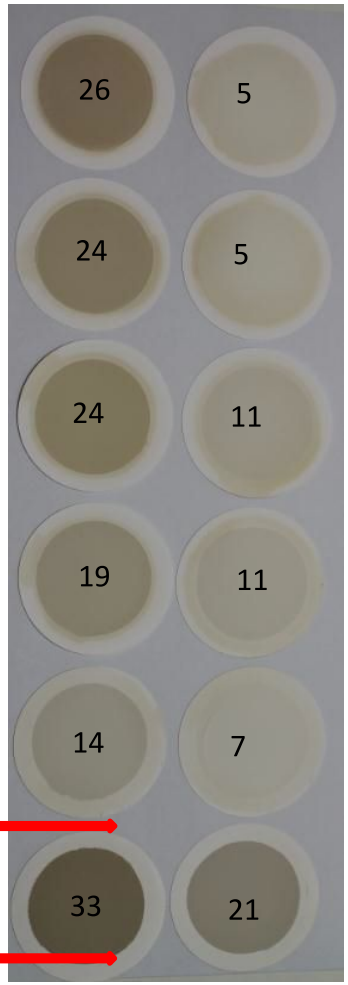
Initial MPC level of 55

Inlet Outlet

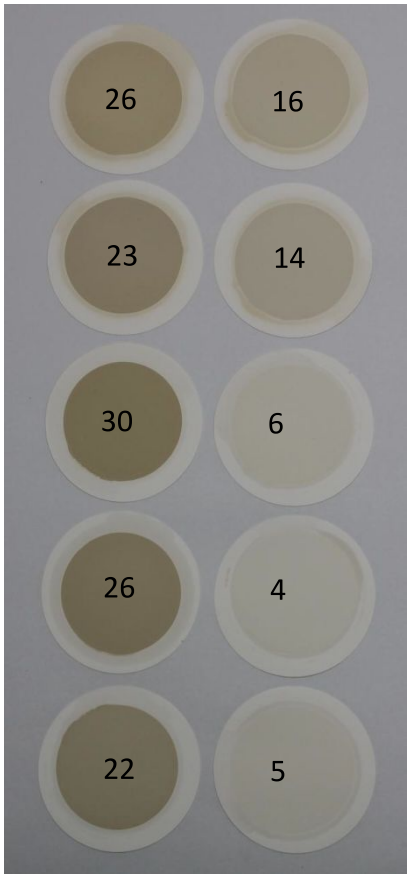
Visual inspection of oil sample 1,
July 26th, 2012.

