

Hydraulic Fluids – Solutions of Complex Requirements

Wolfgang Bock
Gerit Dornacher
Tobias Schürmann



- 01** | Introduction Fuchs Group and Fuchs Schmierstoffe GmbH
- 02** | Pump Viscosity Requirements –
Multigrade Low Temperature Hydraulic Fluids
- 03** | Bosch Rexroth Fluid Rating RD 90235 and RDE 90245,
e.g. RENOLIN Xtreme Temp 46, Multigrade Zn containing
- 04** | Denison HF-0 High Pressure Hydraulic Pump Test,
e.g. RENOLIN ZAF 46 MC, Multigrade ZAF
- 05** | Summary

3 Generations
founded as
family business

No. 1
of independent
suppliers
of lubricants

Family Fuchs
holds **54%** of
the common shares

>2.3 Mrd. Euro
turnover in 2016

round about
5,000
employees
worldwide

Preference share is
MDAX Member

57 companies
worldwide

full range
of more than
10.000
lubricants
and related
specialities

- **Group:** 100% subsidiary of FUCHS PETROLUB SE
- **Founded:** 1931 by Rudolf Fuchs
- **Employees:** 850
- **Sales:** > 600 Mio. € (2016)
- **Portfolio:**
 - Automotive Lubricants
 - Industrial Lubricants
 - Fluid Management
- **Certified acc. to:**
 - DIN/ISO 9001, DIN/ISO 14001
 - DIN/ISO TS 16949
 - OHSAS 18001, KTA 1401
- **Production Plants:**
Mannheim, Kiel and Wedel



Products

2.000+ Products, 6.000+ Articles

Raw Materials

1.200 active Raw Materials, 120 Base Oils

Plant Mannheim

220+ kto Kapazität / Öle

- SAF

2 Blending Vessels (100 / 200 m³)
19 Storage Tanks with 60.000 m³

- Tankfarm

235 Tanks with 17.100 m³

- Plant III

23 Blending Vessels = 208 to

- Filling

15 Filling Lines for IBC, drums, small pack units
800 - 1.000 drums/day
10 - 12 Mio small pack units/year

- Warehouse

30.000 pallets / 21.000 to

Plant Kiel

18+ kto capacity / greases

Lab

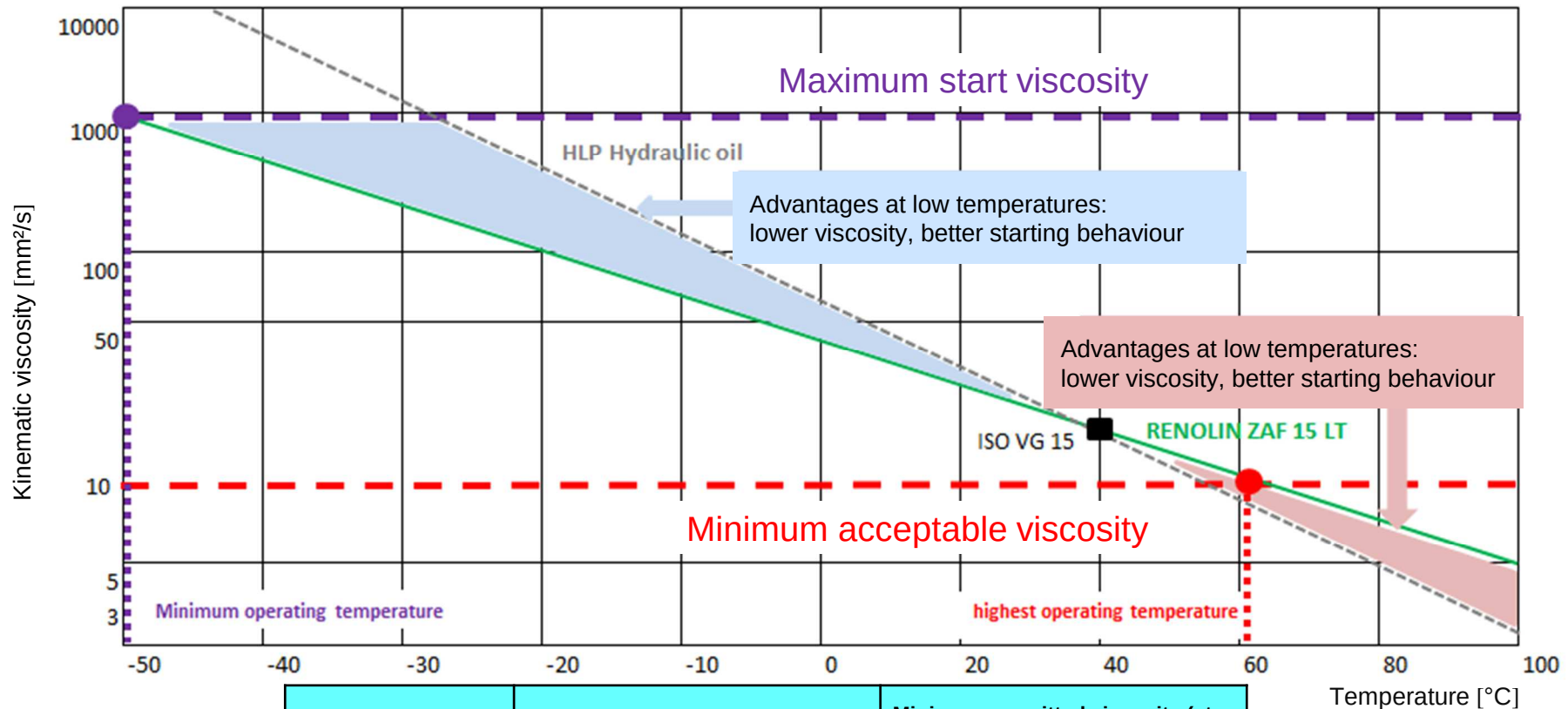
1.000 samples/week (QC-Lab)
400 samples/week (Service-Lab)



Pump Viscosity Requirements

e.g. RENOLIN ZAF 15 LT

Cold temperature viscosities compared to different ISO VG 15 oils



Pump type	Maximum permitted viscosity in mm²/s (short-term at cold start)	Minimum permitted viscosity (at load drop, maximum permitted oil temperature of 90 °C) in mm²/s
Gear pump	approx. 1,000	10 – 25
Piston pump	1,000 – 2,000	10 – 16
Vane pump	200 – 800	16 – 15

