Compatibility test of oil with topcoats for use with FLENDER gearboxes

Based on ISO 2812-3

The aim of this test procedure is to test the compatibility of oils with the gear outside paints which are used for FLENDER gear units. A separate test report must be created for each paint (see attachement).

General definitions

1) When submitting a test order with an approved test institute one liter oil per coating must be delivered free to the consignee's address. The following details must be reported by the purchaser:
   - Information that the test shall be done in accordance with "Test specification for testing the oil compatibility with auter coatings used for FLENDER-Gearboxes"
   - Oil manufacturer
   - Name of the oil or name of the oil sample
   - base oil type (Mineral oil API I, mineral oil API II, mineral oil API III, PAO, PAG, synth. Ester)
   - Viscosity acc. to ISO (industrial gear oil) or acc. to SAE class (engine oils)
   - Batch number of the oil
   - Name of the top coat(s) with which the compatibility tests needs to be carried out

2) Two coated steel test panels type R-36, item number 71242, mat, dimensions 76x152, company Q-Lab Deutschland GmbH are used per oil for the test (duplicate test). All panels shall be coated only on one side and it is not allowed to cover the edges with tape.

3) The filter round blanks for the oil impact have a diameter of 55 mm and consist of glass fibre (manufacturer: Ahlstrom-Munksjö, article-no. BINZ410093, particle retention 1,5 µm; **OR** manufacturer: VWR, glass fibre filter 696, article-no. 516-0876, particle retention 1,5 µm)

4) Both test panels which are coated with the same coating must be coated with a paint of one batch. The batch number of the paint needs to be recorded.

5) All values of the repeat measurement are recorded in a table of one sheet, as given in the attachment.

6) The tests are carried out at a temperature of 80 °C in a warming cabinet.

7) The following checks are to be carried out:
   - Blistering in accordance with DIN EN ISO 4628-2
   - Pendulum hardness according to König in accordance with DIN EN ISO 1522 at a room temperature of 20 to 26 ° C
   - Cross-cut test inclusive adhesive film test in accordance with DIN EN ISO 2409 at a room temperature from 20 to 26 °C.

Test procedure

8) Cleaning / Degreasing of the test panels with special-diluent butyl-acetate 98/100

9) Coating of the primed panels with the top coating to be tested by spraying. The dry layer thickness has to be according to the current oil approval specification for FLENDER gear units.
If a coating system is tested, the complete system with all layer thicknesses has to be reported. Before testing a complete coating system, Flender should be contacted to define the details of the coating system.

10) The drying of the coated test panels has to fulfill the following criteria:
    - 20 days of forced drying in an oven at 25°C (+/- 1 K)
      OR
    - 23 days of drying in standard climate acc. ISO 23270 (23°C)

    After the drying process the test panels can be used for testing for a maximum of 20 days.

11) After the drying process the thickness of the coating has to be checked and recorded in consideration of default values. Test panels with failures and/or with coat thinknesses outside the allowed limits have to be sorted out and must not be used.

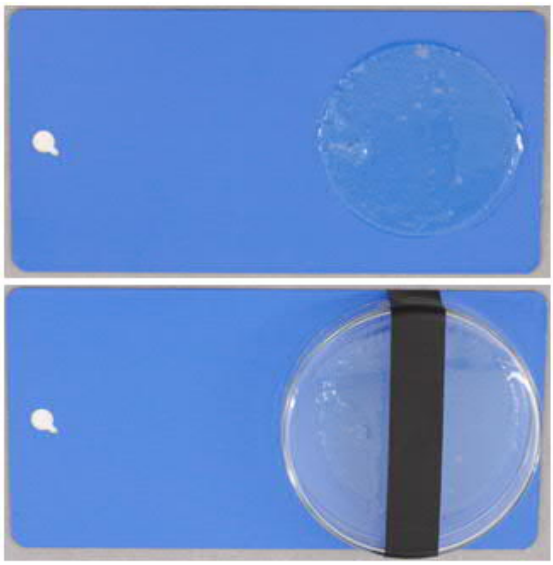
12) The test oil has to be homogenized and dryed for 24

13) Dip the filter into the test oil until it is fully soaked and let excess fluid drain off.

14) Put the filter on the lower part of the test plate, cover it immediately with a petri dish and secure the dish with tape.

15) Store the test plates horizontally inside a warming cabinet for the duration of 168 h at 80° Celsius.

