
**Hydraulic fluid power —
Determination of discharge flow rate
and thermal losses of gas loaded
accumulators —**

**Part 1:
Test method**

*Transmissions hydrauliques — Détermination du débit de décharge et
des pertes thermiques des accumulateurs hydro-pneumatiques —*

Partie 1: Méthode d'essai





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Published in Switzerland

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Foreword

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This document was prepared by Technical Committee ISO/TC 131, *Fluid power systems*.

A list of all parts in the ISO 5352 series can be found on the ISO website.

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Hydraulic fluid power — Determination of discharge flow rate and thermal losses of gas loaded accumulators —

Part 1: Test method

1 Scope

This document defines a test method which enables the determination of the characteristic values of discharge flow rate and thermal losses of gas-loaded accumulators with separators used in fluid power systems.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 5598, *Fluid power systems and components — Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 5598 apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

4 Symbols and units

For the purposes of this document, the symbols and units listed in [Table 1](#) apply.

Table 1 — Symbols and units

Description	Symbol	unit
Hydraulic fluid mass	m	kg
Gas pressure at T	p	MPa
Maximum working pressure	p_s	MPa
Pre-charging pressure, i.e. the gas pressure in the accumulator when the hydraulic circuit is not under pressure (initial state) at a temperature of $20\text{ °C} \pm 5\text{ °C}$	p_0	MPa
Minimum working pressure of the hydraulic circuit	p_1	MPa
Maximum working pressure of the hydraulic circuit	p_2	MPa
Gas constant	R	$\text{J} \cdot \text{mol}^{-1} \cdot \text{°C}^{-1}$
Duration of the dynamic phase	t	s
Time constant for heat exchange	τ	s

NOTE All pressures are expressed in relative terms.

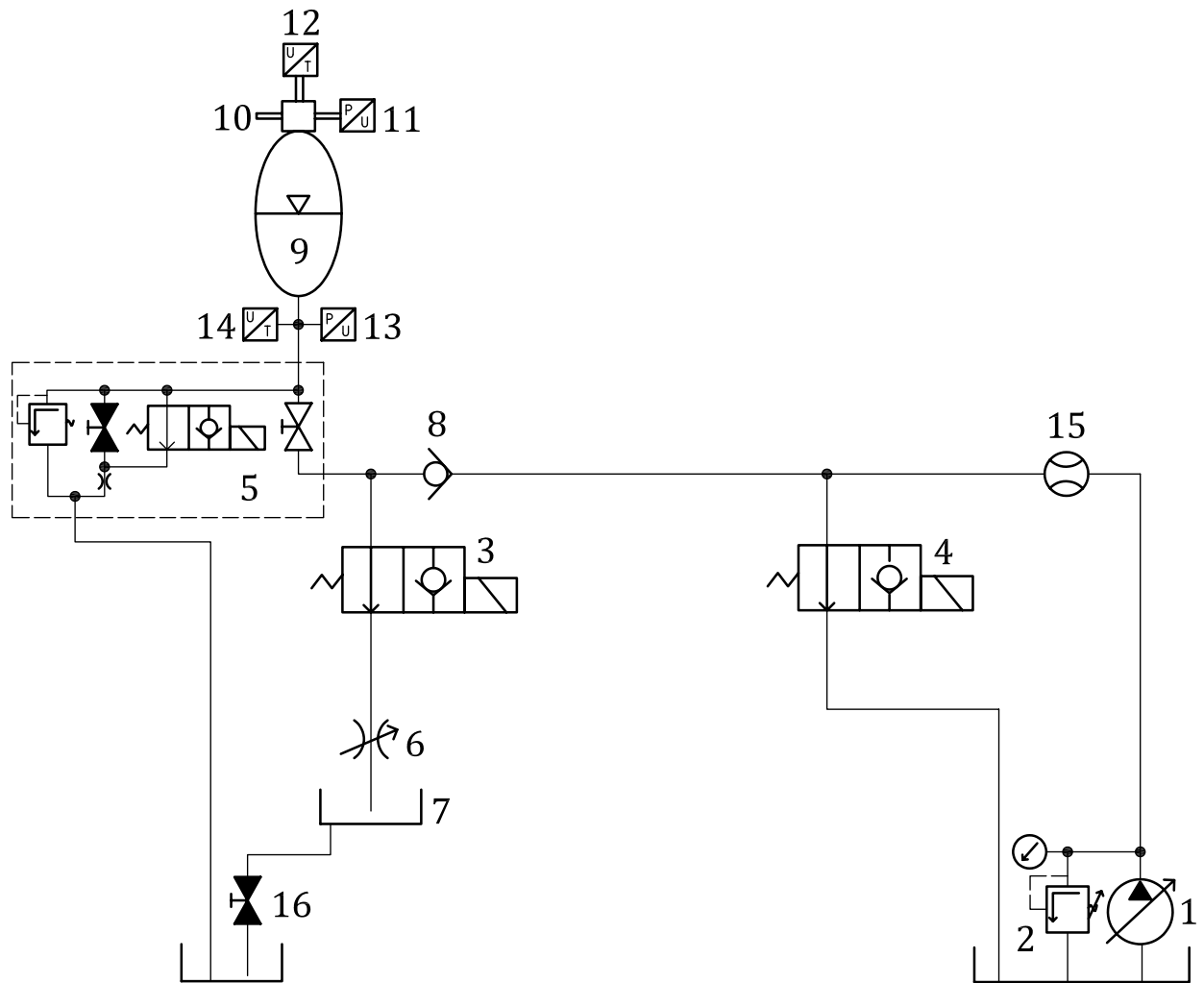
Table 1 (continued)

