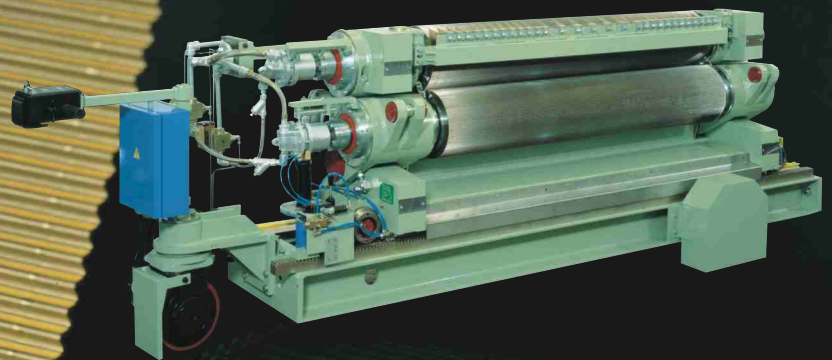
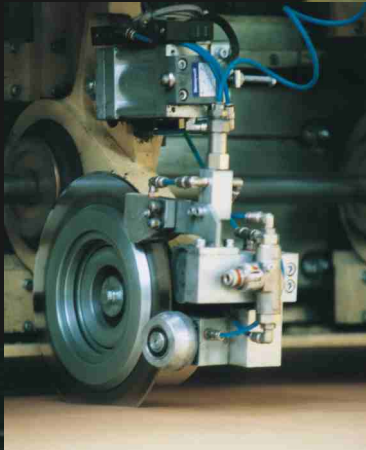


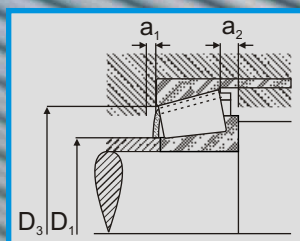
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## HT/HL

Lubricating grease for various types of rolling bearings, subject to high loads, high and extreme temperatures, with favourable friction behaviour



LUBCON  
TURMOTEMP®  
LP 2502  
LP 5002

Your Partner  
for the Lubrication of Bearings



The high efficiency of the **LUBCON** lubricants is proven by

- long service life
- good running properties
- high operational reliability



## Lubrication of Corrugating Machines in General

In many machines containing rolling bearings a lubrication for life is used nowadays to avoid the troublesome relubrication which might even imperil the good function of the machine. This applies above all to ball bearings which are subject to moderate loads.

The  $k_r$ -values of the known service life diagram of greases (see **diagram 1, p. 6**) are low for ball bearings and thus guarantee sufficiently long lubrication intervals or a lubrication for life. The lubrication interval is, of course, shorter than the service life of the grease.

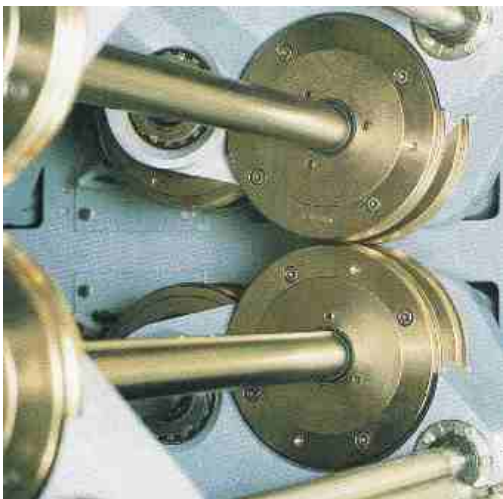
For rolling bearing types with higher demands on the lubrication, such as tapered roller bearings and spherical roller bearings, the  $k_r$ -values are, however, definitely higher and consequently allow only moderate lubrication intervals of about 30 % of the lubrication intervals of ball bearings.

Machines for the corrugated board industry are subject to high loads and thus require bearing types providing a particularly high load carrying capacity and a high resistance to extreme service conditions, e. g. high temperatures. Such points of application, as for instance the bearing of the corrugated roll (see **figure 2, p. 5**), can only be operated safely over long lubricating intervals if the lubricating greases used are specifically conceived for such high demands.

