Comment for PFAS Consultation on Restriction of Production, Marketing and Use of PFAS

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Content

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1. Why PFAS is used by RWG?

RWG Germany is a strategic supplier for various kinds of bearings for the global aerospace industry. The product range of RWG is shown in figure 1.

figure 1: Product range RWG

One of our core product lines are so called self-lubricating plain bearings which do not require any grease or oil for lubrication. These bearings are equipped with a fabric-based liner which contains PTFE as dry-lubricating component. The liner and its positions in the products are shown in red in figure 2.

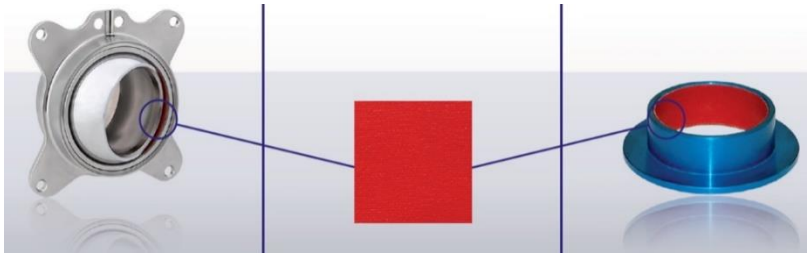

figure 2: Liner

Typical applications in aerospace are: High-lift systems, flight controls, cargo/passenger/emergency exit doors, cockpit controls and many more. There are several reasons why PTFE is used for bearing applications:

a) PTFE provides the lowest coefficient of friction of all known dry lubricants. Low friction results in low handling/actuation forces which is essential for energy efficient systems and safety relevant components. It is also key for low wear rate to allow for long bearing life and helps to reduce waste of resources.

b) Resistance against chemicals and environmental conditions. PTFE is chemically almost inert and therefore is not affected by contamination with aggressive substances potentially present during aircraft operation, such as: Phosphate-ester based hydraulic fluids, kerosene, anti- and de-icing fluids, cleaning agents (e.g. isopropyl), sodium-chloride fog and many more. (DIN EN2755 – 14.5) Furthermore PTFE is suitable for a wide range of operating temperatures up to 315°C

c) PTFE is physiological harmless. This allows it to be processed under regular working conditions without additional safety measures. There are no health risks for the workforce.

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2. How large is the proportion of PFAS in RWG products?

Liner Fraslip-F:

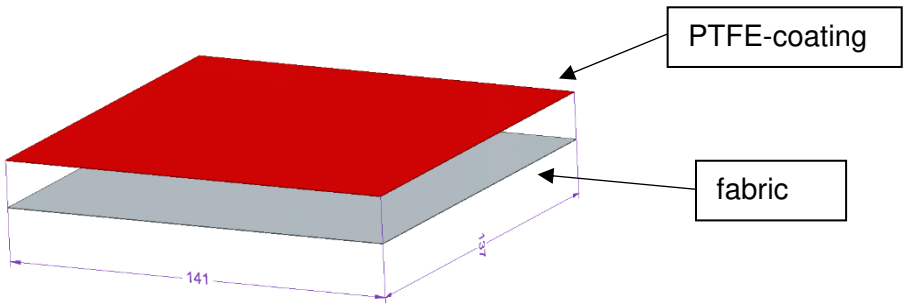

figure 3: Liner Fraslip-F

The most used liner at RWG is the Fraslip-F liner. This liner consists of a fabric and a PTFE coating embedded in it. Figure 3 shows the components of Fraslip-F. The PTFE coating contains 25% PTFE. The finished product of the liner, including the fabric, contains 10,4% PTFE.

The liner and thus PTFE is mainly found in spherical plain bearings and bushes at RWG. In the following, a spherical plain bearing and a bush are described in more detail. Furthermore, the mass fraction of PTFE in the total bearing of these two will be determined.

