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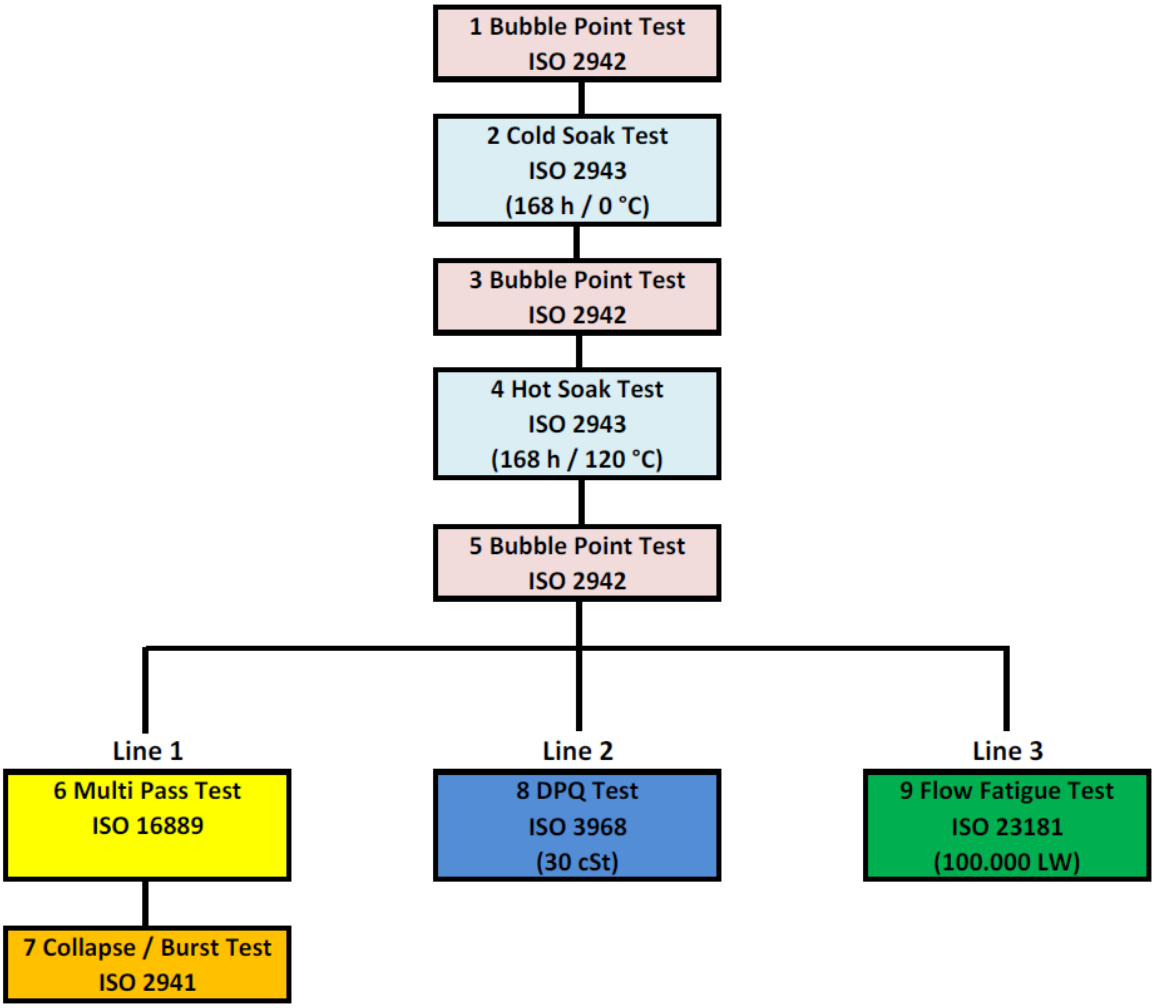
Hydraulic fluid power
Filter elements –
Verification test of the fabrication integrity and material compatibility

1 Referenced Documents

ISO Standards

Ident.	Name
ISO 11170:2003	Hydraulic Fluid Power - Filter elements - Sequence of tests for verifying performance characteristics.
ISO 2942:2004	Hydraulic Fluid Power - Filter elements - Verification of fabrication integrity and determination of first bubble point.
ISO 2943:1998	Hydraulic Fluid Power - Filter elements - Verification of material compatibility with fluids.
ISO 16889:2008	Hydraulic Fluid Power - Filter elements - Multi-pass method for evaluating filtration performance of a filter element.
ISO 2941:2009	Hydraulic Fluid Power - Filter elements - Verification of collapse/burst resistance.
ISO 3968	Hydraulic Fluid Power - Filter elements - Evaluation of differential pressure versus flow characteristics.
ISO 23181:2007	Hydraulic Fluid Power - Filter elements – Determination of resistance to flow fatigue using high viscosity fluid.

