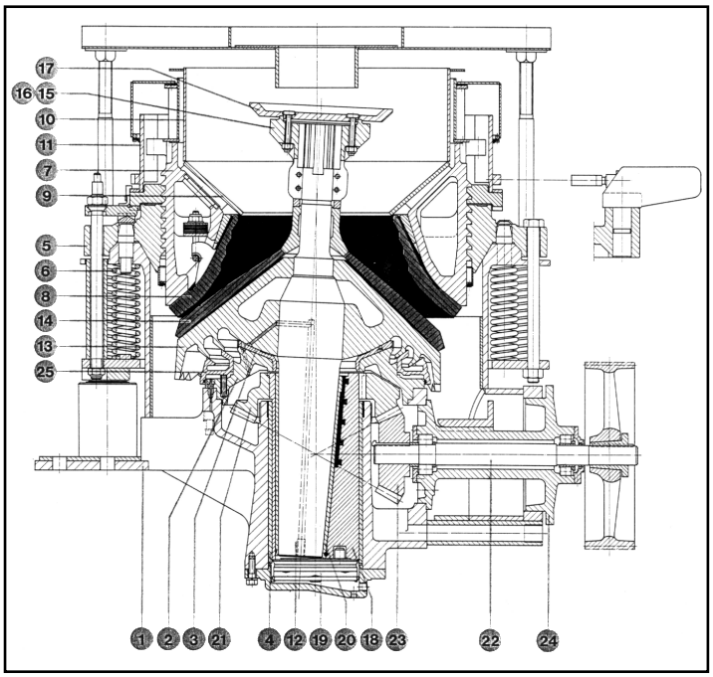
CJC™ APPLICATION STUDY

Customer: The copper mine Compania Minera Disputada, Chile
Machine: Nordberg Symons 5½ std. Cone Crusher
Oil type: Esso Spartan 68
Temperatures: Operating temperature, 50˚C
Fine Filter CJC™ Fine Filter, type HDU 27/54 P-Y

1. Nordberg Symons 5½ std. cone crusher

The Nordberg Symon cone crusher has for many years been produced by Nordberg Manufacturing Co., USA. Cone crushers is used for medium and fine crushing of minerals. The Symons standard cone crusher is significant because of the fact that it has no top bearing. The cross axl is resting on a spherical roller bearing.

The oil system is both a gear and a hydraulic system. The circulating oil enters under pressure through the bottom of the casing to lubricate the pressure bearing. The oil is from here divided into two streams. One stream lubricates the cylindric bushing and the shaft. Another stream is pushed through the channel in the shaft and lubricates the wear plate and the conical shaft. Both streams are then entering and lubricating the gear system and pushed further back into the system tank.



In some newer models of the crusher another stream of oil is used to operate 4 cylinders to install the distance between the crushing surfaces. These are operated with servo valves.

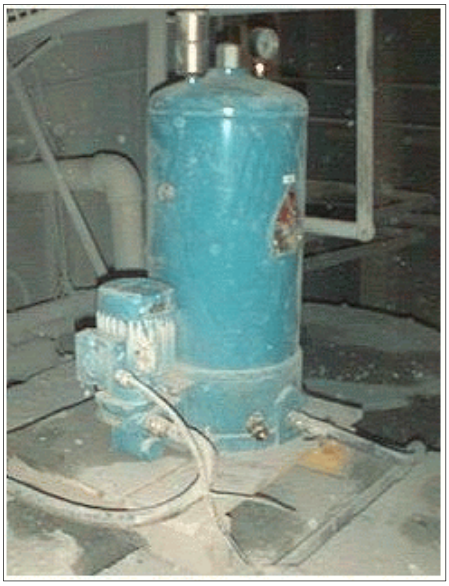
2. The CJC™ Fine Filter, type HDU 27/54 P-Y

The CJC™ Fine Filter, type HDU 27/54 P-Y is a cellulose fine filter dimensioned to remove particles, resin and water in a off-line circuit on the oil reservoir. It is supplied with its own pump that circulates the oil from the bottom of the tank through the filter element and back to the reservoir as near to the system suction as possible.

As protection to the filter pump this type of Fine Filter is equipped with a 125 micron UCC suction strainer . The HDU 27/54 P-Y is supplied with 2 CJC™ Fine Filter elements type B 27/27. This cellulosed based filter element removes:

98,7% of all particles > 3 micron in one pass
50% of all particles > 0,8 micron in one pass.
2 litres of water per B 27/27
resin and oxidation deposits

Dirt Holding capacity per B 27/27: 4 litres



HDU 27/54 P-Y installed at Symons no. 3 at Compania Minera Disputada.