Initial oil sample May 2012

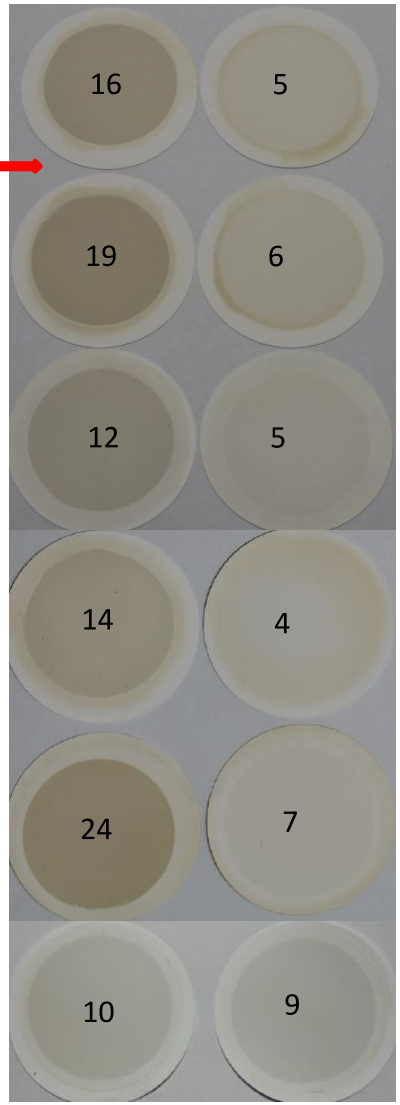
Inlet Outlet



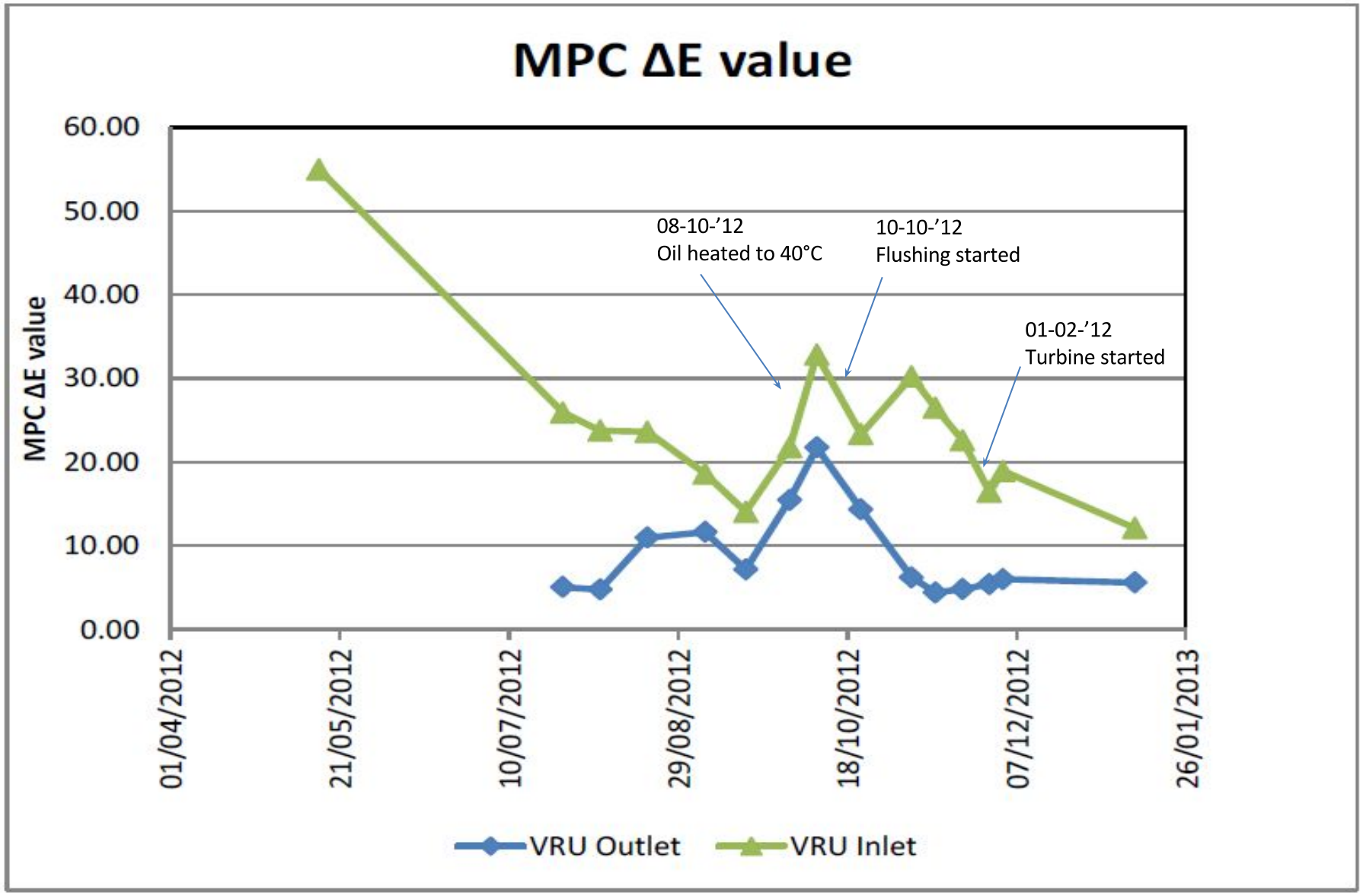
Inlet Outlet



Inlet Outlet

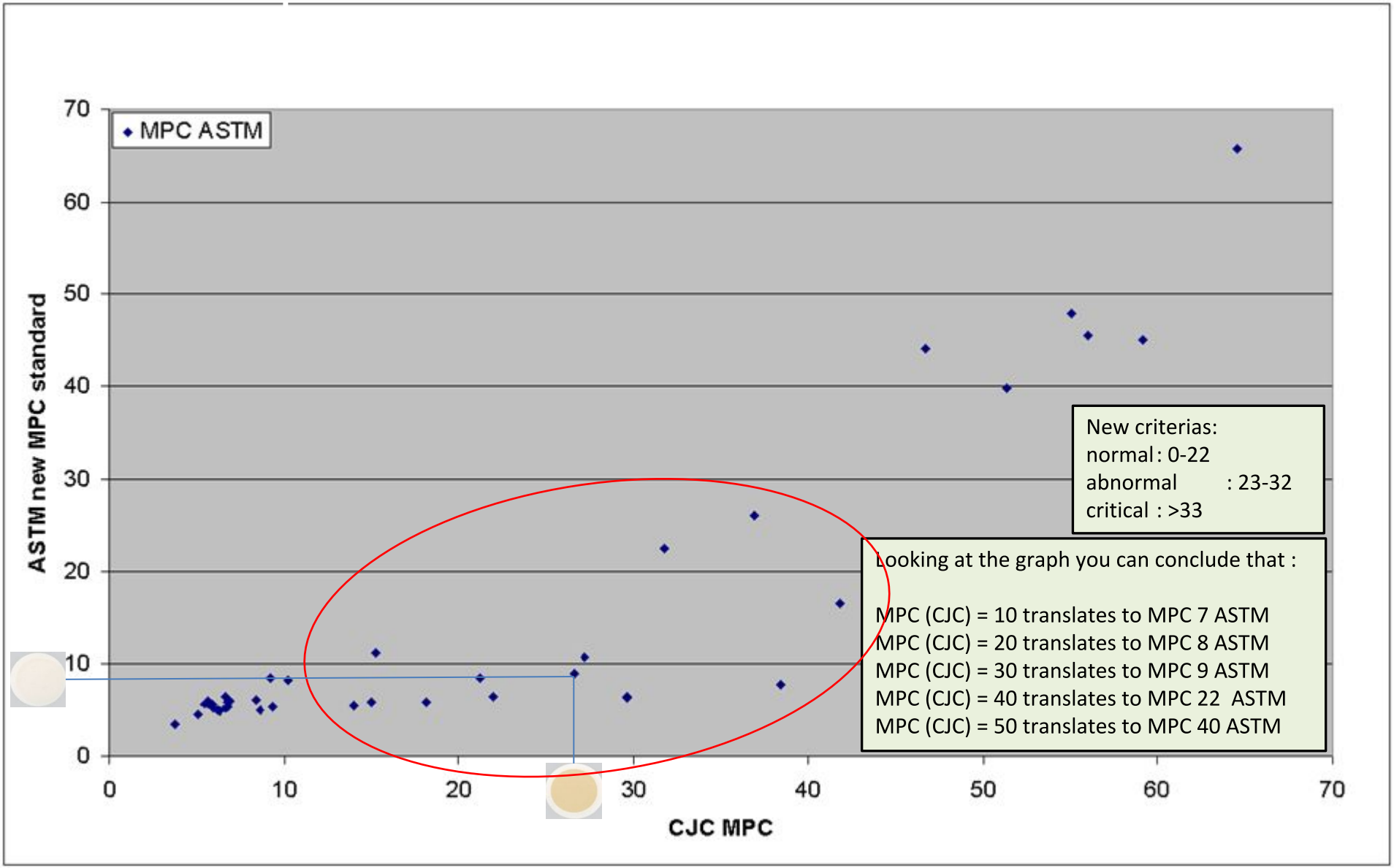


Initial oil sample


MPC ΔE value
60.00
50.00
40.00
30.00
20.00
10.00
0.00
MPC ΔE value
08-10-'12
Oil heated to 40°C
10-10-'12
Flushing started
01-02-'12
Turbine started
01/04/2012
21/05/2012
10/07/2012
29/08/2012
18/10/2012
07/12/2012
26/01/2013
VRU Outlet
VRU Inlet

Some final comments

ASTM MPC values vs. CCJ MPC values



We don’t need filtration, we drain the oil !

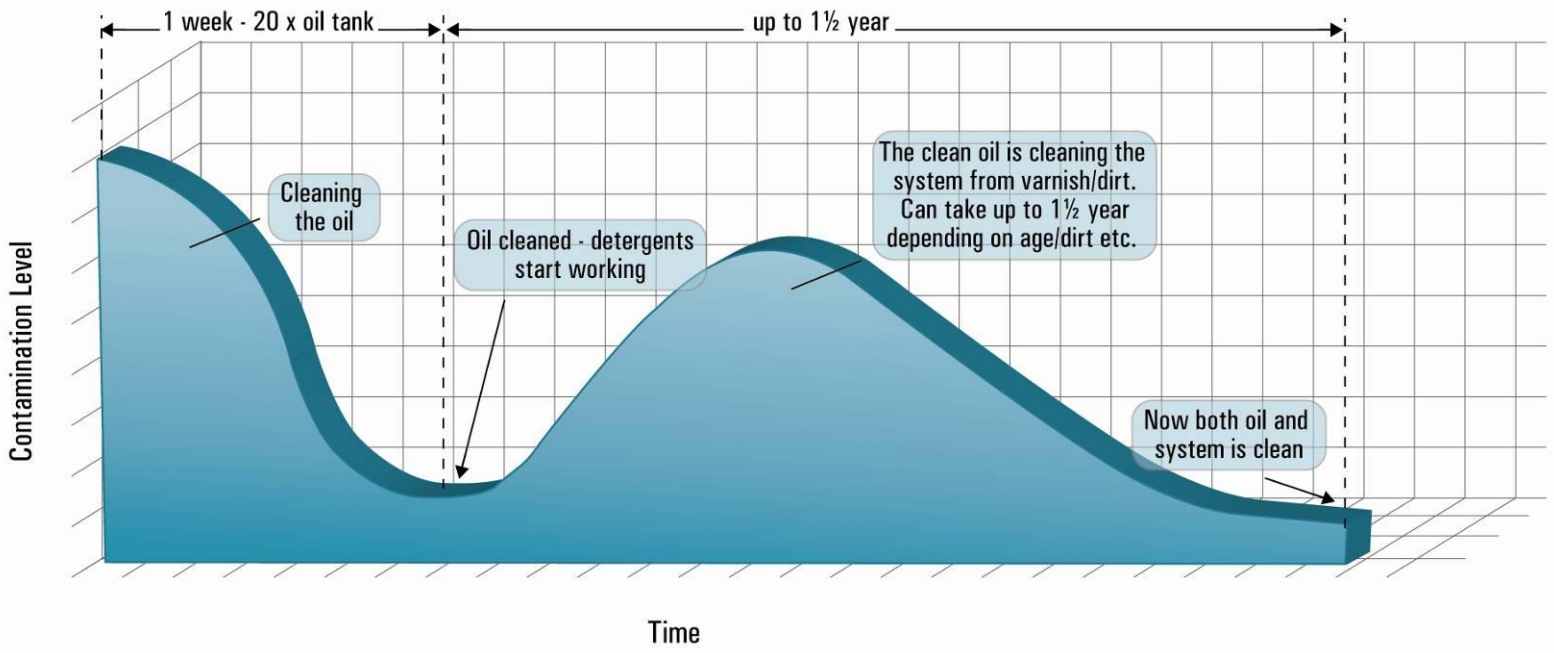
Or Not?

Just replace the oil?

We want Mobile Equipment

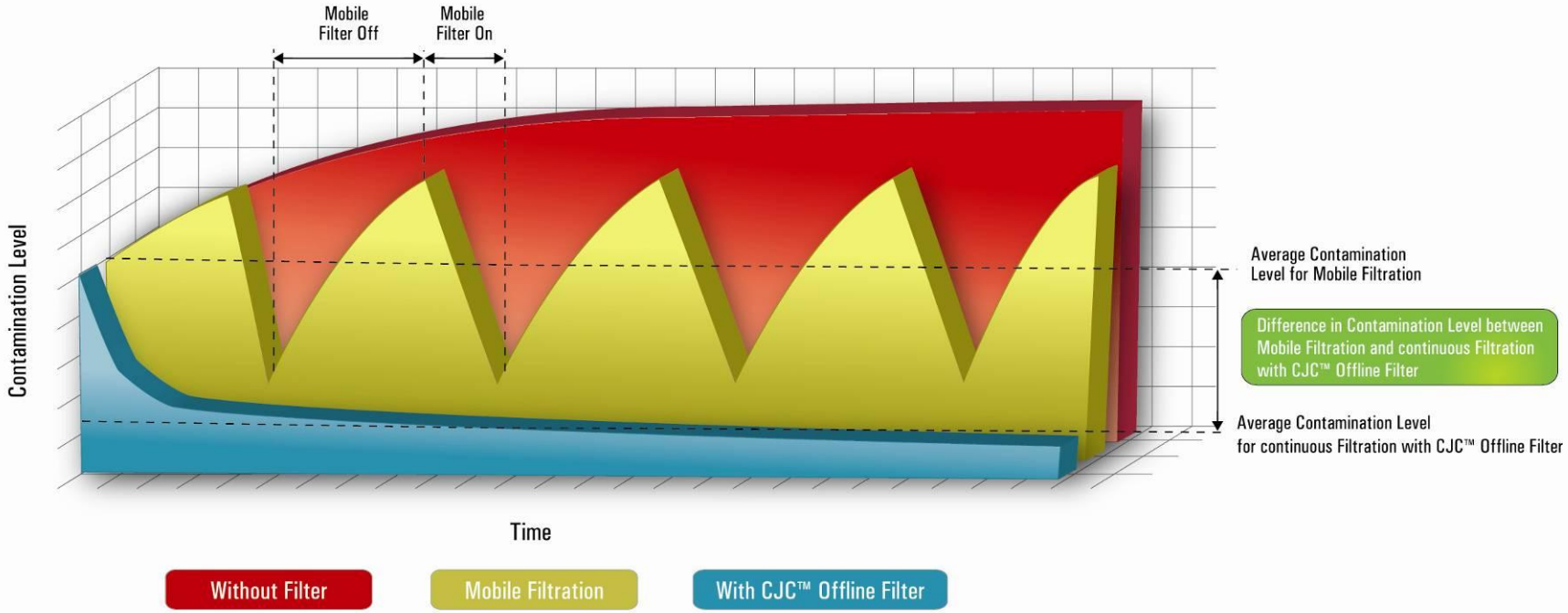
Or Not?

We move from turbine to turbine, or not ?



We move from turbine to turbine, or not ?

The customer decides, but...



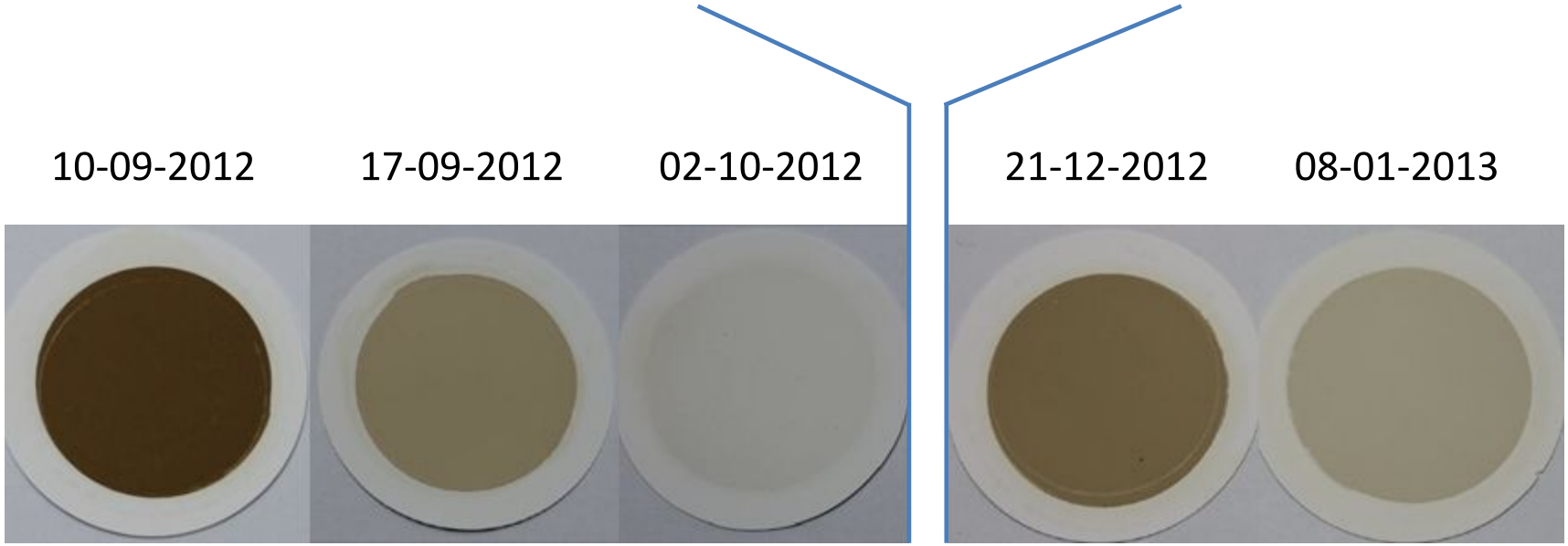
Mobile Equipment

Sure?


