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ENERGYWORKS CARBALLO
(CALVO ENERGIA)

TRIALS ON EXTENSION OF THE USEFUL LIFE OF EXHAUST VALVES UP TO DOUBLING TBO (Time between overhauls) (6,000 H) IN ENGINE nº 1 (nº Deutz 010081)

rb bertomeu S.L.
April-2002

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1- APPROACH ON THE TRIALS AND CONCLUSION

1.1 PRECEDENTS

The additive for heavy fuel oil **"rb bertomeu" beco F1/ASF** is used with notable success to fight against the heat corrosion in Diesel engines. This additive is being used , since several years ago (1995-1996) in Spain, in many co-generation plants which are equipped with **Deutz** Diesel engines.

Deutz Iberia, who already knew this fact from **Deutz Service** and also from the information generated by **rb bertomeu S.L.** along the last years , suggested and proposed to carry out a **Trial on extension of the useful life for the exhaust valves (increasing of TBO)**, as a confirmation of the Homologation Letter for "**rb bertomeu" beco F1/ASF** additive, issued by **Deutz Iberia** in 1999 and also to verify the assertions of **rb bertomeu S.L.** who, in their studies, arrives to the conclusion that, with the use of the mentioned additive "**rb bertomeu" beco F1/ASF** , is possible to get an increase, of a minimum of 50% , in the foreseen TBO for the revision of exhaust valves in Diesel engines working with heavy fuel oil.

The TBO foreseen by **Deutz** is 3,000 hours in plants where heavy fuel oil is used and this TBO is easily reached when the additive **"rb bertomeu" beco F1/ASF** is used (in the same plants, before using that additive , only 2,500 hours of TBO were reached, but even with some difficulties). During the last years several trials to increase the TBO up to 4,500 – 5,000 hours , were carried out succesfully, in all cases, in some plants where that additive is normally used.

Taking into account these precedents, **Deutz Iberia** proposed that the Objective of the new trial must be to reach a **TBO of 6,000 Hours** , which means **the double of the normal TBO.**

1.2 APPROACH OF THE TRIAL

Deutz Iberia approached the trial in colaboration with **EnergyWorks Carballo** (before called **Calvo Energía**) and, logically with **rb bertomeu S.L.**

The execution of the trial has been done following the next points :

Engine to be checked	**:**	**Engine Nº 1 of the Co-generation plant of EnergyWorks Carballo (nº Deutz : 010081)** **Engine type : BV 16M 640**
Fuel	**:**	**Heavy fuel oil**
Fuel additive	**:**	**"rb bertomeu" beco F1/ASF , dosed at 0.5/MT**
Starting up the trial	**:**	**After inspection of 15,800 Hours**

Test carried out in paralel : **Valves with seat at 30º : A1A – A1B – A2A A2B – B1A – B1B**

Installed exhaust valves: **Mainly re-utilized exhaust valves , mechanically rectified (with 1 – 3 uses each one)**
Material of Sleeves : Nimonic
Material of Baskets : Stellite

Inspections to be made:

1st : Approximately at 4,500 H , because this is an already reached value, in other trials.

2nd : Approximately at 5,300-5,500 H

3rd : Last inspection at 6,000 H approxim. if it is possible, and as a maximum value for this trial.

1.3 CONCLUSIONS AFTER FINALIZING THE TRIAL

The trial was given as successfully concluded on 28-March-2002 , after being carried out all foreseen inspections and after being reached a TBO of 6,107 Hours. It is to be mentioned that aparently, the engine was able to follow in operation without shutting down for revision. According to this, we consider that a TBO higher than 6,000 hours could also be possible.

In the following chapters we include the corresponding reports for each carried out inspection , with photographic reports of the checked exhaust valves.

Main conclusions are the following , under our point of view :

A- A TBO of 6,107 hours has been reached without dificulties.

B- During the trial only was absolutely need to change the following valves , all them between 3,000 and 6,000 H:

A8B : changed at 5,400 hours due to blow out
A5 (B) : changed at 5,707 hours due to blow out (1)
B1A : changed before 4,669 horas due to blow out (this is an exhaust valve with seat at 30º , installed for another type of trial by Deutz)

(1) Is not possible to identify exactly if it is the valve "A" or "B", but most probably is "B" because "A" has better aspect in the photos. This valve has a visual mistake in its mechanical rectification angle (see inspection report and photograph).