2 Flow Chart for the whole verification test



3 Verification of fabrication integrity and material compatibility with fluids

3.1 Overview of the test methods

Step 1:	Verification of fabrication integrity in accordance with ISO 2942
Step 2:	Material compatibility with fluids – cold soak: 168 h @ 0 °C
Step 3:	Verification of fabrication integrity in accordance with ISO 2942
Step 4:	Material compatibility with fluids – hot soak: 168 h @ +120 °C
Step 5:	Verification of fabrication integrity in accordance with ISO 2942

3.2 Step 1 – Verification of fabrication integrity

3.2.1 Test Procedure

Verification of fabrication integrity and determination of the first bubble point according to ISO 2942 (➔ BBP-test).

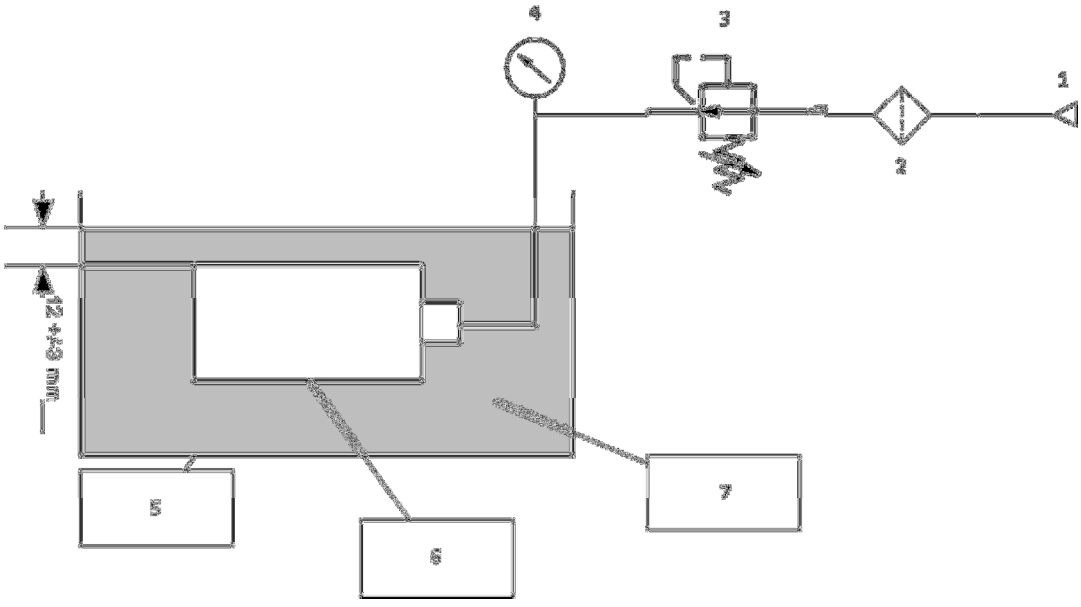
To make a measurement, the element must be immersed in the test liquid to a defined depth and then subjected inside to outside with a steadily increasing pressure. The pressure rise is stopped as soon as a single continues stream of bubbles appears. A pressure value below the specification requirement is an indication negative change of the filter mesh pack caused during the test.

Test conditions

- Test fluid: Isopropyl alcohol*
- Minimum value of initial bubble point pressure: 11 mbar

** no contamination with oil*

3.2.2 Scheme of the test bench



1. compressed air supply
2. air filter
3. pressure control valve
4. pressure sensor
5. test tank
6. test element
7. test fluid

3.2.3 Test results

element	initial bubble point pressure
1	34 mbar
2	40 mbar
3	36 mbar

3.3 Step 2…5 – Verification of material compatibility with fluids

3.3.1 Test Procedure

Verification of material compatibility with customers specified fluid according to ISO 2943. The ability to maintain its collapse burst rating after being subjected to the designated system fluids at low and high temperature. The bubble point test is carried out after each soak test.