AIR
PRODUCTS
VRU - Varnish Removal Unit on
Air Compressor Turbine DEMAG AR350-7V-3
13,000 liter Shell Turbo T 32

The results

Customer stopped using the VRU for 2 months
(Don't use mobile equipment)



MPC Value:	61	29	5	39	19

Different types of varnish

We move from turbine to turbine, or not ?

Klantnummer
[redacted]

Referentie machine [redacted] **er Gasturbine 12 -**
Gasturbine 12
Siemens
V64-3
Mobil DTE 832
Hoeveelheid 13.000 L

VRU Disconnected
VRU Installed
VRU in operation

	G1687	G1607	G1520	G1341	G908
	!	✓	✓	!	!
Productnummer	Mobil DTE 832	Mobil DTE 832	Mobil DTE 832	Mobil DTE 832	!Teresso GT EP 32
Staalname	30/01/2013		31/10/2012	5/09/2012	3/12/2011
Kleur [-] ASTM-D1500	6,5			6,5	6,5
Visueel aspect [-] Intern	helder			helder	helder
Watergehalte (Karl Fischer) [ppm] ASTM-D6304	11			48	32
Kinematische Viscositeit @40°C [mm²/s] ASTM-D445	31,09			30,94	34,66
Zuurtegraad (AN) [mg KOH/g] ASTM-D664	0,09			0,06	0,12
FT-IR Oxidatie [A/cm] DIN 51451	< 1,0			< 1,0	< 1,0
Demulsibiliteit [sec] IP19	310			325	282
Schuim - Sequentie I [mL / mL] ASTM-D892	250/0			310/0	560 / 0
Microfiltratie 0.45 µm [mg/100 mL] ASTM-D4898	4,8			6,4	19,6
Luchtafscheidendvermogen [min.] DIN ISO 9120	1,0			1,0	1,0
Aminisch antioxidant [%] ASTM-D6971	88.0			112.4	6.9
Fenolisch antioxidant [%] ASTM-D6971	61.6			57	0
MPC - Index (Delta E) [None] ASTM-D7843	12,30	6,10	4,10	21,00	26,30
MPC - a (roodwaarde) [None] ASTM-D7843	-0.6	-0.6	-1.0	-0.7	-1.0
MPC - b (geelwaarde) [None] ASTM-D7843	3.5	0.3	0.7	9.6	8.7
MPC - Luminescentie [None] ASTM-D7843	88	94	96	81	75
Aantal deeltjes (>4 µm) [#/mL] ISO 4406-2	55.718,000	424,250	574,250	35.130,000	2.175,000
Aantal deeltjes (>6 µm) [#/mL] ISO 4406-2	33.511,000	172,870	205,380	14.730,000	282,000
Aantal deeltjes (>14 µm) [#/mL] ISO 4406-2	2.736,200	28,375	20,125	394,500	16,000
Aantal deeltjes (>21 µm) [#/mL] ISO 4406-2	214,630	7,500	3,750		
Automatische Deeltjestelling - ISO [Class] ISO 4406-2	23/22/19	16/15/12	16/15/12	22/21/16	18/15/11

Mobile equipment will not give you:

- A Clean system
- A Lifetime improvement of components
- A Lifetime improvement of oil
- An operational improvement of your turbine

We move from turbine to turbine, or not ?

DATOS DE LA MUESTRA

Ref.: FKB-B-S99.1
Descrip.:
Marca: TGA GE FRAME6B EVOL.43MW Modelo: N. Serie:
Ref. Muestra: 26/04/2012-710194 Etiqueta aceite: LAB30117 Fecha toma: 23/03/2012
Aceite: MOBIL.DTE.832 S/Ref. : Fecha recepción: 19/04/2012
Serv. Máquina: Serv. aceite: Añadidos (l): Capac. (l):

DIAGNÓSTICO DE LA MUESTRA

La viscosidad y la acidez del aceite están dentro de los límites de recomendación del fabricante.
CONTAMINACIÓN: El contenido en agua es correcto.
El contaje de partículas está dentro del nivel de recomendación del fabricante.
No se observa la presencia de resinas. Datos: Fecha muestreo-23.03.2012, TG-A, Turbina de Gas, GE 6FB Evolution de 43MW, 6500 L, con HDU 27/81 MZ (1260 l/h) Prod.No. 2044650101 + VRU 27/108 PV (60 l/h) Prod.No. 1.

RESULTADOS

Especificación	Metodología	Recomendación	Resultado
Contaje de partículas			
ISO 4406/99	(PE-5083-AI)	17/15/12	16/14/10
	Part > 4 micras	<130.000	60220
	Part > 6 micras	<32.000	8710
	Part > 14 micras	<4.000	990
NAS1638	(PE-5083-AI)	<5	5
Contenido en agua	(ASTM D 6304-07Proc. A)	<300 ppm	46
Estado del lubricante			
Aspecto (Adim)	(PE-TA.096)	Transparente	Oscuro
Nitración (ABS/cm)	(PE-TA.071)	10	< 1
Oxidación (ABS/cm)	(PE-TA.071)	10	1
Acidez			
TAN (mgr KOH/gr)	(ASTM D 974-12)		0.13
Viscosidad			
a 40° C (cst)	(ASTM D 445-12)	+/- 10%	32.9

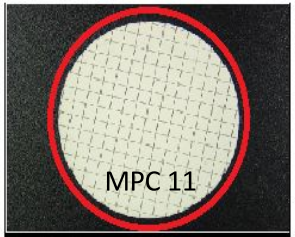


Imagen del filtro

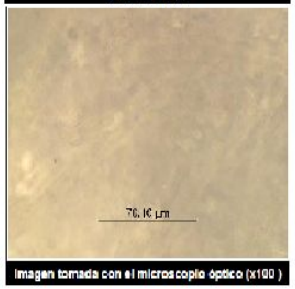


Imagen tomada con el microscopio óptico (x100)

AFTER 6 MONTHS
WITH FILTRATION

and then

DATOS DE LA MUESTRA

Ref.: FKB-B-S99.1
Descrip.:
Marca: TGA GE FRAME6B EVOL.43MW Modelo: N. Serie:
Ref. Muestra: 25/09/2012-738786 Etiqueta aceite: LAB30265 Fecha toma: 06/09/2012
Aceite: MOBIL.DTE.832 S/Ref. : Fecha recepción: 19/09/2012
Serv. Máquina: Serv. aceite: Añadidos (l): Capac. (l):

DIAGNÓSTICO DE LA MUESTRA

La viscosidad y la acidez del aceite están dentro de los límites de recomendación del fabricante.
CONTAMINACIÓN: El contenido en agua es correcto.
El aceite presenta un alto contenido en partículas.
Se observa la presencia de resinas. Datos: Fecha muestreo-06.09.12, TG-A, Turbina de Gas, GE 6FB Evolution de 43 MW, Mobil DTE 832, 6500 L, con HDU 27/81 MZ (1260 L/h) Prod. Nº. 2044650101.

RESULTADOS

Especificación	Metodología	Recomendación	Resultado
Contaje de partículas			
ISO 4406/99	(PE-5083-AI)	17/15/12	22/20/17
	Part > 4 micras	<130.000	3909550
	Part > 6 micras	<32.000	887770
	Part > 14 micras	<4.000	93450
NAS1638	(PE-5083-AI)	<5	11
Contenido en agua	(ASTM D 6304-07Proc. A)	<300 ppm	58
Estado del lubricante			
Aspecto (Adim)	(PE-TA.096)	Transparente	Transp. Oscuro
Nitración (ABS/cm)	(PE-TA.071)	10	1
Oxidación (ABS/cm)	(PE-TA.071)	10	1
Acidez			
TAN (mgr KOH/gr)	(ASTM D 974-12)		0.15
Viscosidad			
a 40° C (cst)	(ASTM D 445-12)	+/- 10%	33

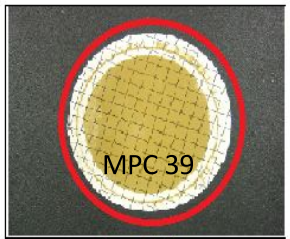


Imagen del filtro

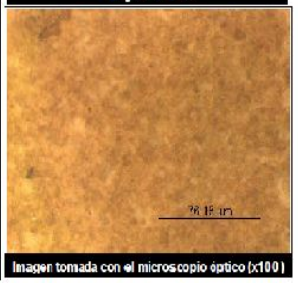


Imagen tomada con el microscopio óptico (x100)

AFTER 6 MONTHS
WITHOUT FILTRATION

Additional comments

Filtration is more than just installing a filter

Together we can innovate

- Plant surveys
  - Mapping all oil systems incl. sampling point positions
  - History (components, oil analyses, oil changes ….)
  - Define critical systems incl. risk/cost evaluation
  - Waste management

- CCJ has great scientists
- Special build In-house test centre
- Many lab tests
- Test centre for oil suppliers

BUT MOST IMPORTANT

Sharing knowledge visa versa about **field experiences** (oil and system performances, costs & benefits)

Thank you for your participation !