Pump Viscosity Requirements

e.g. RENOLIN ZAF 15 LT

Cold temperature viscosities compared to different ISO VG 15 oils

Property	RENOLIN ZAF 15 LT	RENOLIN B 15 HVI	RENOLIN MR 310	RENOLIN ZAF 15 DT	PLANTOHYD 15 S
Viscosity index	387	151	310	86	191
Viscosity at [mm²/s]	-40 °C	1773,7	-	5095	-
	-30 °C	658,5	149,9	1434	455
	-20 °C	400	128	506,8	290
	0 °C	80,5	46	104,5	80
	40 °C	15	15	15	15
	100 °C	3,8	5,4	3,3	4,1
Pourpoint [°C]	< -60	-45	-48	-40	-33

Pump type	Maximum permitted viscosity in mm²/s (short-term at cold start)	Minimum permitted viscosity (at load drop, maximum permitted oil temperature of 90 °C) in mm²/s
Gear pump	approx. 1,000	10 – 25
Piston pump	1,000 – 2,000	10 – 16
Vane pump	200 – 800	16 – 15

→ e.g. RENOLIN ZAF 15 LT shows excellent low temperature properties

Base Oils for Hydraulic Fluids

API classification of base oil types



Classification according API (1995) and ATIEL (Code of Practice):



	<u>Sulfur [%]</u>		<u>Saturates [%]</u>	<u>VI</u>
Group I:	> 0.03	and/or	< 90	80-119
Group II:	≤ 0.03	and	≥ 90	80-119
Group III:	≤ 0.03	and	≥ 90	≥ 120
Group IV:	Poly-alpha-Olefins (PAO)			
Group V:	Other Base Oils (e.g. Esters)			
Group VI:	Poly-Internal-Olefines (PIO), new group introduced in 2003			



Group I: Solvent Neutrals; characterisation according carbon distribution: aromatic – naphthenic – paraffinic (90% market share)



Group II + III: semi-synthetic products by hydrocracking / isodewaxing / hydrofinishing



Group IV / V / VI: fully synthetic

Different performance levels of zinc and ash-free (ZAF) hydraulic fluids, demulsifying: RENOLIN ZAF

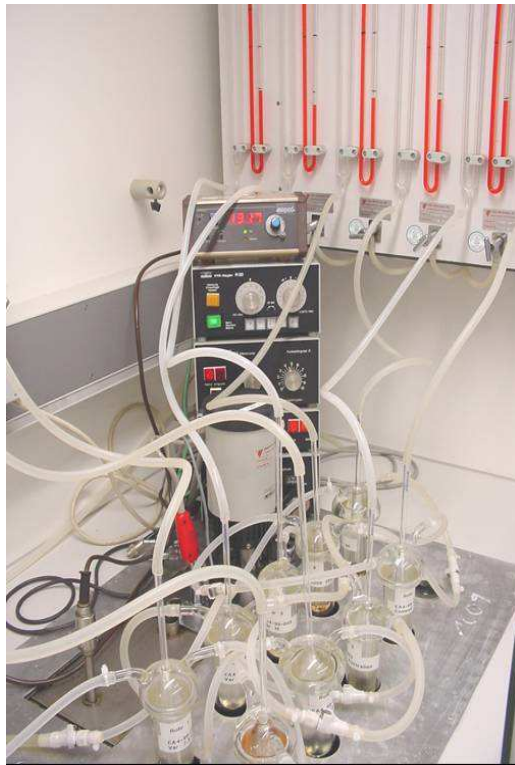
Properties / typical values	Method	Unit	RENOLIN ZAF B 46 HT	RENOLIN ZAF B 46 HT Plus	RENOLIN ZAF 46 MC
Fluid category	DIN 51502	-	HLP	HLP	HVLP
Base oil	API	-	Group I	Group II	Group III
Density at 15 °C	DIN 51757	kg/m³	876	860	848
Kinematic viscosity at 0 °C	DIN EN ISO 3104	mm²/s	580	528	416
Kinematic viscosity at 40 °C	DIN EN ISO 3104	mm²/s	46	46	46
Kinematic viscosity at 100 °C	DIN EN ISO 3104	mm²/s	6,8	7,03	8,0
Viscosity index	DIN ISO 2909	-	101	110	148
Pourpoint	DIN ISO 3016	°C	-24	-21	-45
Flashpoint	DIN ISO 2592	°C	230	244	238
TOST lifetime	DIN EN ISO 4263-1	hours	3.000	> 6.000	> 10.000
Brugger	DIN 51347-2	N/mm²	35	35	23
Air release properties at 50 °C	DIN ISO 9120	minutes	7	4	3
Electric conductivity at 50 °C	ASTM D 2624	pS/m	100	61	7
Sealing compatibility	DIN ISO 13226	-			
NBR			+	+	+
FKM			+	+	+
Sulphur Content - Base oil	DIN 51391-3	ppm	~ 7.000	< 10	< 10
FZG A/8,3/90 - FLS	DIN ISO 14635-1	FLS	> 12	> 12	> 12
FE8-D-7,5-80KN-80°C-80h roller wear cage wear	DIN 51819-3	mg	3 < 100	3 < 100	3 < 100
Energy consumption (in general) Average value due to field / test experience	-	%	100	~ 99*	~ 95**
DIN 51524 ISO VG 46	Requirements	TOST Air release		≥ 1000 hours ≤ 10 minutes	

* due to low density and high VI

** due to low density and VI > 140

TOST Turbine Oil Oxidation Test: DIN EN ISO 42631-1, Lifetime in hours till NZ 2.0 mgKOH/g

e.g. RENOLIN ZAF MC Series
Multigrade zinc-free hydraulic fluids



Test conditions: 95 °C, 3 l O₂/h, Cu/Fe-cat., 300 ml oil, 60 ml water, 2 - 8 weeks
RENOLIN ZAF 46 MC: TOST Lifetime > 10.000 h

Air Release Properties acc. to DIN ISO 9120

e.g. RENOLIN ZAF MC Series
Multigrade zinc-free hydraulic fluids



Test conditions: 50 or 75 °C, 200 ml oil, 7 min. air stream
Limit: max. 10 minutes (acc. DIN 51524-3)

RENOLIN ZAF 46 MC: 3 minutes

Wear Test: FZG Gear Test Rig, FE8 Roller Bearing Wear Test

e.g. RENOLIN ZAF MC Series Multigrade zinc-free hydraulic fluids

Evaluation of scuffing protection of lubricants
EP / AW Performance – FZG Test: DIN ISO 14635-1