Description	Symbol	unit
Gas temperature	T	°C
Ambient temperature	T_{ext}	°C
Minimum range temperature	TS_{min}	°C
Maximum range temperature	TS_{max}	°C
Mean discharge flow rate	q_{m}	l/min
Gas molar volume	v	m ³ ·mol ⁻¹
Internal volume of the gas chamber	V	l
Gas volume at pressure p_0	V_0	l
Volumes occupied by the gas contained in the accumulator and any additional gas bottles at pressures p_1 and p_2 respectively	V_1, V_2	l
Measured hydraulic fluid volume	V_{m}	l
NOTE All pressures are expressed in relative terms.		

5 Test bench

5.1 Appropriate characteristics

A suitable test bench ensuring the scope of this document shall present the appropriate characteristics, as shown in [Figure 1](#).



Key

- | | |
|-----------------------------------|---------------------------------------|
| 1 fluid power supply | 9 test accumulator |
| 2 pressure relief valve | 10 gas filling system |
| 3 normally open valve | 11 gas pressure sensor |
| 4 normally open valve | 12 gas temperature sensor |
| 5 distribution and mounting block | 13 hydraulic fluid pressure sensor |
| 6 adjustable flow-control valve | 14 hydraulic fluid temperature sensor |
| 7 reservoir | 15 flowmeter |
| 8 check valve | 16 drain valve |

NOTE 1 The actuation of the valves 3 and 4 can be electric or hydraulic.

NOTE 2 The safety valve (drawing inside the distribution block, key 5) can be placed on the hydraulic part or on the gas part.

NOTE 3 The flowmeter (15) is required only when the hydraulic fluid filling conditions for the test accumulator need to be known.

Figure 1 — Hydraulic schematic diagram of the gas-loaded accumulator test bench

5.2 Operating principle

Refer to [Figure 1](#) for the devices included in this subclause.

In case of hydraulic actuation, hydraulic parts for actuation shall be installed on the test bench.

The test accumulator (9), charged with inert gas (using the filling device (10)), is installed in its testing position and orientation on the distribution block (5).

NOTE The position and the orientation of the gas-loaded accumulator during the test (vertical, horizontal, or even inclined) are important and can have an impact on the measurements. See [Clause 6](#) for the elements to be included in the test report.

In order to charge the test accumulator (9), the valves (3 and 4) shall be closed. The accumulator is charged up to a value p which was previously set by adjusting the pressure relief valve (2) of the fluid power supply (1).

The charge within the test accumulator (9) is maintained by the check valve (8). At that time, it is possible to by-pass the fluid power supply (1) again by opening the valve (4).

The test accumulator (9) is discharged by opening the valve (3). The discharge rate can be adjusted with the adjustable flow-control valve (6).

The gas and hydraulic fluid pressures and temperatures (11, 12, 13, 14) are recorded during the test.

The hydraulic fluid stored inside the test accumulator (9) during the charging operation is collected in a reservoir (7) placed below the distribution block (5). Depending on the tests to be conducted, the test accumulator (9) may be completely or partially discharged.

A drain valve (16), located below the reservoir (7), is used to drain the reservoir before the next test.

5.3 Design and dimensioning

Refer to [Figure 1](#) for the devices included in this sub-clause.

The non-exhaustive list shown below gives appropriate requirements on how to design the test bench and conduct the tests in order to obtain high-quality results.

- The distribution components (3, 4, 5 and 8) shall be as tight (pressure-sealed) as possible to prevent any leak rate likely to alter the measurements during pressure stabilisation phases.
- The whole distribution system and the piping shall be generously sized in order to perform charging and discharging operations with minimum pressure losses, and therefore perform measurements with high flowrates. A maximum pressure loss of 0,5 MPa shall be ensured for the maximum instantaneous flowrate for which the test bench is designed (with adjustable flow-control valve (6) fully open). The pressure loss shall be determined by calculation (pressure loss in the valves and pressure loss in the pipes).
- Dead volumes shall be as small as possible in relation to the volumes which are to be measured; the cartridge valve technology may be used.
- The opening and closing times of the valves (3 and 4) shall be short in relation to the duration of the charging and the discharging operation, to prevent any effect on the characteristics of the accumulators. A maximum ratio of approximately 8 % between opening/closing times of the valves and duration of the charging/discharging operation shall be ensured;

In order to perform tests with industrial valves, the opening and closing times of the valves shall not be less than 50 ms.

- the pressure losses of the distribution block (5) shall remain negligible in relation to the pressure losses of the coupling of the accumulator.

Two tests can be considered as comparable, provided that, as a minimum, ambient temperature and gas pressures measured are common during the charging phase or discharging phase.