PERPETUATION OF MAPLUB GREASE RANGE

Jacques SICRE (CNES) [1]
Philippe VERGNE (LAMCOS) [2]
Olivier GUILLAUMON (MAP) - Philippe JUGNIOT (MAP) [3]

(1) Centre National d'Etudes Spatiales (CNES)
18 av Edouard Belin 31401 Toulouse Cedex 04 (France)
Tel: 33(0)561273133 Fax: 33(0)561273446
jacques.sicre@cnes.fr

(2) LaMCoS, UMR CNRS/INSA de Lyon 5514
INSA de Lyon, Bât. Jean d'Alembert
20 avenue Einstein – 69100 Villeurbanne
Tél. (33) 04.72.43.84.52 Fax: (33) 04.78.89.09.80
Philippe.vergne@insa-lyon.fr

(3) MAP (Space and High tech coatings)
ZI – Rue Clément Ader-09100 PAMIERS (France)
Tél : 33(0)534012700 Fax : 33(0)561602877
o.guillaumon@map-coatings.com – p.jugniot@map-coatings.com

In collaboration with LAMCOS and MAP Company, CNES have developed MAPLUB greases to meet the specific requirements of space mechanisms.

The main European laboratories and manufacturers (ESTL, LAMCOS, THALES Alenia Space, ASTRIUM, OERLIKON SPACE, etc…) have been characterizing and using these greases since 1996 on such projects as IASI Scan Mechanism for METOP European satellite, Thruster Orientation Mechanism (TOM Stentor, Eurostar 3000, Alphabus, Alphasat,…), Solar Array Drive Mechanisms (JASON SADM (SEPTA 31)), etc.

Nowadays, these greases are internationally recognized and considered reference products for fluide lubricated space mechanisms.

Nevertheless, the thickeners (MoS2 or PTFE powder) that we used to formulate these greases were supplied in a solvent borne system..

In order to meet the requirements of the world regulation relative to the elimination of the greenhouse effect products (ozone layer protection), we had to reformulate these greases several times.

In order to free ourselves from these changes of raw materials and thus perpetuate MAPLUB greases, we made a final formulation using dry powders.
Indeed, these powders are not subject to solvent restrictions and their stability is better over time.
The MAPLUB (index b) products we thus obtained have been characterized in terms of vacuum resistance, viscosity, etc.
These products are on the market now and will eventually replace the former formulations (index a).

1 DEVELOPMENT OF THE STUDY

The purpose of this study is to formulate and characterize greases of similar properties but from dry powders of PTFE. The grease of a-index range are made from aliphatic and cyclic paraffinic oil or polyether polyfluoro oil loaded with PTFE particles. For each type of oil, there is a version added with MoS2. The characteristics of these greases are the inputs (or specifications) of our study.

2 PTFE POWDERS

We have selected for this study a series of PTFE powder, whose function is to thicken the base oil and get the required rheological profile.
The size distribution was one of the considered elements in order to make this selection.
The geographical origin was also a major criterion in this selection because it would also overcome any dependency as regards any product potentially subject to the EAR and ITAR directives.

3 THE OILS

The qualified oils for this application are:

- Pennzane 2001A
- FOMBLIN Z25.

It appears that the dispersion of PTFE particles within the oil is a critical stage in the formulation of greases (removal of agglomerates, homogeneous distribution of particles and no particle sedimentation). This step will be the starting point of these new formulations.

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1- Development of a dispersion process leading to the better dispersion of PTFE particles and the highest viscosity possible for a given load rate.
2- Determination of the minimum load rate to obtain rheological profiles and performance close to the original greases (a-index).

The following graph shows the variation of viscosity depending on shear rate for different types of grease development process.

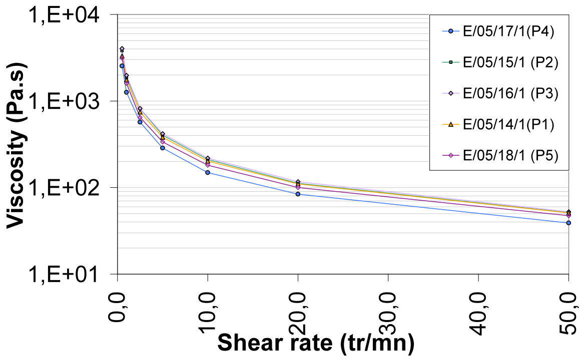

Figure 1: Viscosity plane cone 1°/20 mm of greases obtained according to the tested process

Based on the same process, we tested different types of PTFE powder at a fixed load rate.

The following graph shows the variation of viscosity depending on shear rate for grease formulations based on different PTFE powders (fixed load rate).

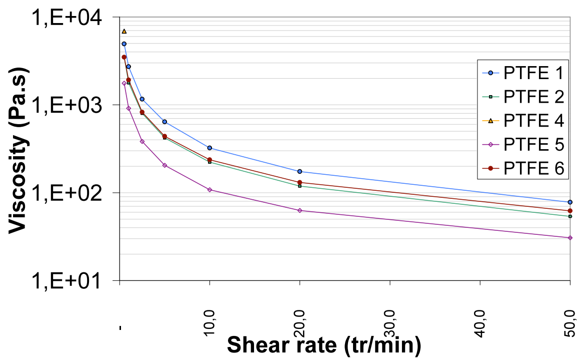

Figure 2: Viscosity plane cone 1°/20 mm of greases obtained according to the types of PTFE loads.

