

Procedure for testing the filterability of oil/fluid used in Flender gear units

The filtration of oils/fluids at different temperatures has to be determined.

Basic definitions:

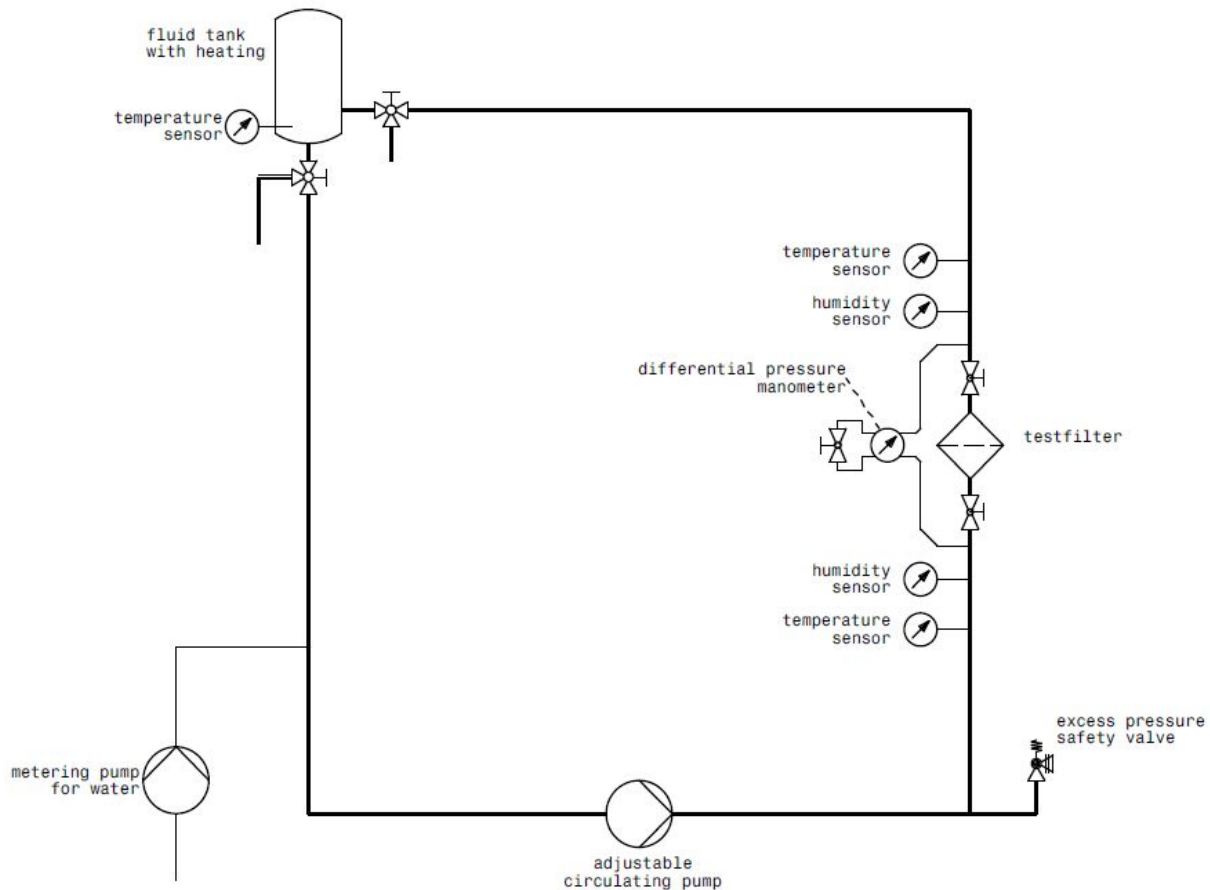
Ordering the filtration test at an approved test laboratory, seven liters of the testing oil have to be delivered free of charge plus the following documentation / information:

- Oil manufacturer
- Oil brandname or oil code
- Base oil type (Mineral oil, semisynthetic oil API-grp. III, PAO, mPAO, P(A)G, synth. Ester)
- Nominal viscosity acc. to ISO VG (Gear Oils) or SAE (Engine Oils)
- Batch Number of the oil
- Information / Order description to perform filtration test acc. „Test procedure for the oil filtration test for use in FLENDER gear units“

For the filtration test, a special filtration test rig, designed in cooperation by the companies ISP and SIEMENS MD, is used. For each filtration test new commercial available filter types based on glass fiber with a pore size (mesh number) of 10 μm and a filtration ratio of $\beta_{10(c)} \geq 200$ are used. A more detailed definition of the filters is given in the SIEMENS MD gear oil approval specification. The pump flow rate is 1 liter per minute.