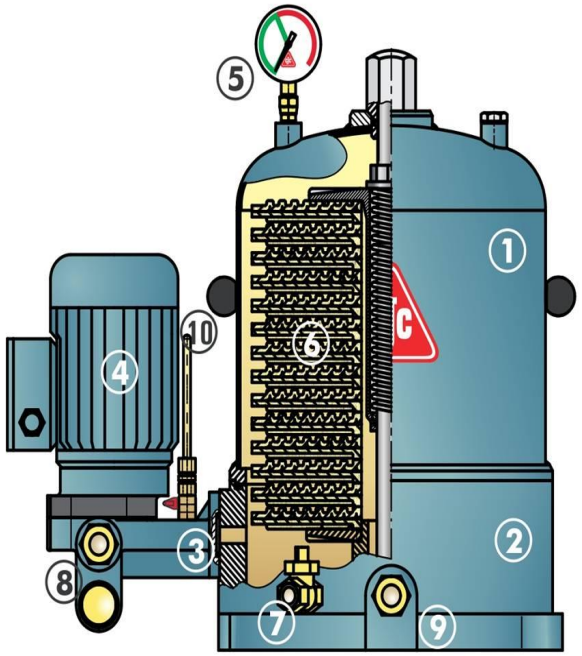
CJC™ Filtration Techniques

CJC™ Fine Filter "HDU" and "PTU"

Condensation water and sporadic small amounts of water ingress

Main Components
HDU 27/- Series

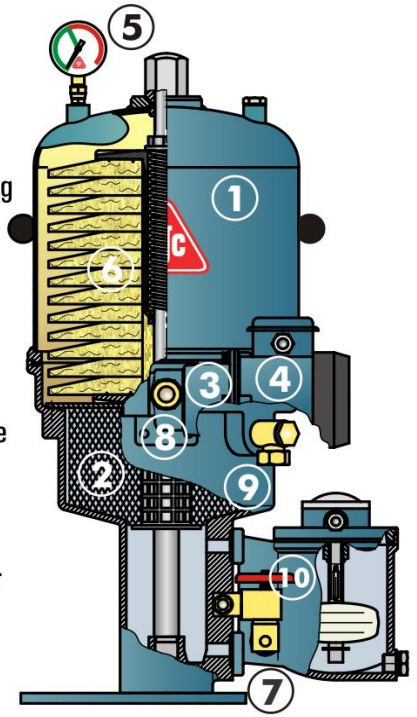
1. Filter housing
2. Filter base
3. Pump
4. E-motor
5. Pressure gauge
6. Filter insert
7. Drain valve
8. Oil inlet
9. Oil outlet
10. Sampling point



Continuous water ingress or sporadic large amounts of water ingress

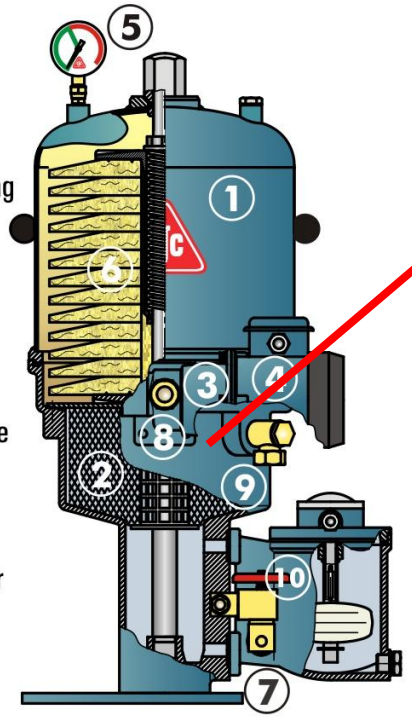
Main Components
PTU2 27/27 Series

1. Filter housing
2. Coalescer housing
3. Pump
4. E-motor
5. Pressure gauge
6. Filter insert
7. Water drain valve
8. Oil inlet
9. Oil outlet
10. Water discharger

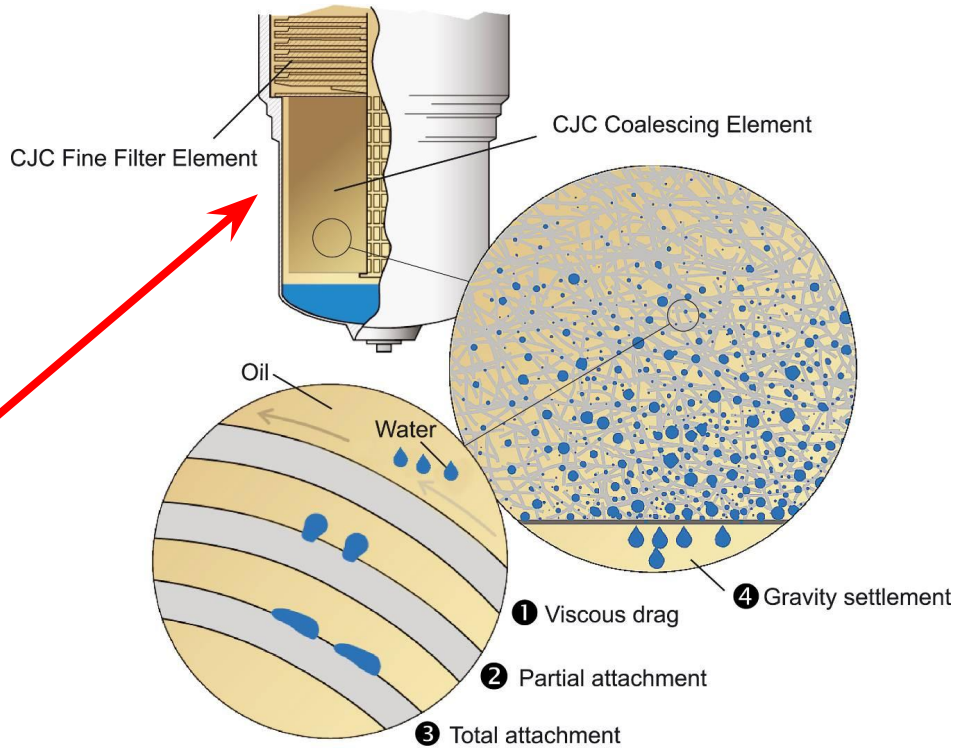


CJC™ Fine Filter Separator "PTU"

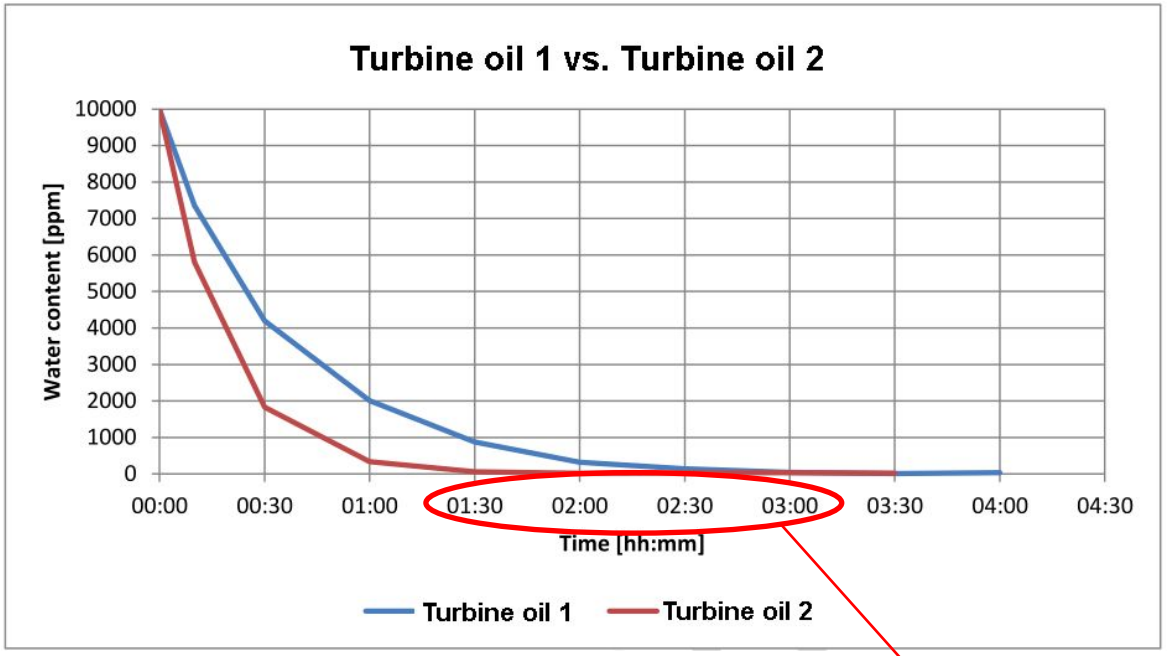
Main Components
PTU2 27/27 Series

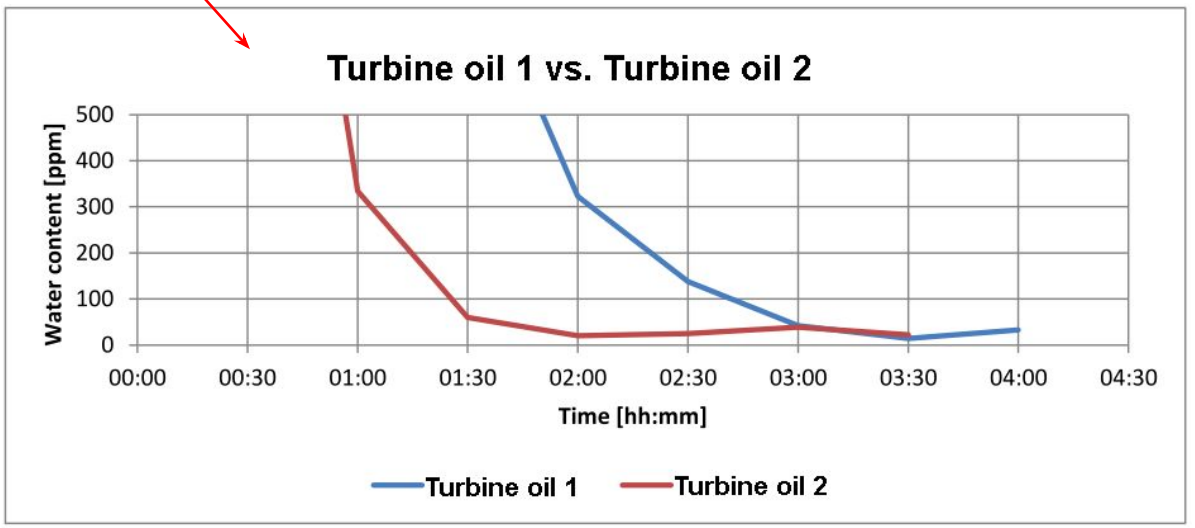


1. Filter housing
2. Coalescer housing
3. Pump
4. E-motor
5. Pressure gauge
6. Filter insert
7. Water drain valve
8. Oil inlet
9. Oil outlet
10. Water discharger