Lubricating greases containing a temperature resistant thickener as well as efficient base oils and additives have proved of good results. Such high performance greases show favourable reducing factors in the field application (see **table 4, p. 6**) and guarantee long lubricating intervals.

For the other lubricating points of the corrugating machines - such as knives, spindles and chains - efficient lubricants tailor-made to the demands of modern machines are, of course, also required. Last but not least, an assembly paste which has proved of good results is also indispensable for the assembly works on corrugating machines.

In the following, lubricants are described which are excellently suitable for the mentioned lubricating points. Their efficiency is documented by technical data and proved in sophisticated mechanical dynamical tests.



**Fig. 1:** Tool body grooving element

## Critical Application Points: Bearings of Corrugated-, Press- and Preheating Rolls

### High performance grease TURMOTEMP® LP 2502 - properties and performance

The technical information of the lubricating grease **TURMOTEMP® LP 2502 (table 1, p. 4)** presents a grease which has worldwide proved of good results for bearings of corrugated-, press- and preheating rolls. The base oil of this grease is a PFPE-oil, its viscosity at +40 °C is approximately 250 mm<sup>2</sup>/s and it shows a good lubricity at high temperatures.

**TURMOTEMP LP 2502** is suitable for high speeds and is consequently considered as standard grease for corrugating machines.

The specific lithium soap used as thickener provides good lubricity to the grease even when used for rolling bearing types subject to high requirements in terms of lubrication engineering. Good protection against corrosion and wear as well as compatibility with elastomers and bearing materials are assured. The application range and the advantages of the grease **TURMOTEMP® LP 2502** are documented in **table 2, p. 6**.

The grease life-time **diagram 1, p. 6** results from tests partly run until bearing failure and allows to calculate the lubrication intervals. The infrared spectrum of **TURMOTEMP® LP 2502** in comparison to the PFPE/PTFE paste (**diagram 2, p. 6**) clearly illustrates the typical differences between grease and paste.

### Determination of the Application Range

The indications made concerning the application range and the grease life-time diagram are based upon test runs on the known, standardized (according to DIN) test machines FE9 and FE8. From the results of these complicated tests, the designer of lubricating greases recognizes the efficiency of his products already in the stage of development.

The FE8 test run with the grease **TURMOTEMP® LP 2502** was performed under test conditions that correspond to the application conditions of the corrugated roll bearing at a moderate speed, but in this case spherical roller bearings were used as test bearings. The test was run with operational intermissions during weekends up to a service time of 500 service hours and, after a total service time of 973 service hours, the results showed moderate wear rates of under 12 mg for the rollers, of under 70 mg for the rings and of under 170 mg for the cages, as illustrated by the **diagram 3, p. 6** and the photo of the tread of one of the inner rings (**figures 3, p. 7**).

The temperature resistance of the grease **TURMOTEMP® LP 2502** was proved successful in FE9 test runs at +200 °C, as demonstrated in **diagram 5, p. 7**. The service time reached of  $F_{50} = 300$  hours points to an upper temperature limit of at least +220 °C.

This brochure only contains product information. For specific information please refer to our technical data and safety data sheets. The indications made represent the present state of development and knowledge of **LUBRICANT CONSULT GMBH**. Subject to change. The products are subject to severe controls of manufacture and comply in full with the specifications set forth by our company, but due to the multitude of different influencing factors, we cannot assume any warranty for the successful application in each individual case. Therefore, we recommend to perform field tests. We strictly refuse any liability.



**Table 1: Technical data of TURMOTEMP® LP 2502**

Technical data	TURMOTEMP® LP 2502	Tested in acc. with
Service temperature range °C	-30 up to +250	
Colour	light beige	
Structure	homogeneous/creamy	
Density at +20 °C g/cm <sup>3</sup>	1.7	
Base oil viscosity (mm <sup>2</sup> /s) +40 °C/+100 °C	PFPE 250/26	DIN 51561
Thickener	Li special	
Worked penetration (mm/10)	265 - 295	DIN ISO 2137
Drop point °C	>+250	DIN ISO 2176
VKA welding force (N)	> 5 500	DIN 51350 pt4
Flow pressure at -30 °C	< 1 600 hPas	DIN 51805
Water resistance 3 h at +90 °C, rating	0 - 90	DIN 51807
Corrosion protection in acc. with SKF-Emcor	0 - 0	DIN 51802
Copper corrosion 24 h/+100 °C	0 - 100	DIN 51811
Speed factor (d <sub>m</sub> · n)	500 000	
Oil separation +40 °C/+100 °C	approx. 1.0 %/ approx. 2.5 %	DIN 51817
Contents of solid foreign matter, particle 25 µm	< 5 mg	