Test conditions

- Test fluid: XXXX
- Cold soak temperature: 0°C
- Hot soak temperature: +120°C
- Fluid soak hours: 168

3.3.2 Test results

element	initial bubble point pressure	
	after cold soak	after hot soak
1	25 mbar	20 mbar
2	30 mbar	28 mbar
3	25 mbar	24 mbar

3.4 Summary

Step 1	
BBP-test	
Criteria for acceptance	**Fulfilled?**
Manufacturers minimum value of 11 mbar or min 40 % of initial bubble point pressure	Yes

Step 3	
BBP-test after cold soak	
Criteria for acceptance	**Fulfilled?**
Manufacturers minimum value of 11 mbar or min 40 % of initial bubble point pressure	Yes

Step 5	
BBP-test after hot soak	
Criteria for acceptance	**Fulfilled?**
Manufacturers minimum value of 11 mbar or min 40 % of initial bubble point pressure	Yes

4 Line 1 – Filtration efficiency / Contaminant retention capacity + Collapse burst pressure rating

4.1 Overview of the test methods

Step 6: Multi pass test in accordance with ISO 16889 for non by-pass filters

Step 7: Verification of the collapse/burst resistance according ISO 2941

4.2 Step 6 – Multi pass test

4.2.1 Test Procedure

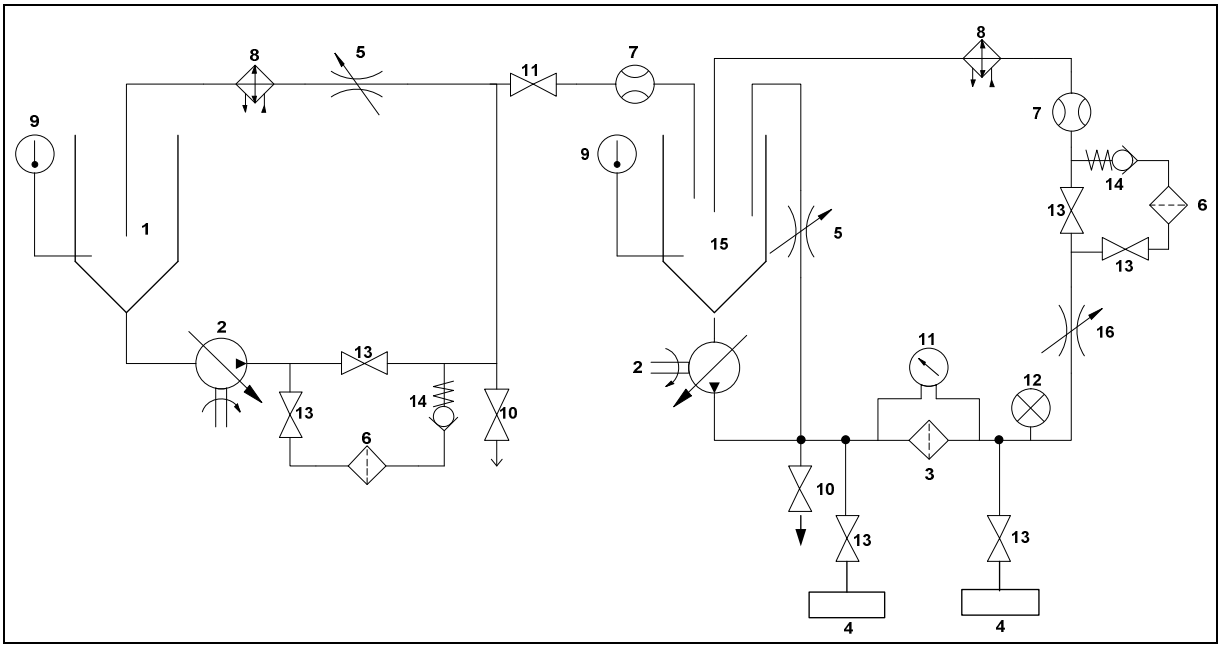
The Multi-pass test method allows for determination of the contaminant capacity, particulate removal efficiency and differential pressure characteristics of a filter element.
The method is based on the principle that in practice, a contaminated fluid passes the filter element several times. Particulate contaminants that initially passed through the filter element might then be filtered out in one of the subsequent passes.

A quantity of fluid containing the test contaminant (ISO MTD-dust suspended in MIL-PRF-5606 oil) is injected from system 1 into the test system. The test filter element is subjected to a continuous influx of contaminated oil. When the terminal differential pressure is reached, the test is interrupted.
In the course of the test, small oil volumes upstream and downstream of the filter are continuously analysed for particle content by online particle counters. The particle counts are used to calculate the filtration performance of the filter element at several consecutive differential pressures.