Water removal efficiency



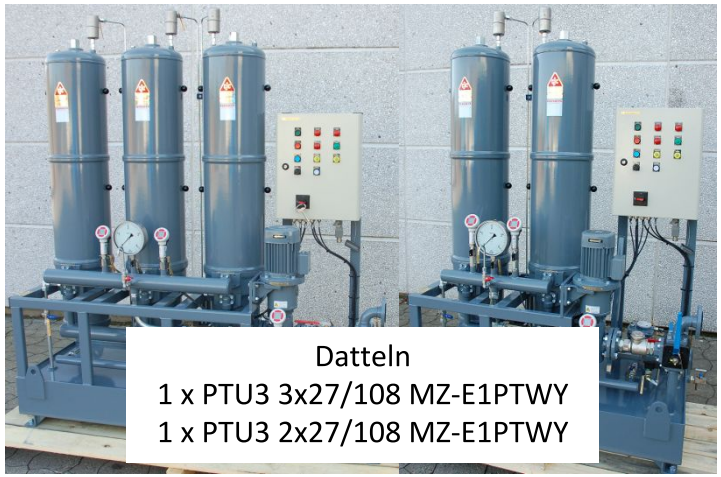


Water removal efficiency

The water removal efficiency is influenced by :

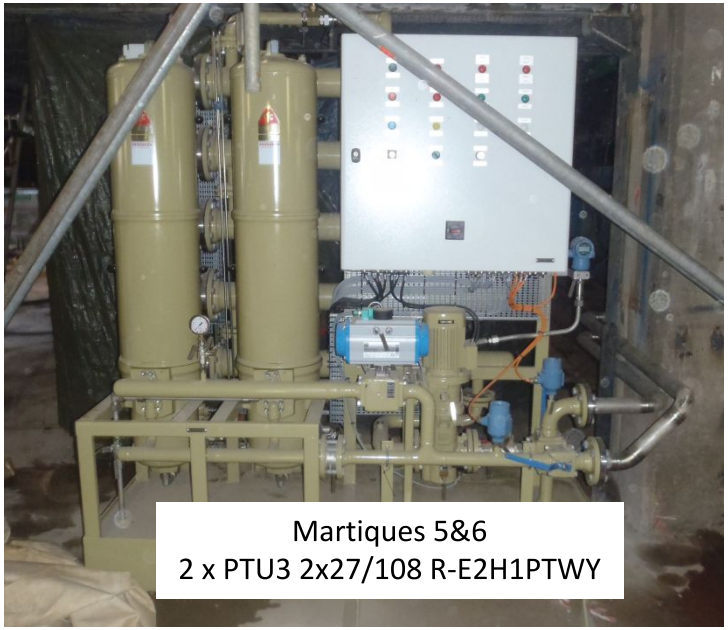
- Interfacial tension
- Additive depletion
- Oil oxidization
- Temperature
- Type of inline pumps
- System and tank design

CJC™ Fine Filter Separator "PTU"

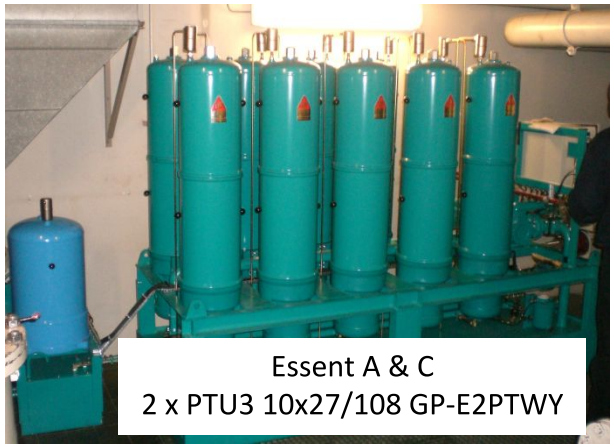


Datteln
1 x PTU3 3x27/108 MZ-E1PTWY
1 x PTU3 2x27/108 MZ-E1PTWY

Venezuela Power
6 x PTU3 10x27/108 GP-E2PTWY



Martiques 5&6
2 x PTU3 2x27/108 R-E2H1PTWY



Essent A & C
2 x PTU3 10x27/108 GP-E2PTWY

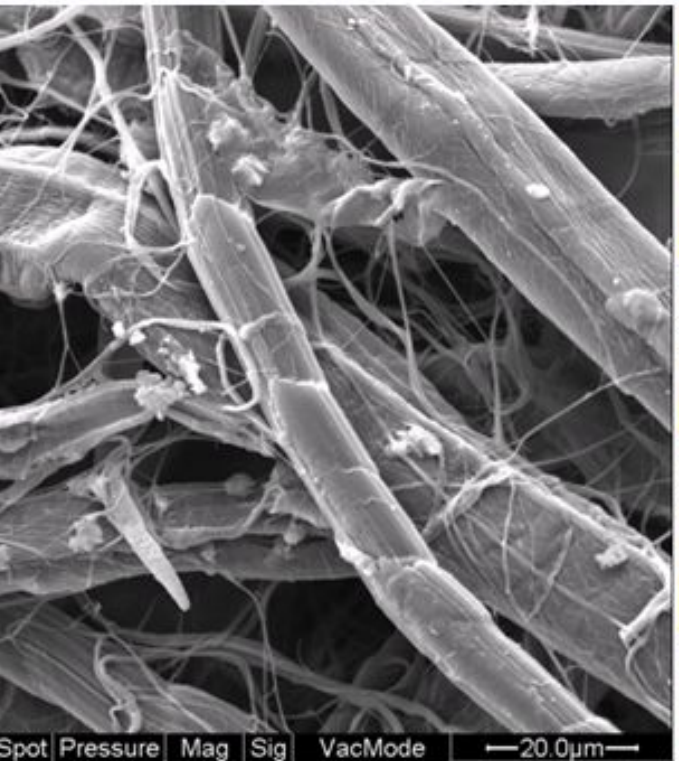
Czestochowa
1 x PTU3 27/108 MZ-E1H1PTWY

Manjung 1 & 2 & 3
3 x PTU3 8x27/108 GP-E2H1PTWY

Facts and figures

The VRi insert

- Super absorbent sub-micron cellulose fibers with extreme affinity for varnish.
- Design made of high filter media surface and volume.
- Non chemical process, with no impact on additives or chemical oil properties.
- Long term anti oxidation properties

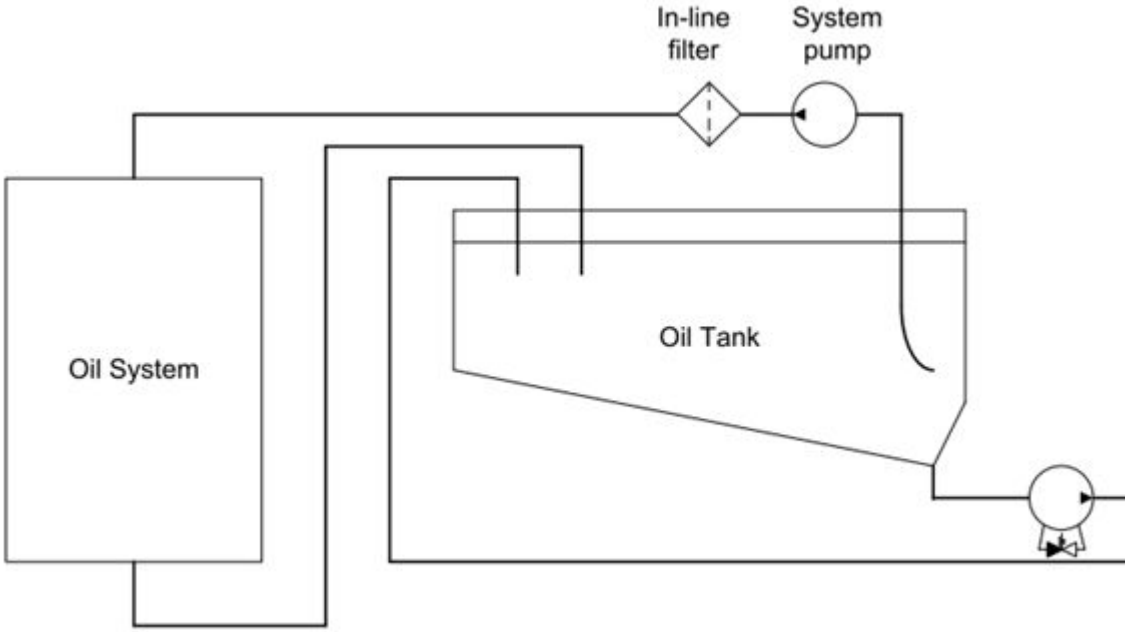


Facts and figures

- Extraordinary high efficiency at HOT and/or COLD turbine oil
- 4 in 1 solution: Removes Varnish - Particles – Moisture and maintain low acid values all in one single pass
- No adjustments of the inserts to the oil type, it just removes ALL oxidation products
- See when your inserts are saturated
- Removes dissolved water to a low degree
- Absorbs huge amounts of water and give a warning when water leakage in your turbine occur
- VRU does a non chemical oil treatment to make dissolved contaminants precipitate and come out of solution.
- Improves the demulsibility, the air release and foam

Facts and figures

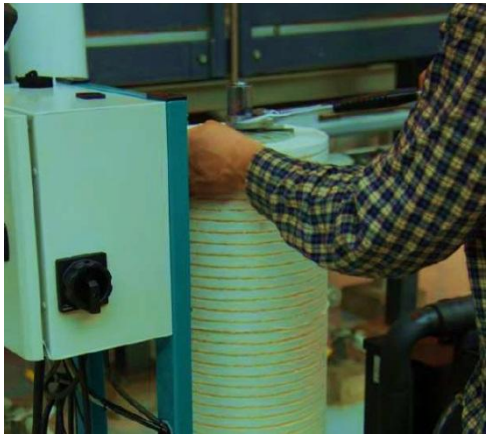
- Installation can be done during operation of the turbine
- The VRU is designed to work 24/7
- Simple and intelligent equipment - > safe and reliable operation of your turbine



How to change your inserts

How to change your inserts

Use a pump for easy, quick and clean oil drain



Where does the oxidation products go?