C- **In the final inspection was only detected 1 valve sleeve with begining of blow out and 1 valve basket with corrosion (not being possible to recovery), and another 3 valves with begining of corrosion , but being aparently possible its recovery by mechanical rectification of seats. With this results it is possible to say that the trial has been easily superseeded.**

The remaining 28 valves only have some compactations in the seats of Sleeves and Baskest , and some hammering signals in the seat of 10 Baskets. Nevertheless, all these 28 valves will be recoverd and re-used after a very soft mechanical rectification of their seats.(See data sheet).

D- **Dismounting valves operation was carried out without difficulties, by using a normal crane for 29 valves and the hydraulic jack for the other 3 valves. Dismounting cylinder heads was not neccessary in any case.**
Only 1 cooper gasket with begining of corrosion (without blow out) was found from among 32 existing cooper gaskets.
Both points are very important to get an increment in the operational TBO , avoiding possible difficulties of seizure in the valve dismounting operations.

E- **Regarding the obtained results, it seems possible that the reached TBO of 6,000 h could be increased up to higher values, because of the reached level of corrosion can be considered low. To think in 8,000 hours without serious corrosions, seems could be the next objective , but studying previously some intermediate maintenance action to prevent and avoid the appearance of seizure in the cylinder heads or blow out in the cooper gaskets.**

In this direction , Mr. Tomás López , from Energyworks Carballo, did a suggestion to avoid that kind of problems, in case that TBO was increased up to 8,000 hours. His suggestion consist, broadly speaking, in the introduction of a short intermediate level of maintenance at 4,000 hours, to make the following operations :

a) **Change of all cooper gaskests.**
b) **Cleaning and re-greasing all valve boxes with the normal anti-seize product.**

2 - REPORT OF FINAL INSPECTION AT TBO = 6,107 H WITH PHOTOGRAPHIC REPORT OF ALL EXHAUST VALVES

ENERGYWORKS CARBALLO (CALVO ENERGIA)

TRIALS ON EXTENSION OF THE EXHAUST VALVES LIFE UP TO 6,000 H IN ENGINE nº 1 (Nº Deutz : 010081)

FINAL INSPECTION AT TBO = 6,107 Hours

Hours in engine counter : 21,907

Final inspection date : 28/03/02
Date of valves inspection in workshop of Deutz Service Vigo : 19/04/02

Final control realized by :

Mr. Tomas López - EnergyWorks Carballo (Calvo Energía)
Mr. Hans Ruckert - Deutz Iberia
Mr. Hans-Jörg Stegmann – Deutz A.G.
Mr. Rosendo Bertomeu - rb bertomeu S.L.

VALVES CHECKED : **All the exhaust valves of the engine**

PHOTOS REALIZED : **All valves of the engine.** See photographic report.

FUEL ADDITIVE : **"rb bertomeu" beco F1/ASF , dosed at 0.5 /MT**

CONDITION OF VALVES AFTER BEING REACHED A TBO OF 6,107 H :

See enclosed data sheets.

About the 32 exhaust valves, dismounted from Engine nº 1 , at 6,107 hours of TBO , which have been analized jointly by DEUTZ , ENERGYWORKS and RB BERTOMEU , we remark the following points :

1- **There is only 1 Valve** , A3A , with begining of blow out in the sleeve and some corrosions on the basket seat (aparently without possibility of recovery).
2- **There are only 3 Baskets with beginig corrosions in its seats**, A6B, B3A and B3B, but all 3 with possibilities of recovey by mechanical rectification.
3- **There are not corrosions in the rest of valves.** Only is possible to see some compactations or hammering signals , due to the solid residues coming from the combustion of the fuel oil.
4- **During total TBO of 6,107 hours,** only the following valves have been susbtituted, in spite of almost all installed valves for the trial were re-used ones, with 1 – 3 mechanical rectifieds each one.

Valve B1A , changed some days before 4,669 Hours . This valve belong to a grup of valves with seat at 30º , instaled by **Deutz** for a paralel test. The **valve B1B** , in good condition , was dismounted at the same time to be inspected with B1A (blowed out) in **Deutz – Mannheim**.

Valve B8B , changed at 4,669 Hours , due to beginig of corrosions. The change was made in the first inspection (see report) , without having necessary, by agrement to check the possible repetition of corrosions in this point. **In the final inspection there is no found corrosion in this valve.**

Valve A8B , changed at 5,400 Hours , due to blow out.

Valve A5 (not identified exactly if "A" ó "B" , but most probabily "B") , changed at 5,707 Hours , due to blow out. In the photograph , identified as Valve A 5 at the end of photographic report , is possible to see a signal of mistake in the angle of the seat, which could be the primary cause of the failure by blow out.