Also, based on the best process of mixing, we varied the load rate of PTFE powder providing the most important thickening.
The following graph shows the variation of viscosity depending on shear rate for formulations of grease at different load rate.

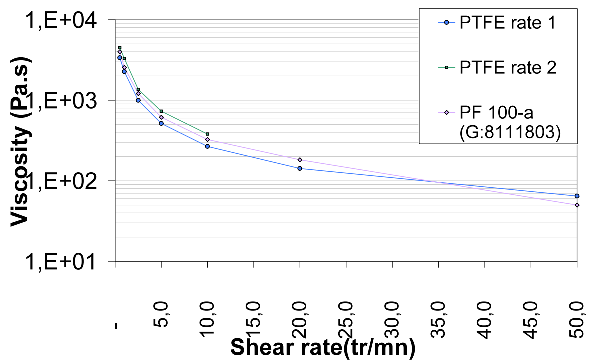

Figure 3: Viscosity plane cone 1°/20 mm of greases obtained according to PTFE rate.

Despite the adjustment in the load rate of PTFE powder to be the closest to the viscosity of a-index greases, we can note that the rheological behaviour of low gradient is different.

This difference is probably due to PTFE polymers dissolved in the solution of PTFE used in the manufacture of a-index greases and which were not present in the dry PTFE powder.

4 REPRODUCIBILITY STUDY

To establish the reproducibility of the process, we created a series of the same manufacturing and we conducted a rheological characterization of these formulations.
The following graph shows the variation of viscosity depending on shear rate for grease formulations with MAPLUB PF 100-b type.

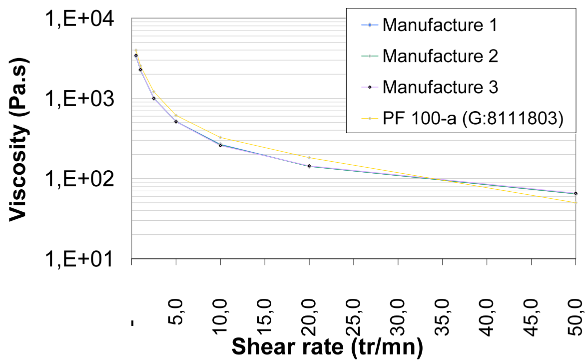

Figure 4: Viscosity plane cone 1°/ 20 mm of different batches of grease from the same reference

The results show that the manufacturing of greases with dry PTFE load and its process gives similar characteristics and thus a good reproducibility.

5 CHARACTERIZATION

Characterization tests were carried out in various laboratories that are experts in the field:

ETS Expertises Technologiques & Services (76 – Mont Saint Aignan) for:

- Worked penetration ¼ cone
- Not worked penetration ¼ cone
- Grade NLGI (not carried out – Value calculated from penetration values)
- Dye check 30 h / 100°C

- Loss by evaporation

Inta (Spain) for:

- Evaporation under vacuum – test according to ECSS Q 70-02A standard (TML, CVCM et RML)

MAP laboratory calculated the following characteristics:

- . Density
- Apparent viscosity at 20°C and 10 s^{-1}
- Apparent viscosity at 20°C and 100 s^{-1}

Test results were gathered in the following table:

Test	Worked penetration ¼ cone 60 cps	Penetration ¼ Cone not worked	Dye chaeck	Loss by evaporation @ 125°C
Method	NF T60-140	NF T60-140	FTMS 321-3	ASTM D972
MAPLUB® PF 100b	320.10^{-4} m	315.10^{-4} m	6.1%m	0.9%m
MAPLUB® PF 100a	269.10^{-4}	288.10^{-4}	2.65%	0.17%
MAPLUB® PF 101b	311.10^{-4} m	302.10^{-4} m	4.7%m	1.1%m
MAPLUB® PF 101a	281.10^{-4}	289.10^{-4}	3.26%	0.37%
MAPLUB® SH 100b	329.10^{-4} m	326.10^{-4} m	3.2%m	0.2%m
MAPLUB® SH 050a	348.10^{-4}	335.10^{-4}	4.19%	0.72%
MAPLUB® SH 101b	319.10^{-4} m	313.10^{-4} m	2.0%m	0.2%m
MAPLUB® SH 101a	365.10^{-4}	248.10^{-4}	3.82%	0.22%

Table 1: Table on measures of ETS

Test results were compiled in the following table:

Test	TML	RML	CVCM
Method	ESA ECSS Q 70-02A standard		
MAPLUB® PF 100b	0.073%	0.066%	0.001%
MAPLUB® PF 100a	0.18%		0.075%
MAPLUB® PF 101b	0.077%	0.064%	0.005%
MAPLUB® PF 101a	0.10%		0.046%
MAPLUB® SH 100b	0.076%	0.073%	0.003%
MAPLUB® SH 050a	0.20%		0.02%
MAPLUB® SH 101b	0.080%	0.073%	0.002%
MAPLUB® SH 101a	0.21%		0.02%

Table 2: Table on measures of INTA

6 CONCLUSION

The characteristics obtained on the new greases (b index) show behaviour similar to the old ones (a index).

However, even if the products are very similar they can not be substituted simply without being subject to further testing: a mechanism qualified with a MAPLUB-a grease version does not keep its qualifying status if we replace the grease- with its equivalent-b ..