FZG A / 8,3 / 90

A = Tooth form

rotating velocity

8.3 m/s

Starting oil temperature

90 °C

max. load stage:

> 12 (> 14)

	RENOLIN ZAF 46 MC
FZG A / 8.3 / 90	
Failure load stage	> 12



FE8 D / 7,5 / 80 - 80 acc. to DIN 51819-3

**Minimum requirement
acc. to DIN 51517-3 CLP:
roller wear ≤ 30 mg**

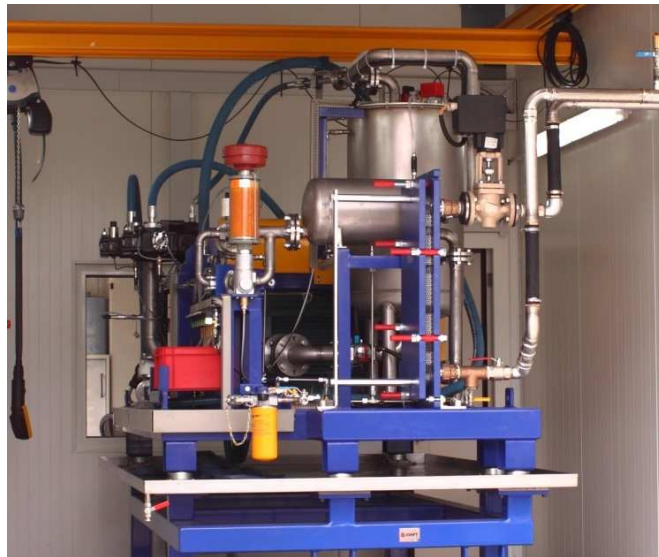
RENOLIN ZAF 46 MC: roller wear 3 mg



Parker Denison HF-0 Hydraulic Pump Test Rig



Photos:
Rhein-Chemie, Germany



High Pressure
Test Rig for
Industrial and
Mobile Hydraulic
Fluids „Dry cycle,
wet cycle“

Parker Denison HF-0 Pump Test for Hydraulic Fluids Details

e.g. RENOLIN ZAF 46 MC

- Pump
 - T6H20C
- Testing cycles
 - Run-in
 - Dry cycle
 - Wet cycle

Hybride pump: piston and vane pump unit

- 7 hours at 250 bar
- 300 h at 250/280 bar*
- 300 h at 250/280 bar*
with 1% water

Constantly switching
between both pumps with
a frequency of 2 seconds

* Vane pump 250 bar / Piston pump 280 bar



Parker Denison HF-0 Pump Test for Hydraulic Fluids Evaluation

e.g. RENOLIN ZAF 46 MC



Set of piston shoes

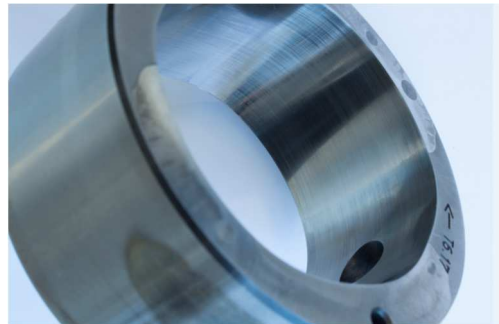


Optical evaluation

**Results:
Excellent!
No wear!**



Weight loss



Parker Denison HF-0 Pump Test for Hydraulic Fluids Evaluation

e.g. RENOLIN ZAF 46 MC

Vane pump

		Start up after	After			
Test results to be recorded in phase I		7 hours	107 hours	207 hours	307 hours	
Output flow @ 250 bar	[l/min]	79,22	80,92	81,14	81,27	
Input torque @ 250/ 280 bar for piston pump	[Nm]	311,32	305,54	302,28	304,17	
Inlet temperature	[° C]	109,66	110,21	109,56	109,71	
Outlet temperature	[° C]	117,03	116,8	116,6	116	
Delta P through the return filter both pumps at P min	[mbar]	712,90	709,30	693,60	694,70	
Fluid contamination SAE AS 4059 ISO 4406		17/14/10	17/14/10	21/17/13	19/16/12	
Water content	[%]	0,008	0,009	0,008	0,009	
Fluid viscosity @ 40° C	[cSt]	46,4	45,6	45,1	44,8	
Fluid viscosity @ 100° C	[cSt]	8,1	7,85	7,75	7,69	
TP-02100	0 % [s]	235	279	292	319	
	2 % [s]	401	535	506	558	
		After				
Test results to be recorded in phase II		308 hours	408 hours	508 hours	608 hours	
Output flow @ 250 bar	[l/min]	89,34	90,72	91,30	91,14	
Input torque @ 250/ 280 bar for piston pump	[Nm]	299,47	296,37	295,97	296,08	
Inlet temperature	[° C]	80,96	80,29	80,33	80,12	
Outlet temperature	[° C]	86,54	85,39	85,26	85,02	
Differential pressure through the return filter both pumps at P min	[mbar]	867,00	1036,90	1041,80	1364,20	
Water content	[%]	0,999	0,807	0,878	0,821	
Fluid viscosity @ 40° C	[cSt]	44,9	44,8	44,9	44,6	
Fluid viscosity @ 100° C	[cSt]	7,71	7,68	7,66	7,65	
TP-02100	1 %	381	453	516	642	
	2 %	612	805	986	>1800	

Piston pump

		Start up after	After			
Test results to be recorded in phase I		7 hours	107 hours	207 hours	307 hours	
Output flow @ 250 bar	[l/min]	59,37	59,07	60,22	59,32	
Drain flow @ 250 bar	[l/min]	2,06	2,36	2,38	2,28	
Inlet temperature	[° C]	108,49	109,83	110,63	110,50	
Outlet temperature	[° C]	113,33	115,22	115,35	115,48	
Drain temperature	[° C]	113,19	123,02	122,38	121,63	
		After				
Test results to be recorded in phase II		308 hours	408 hours	508 hours	608 hours	
Output flow @ 250 bar	[l/min]	62,58	62,86	60,99	61,74	
Drain flow @ 250 bar	[l/min]	1,47	1,61	2,11	2,24	
Inlet temperature	[° C]	79,24	79,87	80,05	79,85	
Outlet temperature	[° C]	83,56	84,30	84,47	84,21	
Drain temperature	[° C]	84,35	92,63	92,60	92,46	

Nearly no shear loss after 608 h runtime (EoT)

Parker
Denison Vane Technology

Parker Hannifin France SAS
142, rue de la Forêt
FR-94130 Courcouronnes-Arce
Tél. +33 (0)4 90 25 60 23
Fax +33 (0)4 90 25 67 57

FUCHS SCHMIERSTOFFE GmbH
Alt. Mr. Tobias Schürmann
Friedenheimer Strasse 19
68219 Mannheim,
Germany

Vierzon, January 11th, 2017

Subject : Fluid RENOLIN ZAF ** MC.