3. Condition of oil and machinery before installation of fine filter

Before installation of the fine filter 2 samples was taken on 2 identical cone crushers and the analysis report showed and estimated contamination code of ISO 25/22 (ISO 4406).

The annual expenditure for spare parts was:

Oil change (every 3 month)	US$	800,-	3.200,-
Change of cylindrical bushing (yearly)	US$	5.000,-	5.000,-
Change of conical bushing (yearly)	US$	3.000,-	3.000,-
Change of wearing plate (every 2. year)	US$	5.500,-	2,750,-

The total annual expenditure for spare parts amounts to US$ 13.950,-.

To above spare parts expenditure the annual expenditure must be considered

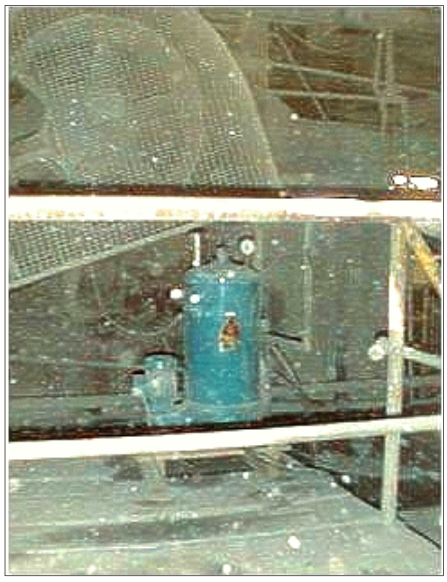
- the cost of labour for above maintenance and occasional cleaning of oil tanks
- the cost of production stops for maintenance
- handling, storage and environmental costs for disposal of oil

4. The testing procedure

After consideration of the theoretical life time improvement of both system components and oil in connection of the installation of off-line filtration equipment it was decided to carry out a trial test. The test was to be carried out as a comparison test on 2 identical cone crushers, one of them fitted with a efficient off-line filtration system.

The 7th of December 1999 the CJC™ Fine Filter, type HDU 27/54 P-Y was installed on crusher no 3 and the comparison crusher was decided to be no. 4. The following terms were agreed upon:

- 3 months trial period
- minimum cleanliness level to be reached ISO 16/13
- 4 element changes per year as maximum



The incredibly contaminated working environment at Minera Disputada.

5. The oil samples

The oil condition was monitored by independent oil laboratories in Chile and Holland and samples were taken after installation of fine filter, after 300 hours, after 1200 hours and after 1700 hours.

It is important to notice that the samples from the crusher no. 3 with filter was taken from the bottom of the tank and the samples from the crusher no. 4 was taken from the middle of the tank and therefore is the oil in crusher no. 4 without doubt a lot more contaminated than measured by the particle counts.

6. Comments to the oil analysis results

Comparing the particle contamination level the ISO code clearly states the dramatic removal of particles that the filter has obtained.

ISO 4406	After 2 hours	After 1212 hours	After 1704 hours
Crusher no. 3	22/15	16/13	19/17/14
Crusher no. 4	22/16	27/22	23/19/17

From the **spectral analysis** it is obvious that the particle removal has reduced machinery wear considerably. The amount of wear metals have fallen dramatically and the filter removes a large amount of copper that in connection with the oil will act as a catalyzer for the oxidation process of the oil.

The rise in contamination level on the crusher with filter is probably due to the fact that most oils have been added an additive which gives the oil an ability to encapsule particles and water to a certain limit. This is done to keep the particles and water suspended in the oil and not have the contamination settle in the system on sensitive components and create system wear.

In an as contaminated system as this the oil has reached its limit of this properties and therefore millions of particles have been settling in the system. When a fine filter is installed on a dirty system it will first and foremost remove the particles flowing in the oil. This will enable the clean oil to attract the particles lying around in valves, pipes etc and transfer these to the tank and thereby to the fine filter.

In such cases the contamination level will often fall - raise - and fall and stabilize at a low level. This is most likely the reason for the small rise in contamination.

It is without doubt that the CJC™ Fine Filter, type HDU 27/54 P-Y with time is able to keep a ISO code of 16/14.

It is important to notice that dimensioning of off-line filtration systems often can be difficult due to the unmeasurable particle ingress, changing from system to system.

The dramatic increase of viscosity is due to the rapid oxidation of the oil. Catalysts like metals, especially copper, accelerates the speed of this oxidation process rapidly. Please note, that according to Nordberg specifications the oil viscosity of 128,1 cSt made the oil due for replacement already after 314 hours as the max. recommended viscosity is 74,8 cSt.. As “new” oil is often delivered with ISO-codes above 17/15 the oil on crusher no. 3 can be considered as better than new oil. In contrary the oil on crusher no. 4 was already due to change after 314 hours.