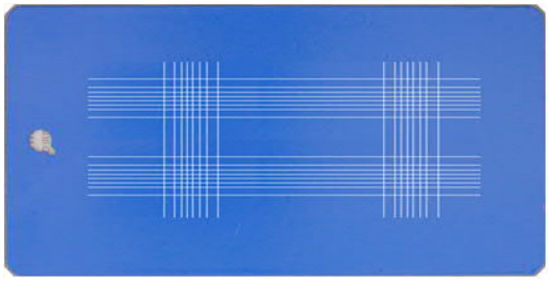
16) Take the plates from the warming cabinet, remove filters and clean the plates with white spirit.



17) **Optical evaluation** of the test panels has to be carried out after the testing period. All determined changes of the test panels has to be recorded. To do that all test specimen are taken out of the oil and an examination of surface blistering and separation phenomena has to be carried out. If necessary a lint free rag can be used. In case the optical evaluation shows that the primer is already destroyed and/or surface blistering is greater than 1 in accordance with DIN EN ISO 4628-2 the panels has to be photographed and the evalution is: **not resistant.** To ensure that the surface blistering can be well recognized on the photo either a detail has to be photographed or an enlarged section of a high quality photo has to be showed in the test report. If necessary the test specimen can be cleaned with white spirit. The cross-cut test and the pendulum hardness test according to König are not necessary. If the test is carried out with "not resistant" the test is to continue with item 13.

18) The test panels have to rest 16 to 24 hours at room temperature from 20°C to 26°C in accordance with DIN EN ISO 2409 after the cleaning.

19) Execution of the cross-cut test according to DIN EN ISO 2409 inclusive the adhesive film test and pendulum hardness test according to König in accordance with DIN EN ISO 1522 on both areas the oil loaded area and the non-oil loaded area of the test panels.



20) If not already done take photos of the test panels now.

21) Completion of the test report (see also attachment). For each tested panel has to exist a photo, which if necessary shows also only a respective area. In case no clear assignment between the photo and the test panels is apparent the photo in the test report needs to be labeled and/or explained.

22) The compatibility of the oil with the outer coating is given if the surface blistering according to DIN EN ISO 4628-2 of both test panels is not greater than 1, the pendulum hardness according to König in accordance with DIN EN ISO 1522 of both test panels is not below 30% of the reference value and the result of the cross-cut test inclusive the adhesive film test according to DIN EN ISO 2409 of both test samples is not greater than Gt 1.

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Attachment – Example Test Result Table

Results of the test "Compatibility test of oil with topcoats for use with FLENDER gearboxes"

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Bitte Feld markieren und mittels rechtem Pfeil Kunden auswählen:

Please mark field and select customer by right arrow

Laboratory: 0 2871 ...
Laborname Teil 1
Laborname Teil 2
Straße, Nummer
Postleitzahl Ort

Testing standards:
Cross-cut test (ISO 2409)
Pendulum hardness test - König (ISO 1522)
Evaluation of degree of blistering (ISO 4628-2)

Tester: Name 1

Validation date: xx.yy.zzzz

Rating: Compatible

Primer: PU-Decklack 5240

Primer Charge: 4711

Date primer coating: xx.yy.zzzz

Oil-type: Mineral oil API 1 / API 2

Oil viscosity ISO VG / SAE: VG 220

Oil / Sample supplier: Flender GmbH

Oil / Sample name: Fluid W

Oil / Sample Charge: best one 1

Test start (date): xx.yy.zzzz

No.	Pendulum hardness before the test		Dry film thickness [µm] before the test				168 h at 80 °C	Blistering after test	area without oil contact				area with oil contact				Remark	Compatibility
	[swings]	[s]	measured			Ø			Cross-cut test [Gt]	Pendulum hardness [swings]	Pendulum hardness [s]	Pendulum hardness ratio*)	Cross-cut test [Gt]	Pendulum hardness [swings]	Pendulum hardness [s]	Pendulum hardness ratio*)		
1	82	115	46	46	46	46	X	0	1	79	111	0,99	0	80	112	0,99		yes
2	83	116	49	49	47	48		0	0	75	105	0,94	0	80	112	0,94		yes

*) Pendulum hardness quotient: [Pendulum hardness oil-loaded area after test] / [Pendulum hardness non-loaded area after test]

Picture for No. 1

Picture for No. 2