Kind attn : Mr. Tobias Schürmann,

Dear Sir,

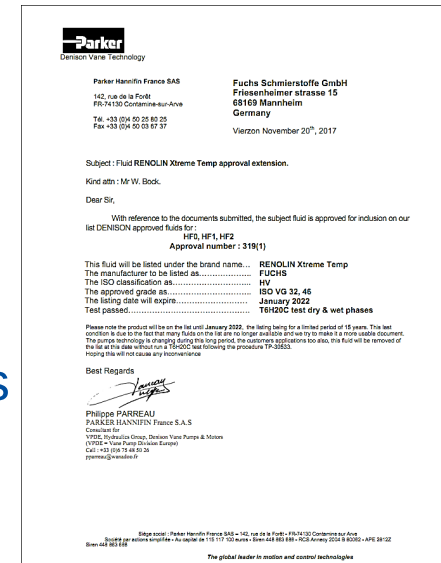
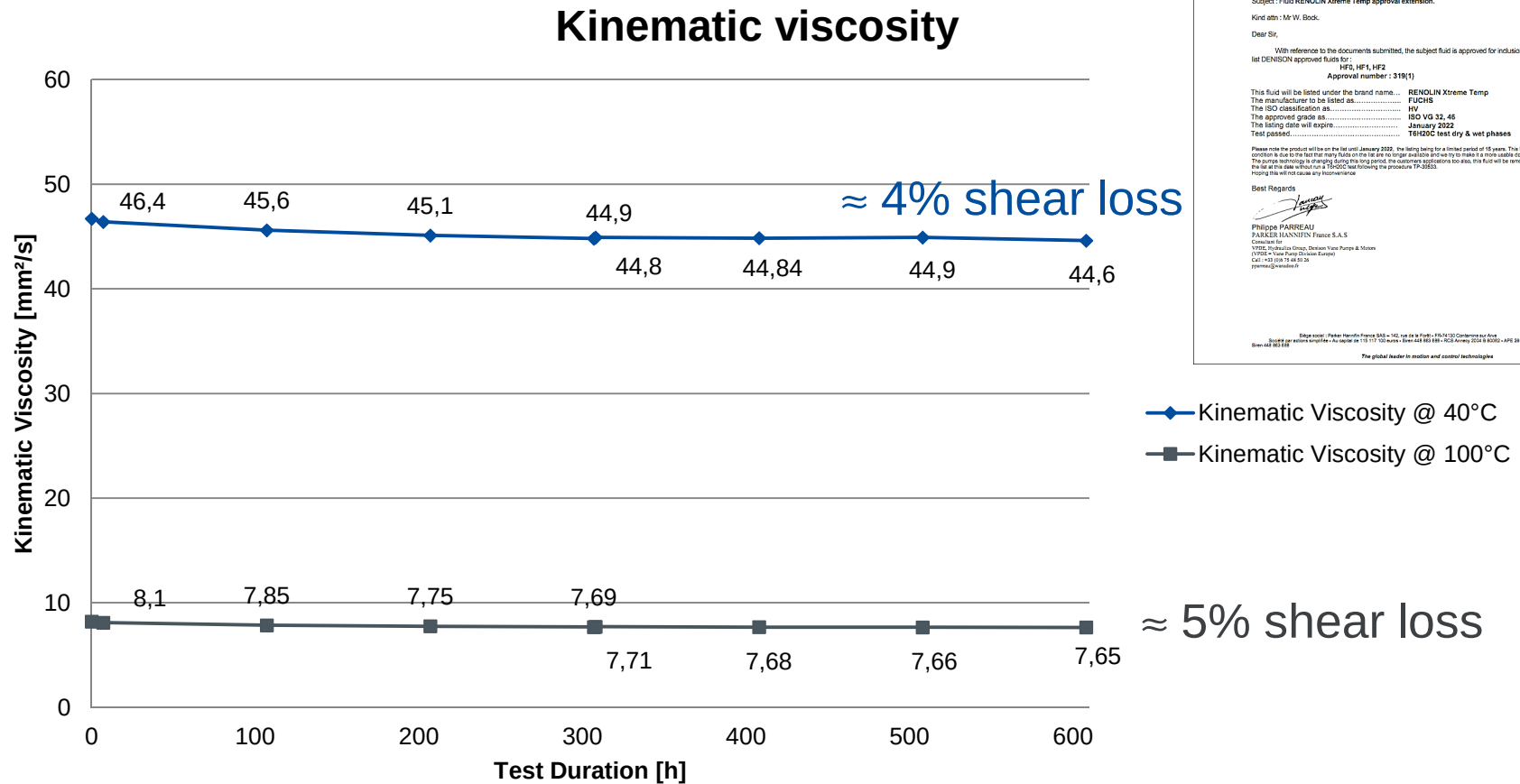
With reference to the documents submitted, the subject fluid is approved for being included on our full DENISON approved fluids list :