Test conditions

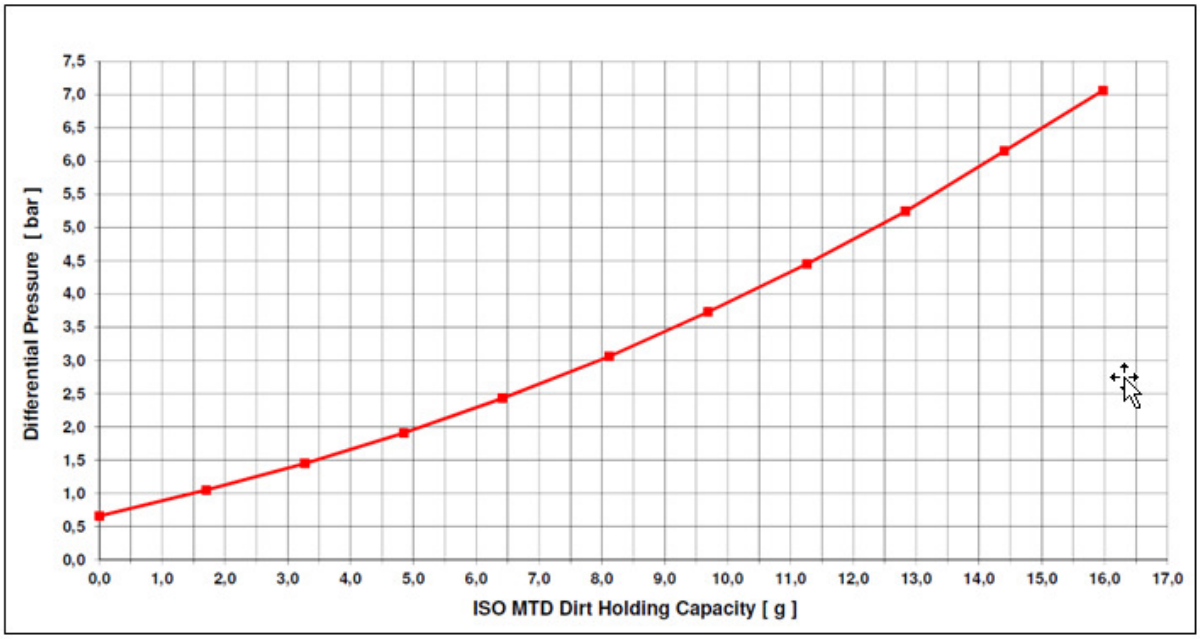
- Test fluid: MIL-PRF-5606
- Test temperature: 40°C
- Test flow rate: 6 L/min
- Test contaminant: ISO MTD
- Mass of contaminant added per unit time: 150 mg/min
- Upstream gravimetric level: 15,06 mg/l
- Viscosity: 14 mm²/s

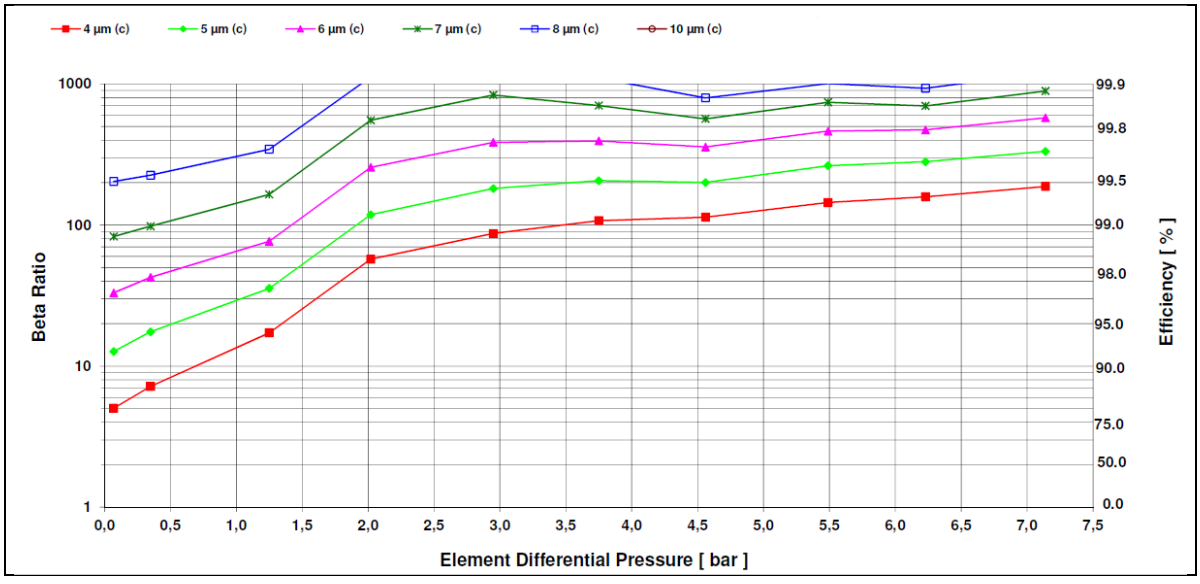
4.2.2 Scheme of the test bench



1. reservoir	2. pump	3. test filter	4. particle counting system
5. flow control valve	6. clean-up filter	7. flow meter	8. temperature controller
9. temperature sensor	10. sampling valve	11. diff. pressure indicator	12. pressure gauge
13. shut off valve	14. non return valve	15. reservoir	16. back pressure valve