Schematic view of the test principle



The test procedure is defined as follows:

- 1) Extraction of an aliquot of fresh candidate oil for elemental analysis. Sulphur, phosphorous, boron, molybdenum and silicon content to be determined by either ICP or x-ray methodology.
- 2) Measurement of the kinematic viscosity V40 and V100 of the fresh candidate oil
- 3) Performing of the FLENDER foam test according to ISO 12152 with room temperature of the fresh unfiltered oil, observation time 20 minutes; The further FLENDER foam tests be carried out also according to ISO 12152 with room temperature of the test fluid and with an observation time of 20 minutes.
- 4) Flush procedure with flushing oil (TMP ester of nominal viscosity $VG \leq 32$ based on C8, C9 or C10 acid, such as Priolube 3970, Radialube 7368, Esterex NP343 or Oxylube L9 TMP) and candidate oil; the pump delivery rate is 1 liter per minute:

- Drain previous test oil out of the oil tank and clean the oil tank with a lint free tissue / white spirit
- Dismantle the filter with the filter housing and clean the filter housing with a lint free tissue / white spirit
- Assemble the filter housing
- Fill 2 liters of flushing oil into the oil tank.
- Switch over the two-way valve in the return line to drain mode.
- To ensure thorough flushing of the entire test rig, the two individual circuits are flushed separately with the 2 liter flushing oil. The “filter line” and the “differential pressure converter line” are flushed sequentially with 1 liter each of this flushing oil. Allow the flush oil to drain from the individual lines by drain tap. Do not let the flush oil return to the tank.
- Switch over the two-way valve in the return line back to circulation mode.
- Dispose of the used flushing oil following the correct environmental procedures.
- Dismantle the filter housing and clean it with a lint free tissue / white spirit .
- Assemble the filter housing without filter.
- Fill 1 liter of flushing oil into the oil tank.
- To ensure thorough flushing of the entire test rig, the two individual circuits are flushed separately using the same 1 liter of Priolube 3970. The “filter line” and “differential pressure converter lines” are flushed in sequence for 10 minutes each by operation in circulation mode.
- Drain thoroughly and dispose of the used flushing oil following the correct environmental procedures.
- Clean the oil tank with a lint free tissue / white spirit.
- Dismantle the filter housing and clean the housing with a lint free tissue / white spirit
- Assemble the filter housing without the filter
- Fill 2 liters of the candidate oil into the oil tank.
- Switch over the two-way valve in the return line to drain mode.
- To ensure thorough flushing of the entire test rig, the two individual circuits are flushed separately with the 2 liter candidate oil. The “filter line” and the “pressure converter line” are flushed sequentially with 1 liter each of this candidate oil. Allow the candidate oil to drain from the individual lines by drain tap. Do not let the as flushing oil used candidate oil return to the tank.
- Switch over the two-way valve in the return line back to circulation mode.
- Dispose of the as flushing oil used candidate oil following the correct environmental procedures
- Dismantle the filter housing and clean with a lint free tissue / white spirit
- Assemble the filter housing without filter.
- Fill 1 liter of the candidate oil into the oil tank
- To ensure thorough flushing of the entire test rig, the two individual circuits are flushed separately using the same 1 liter of the candidate oil. The “filter line”, and “differential pressure converter lines” are flushed in sequence for 10 minutes each by operation in circulation mode.

- Drain thoroughly and dispose of the as flushing oil used candidate oil following the correct environmental procedures, except a small volume for measurement of the elemental content analysis.
 - Clean the oil tank with a lint free tissue / white spirit.
 - Dismantle the filter housing and clean it with a lint free tissue / white spirit.
- 5) Assemble the testing filter cartridge.
 - 6) Fill of the heatable oil tank with 2.5 liters of the candidate oil.
 - 7) First test step (period 7.5 hours): Start of the pump at room temperature ($25^{\circ}\text{C} \pm 2 \text{ K}$) of the candidate oil.
 - 8) Second test step (period 7.5 hours): Heating up of the candidate oil to $60^{\circ}\text{C} \pm 2\text{K}$, measured at filter entry, after operating filtration test, keep the temperature –
 - 9) Third test step (period 7.5 hours): Heating up the candidate oil to $80^{\circ}\text{C} \pm 2\text{K}$ measured at filter entry, after operating filtration test, keep the temperature
 - 10) Stop the pump for a short time (at most 10 minutes); Drain of an oil sample for the ICP measuring and of one litre of candidate oil for a Flender foaming test into a clean closeable vessel; let removed oil cool down
 - 11) Fourth test step (period 4.5 hours): keep the temperature on 80°C ; add 1.5 ml of distilled water into the candidate oil in front of the circulating pump
 - 12) Carrying out Flender foaming test with candidate oil removed after the third test step parallel to the fourth test stage or later
 - 13) After the end of the fourth test step shut down the pump and heating, drain the candidate oil in a clean closeable vessel and let it cool down to room temperature ($25^{\circ}\text{C} \pm 2 \text{ K}$)
 - 14) Determination of sulphur, phosphorous, boron, molybdenum and silicon content of the fresh candidate oil, of the candidate oil after flushing in circulation mode, of the drained candidate oil after the third test step and of the filtered candidate oil after the fourth test step. Analysis to be conducted by either ICP or x-ray methodology and importantly the determinations must all be conducted on the same day, with the same measurement device with one and the same calibration.
 - 15) Measurement of the kinematic viscosity of V40 and V100 of the filtered candidate oil after the fourth test step

- 16) Execute the Flender Foam test acc. to ISO 12152 of the filtered candidate oil after the fourth test step

Decrease in pressure by the filter, oil temperature and the relative oil humidity at filter entry and at filter exit are continuously registered. All test data are recorded. If the test room is not air-conditioned filtered and/or the candidate oil is stored for some time before the measuring, the vessel into which the candidate oil is stored for the further measuring must be locked airtightly.

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