Behaviour towards FPM elastomer, 14 days/+200 °C	Initial value	Value after testing or change	Tested in acc. with
Hardness Shore A	75	74	DIN 53505
Change in volume (%)		3.2	DIN 53521
Tensile strength (N/mm <sup>2</sup> )	11.8	11.5	DIN 53504
PAEK-GF 20, 42 days/+200 °C			
Bending strength σ <sub>bB</sub> (N/mm <sup>2</sup> )	198	220	DIN 53452
Perimeter fibre elongation ε <sub>bB</sub> (%)	3.7	3.5	DIN 53452

**Table 2: Application range of TURMOTEMP® LP 2502 at load ratio P/C = 0.05 and temperature up to +200 °C**

Bearing	Speed factor n · d <sub>m</sub> (min <sup>-1</sup> · mm)
Ball bearing	500 000
Taper roller bearing and spherical roller bearing	250 000

Comparison of field-conditions: Application conditions of bearings in corrugated-, press- and preheating rolls.

Bearing	Speed factor n · d <sub>m</sub> (min <sup>-1</sup> · mm)	Life-time
Taper roller bearing	60 000 ... 100 000 at P/C < 0.05 and temperatures +170 up to +210 °C	1. Generation: Shaft hardened, grinded, 1.5 years, i. e. 20 Mill. meter corrugated bord 2. Generation: Shaft chromium plated, 2 years, i. e. 30 Mill. meter corrugated bord 3. Generation: Shaft coated with tungsten, 4 years, i. e. 70 Mill. meter corrugated bord
Spherical roller bearing		

Influence of speed factor on lubrication interval - see diagram 1, p. 6.

### Advantages of TURMOTEMP® LP 2502/5002

Why is the grease **TURMOTEMP® LP 2502** so favourable for the lubrication of roller bearings?

A lithium soap is used as a thickener providing a high dropping point >+250 °C and thus softening at a higher temperature. Consequently, the grease flows back to the point of contact leading indirectly to a relubrication of such points of lubrication.

This very important characteristic is the reason why the lubricating effect is outstanding even in roller bearing types which are subject to high requirements in terms of lubrication engineering.

The grease shows good lubricating properties over extended service times. The long lubrication interval can be calculated by means of the grease life-time diagram for **TURMOTEMP® LP 2502**.

The good lubricating effect results in low wear rates, approximately only 1/6 of the wear that has to be tolerated with various PFPE/PTFE pastes.

The grease shows good damping properties and provides low noise operation.

With **TURMOTEMP® LP 2502** the user saves 13 % compared to the PFPE/PTFE containing pastes: The weight of one litre of the grease **TURMOTEMP® LP 2502** is 1.73 kg, whereas that of one litre of PFPE/PTFE paste is 1.96 kg.

**It is the weight that has to be paid for, but it is the volume that counts for the lubrication of the bearings!**

The grease is non-poisonous, not detrimental to health, not subject to identification.

There is no special cleaner required.

The grease can be mixed with PFPE/PTFE containing pastes without any disadvantages.