4.2.3 Test results





4.3 Step 7 – Verification of collapse pressure

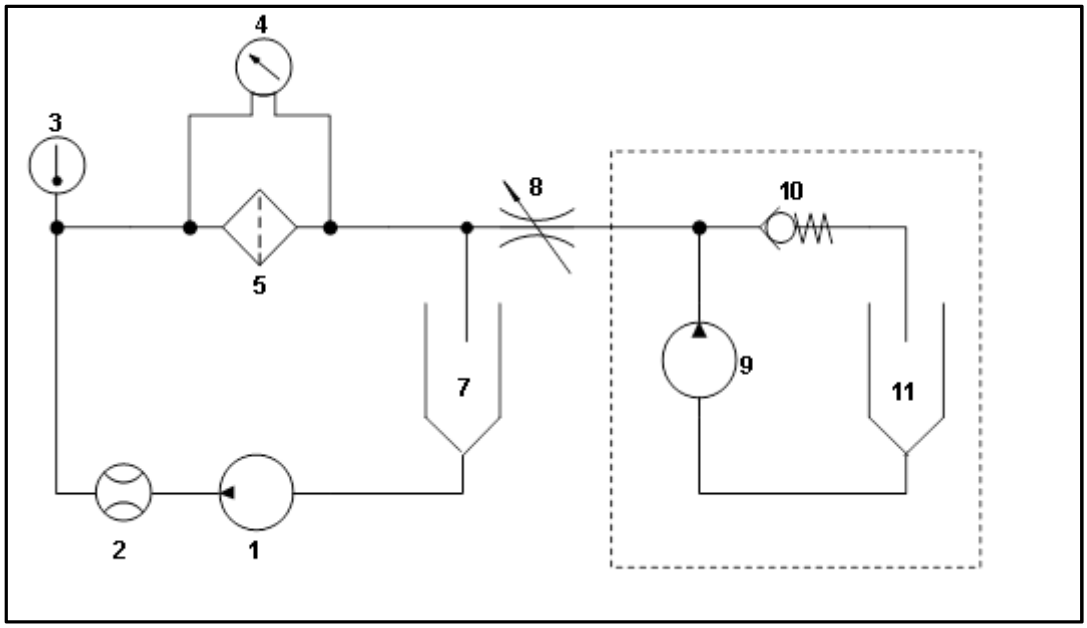
4.3.1 Test procedure

The International Standard ISO 2941/2009 specifies a method for verifying the collapse/burst pressure rating of a hydraulic fluid power filter element; i. e. the capability of a filter element to withstand a designated differential pressure at the normal (i.e., intended direction of) flow by means of pumping contaminated fluid through the filter element until either collapse occurs or the maximum expected differential pressure is reached without element failure. In the second case, the integrity of the filter element is confirmed by examination of fabrication integrity in accordance with ISO 2942.