VRU vs. Electrostatic

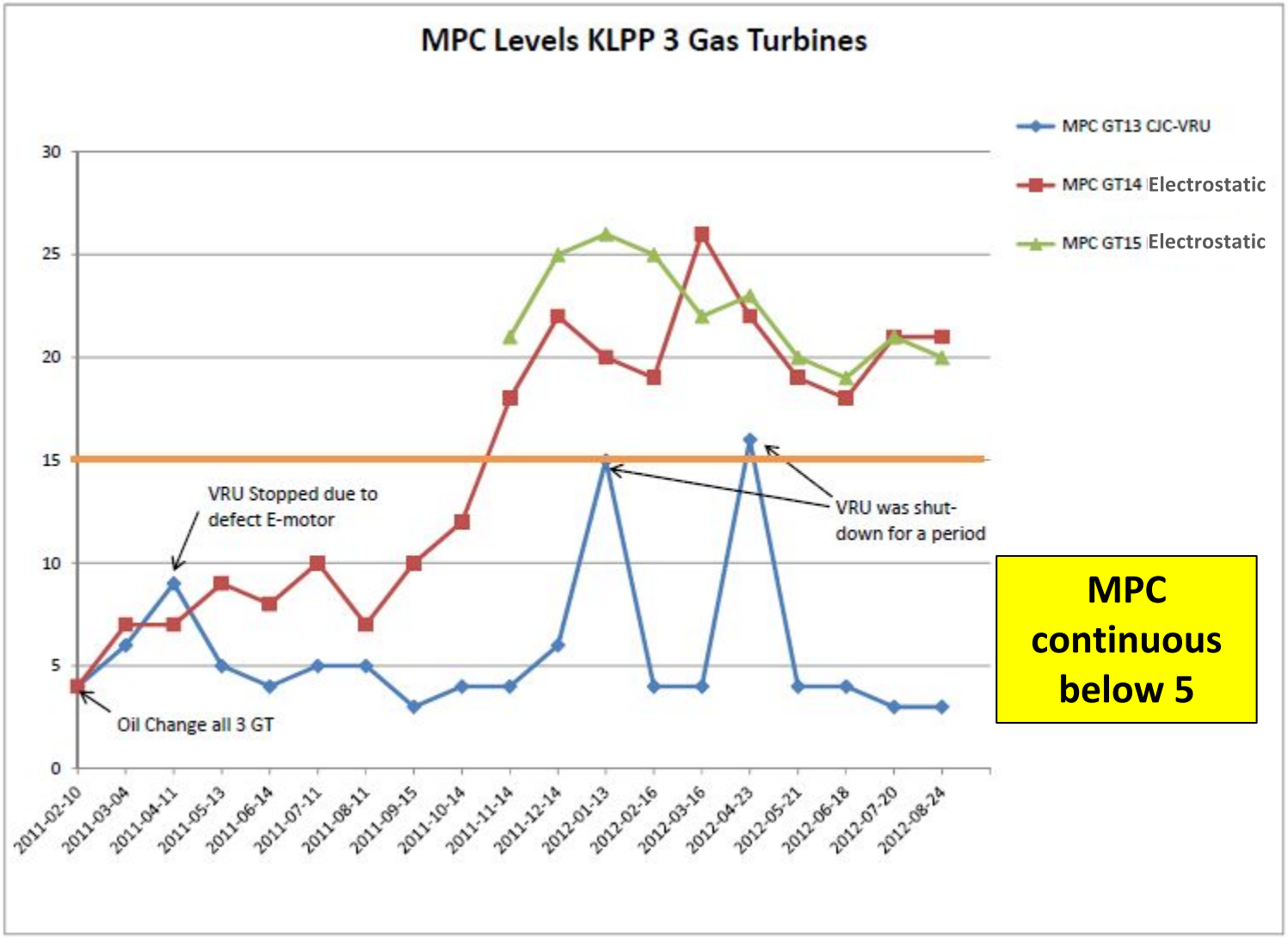
Kuala Langat Power Plant, Malaysia

Problem: Too high MPC level

Question from Alstom:
Can we test electrostatic vs. depth media filtration

Alstom 3x GT13E2M
Regal R&O 46
20.000 liter
MPC level: >40

VRU versus Electrostatic



MPC continuous below 5

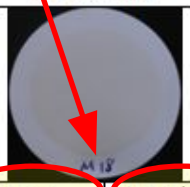
VRU - Varnish Removal Unit on
GE 9FB (250 MW) – 17.000 liters Repsol Turbo CC 32 at
Iberdrola Arcos de la Frontera, Cadiz, Spain

The problem:
MOOG servo valve sticking and mal function due to varnish

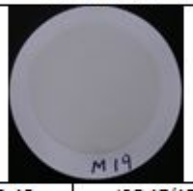

The solution:
CJC VRU – Varnish Removal Unit

The results: MPC reduction from 37 to 15 within 40 days

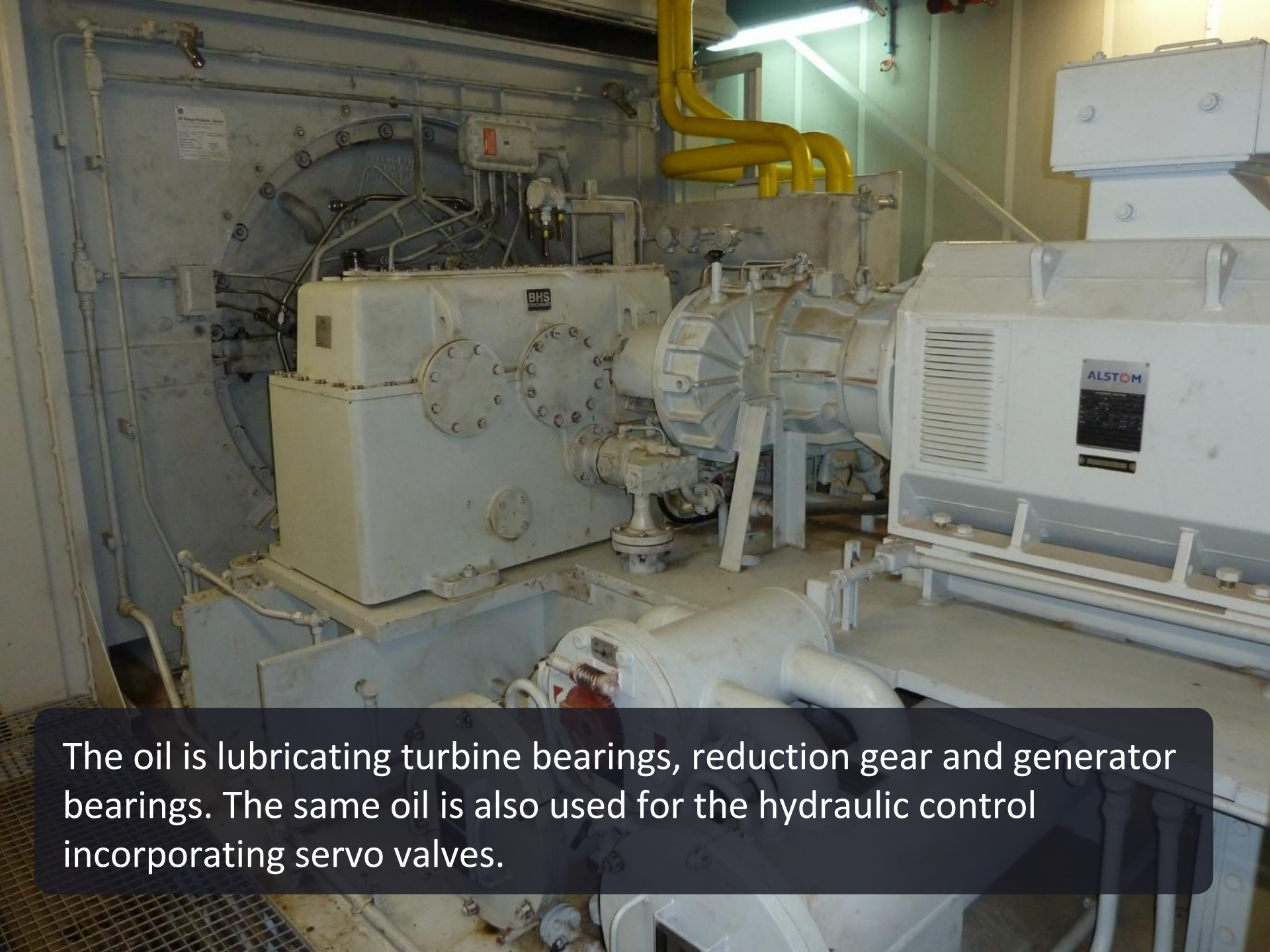
ELIMINACIÓN DE BARNICES SISTEMA LUBRICACIÓN TG3 CC ARCOS 3

FECHA MUESTREO	DÍAS	ENTRADA VRU		SALIDA VRU	
30/03/2012	1	110127-1-M1 		110127-1-M2 	
		MPC=37	ISO 21/20/18	MPC=15	
13/04/2012	16	110127-1-M5 		110127-1-M7 	
		MPC=30	ISO 21/20/18	MPC=14	
20/04/2012	23	110127-1-M9 		110127-1-M11 	
		MPC=24	ISO 21/20/17	MPC=17	ISO 21/19/15
27/04/2012	30	110127-1-M13 		110127-1-M14 	
		MPC=16	ISO 21/20/18	MPC=13	ISO 21/20/17
04/05/2012	37	110127-1-M17 		110127-1-M18 	
		MPC=16	ISO 18/15/11	MPC=12	ISO 17/15/11