ISO VG 46, ISO VG 68, ISO VG 100, ISO VG 150, ISO VG 220, ISO VG 320, ISO VG 460, ISO VG 680, ISO VG 1000, ISO VG 1500, ISO VG 2200, ISO VG 3200, ISO VG 4600, ISO VG 6800, ISO VG 10000, ISO VG 15000, ISO VG 22000, ISO VG 32000, ISO VG 46000, ISO VG 68000, ISO VG 100000, ISO VG 150000, ISO VG 220000, ISO VG 320000, ISO VG 460000, ISO VG 680000, ISO VG 1000000, ISO VG 1500000, ISO VG 2200000, ISO VG 3200000, ISO VG 4600000, ISO VG 6800000, ISO VG 10000000, ISO VG 15000000, ISO VG 22000000, ISO VG 32000000, ISO VG 46000000, ISO VG 68000000, ISO VG 100000000, ISO VG 150000000, ISO VG 220000000, ISO VG 320000000, ISO VG 460000000, ISO VG 680000000, ISO VG 1000000000, ISO VG 1500000000, ISO VG 2200000000, ISO VG 3200000000, ISO VG 4600000000, ISO VG 6800000000, ISO VG 10000000000, ISO VG 15000000000, ISO VG 22000000000, ISO VG 32000000000, ISO VG 46000000000, ISO VG 68000000000, ISO VG 100000000000, ISO VG 150000000000, ISO VG 220000000000, ISO VG 320000000000, ISO VG 460000000000, ISO VG 680000000000, ISO VG 1000000000000, ISO VG 1500000000000, ISO VG 2200000000000, ISO VG 3200000000000, ISO VG 4600000000000, ISO VG 6800000000000, ISO VG 10000000000000, ISO VG 15000000000000, ISO VG 22000000000000, ISO VG 32000000000000, ISO VG 46000000000000, ISO VG 68000000000000, ISO VG 100000000000000, ISO VG 150000000000000, ISO VG 220000000000000, ISO VG 320000000000000, ISO VG 460000000000000, ISO VG 680000000000000, ISO VG 1000000000000000, ISO VG 1500000000000000, ISO VG 2200000000000000, ISO VG 3200000000000000, ISO VG 4600000000000000, ISO VG 6800000000000000, ISO VG 10000000000000000, ISO VG 15000000000000000, ISO VG 22000000000000000, ISO VG 32000000000000000, ISO VG 46000000000000000, ISO VG 68000000000000000, ISO VG 100000000000000000, ISO VG 150000000000000000, ISO VG 220000000000000000, ISO VG 320000000000000000, ISO VG 460000000000000000, ISO VG 680000000000000000, ISO VG 1000000000000000000, ISO VG 1500000000000000000, ISO VG 2200000000000000000, ISO VG 3200000000000000000, ISO VG 4600000000000000000, ISO VG 6800000000000000000, ISO VG 10000000000000000000, ISO VG 15000000000000000000, ISO VG 22000000000000000000, ISO VG 32000000000000000000, ISO VG 46000000000000000000, ISO VG 68000000000000000000, ISO VG 100000000000000000000, ISO VG 150000000000000000000, ISO VG 220000000000000000000, ISO VG 320000000000000000000, ISO VG 460000000000000000000, ISO VG 680000000000000000000, ISO VG 1000000000000000000000, ISO VG 1500000000000000000000, ISO VG 2200000000000000000000, ISO VG 3200000000000000000000, ISO VG 4600000000000000000000, ISO VG 6800000000000000000000, ISO VG 10000000000000000000000, ISO VG 15000000000000000000000, ISO VG 22000000000000000000000, ISO VG 32000000000000000000000, ISO VG 46000000000000000000000, ISO VG 68000000000000000000000, ISO VG 100000000000000000000000, ISO VG 150000000000000000000000, ISO VG 220000000000000000000000, ISO VG 320000000000000000000000, ISO VG 460000000000000000000000, ISO VG 680000000000000000000000, ISO VG 1000000000000000000000000, ISO VG 1500000000000000000000000, ISO VG 2200000000000000000000000, ISO VG 3200000000000000000000000, ISO VG 4600000000000000000000000, ISO VG 6800000000000000000000000, ISO VG 10000000000000000000000000, ISO VG 15000000000000000000000000, ISO VG 22000000000000000000000000, ISO VG 32000000000000000000000000, ISO VG 46000000000000000000000000, ISO VG 68000000000000000000000000, ISO VG 100000000000000000000000000, ISO VG 150000000000000000000000000, ISO VG 220000000000000000000000000, ISO VG 320000000000000000000000000, ISO VG 460000000000000000000000000, ISO VG 680000000000000000000000000, ISO VG 1000000000000000000000000000, ISO VG 1500000000000000000000000000, ISO VG 2200000000000000000000000000, ISO VG 3200000000000000000000000000, ISO VG 4600000000000000000000000000, ISO VG 6800000000000000000000000000, ISO VG 10000000000000000000000000000, ISO VG 15000000000000000000000000000, ISO VG 22000000000000000000000000000, ISO VG 32000000000000000000000000000, ISO VG 46000000000000000000000000000, ISO VG 68000000000000000000000000000, ISO VG 100000000000000000000000000000, ISO VG 150000000000000000000000000000, ISO VG 220000000000000000000000000000, ISO VG 320000000000000000000000000000, ISO VG 460000000000000000000000000000, ISO VG 680000000000000000000000000000, ISO VG 1000000000000000000000000000000, ISO VG 1500000000000000000000000000000, ISO VG 2200000000000000000000000000000, ISO VG 3200000000000000000000000000000, ISO VG 4600000000000000000000000000000, ISO VG 6800000000000000000000000000000, ISO VG 10000000000000000000000000000000, ISO VG 15000000000000000000000000000000, ISO VG 22000000000000000000000000000000, ISO VG 32000000000000000000000000000000, ISO VG 46000000000000000000000000000000, ISO VG 68000000000000000000000000000000, ISO VG 100000000000000000000000000000000, ISO VG 150000000000000000000000000000000, ISO VG 220000000000000000000000000000000, ISO VG 320000000000000000000000000000000, ISO VG 460000000000000000000000000000000, ISO VG 680000000000000000000000000000000, ISO VG 1000000000000000000000000000000000, ISO VG 1500000000000000000000000000000000, ISO VG 2200000000000000000000000000000000, ISO VG 3200000000000000000000000000000000, ISO VG 4600000000000000000000000000000000, ISO VG 6800000000000000000000000000000000, ISO VG 10000000000000000000000000000000000, ISO VG 15000000000000000000000000000000000, ISO VG 22000000000000000000000000000000000, ISO VG 32000000000000000000000000000000000, ISO VG 46000000000000000000000000000000000, ISO VG 68000000000000000000000000000000000, ISO VG 100000000000000000000000000000000000, ISO VG 150000000000000000000000000000000000, ISO VG 220000000000000000000000000000000000, ISO VG 320000000000000000000000000000000000, ISO VG 460000000000000000000000000000000000, ISO VG 680000000000000000000000000000000000, ISO VG 1000000000000000000000000000000000000, ISO VG 1500000000000000000000000000000000000, ISO VG 2200000000000000000000000000000000000, ISO VG 3200000000000000000000000000000000000, ISO VG 4600000000000000000000000000000000000, ISO VG 6800000000000000000000000000000000000, ISO VG 10000000000000000000000000000000000000, ISO VG 15000000000000000000000000000000000000, ISO VG 22000000000000000000000000000000000000, ISO VG 32000000000000000000000000000000000000, ISO VG 46000000000000000000000000000000000000, ISO VG 68000000000000000000000000000000000000, ISO VG 100000000000000000000000000000000000000, ISO VG 150000000000000000000000000000000000000, ISO VG 220000000000000000000000000000000000000, ISO VG 320000000000000000000000000000000000000, ISO VG 460000000000000000000000000000000000000, ISO VG 680000000000000000000000000000000000000, ISO VG 1000000000000000000000000000000000000000, ISO VG 1500000000000000000000000000000000000000, ISO VG 2200000000000000000000000000000000000000, ISO VG 3200000000000000000000000000000000000000, ISO VG 4600000000000000000000000000000000000000, ISO VG 6800000000000000000000000000000000000000, ISO VG 100, ISO VG 15000000000000000000000000000000000000000, ISO VG 22000000000000000000000000000000000000000, ISO VG 32000000000000000000000000000000000000000, ISO VG 46000000000000000000000000000000000000000, ISO VG 68000000000000000000000000000000000000000, ISO VG 1000, ISO VG 1500, ISO VG 2200, ISO VG 3200, ISO VG 4600, ISO VG 6800, ISO VG 100, ISO VG 15000, ISO VG 22000, ISO VG 32000, ISO VG 46000, ISO VG 68000, ISO VG 1000, ISO VG 1500, ISO VG 2200, ISO VG 3200, ISO VG 4600, ISO VG 6800, ISO VG 100, ISO VG 15000, ISO VG 22000, ISO VG 32000, ISO VG 46000, ISO VG 68000, ISO VG 1000, ISO VG 1500, ISO VG 2200, ISO VG 3200, ISO VG 4600, ISO VG 6800, ISO VG 100, ISO VG 15000, ISO VG 22000, ISO VG 32000, ISO VG 46000, ISO VG 68000, ISO VG 1000, ISO VG 1500, ISO VG 2200, ISO VG 3200, ISO VG 4600, ISO VG 6800, ISO VG 100, ISO VG 15000, ISO VG 22000, ISO VG 32000, ISO VG 46000, ISO VG 68000, ISO VG 1000, ISO VG 1500, ISO VG 2200, ISO VG 3200, ISO VG 4600, ISO VG 6800, ISO VG 100, ISO VG 15000, ISO VG 22000, ISO VG 32000, ISO VG 460