**Table 3: LUBCON TURMOTEMP® general survey (product features)**

Product characteristics	TURMOTEMP® II/400 S	TURMOTEMP® II/400	TURMOTEMP® II/400 MI	TURMOTEMP® II/400 IL	TURMOTEMP® II/400 EL
Service temperature range °C	-30 up to +280	-30 up to +250	-35 up to +220	-40 up to +200	-40 up to +180
Colour	whitish	whitish	whitish	whitish	whitish
Structure	homogen	homogen	homogen	homogen	homogen
Density at +20 °C approx.	1.9	1.9	1.9	1.9	1.9
Consistency class NLGI DIN 51818	2	2	2	2	2
Mechanical load *VKA-o.k. load (N)	> 7 000	> 7 000	> 7 000	> 7 000	> 7 000
Speed factor (n · d <sub>m</sub> )	450 000	450 000	500 000	650 000	750 000
Corrosion protection DIN 51802	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0
Product characteristics	TURMOTEMP® II/400 OX <sup>3)</sup>	TURMOTEMP® II/400 RS 2 <sup>1)</sup>	TURMOTEMP® II/400 VAC-1	TURMOTEMP® II/400 SM	TURMOTEMP® II/400 KL <sup>2)</sup>
Service temperature range °C	-40 up to +200	-30 up to +260	-30 up to +280	-30 up to +280	-30 up to +260
Colour	whitish	whitish	whitish	grey/metallic	whitish
Structure	homogen	homogen	homogen	homogen	homogen
Density at +20 °C approx.	1.9	1.9	1.9	1.9	1.9
Consistency class NLGI DIN 51818	2	2	2	2	2
Mechanical load *VKA-o.k. load (N)	> 8 500	8 500	> 7 000	> 7 000	> 8 500
Speed factor (n · d <sub>m</sub> )	450 000	450 000	450 000	450 000	450 000
Corrosion protection DIN 51802	--	0 - 0	--	0 - 0	0 - 0

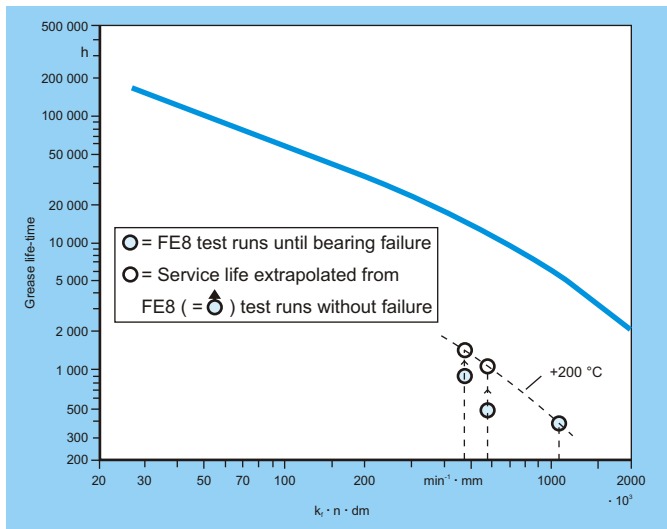
1) FE9 lifetime test +220 °C F<sub>50</sub> ≈ 300 h    2) FE9 lifetime test +150 °C F<sub>50</sub> ≈ 1 000 h    3) Oxygen-shock pressure limit 110 bar/+60 °C

According to DIN 51801 the dropping point of **TURMOTEMP®** lubricants is not determinable, that means they are not melting. Above +150 °C a certain oil dispensing is possible varying to the type.

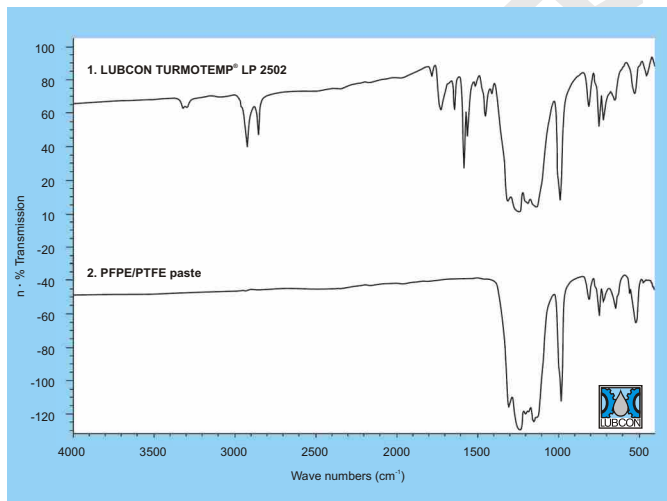
\*Four Ball Wear: Determines the wear preventive properties under conditions of boundary lubrication. Carried out under specific speed, temperature and load conditions with four balls arranged in the form of a tetrahedron (pyramid). Results are measured in mm, the average diameter of the scars on the lower three balls in the pyramid.