Spherical plain bearing:

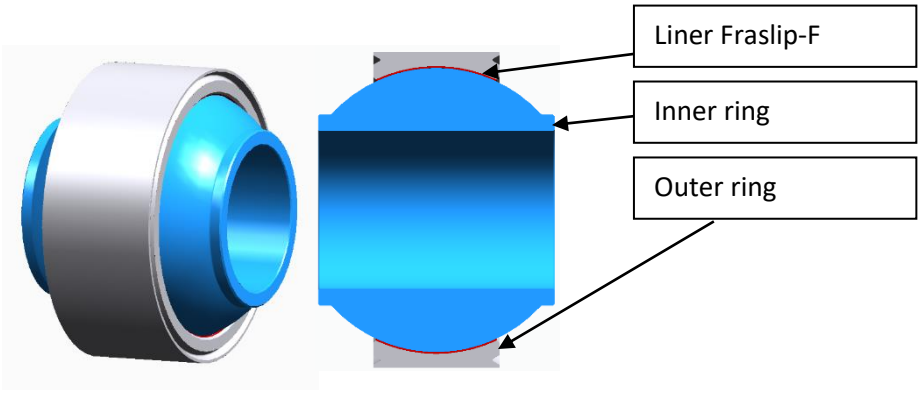

figure 4: Spherical plain bearing as 3D model (left) / Spherical plain bearing in section with individual part labeling (right)

table 1: Masses individual parts spherical plain bearing

part	weight [g]
Outer ring	136
Inner ring	449
Liner Fraslip-F	2,12
Total	587,12

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A spherical plain bearing consists of an outer ring and an inner ring. Between them is the liner. Figure 4 shows a 3D model and a sectional view of such a bearing. In this representation, the three components of the bearing can be clearly seen.

Table 1 shows the masses of the individual parts. The liner makes up only a very small part of the total mass of the bearing. Furthermore, only 10.4% of the liner consists of PTFE. This results in a pure PTFE mass of 0.22 g for this bearing.

The percentage of PTFE in this spherical plain bearing is:

$$\frac{0{,}22\ g}{587{,}12\ g} = 0{,}0003747\ \approx 0{,}037\ \%$$

Bushing:

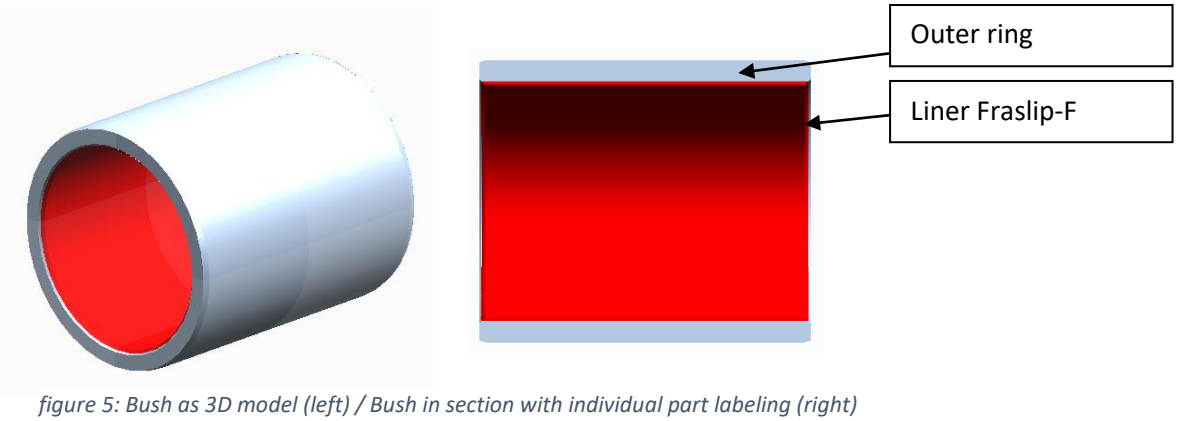

figure 5: Bush as 3D model (left) / Bush in section with individual part labeling (right)

table 2: Masses of individual parts bushings

part	weight [g]
Outer ring	40
Liner Fraslip-F	1
total	41

A bushing usually consists of an outer ring and a liner, which is mounted in the bore of the bushing. Figure 5 shows a 3D model and a sectional view of a bushing. In this view, the components are clearly visible.

Table 2 shows the masses of the individual parts. The liner makes up only a small part of the total mass. Only 10.4% of the liner consists of PTFE. This results in a pure PTFE mass of 0.104 g.

The percentage of PFTE in this bushing is:

$$\frac{0{,}104\ g}{41\ g} = 0{,}0025\ \approx 0{,}25\ \%$$

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➔ The proportion of PTFE in our products is very low. However, this small amount of PTFE has a decisive influence on the quality and safe functionality of the components in our applications.