Parker Denison HF-0 Pump Test for Hydraulic Fluids Record of Viscosity

e.g. RENOLIN ZAF 46 MC

Multigrade HVI Hydraulic Fluid – shear loss!



Approval according to **Bosch Rexroth RDE 90245** and **Denison HF-0**

e.g. **RENOLIN Xtreme Temp**

- Premium AW hydraulic fluid,
Group III Base oils
- HVLP / HV (DIN 51524-3 / ISO 6743-4)
- Excellent lifetime
- Very good wear protection
- Extremely high and shear stable viscosity index (VI = 180)
- Wide operating temperature range
- Approvals:
 - **BR Fluid Rating List RDE 90245**
 - **Denison HF-0**

Product Information


RENOLIN Xtreme Temp

AW hydraulic and lubricating oils with a high viscosity index - high shear stability

Description

The RENOLIN Xtreme Temp series was developed for hydraulic systems which are working in a wide temperature range. The shear-stable, high viscosity index (HVI) guarantees a low viscosity at low start-up temperatures and a good low-temperature flowability of the oil. This shear-stable viscosity index will also guarantee a higher viscosity at high temperatures – a stable lubricating film at high working temperatures compared to standard HLP hydraulic oils. The RENOLIN Xtreme Temp series is based on selected semi-synthetic base oils in combination with additives to improve the viscosity-temperature behaviour (so-called VI improvers). These polymers guarantee a shear-stable viscosity index – low viscosity at low temperatures, higher viscosity at high temperatures. The energy consumption when starting up the system is reduced, and the stability of the lubricating film at high temperatures is improved by using RENOLIN Xtreme Temp. Therefore wear on hydraulic pumps and motors can be reduced. The use of RENOLIN Xtreme Temp will offer a thicker lubricating film at high temperatures and a better high-pressure stability, which reduces wear and leakages in the system. The combination of the base oil with selected additives guarantees the improvement of the low-temperature properties compared to conventional HVI oils. The RENOLIN Xtreme Temp series contains VI improvers (polymers) which are extremely shear-stable.

Shear losses can occur after a short time of operation when conventional HVI oils are used which contain low-performance VI improvers. This leads to a viscosity decrease, a decrease of the viscosity index due to shearing of the long molecule chains of the polymer additives (VI improvers).

Advantages

- Excellent shear stability
- Excellent viscosity-temperature-behaviour
- High viscosity index
- Excellent low-temperature behaviour
- Low foaming
- Good air release
- High ageing stability
- Good corrosion protection
- Very good wear protection
- Wide operating temperature range
- Selected semi-synthetic base oils