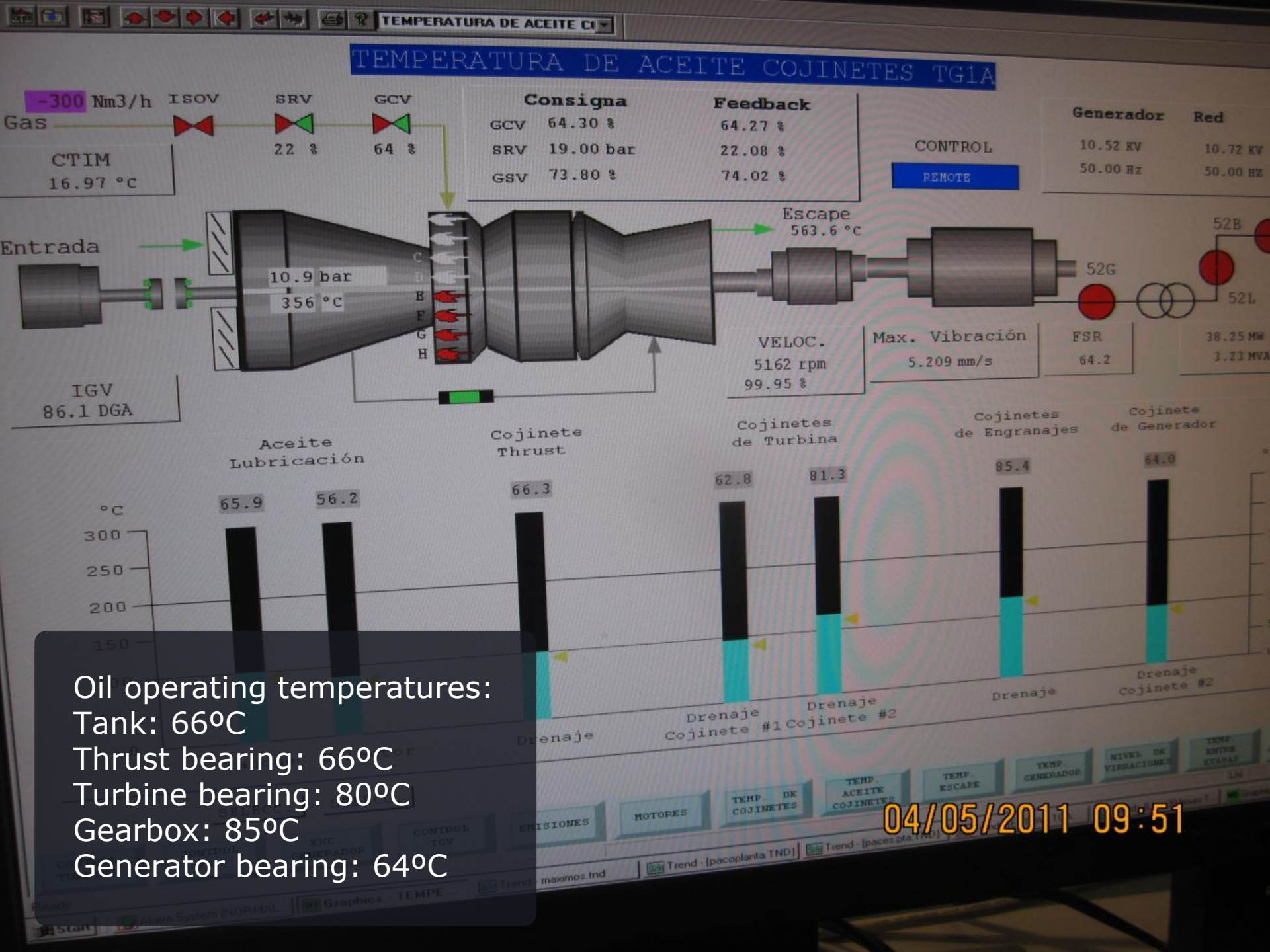
ELIMINACIÓN DE BARNICES SISTEMA LUBRICACIÓN TG4 CC ARCOS 3

FECHA	DÍAS	ENTRADA VRU		SALIDA VRU	
30/03/2012	1	110127-1-M3 		110127-1-M4 	
		MPC=37	ISO 21/20/18	MPC=21	
13/04/2012	16	110127-1-M6 		110127-1-M8 	
		MPC=42	ISO 21/20/18	MPC=20	
20/04/2012	23	110127-1-M10 		110127-1-M12 	
		MPC=28	ISO 21/20/16	MPC=15	ISO 21/20/18
27/04/2012	30	110127-1-M15 		110127-1-M16 	
		MPC=23	ISO 21/19/16	MPC=15	ISO 20/19/15
10/05/2012	40	110127-1-M19 		110127-1-M20 	
		MPC=15	ISO 17/15/11	MPC=12	ISO 17/14/11

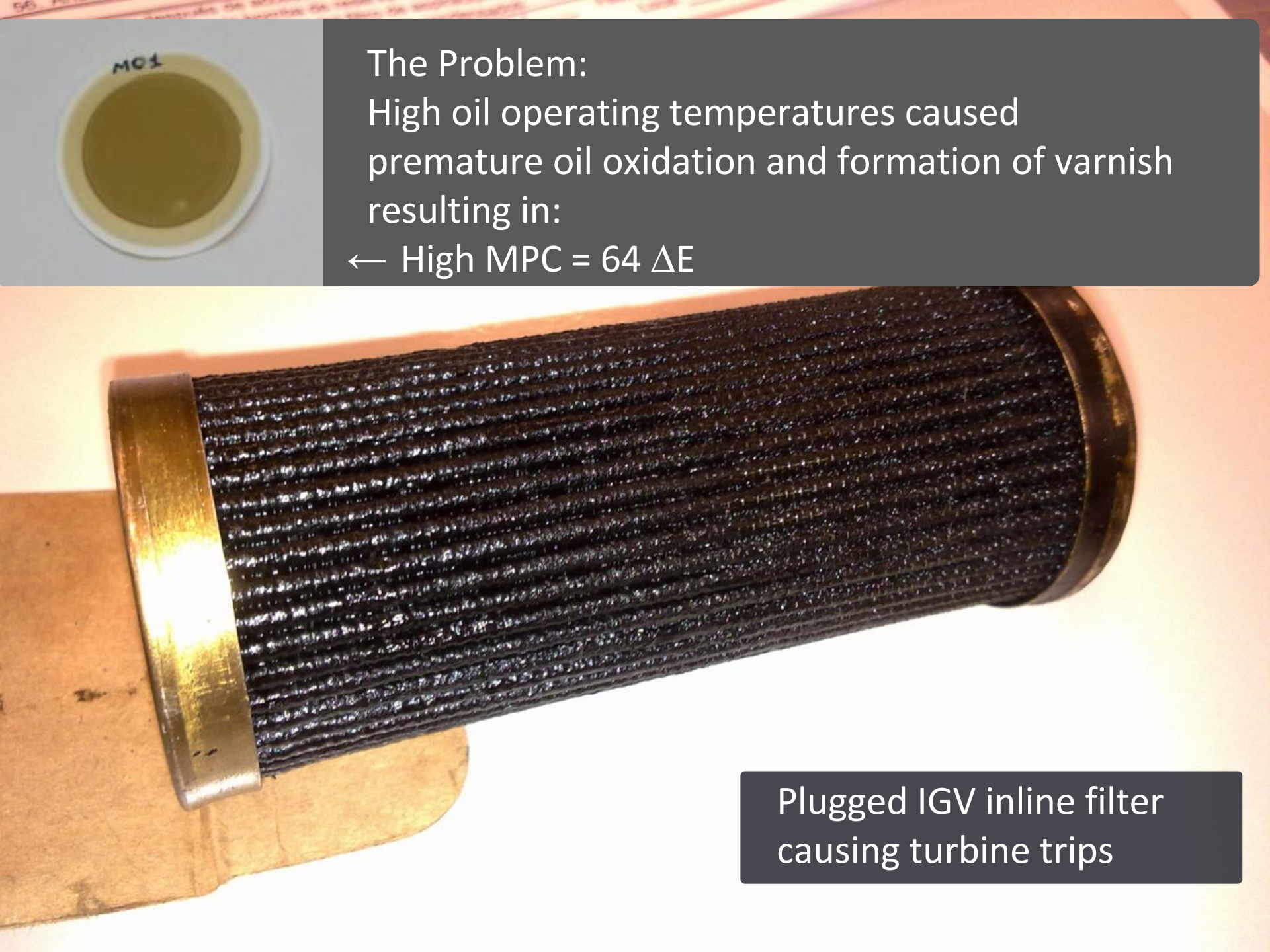
VRU - Varnish Removal Unit on
GE 6B (42MW) gas turbine – 6.500 litres Mobil DTE 832 at Iberdrola Energyworks Cartagena, (SABIC) Spain



The oil is lubricating turbine bearings, reduction gear and generator bearings. The same oil is also used for the hydraulic control incorporating servo valves.



Oil operating temperatures:
Tank: 66ºC
Thrust bearing: 66ºC
Turbine bearing: 80ºC
Gearbox: 85ºC
Generator bearing: 64ºC



The Problem:
High oil operating temperatures caused premature oil oxidation and formation of varnish resulting in:
← High MPC = 64 ΔE

Plugged IGV inline filter causing turbine trips

VRU – Varnish Removal Unit
Installed at Energyworks Cartagena


The result:
VRi – Varnish Removal inserts
after 5 days of VRU operation.

The results

Oil samples taken at the VRU inlet vs. outlet

MPC membranes (0,45 µm)
Samples taken during first month of VRU operation.

Starting MPC:	55 ΔE
After 1 month MPC:	15 ΔE


The result:
IGV inline filter
before VRU operation vs. after 6 month VRU operation

Phosphate Esters

What is a phosphate ester oil?

A synthetic, fire resistant lubrication fluid, for high pressures and hot sections

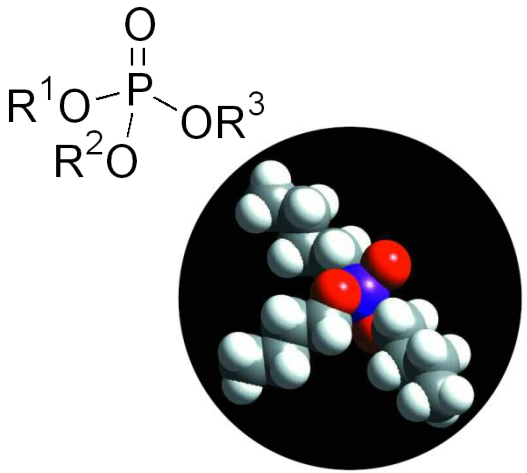
Often used in hydraulic control systems e.g. steam turbines nuclear power plant)

Why the use?