3. Are there alternatives to PTFE?

There are very few known substances which theoretically could be considered as alternatives to PTFE for bearing applications. Molybdenum disulphide, tungsten disulphide and graphite are the only ones currently known and rarely used in aerospace bearing applications. None of them comes even close to the wide spectrum of relevant characteristics of PTFE and therefore are no direct replacements.

4. Why PFAS was chosen earlier?

PTFE as bearing material has been used in aerospace for many decades. Its unique tribological and chemical characteristics are of paramount importance for the global aerospace industry. This is manifested by countless public and company standards which specifically require PTFE as dry-lubricant for bearings. Table 3 shows a list of a few standards requiring PTFE in self-lubricating coatings.

table 3: Standards for self-lubricating plain spherical bearings and bushings

Product type	Standard
Bushings	SAE-AS 81934 (general technical standard)
	ABS 2045 (Airbus standard)
	BACB28BF (Boeing standard)
Spherical plain bearings	SAE-AS 81820 (general technical standard)
	ASNA 2123 (Airbus standard)
	ABS 0683 (Airbus standard)
	ASNA 2121 (Airbus standard)
	BACB10JE (Boeing standard)
	BACB10ES (Boeing standard)
	BACB10FA (Boeing standard)

RWG Germany has chosen PTFE because of its characteristics and, predominately, because it was and is specifically required by our domestic and international customers.

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5. What would it mean for the product and company to switch to PFAS-free alternatives?

A short term (<10 years) ban of PTFE would cause loss of app. 65% of RWG's business and about 130 jobs (out of 200). The main, and much higher ranking impact would be on the global aerospace industry in general. Without PTFE lubricated bearings it is no longer possible to build aircrafts to the current technological standard. For RWG this would directly impact the majority of our 180 active customers. Amongst them companies such as Airbus, Boeing and Liebherr. Table 4 provides a list of our key customers.

table 4: RWG-customer-list

Name	Country
AIRBUS HELICOPTERS	DE
AIRBUS	GB
Chinese aerospace industry	CN
LIEBHERR	DE
PREMIUM AEROTEC	DE
LIQUID PROPULSION	IN
Bombardier	GB
Boeing	US
LATECOERE	FR
Goodrich	GB
SFS	DE
EMBRAER	BR
TAC	FR
BUNDESAMT für Wehrtechnik (German military)	DE
GULFSTREAM	US
GKN	GB
CTG	GB
Airbus Defense and Space	DE
FOKKER AEROSTRUCTURES	NL
PILATUS	CH

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Development of potential alternatives will be costly and time consuming as aerospace equipment is typically safety relevant and new products and technologies require extensive testing to substantiate their suitability. Both, aircraft manufacturers and standardisation organisations would be required to re-write or even release new standards, norms, blue-prints etc. calling out the to be developed new technology. As it is unlikely that any new developed alternative will provide identical characteristics as PTFE, significant efforts in re-designing entire aircraft systems along with time consuming qualification testing will be required.

As an example, aircraft passenger and emergency exit doors shall be mentioned here. The low coefficient of friction of PTFE ensures that the handling forces to unlock these doors are always on a level that ensures easy and quick opening in case of emergency. Higher friction materials in the relevant bearings would either be a major safety concern or would require an re-design of the doors.

figure 6: aircraft door and bearings installed there

Another example is the attachment of rotor blades to the rotor head of helicopters. There have been instances where traditional bushings without PTFE coating have caused fretting and ultimately cracks appeared with the risk of losing a rotor blade which would have lead to immediate crash of the helicopter. The problem was solved with additional PTFE liners on the relevant components which now ensures safe air travel.

There are numerous other applications where the unique characteristics of PTFE are essential to maintain the highest safety standards in air travel. Figure 7, 8 and 9 illustrates some further examples.

It is expected that even with a fairly suitable alternative to PTFE every aircraft platform would have to go through a full re-certification process as defined by European Aviation Safety Agency (EASA), Federal Aviation Administration (FAA) and many other national aviation safety organizations.