5- **About the 27 remaining Valves , 23 have superseded the TBO of 6,107 hours, without corrosions in the final inspection and the other 4 have also superdeded the TBO of 6,107 hours but with the corrosions already mentioned in point 1 and 2.**

6- In the final inspection we have detected 2 heads of sleeve valve with Thermal Fatigue and other 2 sleeve valve were the Thermal Fatigue is starting. This probabily can be considered normal by Deutz, taking into account that valves are not news.(Anyway , this must be avaluated by Deutz since Thermal Fatigue is not chemical corrosion).

Customer : **ENERGYWORKS CARBALLO (CALVO ENERGIA)** **TRIALS ON EXTENSION LIFE OF VALVES - ENGINE Nº : 1**

UP TO 6,000 Horas

INSPECTION : **21.907** Hours **TBO : 6,107 Hours** DATE : 28/03/02 (Inspection valves on 19/04/02)

	VALVE Nº	BEFORE CLEANING grams	AFTER CLEANING grams	RESIDUE ACUMUL. grams	COMMENTS	VALVE Nº	BEFORE CLEANING grams	AFTER CLEANING grams	RESIDUE ACUMUL. grams	COMMENTS
ALTERNATOR	B1A(left) 17	**----**	----	(5)	Compactations seat head valve Hammering seat of basket	A1A(rig) 1	----	----		Compactations seat head valve Hammering seat of basket
	B1B(rig) 18	----	----		Compactations seat head valve Compactations seat of basket	A1B(left) 2	----	----		Compactations seat head valve Compactations seat of basket
	B2A(left) 19	----	----		Compactations seat head valve Hammering seat of basket	A2A(rig) 3	----	----		Compactations seat head valve
	B2B(rig) 20	----	----	T.F. (1)	Compactations seat head valve Compactations seat of basket	A2B(left) 4	----	----		Compactations seat head valve Hammering seat of basket
	B3A(left) 21	----	----		Compactations seat head valve Begining corrosion seat of basket	A3A(rig) 5	----	----		Begining blow out head valve sleeve Corrosion seat of basket
	B3B(rig) 22	----	----		Compactations seat head valve Begining corrosion seat of basket	A3B(left) 6	----	----		Compactations seat head valve
	B4A(left) 23	----	----	b T.F.(2)	Compactations seat head valve	A4A(rig) 7	----	----	b T.F.(2)	Compactations seat head valve Compactations seat of basket
	B4B(rig) 24	----	----	T.F. (1)	Compactations seat head valve Compactations seat of basket	A4B(left) 8	----	----		Compactations seat head valve Hammering seat of basket
	B5A(left) 25	----	----		Compactations seat head valve Compactations seat of basket	A5A(rig) 9	----	----	(3)	Compactations seat head valve Hammering seat of basket
	B5B(rig) 26	----	----		Compactations seat head valve Compactations seat of basket	A5B(left) 10	----	----	(3)	Compactations seat head valve
	B6A(left) 27	----	----		Compactations seat head valve Compactations seat of basket	A6A(rig) 11	----	----		Compactations seat of basket
	B6B(rig) 28	----	----		Compactations seat head valve Hammering seat of basket	A6B(left) 12	----	----		Hammering seat head valve Begining corrosion seat of basket
	B7A(left) 29	----	----		Compactations seat head valve Compactations seat of basket	A7A(rig) 13	----	----		Compactations seat of basket
	B7B(rig) 30	----	----		Compactations seat head valve Compactations seat of basket	A7B(left) 14	----	----		Compactations seat head valve Compactations seat of basket
	B8A(left) 31	----	----		Compactations seat head valve	A8A(rig) 15	----	----		Compactations seat head valve Hammering seat of basket
TURBOS	B8B(rig) 32	----	----		Compactations seat head valve Hammering seat of basket	A8B(left) 16	----	----	(4)	Compactations seat head valve Hammering seat of basket
			Average	**-----**				**Average**	**-----**	

Notas :

(1) T.F. = Thermal fatigue in head of sleeve

(2) b T.F. = Begining Ther. fatigue in head of sleeve

(3) Valve "A" ó "B" (not identified) changed due to blow out, at 5,707 hours of TBO. Possible angle of rectified seat not correct, according the signals in photo.