FUCHS SCHMIERSTOFFE GMBH
Friedenstraße 10
83153 Marzling-Garmisch

Phone +49 821 9751-0
Fax +49 821 9751-673
service@fuchs-schmierstoffe.de

10718 9545333
DIN 51524-3 / ISO 6743-4
HLP-HV
HSD-M-Lite



PI 4-1088, Page 1, PM 4 / 02.16



3/19/2018

Wolfgang Bock, Gerit Dornacher, Tobias Schürmann

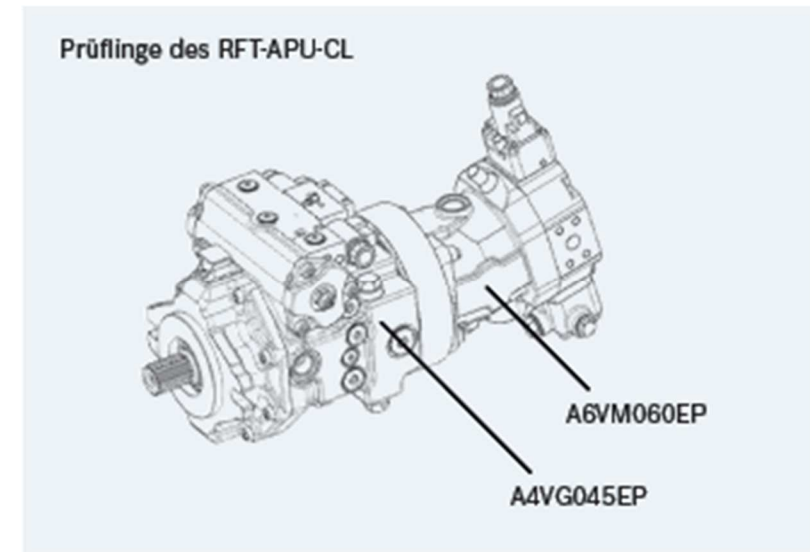
18

RFT-APU-CL – Bosch Rexroth Germany

Rexroth Fluid Test Axial Piston Unit Closed Loop

- Fluid test for closed loops / circuits
- Use of a combined unit:
 - Hydraulic pump A4VG045EP
 - Hydraulic motor A6VM060EP
- Simulation of hydrostatic drivetrain
- Test procedure
 - Break-in test
 - Swivel cycle cyclus
 - Corner Power Test
- Approval criterions
 - Meassurement of weight- or dimension change of components
 - Material compatibility
 - Optical surface evaluation

High Pressure Test Rig for Industrial and Mobile Hydraulic Fluids



Source: Bosch Rexroth

RFT-APU-CL – Bosch Rexroth Germany

Rexroth Fluid Test Axial Piston Unit Closed Loop

2. Swivel cycle test

- Revolutions 4000 min⁻¹
- Pressure 450 bar
- Duration 300 h

2. Test unit

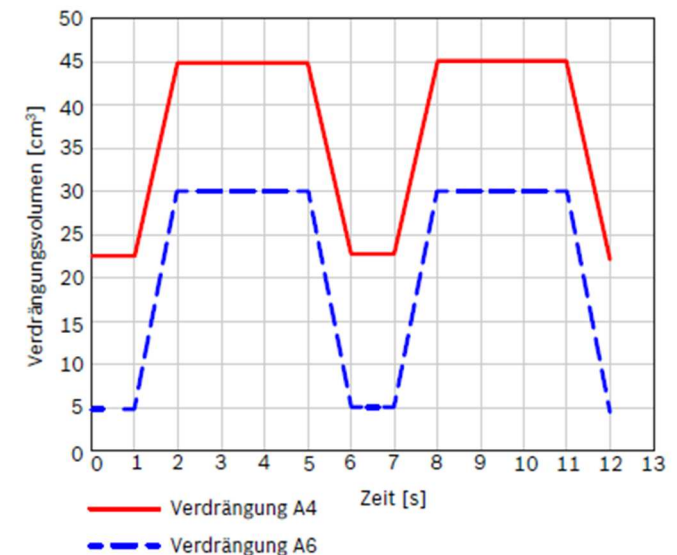


Fig. 2: test unit (tandem unit - A4VG pump / A6VM motor)

Source: Bosch Rexroth

- Pump swivels between half and maximum swivel angle (22,5 ccm / 45 ccm)
- Motor swivels contemporaneous between minimum and half swivel angle (5 ccm / 30 ccm)
- Difference (15 ccm) goes through pressure relief valve (450 bar)
- Pressure constant at 450 bar

▼ Schwenkzyklus (schematische Darstellung)



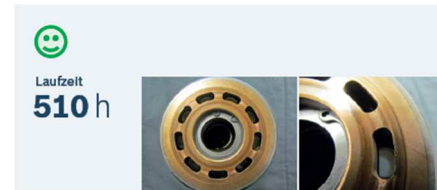
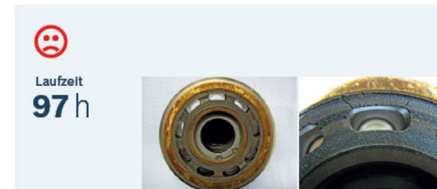
RFT-APU-CL – Bosch Rexroth Germany

Rexroth Fluid Test Axial Piston Unit Closed Loop

3. Corner Power Cycle

- Revolutions 4000 min⁻¹
 - Pressure 500 bar
 - Duration 200 h
-
- Pump fixed on maximum swivel angle (= 45 ccm)
 - Motor fixed on half swivel angle (= 30 ccm)
 - Difference (15 ccm / revolution) runs back through pressure relief valve (500 bar)
 - Pressure constant at 500 bar

Pump



Motor

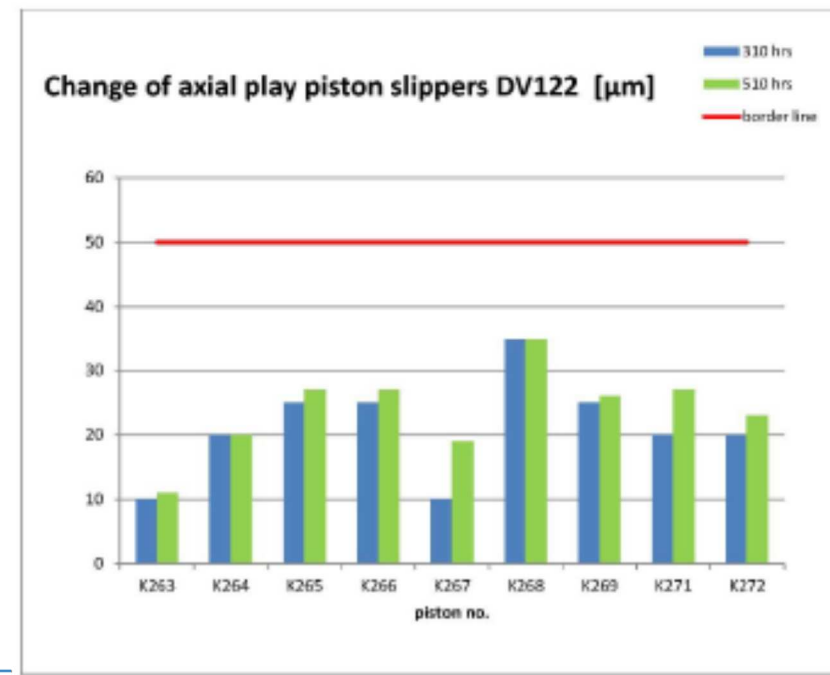
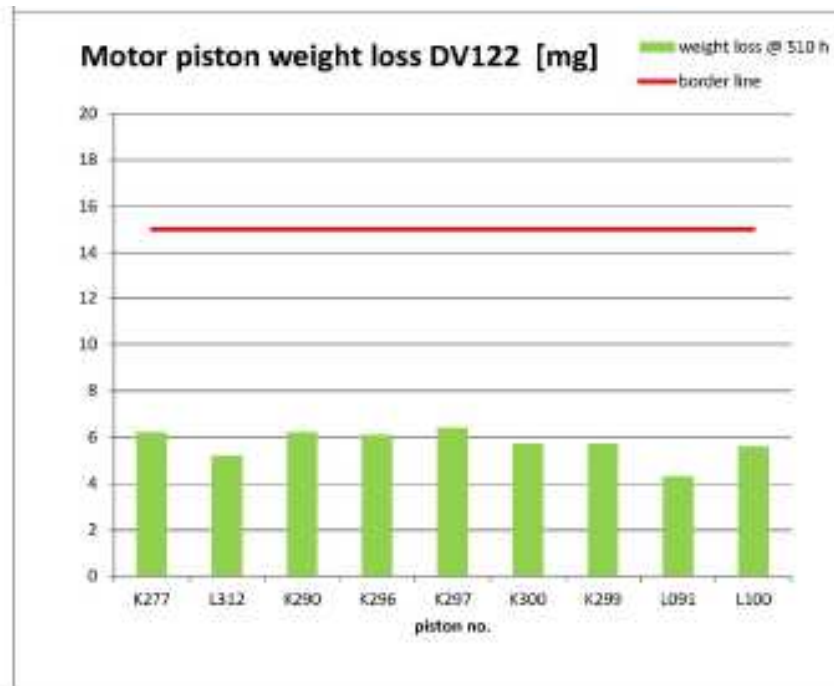