7. Replacement of filter elements

The first elements were due for replacement after 1212 hours. After draining and drying the elements it was measured that the elements contained at least 12 kg of dirt.

We predict that continous filtration on the systems will prolong the lifetime of the elements considerably and without doubt to the success criteria (3 months) agreed upon.

8. Conlusion

Based on the ISO-codes, water level, our experience and examinations done by the American company Diagnetics Inc. the lifetime increase on the spherical roller bearing will increase by a factor 5.

The lifetime of bushings/ slide bearings and wear plate is, based on examinations of mechanical wear issues, without doubt concluded to at least double.

Based on our experience a much more extended lifetime on these components can be expectet. However considering the various aspects with influence on this lifetime we feel that this a conservative conclusion without doubt will turn out as the truth.

Comparing the 2 oils it is obvious that the crushers without additional filtration is lubricated by sandpaper and not oil!!!!

Filter element type B 27/54 after 1.212 hours of continous operation in Symons no. 3 at Compania Minera Disputada

9. Economic review

The investment of the CJC™ Fine Filter, type HDU 27/54 P-Y is appr. US$ 5.000,- and 1 replacement of filter elements is appr. US$ 736,-.

Therefore the following calculation:

Yearly direct maintenance costs without filtration	US$		13,950,-
Yearly direct maintenance cost with filtration			
- Oil change (every 2. year)	US$	800.-	400.-
- Change of cylindrical bushing (every 2. year)	US$	5,000.-	2,500.-
- Change of conical bushing (every 2. year)	US$	3,000.-	1,500.-
- Change of wearing plate (every 4. year)	US$	5,500.-	1,350,-
- Change of filter elements (4 changes per year)	US$	736.-	2,944.-
Total	US$		8,694.-
Annual savings	US$		**5,226.-**

Based on above payback time is less than one year.

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HOJA N° 1

EMPRESA :	EQUIPOS MARINOS S.A.	APLICACION :	ENGRANAJE
LUBRICANTE:	ESSO SPARTAN 68	USO ACEITE :	1212 HRS
EQUIPO :	CHANCADOR SYMONS N°3	USO UNIDAD :	HRS
INFORME :	01-Feb-00	UNIDAD :	SYMONS N°3
DIRECCION	MANUEL RODRIGUEZ 27 STGO. CENTRO		
TELEFONO	6980055	FAX 6980055	
CONTACTO	MARCELO GONZALEZ		
CAPACIDAD :	800 LTS		

IDENTIFICACION DE MUESTRAS			VISCOSID	FT-IR								FINE	ANALISIS ESPECTROMETRICO												- PPM						
N° ANALISIS	HORAS	FECH. MUEST.	40°C	OXIDA	SULFA	NITRA	AGUA %	GLICOL	DILUCION	HOLLIN	ZnDTP	FE	CR	PB	CU	SN	AL	NI	AG	SI	B	NA	MG	CA	BA	P	ZN	MO	TI	V	K
SYMONS N°3	2	07-Dic-99	67.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7	0	2	11	2	1	0	0	6	58	1	0	0	0	333	3	0	0	0	1
SYMONS N°3 CON FILTRO CJC	314	20-Dic-99	70.56	0.05	0.05	0.07	0.00	0.00	0.00	0.00	0.00	3	0	5	26	1	0	0	0	2	10	0	0	0	1	331	5	0	0	0	1
SYMONS N°3 CON FILTRO CJC	1212	26-Ene-00	69.43	0.10	0.14	0.06	0.00	0.00	0.00	0.41	-0.03	5	0	7	38	2	1	0	0	2	7	0	0	0	2	354	10	0	0	0	0

OBSERVACIONES:

PRECAUCION

VISCOSIDAD NORMAL PARA UN ACEITE GRADO ISO 68.
AUMENTA EL DESGASTE DE COBRE (BRONCE) REVISAR COMPONENTES (BUJES).
PRESENCIAS DE HOLLIN (CARBON) POR COCKIFICACION DEL ACEITE EXPUESTO A ALTAS TEMPERATURAS.
AUMENTA LA OXIDACION Y SULFATACION (ACIDEZ)
AUMENTAN PARTICULAS MENORES DE 15 MICRONES.
SE SUGIERE REALIZAR PURIFICACION EXTERNA Y ENVIAR NUEVA MUESTRA.