**Fig. 2: Corrugated roll**

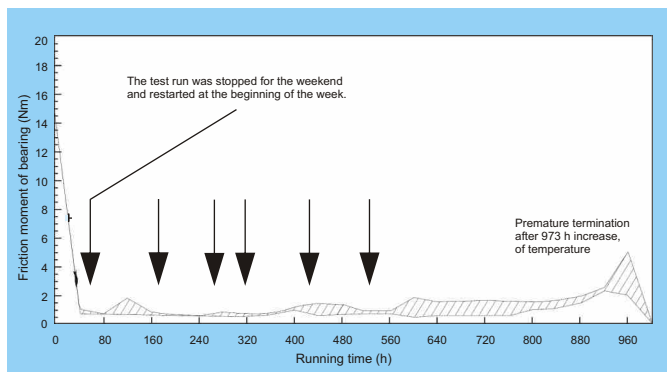
# Grease Life-time and Infrared Spectrum



**Diagram 1:**  
Grease life-time of **TURMOTEMP® LP 2502**



**Diagram 2:**  
Infrared spectrum of grease **TURMOTEMP® LP 2502** (=1) as well as a PFPE/PTFE-paste (=2). As PFPE/PTFE-paste **TURMOTEMP® II/400 RS 2** had been used



**Diagram 3:**  
FE8 test run with spherical roller bearings 22312 E.A.S.M.C3; axial load  $F_a = 5 \text{ kN}$ ; speed  $n = 750 \text{ min}^{-1}$ ; running time 973 h, up to a service time of 500 h with intermissions during the weekend  
Lubrication with **TURMOTEMP® LP 2502**

**Table 4:**

Bearing type		$k_f$
Deep groove ball bearing	single row	0.9 ... 1.1
	double row	1.5
Angular contact ball bearing	single row	1.6
	double row	2
Spindle bearing	$\alpha = 15^\circ$	0.75
	$\alpha = 25^\circ$	0.9
Four-point contact ball bearing		1.6
Self-aligning ball bearing		1.3 ... 1.6
Thrust ball bearing		5 ... 6
Angular contact thrust ball bearing	double row	1.4
	single row	3 ... 3.5
Cylindrical roller bearing	double row	3.5
	full complett	25
Cylindrical roller thrust bearing		90
Needle bearing		3.5
Taper roller bearing		4
Barrel roller bearing		10
Spherical roller bearing, no lips ("E")		7 ... 9
Spherical roller bearing with center lip		9 ... 12

## Reduction factors for application of TURMOTEMP® LP 2502 in bearings of corrugated rolls

The grease life-time getting from diagram must be multiplied by these reduction factors to get the realistic grease life-time. As lubrication interval should be taken according to requirements 50 % up to 80 % of the realistic grease life-time.

Effect of dust and moisture on the bearing contact surfaces, moderate  $f_1 = 0.7 \dots 0.9$

Effect of shock load and vibrations, moderate  $f_2 = 0.7 \dots 0.9$

Effect of high bearing temperature must not be considered because the grease life-time-diagram contains results at realistic temperature.

Effect of high loads according to  $P/C = 0.03 \dots 0.05$   $f_4 = 0.7 \dots 1.0$