Test conditions

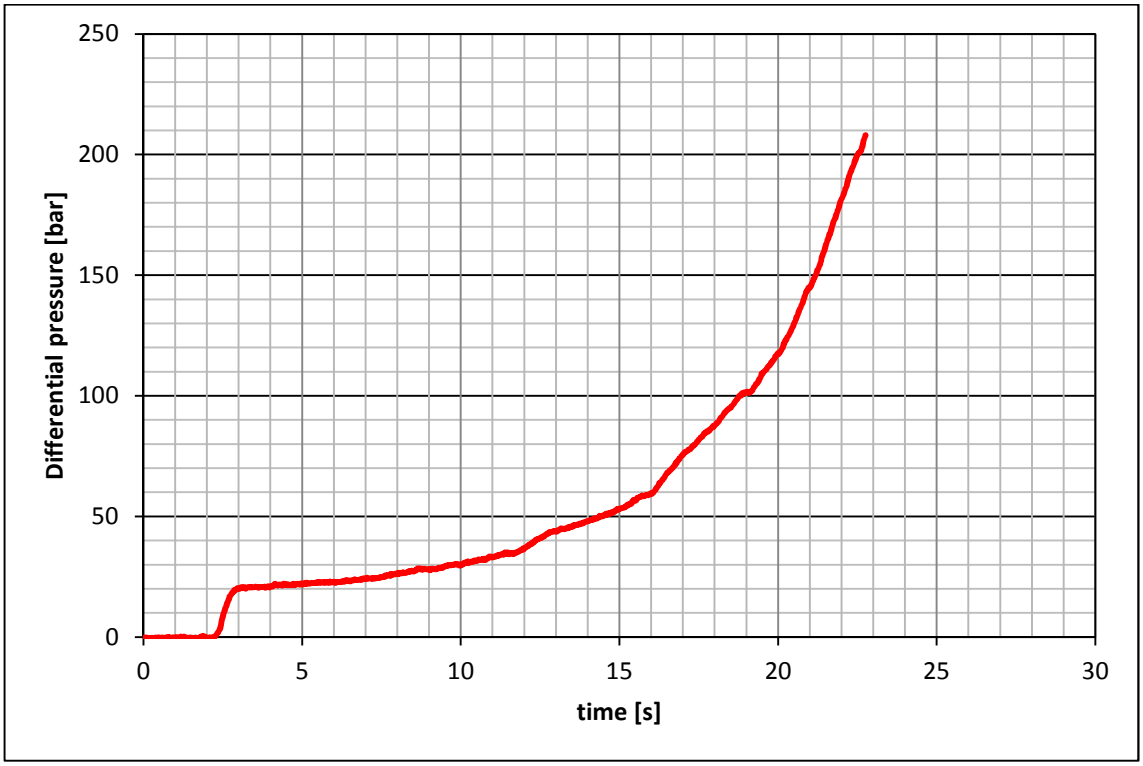
- Test fluid: Meguin HLP 32
- Test temperature: 20…40 °C
- Test flow rate: 10 L/min
- Test contaminant: ISO MTD
- Mass of contaminant injected: approx.100 mg/min
- Target collapse pressure: 200 bar
- Preloaded elements from multi pass test
- Verification of fabrication integrity in accordance with ISO 2942

4.3.2 Scheme of the test bench



1. piston pump
2. flow meter
3. temperature sensor
4. diff.pressure indicator
5. test housing
7. main reservoir
8. flow control valve
9. injection pump
10. non return valve
11. injection reservoir

4.3.3 Test results



Element 1 – collapse pressure: > 200 bar

element	collapse pressure
1	> 200 bar
	initial bubble point pressure after collapse test
	17 mbar

4.4 Summary

Step 6	
Multi pass test	
Criteria for acceptance	**Fulfilled?**
The ß-stability still maintained	Yes

Step 7	
Verification of collapse pressure	
Criteria for acceptance	**Fulfilled?**
Pressure min. 200 bar	Yes
Bubble point after Flow fatigue test	
Criteria for acceptance	**Fulfilled?**
Manufacturers minimum value of 11 mbar or min 40 % of initial bubble point pressure	Yes

5 Line 2 – Pressure drop versus flow characteristics

5.1 Overview of the test methods

Step 8: Evaluation of differential pressure versus flow characteristics in accordance with ISO 3968

5.1 Step 8 – Evaluation of differential pressure versus flow characteristics

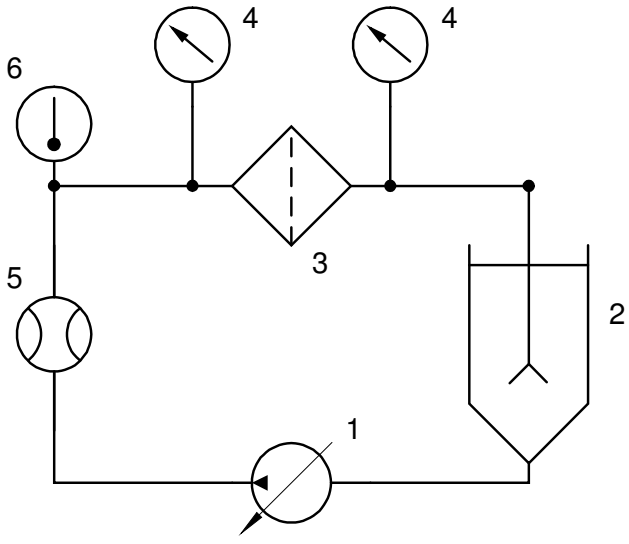
5.1.1 Test procedure

The test element is charged with an ascending and then decreasing volume flow and the resulting differential pressure is measured. In order to obtain comparable results, the elements are examined at a defined oil viscosity.