HOJA N° 2

EMPRESA :	EQUIPOS MARINOS S.A.	APLICACION :	ENGRANAJE	DIRECCION :	MANUEL RODRIGUEZ 27 STGO. CENTRO
LUBRICANTE:	SHELL OMALA 68	USO ACEITE :		TELEFONO :	6980055 FAX : 6980055
EQUIPO :	CHANCADOR SYMONS N°3	USO UNIDAD :		CONTACTO :	MARCELO GONZALEZ
INFORME :	01-Feb-00	UNIDAD :		CAPACIDAD :	800 LTS

		COARSE	S ESPECTROMETRICO											PARTICULAS	MICRONES	POR ML						RELLENO
N° ANALISIS	FECHA	FE	CR	PB	CU	SN	AL	NI	AG	SI	B	MO	TI	2-5	5-15	15-25	25-50	50-100	>100	ISO	IA	LITROS
SYMONS N°3	07-Dic-99	4	0	0	4	0	0	1	0	1	4	0	0	27059	27475	248	13	1	0	22/15	0.7	
SYMONS N°3 CON FILTRO CJC	20-Dic-99	0	0	0	2	0	0	1	0	0	0	0	0	4196	322	24	3	0	0	16/12	0.0	
SYMONS N°3 CON FILTRO CJC	26-Ene-00	2	0	1	14	0	0	1	0	0	0	0	0	10093	922	3	0	0	0	17/11	0.1	

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LAB N° 23533

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INGELUBE ®

HOJA N° 1

EMPRESA :	EQUIPOS MARINOS S.A.	APLICACION :	ENGRANAJE
LUBRICANTE:	ESSO SPARTAN 68	USO ACEITE :	314 HRS
EQUIPO :	CHANCADOR SYMONS N°4	USO UNIDAD :	SYMONS N°4 HRS
INFORME :	22-Dic-99	UNIDAD :	
DIRECCION	MANUEL RODRIGUEZ 27 STGO. CENTRO		
TELEFONO	6980055	FA 6980055	
CONTACTO	MARCELO GONZALEZ		
CAPACIDAD :	LTS		

IDENTIFICACION DE MUESTRAS			VISCOSID	FT-IR								FINE	ANALISIS ESPECTROMETRICO												- PPM						
N° ANALISIS	HORAS	FECH. MUEST.	40°C	OXID	SULF	NITR	AGUA %	GLICOL	DILUCIO	HOLLIN	ZnDT	FE	CR	PB	CU	SN	AL	NI	AG	SI	B	NA	MG	CA	BA	P	ZN	MO	TI	V	K
SYMONS N°4	2	07-Dic-99	70.33	0,00	0,00	0,00	0,00	0.00	0,00	0,00	0,00	16	0	2	16	1	1	0	0	6	64	2	1	4	0	322	2	0	0	0	1
SYMONS N°4 (SIN FILTRO CTC)	314	20-Dic-09	128.10	0.52	0.00	0.61	3.18	0.86	0.00	0.15	0.00	231	0	37	205	15	17	1	0	80	58	45	18	95	0	389	2	0	1	0	20

OBSERVACIONES:

PRECAUCION

VISCOSIDAD ALTA PARA UN ACEITE SHELL OMALA 68.
ALTA OXIDACION Y NITRACION POR CONTAMINACION CON AGUA.
SE DETECTA ALTA CONTAMINACION CON HOLLIN
ALTO DESGASTE POR MAYOR CONTAMINACION CON POLVO.
CONTENIDO DE ADITIVOS SE DEBEN COMPARAR CON ACEITE NUEVO.
AUMENTAN PARTICULAS EN TODOS LOS RANGOS DE TAMAÑO.
MAYOR CODIGO ISO.
ENVIAR NUEVA MUESTRA.

HOJA N° 2

EMPRESA :	EQUIPOS MARINOS S.A.	APLICACION :	ENGRANAJE	DIRECCION :	MANUEL RODRIGUEZ 27 STGO. CENTRO
LUBRICANTE:	SHELL OMALA 68	USO ACEITE :		TELEFONO :	6980055 FAX : 6980055
EQUIPO :	CHANCADOR SYMONS N°4	USO UNIDAD :		CONTACTO :	MARCELO GONZALEZ
INFORME :	22-Dic-99	UNIDAD :		CAPACIDAD :	LTS

		COARSE	ESPECTROMETRICO											PARTICULAS	MICRONES	POR ML						RELLENO
N° ANALISIS	FECHA	FE	CR	PB	CU	SN	AL	NI	AG	SI	B	MO	TI	2-5	5-15	15-25	25-50	50-100	>100	ISO	IA	LITROS
SYMONS N°4	07-Dic-99	9	0	1	7	0	0	1	0	3	3	0	0	23809	34394	371	16	1	0	22/16	0,6	
SYMONS N°4 (SIN FILTRO CTC)	20-Dic-09	31	0	5	22	0	0	1	0	6	3	0	0	635698	858064	22337	1022	48	3	27/22	433,0	

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