(4) Blow out with 5.400 H

(5) Blow out with 3.248 H Experimental valve with seat at 30º (Deutz)

Material of valves :
Sleeves : Nymonic
Baskets : Estellite

Average Value of acumul. residues (grams)

Customer : **ENERGYWORKS CARBALLO (CALVO ENERGIA)**

TRIALS ON EXTENSION LIFE OF VALVES - ENGINE Nº : 1
UP TO 6,000 Hours

INSPECTION : **21.907** Hours **TBO : 6,107 Hours**

DATE : 28/03/02 (Inspection valves on 19/04/02)

	VALVE Nº	Hours operation SLEEV.	Hours operation BASK.	Dimentions SLE	Dimentions BAS	SERIAL NUMBERS	VALVE Nº	Hours operation SLEEV.	Hours operation BASK.	Dimentions SLE	Dimentions BAS	SERIAL NUMBERS
ALTERNATOR	B1A(left) 17					Nº H : 404 6211 E 76441 Nº C : 60068	A1A(rig) 1					Nº H : 404 6821 Z 0101 Nº C : 22 ST 30
	B1B(rig) 18					Nº H : 404 6211 E 77076 Nº C : 1473	A1B(left) 2					Nº H : 404 6821 Z 0101 Nº C : 14 ST 30
	B2A(left) 19					Nº H : 404 6211 E 74952 Nº C : 4303	A2A(rig) 3					Nº H : 404 6821 Z 0101 Nº C : 1 ST 30
	B2B(rig) 20					Nº H : 404 510 E 71052 Nº C : 1933	A2B(left) 4					Nº H : 404 6821 Z 0101 Nº C : 9 ST 30
	B3A(left) 21					Nº H : 404 6211 E 73689 Nº C : 5160	A3A(rig) 5					Nº H : 404 5010 73763 Nº C : 1091
	B3B(rig) 22					Nº H : 404 6211 E 73970 Nº C : 1774	A3B(left) 6					Nº H : 404 5010 E 71052 Nº C : 306
	B4A(left) 23					Nº H : 1. 533/ 74454 Nº C : 951	A4A(rig) 7					Nº H : 404 6211 E 73090 Nº C : 4780
	B4B(rig) 24					Nº H : 404 6211 E 73763 Nº C : 5120	A4B(left) 8					Nº H : 404 6211 E 74452 Nº C : 1480
	B5A(left) 25					Nº H : 404 6211 E 74952 Nº C : 5221	A5A(rig) 9					Nº H : 404 6211 E 74453 Nº C : 5228
	B5B(rig) 26					Nº H : EX 404 6211 E 73978 Nº C : 4320	A5B(left) 10					Nº H : 404 6211 E 76503 Nº C : 629
	B6A(left) 27					Nº H : 404 6211 E 74453 Nº C : 5143	A6A(rig) 11					Nº H : ------ Nº C : 453
	B6B(rig) 28					Nº H : 404 6211 E 71052 Nº C : 1783	A6B(left) 12					Nº H : 404 510 E 71052 Nº C : 1678
	B7A(left) 29					Nº H : 404 6211 E 73976 Nº C : 360	A7A(rig) 13					Nº H : 404 6211 E 74452 Nº C : 1512
	B7B(rig) 30					Nº H : 404 6211 E 76441 Nº C : 600720	A7B(left) 14					Nº H : 404 6211 E 73926 Nº C : 3478
	B8A(left) 31					Nº H : 404 6211 E 76375 Nº C : 673	A8A(rig) 15					Nº H : 404 6211 E 77076 Nº C : 5622
TURBOS	B8B(rig) 32					Nº H : 404 6211 E 74043 Nº C : 600717	A8B(left) 16					Nº H : 404 6211 E 76336 Nº C : 600668

See photographic report of the revisions made (final revision and intermediate revisions in our web site: www.rbbertomeu.com

3 - REPORT OF PARTIAL INSPECTION AT TBO = 5,318 H WITH PHOTOGRAPHIC REPORT OF THE 2 CHECKED EXHAUST VALVES

ENERGYWORKS CARBALLO (CALVO ENERGIA)

TRIALS ON EXTENSION OF THE EXHAUST VALVES LIFE UP TO 6,000 H IN ENGINE nº 1 (Nº Deutz : 010081)

PARTIAL INSPECTION AT TBO = 5,318 Horas

Hours in engine counter : 21,118

Date of inspection : 26/01/02

Realized by : EnergyWorks Carballo (Calvo Energía)
Deutz Iberia
rb bertomeu

VALVES CHECKED : **B8A - B8B**

These valves were choosen by CALVO for the second partial inspection because of the same valves were inspected in the first inspection on 24/11/01 at TBO= 4,669 h. Must be remembered that valve B8A was changed in that first inspection, but only to check the possible repetition of anomalies.