Test conditions

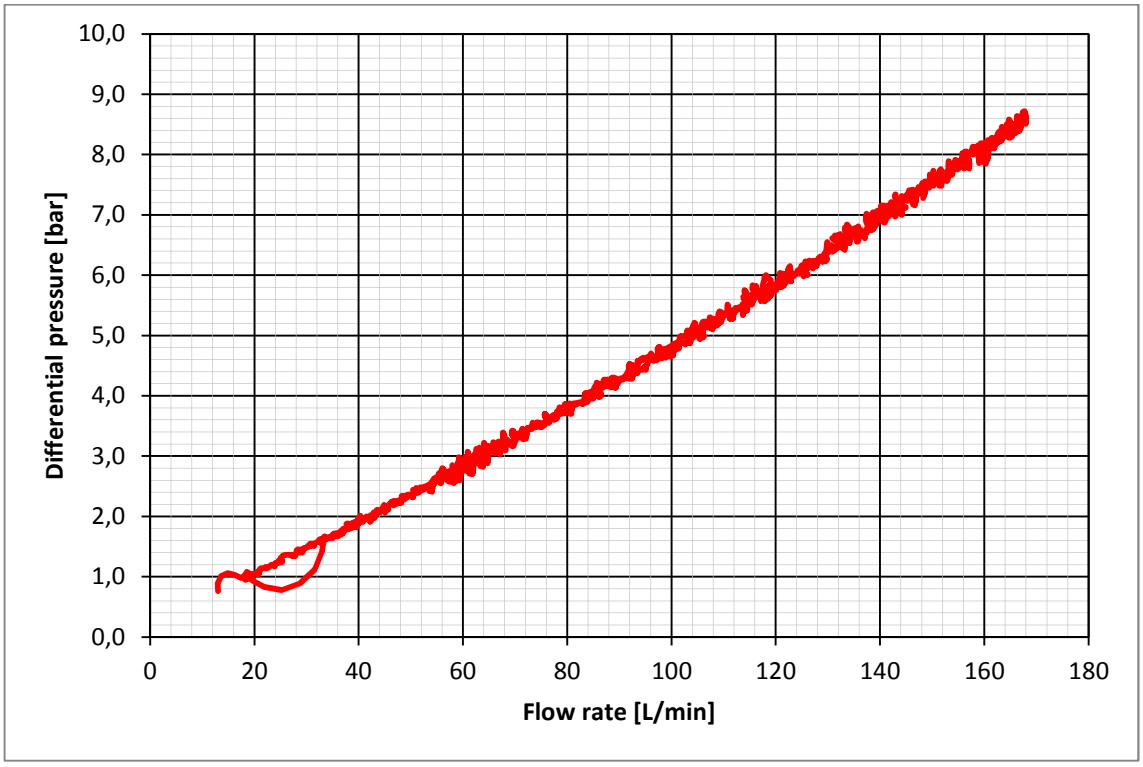
- Test fluid: Meguin HLP 32
- Test temperature: 41 °C
- Viscosity: 30 mm²/s
- Maximum differential pressure @120L/min: 7,0 bar

5.1.2 Scheme of the test bench



1 system pump	2 reservoir	3 test element
4 pressure transducer	5 flowmeter	6 temperature sensor

5.1.3 Test results



Element no. 2 – Pressure gradient @30 cst

element	differential pressure @ 120 L/min (30 cst)
2	5,8 bar

5.2 Summary

Step 8	
Pressure drop vs. flow characteristics	
Criteria for acceptance	**Fulfilled?**
Max. differential pressure 7,0 bar @ 120 L/min	Yes