Source: Bosch Rexroth

RFT-APU-CL – Bosch Rexroth Germany

Rexroth Fluid Test Axial Piston Unit Closed Loop

Test result: e.g. RENOLIN XtremeTemp 46 = excellent



RFT-APU-CL – Bosch Rexroth Germany

Rexroth Fluid Test Axial Piston Unit Closed Loop



6. Pictures of visual inspection after 510 hrs



Fig.51: cylinder A4 sphere overview



Fig.52: cylinder A4 sphere detail

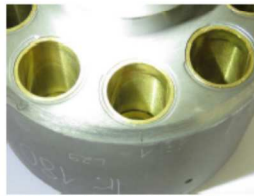


Fig.53: cylinder A4 with bushing in piston bores



Fig.54: control plate overview



Fig.55: control plate detail high pressure outlet (left kidney)



Fig.56: control plate detail high pressure inlet (left kidney)



Fig.57: piston slipper pad



Fig.58: slipper pad retaining plate side



Fig.59: slipper pad



Fig.60: view on top side of cradle



Fig.61: cradle bearing low pressure side



Fig.62: cradle bearing high pressure side



Fig.63: liner low pressure side



Fig.64: liner high pressure side

Test result: e.g. RENOLIN Xtreme Temp 46 = excellent

Bosch Rexroth Fluid Rating List RDE 90245

The Drive & Control Company
Rexroth
Bosch Group

Bosch Rexroth Fluid Rating List
für Rexroth-Hydraulikkomponenten (Pumpen und Motoren)*
*for Rexroth hydraulic components (pumps and motors)**

RDE 90245
Edition: 09.2017
Replaces: 03.2017

*Exception Hägglunds products, see 15414

Die unten genannten Hydraulikflüssigkeiten sind von der Bosch Rexroth AG positiv bewertet. Sie erfüllen die Bedingungen nach RD 90235 für eine Listung in der Bosch Rexroth Fluid Rating List 90245.

Hydraulic fluids mentioned below have been rated favourably by Bosch Rexroth AG. The requirements for listing according to RE 90235 on the Bosch Rexroth Fluid Rating List 90245 are fulfilled.

Klassifizierung von Hydraulikflüssigkeiten / <i>Hydraulic Fluids Classification</i>	
Hydraulikflüssigkeiten auf Basis von Mineralölen und artverwandten Kohlenwasserstoffen / <i>Hydraulic fluids based on mineral oil and related hydrocarbons</i>	HL (HL), HLP (HM), HVLP (HV) und weitere / <i>and other</i>
Umweltverträgliche Hydraulikflüssigkeiten / <i>Environmentally acceptable hydraulic fluids</i>	HETG, HEPG, HEES, HEPR
Schwerentflammbare Hydraulikflüssigkeiten – wasserfrei / <i>Fire-resistant, water-free hydraulic fluids</i>	HFDR, HFDU und weitere / <i>and other</i>
Schwerentflammbare Hydraulikflüssigkeiten – wasserhaltig / <i>Fire-resistant, water-containing hydraulic fluids</i>	HFAE, HFAS, HFB, HFC und weitere / <i>and other</i>

Product name	Base oil type	Characteristics	Additive type
RENOLIN B HP	Group I	HLP	zn-containing
RENOLIN B HP PLUS	Group II	HLP	zn-containing
RENOLIN XTREME TEMP	Group III	HVLP	zn-containing
RENOLIN ZAF 46 MC	Group III	HVLP	zn-free

„Approved“
with excellent
results

- **Hydraulic fluids are liquid machine elements**
- **Pump viscosity requirements (at low temperatures) have to be considered**
- **Trend to new base oil qualities, Group II, Group III**
- **Pump manufacturers qualify the hydraulic fluids in stress tests to guarantee lifetime of components**
- **Multigrade fluids with optimized additive systems can surpass the stress tests, e.g. Parker, Bosch Rexroth**
 - to guarantee wear protection**
 - film thickness**
 - lifetime**

Thank you for your attention!

Contact:

Fuchs Schmierstoffe GmbH
Friesenheimer Strasse 19
68169 Mannheim/Germany

- Wolfgang Bock
Head of Product Management Industrial Oils
Phone: +49 621 3701 1684
e-mail: Wolfgang.Bock@fuchs-schmierstoffe.de
- Gerit Dornacher
Product Management Industrial Oils
Phone: +49 621 3701 1421
e-mail: Gerit.Dornacher@fuchs-schmierstoffe.de
- Tobias Schürmann
Research & Development Industrial Oils
Phone: +49 621 3701 1413
e-mail: Tobias.Schuermann@fuchs-schmierstoffe.de