PHOTOS REALIZED :

Photo nº 1 : Sleeve of Valve **B8A** , after cleaning to verify possible corrosions

Photo nº 2 : Sleeve of Valve **B8B** , after cleaning to verify possible corrosions

Photo nº 3 : Basket of Valve **B8A ,** after cleaning to verify possible corrosions

Photo nº 4 : Basket of Valve **B8B ,** after cleaning to verify possible corrosions

FUEL ADDITIVE : **"rb bertomeu" beco F1/ASF**

CONDITION OF VALVES :

See enclosed data sheets. Both checked valves are in good condition and , consequently are re-instaled in the same position.
Valve B8A , changed in the first inspection , has not , with 649 hours in operation, eny repetition of corrosion anomalies that were detected in that first inspection.

NEXT INSPECTION :

It was decided , between **Deutz Iberia** and **Calvo Energía**, that into the following two weeks , when the valves for the overhaul of engine nº 1 were prepared , the Engine will be stopped and the Trial on extension of the life of valves will be finalized.
In this next inspection , all valves will be changed and checked also by **rb bertomeu**, in order to make the final report about the condition of that valves after the trial.

Customer : **ENERGYWORKS CARBALLO (CALVO ENERGIA)** **TRIALS ON EXTENSION LIFE OF VALVES - ENGINE Nº : 1**

UP TO 6,000 Horas

INSPECTION : **21.118** Hours **TBO : 5,318 Hours** DATE : 26/01/2002

	VALVE Nº	BEFORE CLEANING grams	AFTER CLEANING grams	RESIDUE ACUMUL. grams	COMMENTS	VALVE Nº	BEFORE CLEANING grams	AFTER CLEANING grams	RESIDUE ACUMUL. grams	COMMENTS
ALTERNATOR	B1A(left) 17					A1A(rig) 1				
	B1B(rig) 18					A1B(left) 2				
	B2A(left) 19					A2A(rig) 3				
	B2B(rig) 20					A2B(left) 4				
	B3A(left) 21					A3A(rig) 5				
	B3B(rig) 22					A3B(left) 6				
	B4A(left) 23					A4A(rig) 7				
	B4B(rig) 24					A4B(left) 8				
	B5A(left) 25					A5A(rig) 9				
	B5B(rig) 26					A5B(left) 10				
	B6A(left) 27					A6A(rig) 11				
	B6B(rig) 28					A6B(left) 12				
	B7A(left) 29					A7A(rig) 13				
	B7B(rig) 30					A7B(left) 14				
	B8A(left) 31	**Normal valve removed for control at TBO 649 h (3)**			Sleeve : Slight compactations Basket : Slight compactations	A8A(rig) 15				
TURBOS	B8B(rig) 32	**Normal valve removed for control at TBO 5.318 h**			Sleeve : Slight compactations Basket : Slight compactations	A8B(left) 16				
		Average	**-----**			**Average**		**-----**		

Notes :

1- It was re-installed same valves **B8A and B8B** in very good condition

2- Solid residues were not weight , due to its low quantity, as can be apreciated in the photos.

3- This valve was changed in previous inspection and removed only to check any repetition of anomalies

Average Value of acumul. residues (grams)