6 Line 3 – Flow fatigue characteristics

6.1 Overview of the test methods

Step 9: Verification of flow fatigue resistance in accordance with ISO 3724

6.2 Step 9 – Verification of flow fatigue resistance

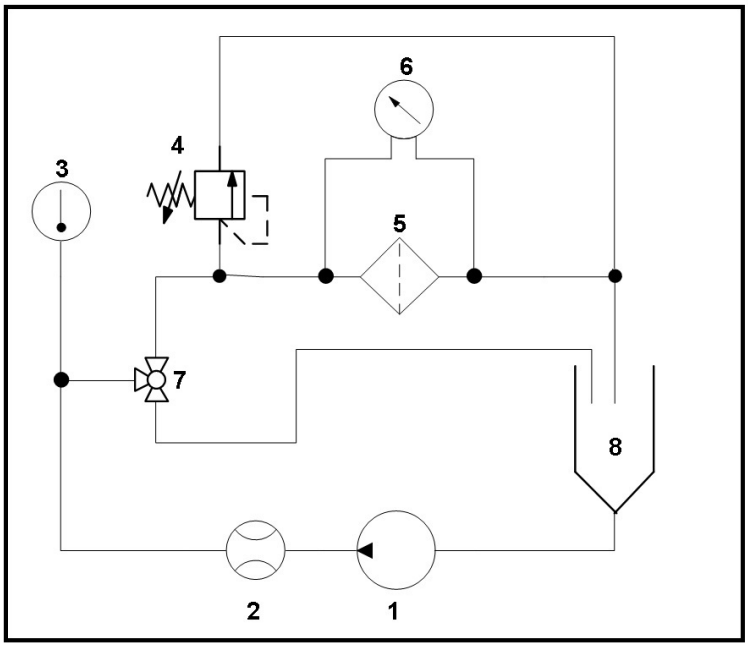
6.2.1 Test procedure

The Flow fatigue test is a method of determining the resistance of a hydraulic filter element to flow fatigue, using a uniformly varying flow rate up to a predetermined maximum differential pressure and a controlled waveform.
It establishes a method for verifying the ability of a filter element to withstand the flexing caused by cyclic differential pressures induced by a variable flow rate.

Test conditions

- Minimum flow for flow fatigue testing: 10 L/min
- Minimum terminal pressure drop for flow fatigue test: 25 bar
- Required number of flow fatigue cycles: 10^5 (100.000)
- Verification of fabrication integrity in accordance with ISO 2942

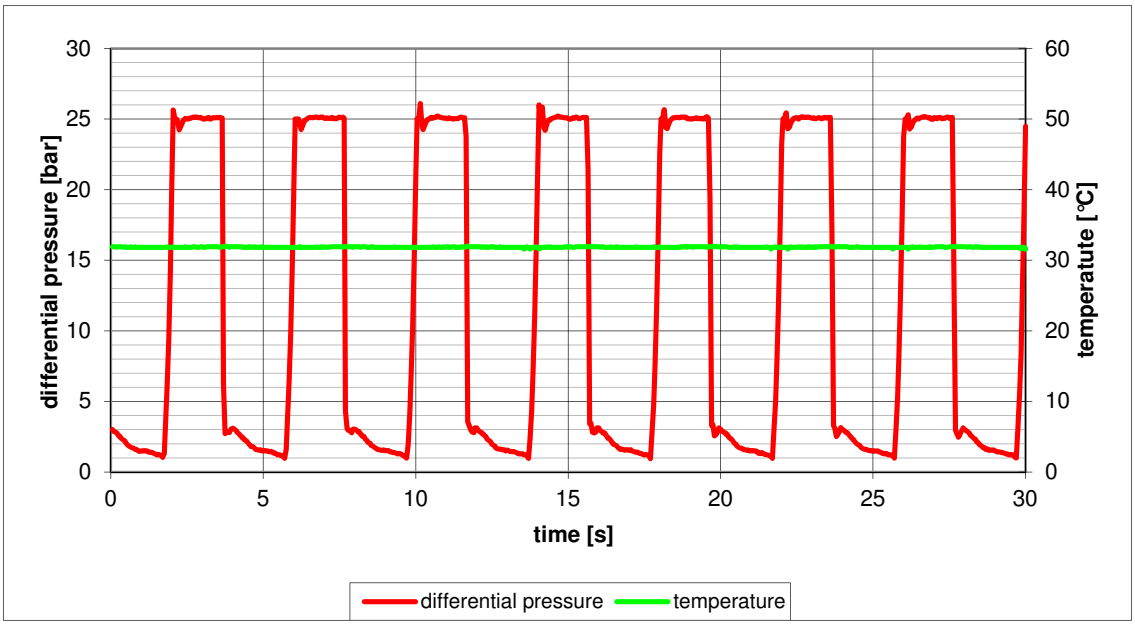
6.2.2 Scheme of the test bench



1. pump 2. flow meter 3. temperature sensor 4. pressure relief valve
5. test housing 6. diff pressure indicator 7. pneumatic ball valve 8. reservoir

6.2.3 Test results

Typical differential pressure curve



element	initial bubble point pressure after flow fatigue
3	18 mbar

6.3 Summary

Step 9	
Flow fatigue test	
Criteria for acceptance	**Fulfilled?**
No decrease in max. differential pressure of 25 bar	Yes
Bubble point after Flow fatigue test	
Criteria for acceptance	**Fulfilled?**
Manufacturers minimum value of 11 mbar or min 40 % of initial bubble point pressure	Yes

7 Conclusion

Specification	Fulfilled?
Verification of fabrication integrity and material compatibility with fluids	Yes
Filtration efficiency / Contaminant retention capacity + Collapse burst pressure rating	Yes
Pressure drop versus flow characteristics	Yes
Flow fatigue characteristics	Yes

All elements fulfilled the specified requirements of the ISO 11170 and passed here with the whole verification test of the fabrication integrity and material compatibility.