Because of safety requirements at power stations

Production of a phosphate ester

(by chemical reaction, reversible process)



Esterification

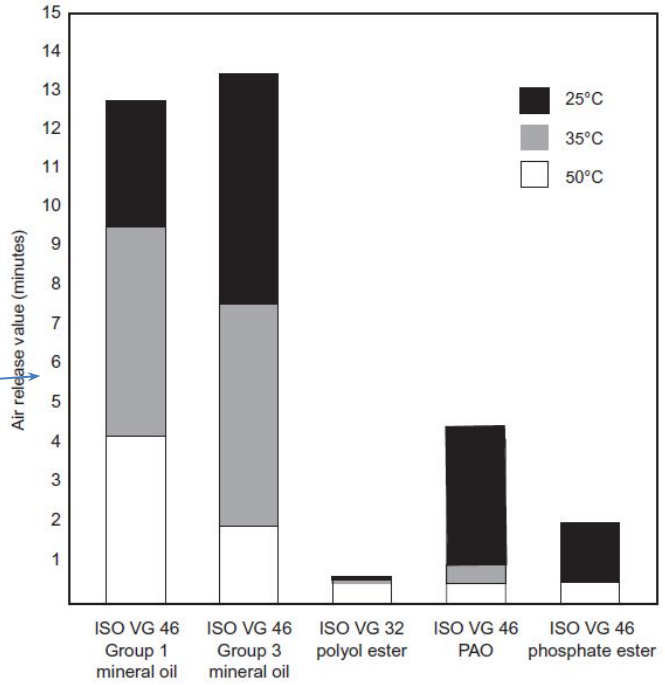
Acid + Alcohol ⇌ Ester + Water

Hydrolysis

Properties of Phosphate Ester

Advantages:

- Good lubricity
- Extremely difficult to ignite and self-extinguish
- Thermally stable
- Low volatility
- Readily good lubricity
- Good air release
- Good thermal/oxidation stability if treated well

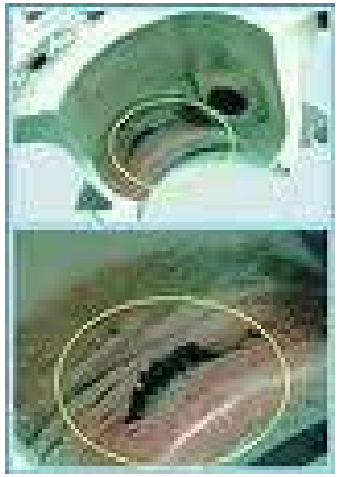


Disadvantages:

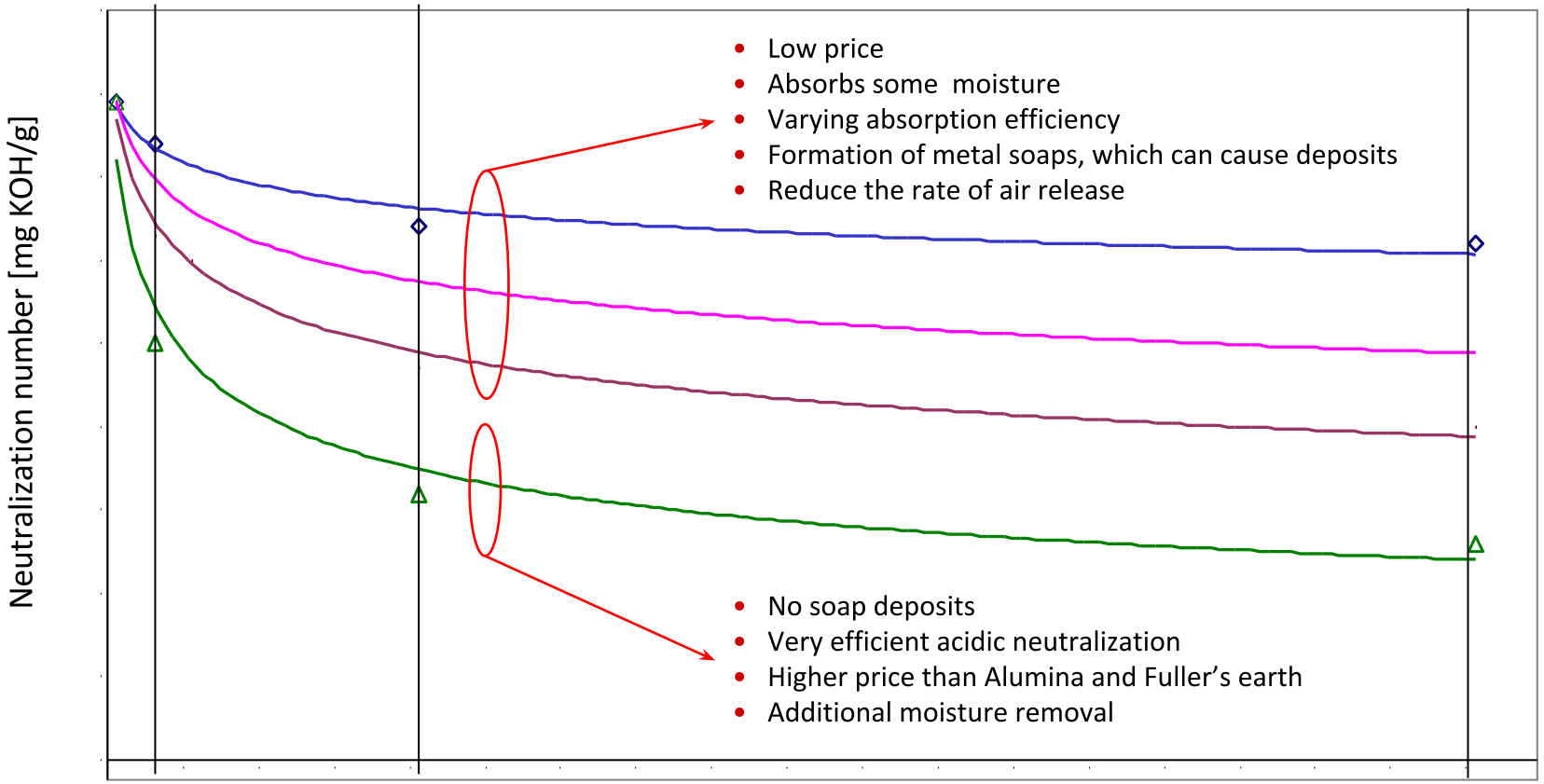
- Very hygroscopic, high water saturation point up to: 4000-5000ppm@50°C
- Sensitive to hydrolysis (in function of °C and water)
- Not compatible with conventional seals, paints and other fluids
- Price

Consequences of degraded PE

- Free acids lead to **further degradation (sludge, decrease of resistivity) and corrosion**
- Sticking of valves, **varnish problems**
- Servo-valve **erosion**
- Polymerization to form **gels**



Efficiency of the acid neutralization media's



Source: Karberg&Hennemann

A 21 Ion exchange resin

Fluid: Phosphate Ester, Temperature: 50°C, Adsorption material added: 1 %, Starting conditions: 0,79 mg KOH/g

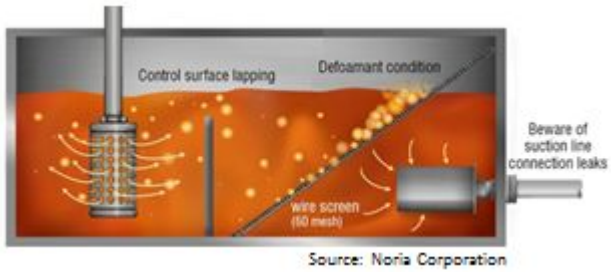
Oil analyses

Test		Suggested	Max. Limit	Fequency		
				Monthly	Quarterly	Yearly
Viscosity	cSt		± 10%	X	X	X
Water	ppm	<500	800	X	X	X
Acid	mg KOH/g	0,05	0,1	X	X	X
Particle count	ISO 4406	13/10	15/12	X	X	X
Insolubles	mg/kg	30		X	X	X
MPC		<15	30	X	X	X
Air release	min.	<5	7		X	X
Chlorine	ppm	10	50		X	X
Resistivity	GΩ.cm	>5	5			X
Foaming	ml. (tent/stab)	10/nil	50/nil			X
Flash point	°C	235	235			X
Ruler	-	<400	700			X

How to optimize your system

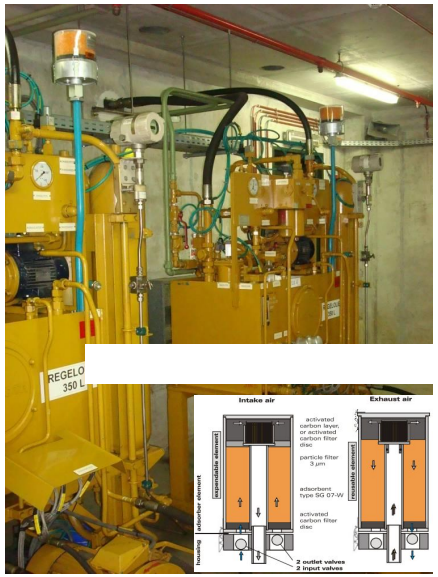
Points to pay attention to:

- Pressure compensated pump (instead of constant volume pumps)
- System leaks and suction line connection leaks
- Use compatible materials (seals, paints …)
- Oil return line approx. 40 cm below oil level in tank
- Enough air retention time (enough oil volume, tank baffles)
- Assure maximum oil level in tank
- Head space de-humidifiers
- Tank breathers
- Use clean PE oil related tools (mobile oil pumps, buckets..)
- Filter the new oil first before adding to your system



Source: Noria Corporation

Avoid micro-dieseling



How to treat the contaminations in a PE

It might be necessary to use multiple technics

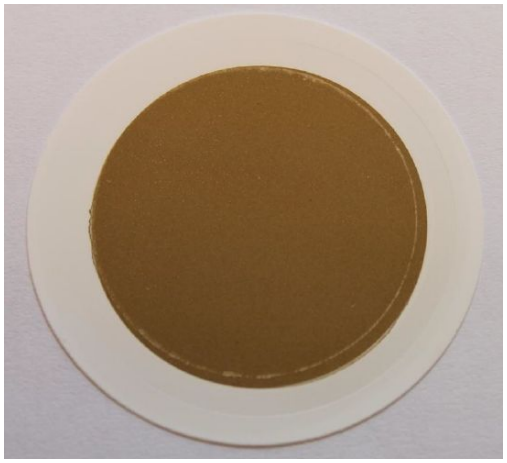
Acid neutralization : Ion exchange

Water control: molecular, desorption, dry air de-humidifier

Depth filtration for particle removal

BUT

ALWAYS START WITH A GOOD OIL ANALYSES FIRST !



Varnish

Micro Dieseling / Sparking
(Carbon deposits)