Customer : **ENERGYWORKS CARBALLO (CALVO ENERGIA)**

TRIALS ON EXTENSION LIFE OF VALVES - ENGINE Nº : 1
UP TO 6,000 Hours

INSPECTION : **21.118** Hours **TBO : 5,318 Hours**

DATE : 26/01/2002

	VALVE Nº	Hours operation SLEEV.	Hours operation BASK.	Dimentions SLE	Dimentions BAS	SERIAL NUMBERS	VALVE Nº	Hours operation SLEEV.	Hours operation BASK.	Dimentions SLE	Dimentions BAS	SERIAL NUMBERS
ALTERNATOR	B1A(left) 17					Nº H : Nº C :	A1A(rig) 1					Nº H : Nº C :
	B1B(rig) 18					Nº H : Nº C :	A1B(left) 2					Nº H : Nº C :
	B2A(left) 19					Nº H : Nº C :	A2A(rig) 3					Nº H : Nº C :
	B2B(rig) 20					Nº H : Nº C :	A2B(left) 4					Nº H : Nº C :
	B3A(left) 21					Nº H : Nº C :	A3A(rig) 5					Nº H : Nº C :
	B3B(rig) 22					Nº H : Nº C :	A3B(left) 6					Nº H : Nº C :
	B4A(left) 23					Nº H : Nº C :	A4A(rig) 7					Nº H : Nº C :
	B4B(rig) 24					Nº H : Nº C :	A4B(left) 8					Nº H : Nº C :
	B5A(left) 25					Nº H : Nº C :	A5A(rig) 9					Nº H : Nº C :
	B5B(rig) 26					Nº H : Nº C :	A5B(left) 10					Nº H : Nº C :
	B6A(left) 27					Nº H : Nº C :	A6A(rig) 11					Nº H : Nº C :
	B6B(rig) 28					Nº H : Nº C :	A6B(left) 12					Nº H : Nº C :
	B7A(left) 29					Nº H : Nº C :	A7A(rig) 13					Nº H : Nº C :
	B7B(rig) 30					Nº H : Nº C :	A7B(left) 14					Nº H : Nº C :
	B8A(left) 31	649	649			Nº H : without number Nº C : 22176.1	A8A(rig) 15					Nº H : Nº C :
TURBOS	B8B(rig) 32	5318	5318			Nº H : see report of 4.669 h Nº C : see report of 4.669 h	A8B(left) 16					Nº H : Nº C :

See photographic report of the revisions made (final revision and intermediate revisions in our web site: www.rbbertomeu.com

4 - REPORT OF PARTIAL INSPECTION AT TBO = 4,669 H WITH PHOTOGRAPHIC REPORT OF THE 3 CHECKED EXHAUST VALVES

ENERGYWORKS CARBALLO (CALVO ENERGIA)

TRIALS ON EXTENSION OF THE EXHAUST VALVES LIFE UP TO 6,000 H IN ENGINE nº 1 (Nº Deutz : 010081)

PARTIAL INSPECTION AT TBO = 4,669 Horas

Hours in engine counter : 20,469
Date of inspection : 24/11/01
Realized by : EnergyWorks Carballo (Calvo Energía)
Deutz Iberia
rb bertomeu

VALVES CHECKED : **B8A - B8B (Normal valves at 45º)**

These valves were choseen by CALVO for checking because they belong to the cylinder that has been historically operating at higher temperature, and they have more possibilities of corrosion.

Experimental valves with seats at 30º : A1A – A1B – A2A – A2B – B1A – B1B

Note important : An aditional checking was made on the valves **B1A** and **B1B**, (experimental valves with seat at 30º) because of the valve **B1A** was changed few days ago due to blow out. Both valves **B1A** (blowed out) and **B1B** (in good condition) were sent to **Deutz Mannheim** to be checked. Normal valves at 45º were installed.

PHOTOS REALIZED :
Photo nº 1 : Sleeve of Valve **B1A** , blowed out before revision at TBO 4,669 H
Photo nº 2 : Sleeve of Valve **B8A** , before cleaning
Photo nº 3 : Sleeve of Valve **B8A** , after cleaning , to verify possible corrosions
Photo nº 4 : Basket of Valve **B8A**
Photo nº 5 : Sleeve of Valve **B8B** , before cleaning
Photo nº 6 : Sleeve of Valve **B8B** , after cleaning , to verify possible corrosions
Photo nº 7 : Basket of Valve **B8B**

FUEL ADDITIVE : **“rb bertomeu” beco F1/ASF**

CONDITION OF VALVES :
See enclosed data sheets. It was decided to change the valve B8A , with only “begining of corrosion” (not serious corrosion), to verify possible repetition of that anomaly in this point , in the next inspection.

NEXT INSPECTION :
Around 19 of January of 2002 , with approximately 21,100 hours in the engine counter and a TBO of 5,300 hours since the begining of the trial . It is foreseen to check again the valve B8B , besides the valves from the cylinder with higher operational temperature.