Effect of air slight current passing through the bearing  $f_5 = 0.7 \dots 1.0$

**Table 5:**

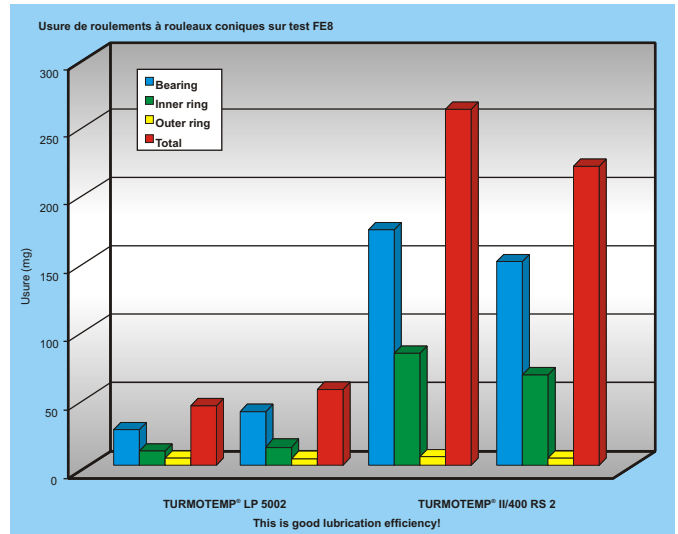
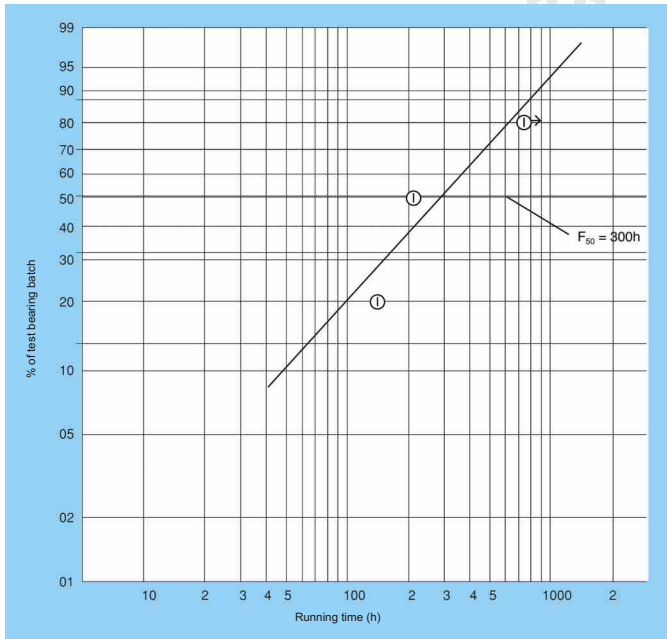
Parameters	Test run 1	FAG requirements after 500 h of service time
Steady-state temperature in °C	202/220	
Wear in mg of		
- rolling elements	11/9	< 35
- cage	170/30	< 100
- inner ring	67/10	Evaluation: good wear protection
- outer ring	30/7	
Friction behaviour over the time (see diagram above)	smooth operation, later not smooth	

**Diagram 4:**

The results of the FE8 test runs with **TURMOTEMP® LP 5002** and **TURMOTEMP® II/400 RS 2**, are shown in direct comparison on the following diagram.

It is obvious that the wear is reduced to 80 % and therefore an extended lifetime of the bearings is guaranteed.

On the following pages the different FE8 test runs are represented.



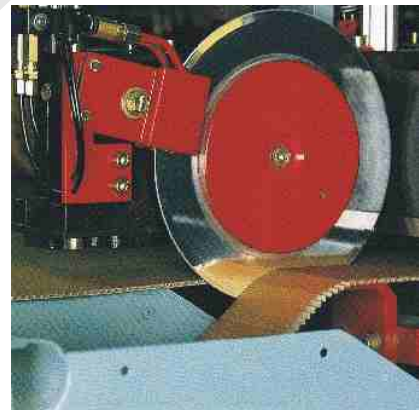
**Diagram 5:**

FE9 test run with angular contact ball bearing 529689 ( $\cong$  7206 B), assembly A, i. e. open bearing; axial load  $F_a = 1,5 \text{ kN}$ ; speed  $n = 3000 \text{ min}^{-1}$ ; temperature  $+200 \text{ }^\circ\text{C}$

Lubrication with **TURMOTEMP® LP 2502**, grease service life of tested bearings in hours according to the Weibull diagram:  
 $F_{50} = 300 \text{ h}$



**Fig. 3:** Photos of roller tube surfaces as well as running tread of bearing inner ring - as tested see **diagram 3, p. 6**



**Fig. 4:** Cross cutter knives and Disc-Cut system



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