figure 7: Liner bearing installed on the engine of an aircraft

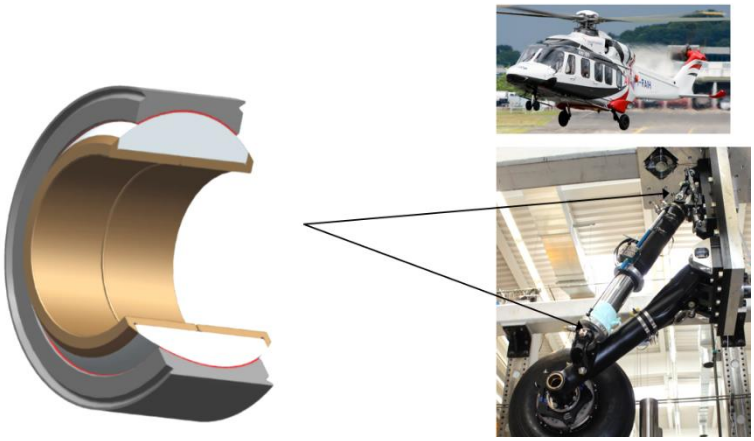

figure 8: Liner bearing in the landing gear of a helicopter

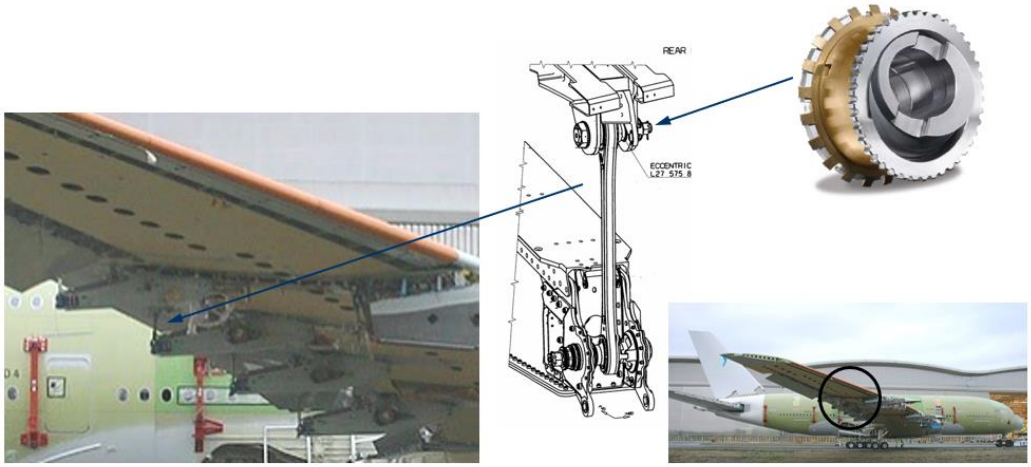

figure 9: Liner bearing in the wings of an aircraft

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RWG products are used in many European civil applications. The restriction of PFAS would have a negative impact on the production of many civil aircrafts. Table 5 shows some civil projects in which RWG parts are used.

table 5: Civil projects RWG

Civil application	Type of application
Airbus A220	Passenger airplane
Airbus A320	Passenger airplane
Airbus A321	Passenger airplane
Airbus A330	Passenger airplane
Airbus A340	Passenger airplane
Airbus A350	Passenger airplane
Airbus A380	Passenger airplane
Airbus Helicopters EC145	Utility helicopter
Airbus Helicopters BK117	Utility helicopter
Airbus Helicopters EC135	Utility helicopter
Airbus Beluga	Transport aircraft
Embraer ERJ-170	Passenger airplane
Embraer ERJ-190	Passenger airplane
Pilatus PC-12	Utility airplane
Pilatus PC-24	Passenger airplane
Dassault Falcon 5X	Passenger airplane

Furthermore, RWG products are used in many European military applications. Restricting PFAS would also have a major negative impact on the production of these applications. Table 6 shows a list of some military projects in which the RWG is involved.

table 6: Military projects RWG

Military application	Type of application
Eurofighter Typhoon	Fighter aircraft
Airbus A400M	Military transport aircraft
Lockheed Martin F-35	Fighter aircraft
Airbus A330-MRTT	Military used version of Airbus A330
Eurocopter Tiger	Attack helicopter
NH Industries NH 90	Military transport helicopter
Sikorsky CH-53G	Military transport helicopter
SAAB Gripen	Fighter aircraft
C-160 Transall	Military transport aircraft
Panavia Tornado	Fighter aircraft

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6. Conclusion

The restriction of PTFE would have a significant negative impact on the company's sales and therefore on the employees of RWG. Furthermore, it would have a very negative impact on the products produced by RWG in terms of quality and safety. The applications in which RWG products are used would also be affected. It would also cause problems for many major manufacturers of aircrafts, helicopters, etc. If there is an alternative for PTFE that has the same properties, it will also take a lot of time and cost to qualify it for the aerospace industry.