Customer : **ENERGYWORKS CARBALLO (CALVO ENERGIA)** **TRIALS ON EXTENSION LIFE OF VALVES - ENGINE Nº : 1**

UP TO 6,000 Horas

INSPECTION : **20.469** Hours **TBO : 4,669 Hours** DATE : 24/11/2001

	VALVE Nº	BEFORE CLEANING grams	AFTER CLEANING grams	RESIDUE ACUMUL. grams	COMMENTS	VALVE Nº	BEFORE CLEANING grams	AFTER CLEANING grams	RESIDUE ACUMUL. grams	COMMENTS
ALTERNATOR	B1A(left) 17	**Experimental valve with seats at 30º (TBO 3284h)**			Blow out in sleeve.Not observed general corrosions.	A1A(rig) 1				
	B1B(rig) 18					A1B(left) 2				
	B2A(left) 19					A2A(rig) 3				
	B2B(rig) 20					A2B(left) 4				
	B3A(left) 21					A3A(rig) 5				
	B3B(rig) 22					A3B(left) 6				
	B4A(left) 23					A4A(rig) 7				
	B4B(rig) 24					A4B(left) 8				
	B5A(left) 25					A5A(rig) 9				
	B5B(rig) 26					A5B(left) 10				
	B6A(left) 27					A6A(rig) 11				
	B6B(rig) 28					A6B(left) 12				
	B7A(left) 29					A7A(rig) 13				
	B7B(rig) 30					A7B(left) 14				
	B8A(left) 31	**Normal valve removed for control at TBO 4.669 h**			Sleeve : compactations Basket : beginig corrosions	A8A(rig) 15				
TURBOS	B8B(rig) 32	**Normal valve removed for control at TBO 4.669 h**			Sleeve : compactations Basket : compactations	A8B(left) 16				
		Average	**-----**			**Average**			**-----**	

Average Value of acumul. residues (grams)

Notes :

1- It is decided to change valve **B8A**.

2- Re-installed same valve **B8B** , in good condition

3- Solid residues were not weight , due to its low quantity, as can be apreciated in the photos.

4- Next control foreseen at 21.200 H approx.,with a TBO of 5,400 H

Customer : **ENERGYWORKS CARBALLO (CALVO ENERGIA)**

TRIALS ON EXTENSION LIFE OF VALVES - ENGINE Nº : 1
UP TO 6,000 Hours

INSPECTION : **20.469** Hours **TBO : 4,669 Hours**

DATE : 24/11/2001

	VALVE Nº	Hours operation SLEEV.	Hours operation BASK.	Dimentions SLE	Dimentions BAS	SERIAL NUMBERS	VALVE Nº	Hours operation SLEEV.	Hours operation BASK.	Dimentions SLE	Dimentions BAS	SERIAL NUMBERS
ALTERNATOR	B1A(left) 17	3284	3284			Nº H : 0404 6821 Z 0101 Nº C :	A1A(rig) 1					Nº H : Nº C :
	B1B(rig) 18					Nº H : Nº C :	A1B(left) 2					Nº H : Nº C :
	B2A(left) 19					Nº H : Nº C :	A2A(rig) 3					Nº H : Nº C :
	B2B(rig) 20					Nº H : Nº C :	A2B(left) 4					Nº H : Nº C :
	B3A(left) 21					Nº H : Nº C :	A3A(rig) 5					Nº H : Nº C :
	B3B(rig) 22					Nº H : Nº C :	A3B(left) 6					Nº H : Nº C :
	B4A(left) 23					Nº H : Nº C :	A4A(rig) 7					Nº H : Nº C :
	B4B(rig) 24					Nº H : Nº C :	A4B(left) 8					Nº H : Nº C :
	B5A(left) 25					Nº H : Nº C :	A5A(rig) 9					Nº H : Nº C :
	B5B(rig) 26					Nº H : Nº C :	A5B(left) 10					Nº H : Nº C :
	B6A(left) 27					Nº H : Nº C :	A6A(rig) 11					Nº H : Nº C :
	B6B(rig) 28					Nº H : Nº C :	A6B(left) 12					Nº H : Nº C :
	B7A(left) 29					Nº H : Nº C :	A7A(rig) 13					Nº H : Nº C :
	B7B(rig) 30					Nº H : Nº C :	A7B(left) 14					Nº H : Nº C :
	B8A(left) 31	4669	4669			Nº H : EX 404 6211 E 74196 Nº C : 5145	A8A(rig) 15					Nº H : Nº C :
TURBOS	B8B(rig) 32	4669	4669			Nº H : EX 404 6211 E 73975 Nº C : 673	A8B(left) 16					Nº H : Nº C :

See photographic report of the revisions made (final revision and intermediate revisions in our web site: www.rbbertomeu.com

5 - ATTACHED : Report on the use of MAGNESSIUM as a solution to solve the corrosion problems derived from the combustion of heavy fuel oil

MAGNESSIUM AS A SOLUTION FOR THE CORROSION PROBLEMS DERIVED FROM THE COMBUSTION OF HEAVY FUEL OIL

rb bertomeu S.L.
April-02

Regarding to the heavy fuel oil combustion , the following facts are generally accepted all around the world :

1- Heavy fuel oil contains several metallic impurities, mainly Vanadium and Sodium that promotes the formation of corrosive compounds during the combustion, because of all of these are in liquid state at temperatures below 650ºC :
   - Vanadium pentoxide (melts at 600-650ºC)
   - Sodium Vanadates (melts at 340-650ºC depending on molar ratio V/Na)

   If these type of compounds are not neutralized, during the combustion a lot of corrosions will appear on the valves and turbos of Diesel engines , and also on the surface of the boilers heat exchargers (besides solid encrustations)

2- Heavy fuel oil also contains Sulphur as impurity, which causes the formation of SO2 and some SO3 during combustion, and the possible formation of suphuric acid when exhaust gases temperature down under 160ºC , or even sulphurous acid at temperature below 50ºC.

Regarding the use of heavy fuel oil ADDITIVES CONTAINING MAGNESSIUM as a solution for the related corrosion problems during its combustion, is neccessary to clearly understand the following concepts and proved facts :

COMBUSTION OF HEAVY FUEL OIL IN STEAM BOILERS AND GENERATORS WITH STEAM BOILERS.

It has been used , in the past and also in the present, **additives with Magnessium** wich are injected into the furnace. These kind of additives consist on a **suspension of solid Magnessium oxide,** in water, kerosene or another liquid agent, wich are sprayed to the combustion gases, or injected into the fuel oil pipe just before the combustion

These kind of additives , with Magnessium in solid state (suspension of magnessium oxide), are quite efectives to neutralize the possible formation of sulphuric acid in the exhaust gases, less effectives to transform the Vanadium into Magnessium Vanadates of high melting point and non corrosives , but they can be only used when the combustion equipment is a burner or similar , NEVER WHEN USING A DIESEL ENGINE because of the presence of solid magnessium oxide inside the engine, can cause damages by scratching of metallic parts.

COMBUSTION OF HEAVY FUEL OIL IN DIESEL ENGINES.

Avoiding corrosion in Diesel engines by using additives containing magnessium, without damage in the engine internals, is only possible by using additives where the Magnessium is in form of ORGANIC SALT, SOLUBLE in hydrocarbons, as in our additive "rb bertomeu" beco F1/ASF, because in this way, there is no solid magnessium oxide nor another type of solid derived from the additive, that can cause damages by scratching.

Just during fuel oil combustion, the magnessium salt reacts with the Vanadium oxide and forms Magnessium Vanadate of high melting point (more than 1000ºC), which is solid and non corrosive at the internal engine temperature.

The theoretical damage that can produce, in the engine, the use of heavy fuel oil treated with Magnessium oxide (case of several additives for boilers mentioned above), can not be produced when using the additive with soluble magnessium "rb bertomeu" beco F1/ASF, because there is no magnessium oxide present , solid nor liquid , before the combustion nor after the combustion of fuel oil.

Magnessium salts formed during the combustion are inert (non corrosives), as the Calcium salts also formed from Calcium contained in the fuel and from Calcium contained in the engine oil consumed by the engine.

Magnessium , Mg , becames integrated in the molecule of Vanadate, which leaves the engine jointly the rest of solid residues formed in the combustion (for example , MgV_2O_6 or $Mg_3V_2O_8$). The rest of the organic components of **"rb bertomeu" beco F1/ASF** additive, including the organic ion which has been supported the atom of Magnessium in soluble form, are burned during the combustion in the engine, generating residual gases as CO_2 and H_2O , like the fuel oil, and non generating solid residues.

CONCLUSIONS REGARDING THE USE OF ADDITIVES CONTAINING MAGNESSIUM :

1- **Additives containing Magnessium oxide are not solubles and THEY CAN NOT BE USED IN DIESEL ENGINES. They can be only used in boilers, furnaces or similar combustion equipments.**

2- **The additive "rb bertomeu" beco F1/ASF , containing Magnessium completely soluble in Hydrocarbons, in which the magnessium are not as oxide form , CAN BE USED IN DIESEL ENGINES , and it is very effective to minimize the corrosion in their valves, turbos and also in the associated boilers, acting jointly with the remaining components of the additive.**

3- **The kind of Magnessium compound present in the "rb bertomeu" additives, is innocuous , is not magnesium oxide, and it is sufficiently proved since 1995 that it not produce eny type of damage in the engines and that, jointly with the other components of the respective formulas, provides the excelent economic profits, which have been largely demonstrated in a lot of plants with Diesel engines.**