TECHNICAL EXPLANATIONS HYDRAULIC VALVES

Contents

1. Foreword

The technical explanations serve to explain and define the terms, abbreviations and diagrams used in the valve data sheets with respect to characteristic hydraulic values.
Serving as reference are:

DIN 2.4564-1	Fluid Technology – **Components for Hydraulic Systems** – Part 1: Characteristic values
DIN 24 312	Fluid Technology – **Pressure** – Values, terms
DIN 24 311	Fluid Technology – **Hydraulic Continuous Action Valves** – Terms, symbols, units

2.1. Characteristic Values for Directional Control Valves

The information provided is exclusively applicable to Wandfluh directional control valves (spool valves and poppet valves) of the documentation registers 1.2 to 1.12.

2.1.1 Standard Values

Nominal pressure
Maximum pressure
Calculated pressure

p_{max}

Nominal pressure
Maximum static presure, for which the valves have been designed for achieving their operatability
(also refer to **„Performance Limit“**)

Calculated pressure
Actuating elements, fixing elements, seals and wall thicknesses are designed for this pressure with the necessary safety margin.
(also refer to **„Operating Pressure“**)
This value must not be exceeded under static conditions (safety).

Maximum pressure
Pressure peaks (pressure pulses) can exceed this value, they should, however, be kept as small as possible with respect to their maximum value and their frequency of occurrence, in order to ensure an impeccable operation and a maximum service lifetime.

In the case of the directional control valves of Wandfluh AG, nominal pressure, calculated pressure and maximum pressure are one and the same value. This value is indicated in the header of the data sheets and on the valve nameplates.

Maximum volume flow

Q_{max}

Value defined by the factory, which determines the maximum volume flow, which under certain conditions can pass through the valve. The maximum volume flow is dependent on the pressure.
(also refer to **„Performance Limit“**)

This value is indicated in the header of the data sheets.

2.1.2 General Characteristic Values

Operating pressure at the connections…

Tank load in the connection…

p_{max}

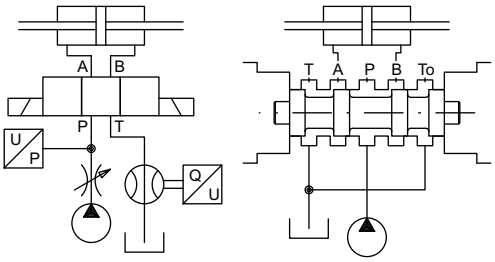
Maximum pressure, for which the valves have been designed in order to achieve their operatability. Actuating elements, fixing elements, seals and wall thicknesses are designed for this pressure with the necessary safety margin. Frequently the maximum permissible tank load in the connection T is lower than the maximum operating pressure in the other connections. Pressure peaks (pressure pulses) can exceed this value, they should, however, be kept as small as possible with respect to their maximum value and their frequency of occurrence, in order to ensure an impeccable operation and a maximum service lifetime. An optimum functioning can be limited, if the operating pressures of the individual connections are all kept at the maximum value at the same time.
(also refer to **„Performance Limit“**)

Performance Limit p = f (Q)
is not applicable for register 1.10
(continuous action
directional control valves)

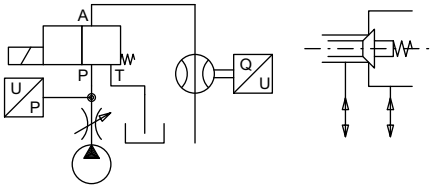
Within the limit values indicated (P, Q), the valves operate without any limitation under the test conditions indicated below. If the performance data are exceeded, switching delays can occur, resp., the switching can be made impossible with the actuation forces available.

Test conditions:
One departs from unfavourable conditions with respect to driving (under-voltage, minimum actuation forces, minimum drive pressures). A switching of the valves must be possible without any problem with the predefined pressure and with the predefined volume flow .

Test installation:
1. Directional control valves



2.Poppet valves



Hydraulic fluid: Garantol HLP46-ISO-VG46
(viscosity = 30 mm²/s at 50°C)
Hydraulic fluid temperature: 50 ± 2°C

If the application involving the valves is different from the illustrated test installation, then it is possible that the indicated performance limits are restricted. An optimum functioning can be restricted, if the operating pressures of other, not switched connections are simultaneously held at the maximum value.

Leakage volume flow characteristic curve $Q_L = f(p)$
is not applicable for register 1.11
(poppet valves)

Measured leakage volume flow across **one control edge.** The indicated values refer to the indicated oil viscosity and not to the viscosity range indicated under „characteristic hydraulic values".
The enveloping curve takes into account the possible centricity, resp., eccentricity of the spool as well as the manufacturing tolerances of the valve bores and of the valve spools.

Pressure loss - volume flow characteristic curve $\Delta p = f(Q)$
is not applicable for register 1.10
(continuous action directional
control valves)

Measured pressure loss across **one control edge** in function of the volume flow. The pressure loss is measured as close to the valve as possible.

Pressure losses of possible connection elements or pipelines, resp., hoses have to be taken into account in addition.

2.1.3 Special Characteristic Values

Pressure loss - volume flow characteristic curve
is only applicable for register 1.10 (continuous action directional control valves)

$\Delta p = f(Q)$

Measured pressure loss across **two control edges** in function of the volume flow. The pressure loss is measured as close to the valve as possible.

Pressure losses of possible connection elements or pipelines, resp., hoses have to be taken into account in addition.

Below the indicated curves, the valve cannot be utilized. (also refer to **„Volume flow - pressure characteristic curve“**)

Volume flow - (signal) characteristic curve
is only applicable for register 1.10 (continuous action directional control valves)

$Q = f(I)$

Dependence of the volume flow on the input signal (I) at a constant valve pressure difference of 10 bar. The hysteresis is indicated as flow hysteresis under „hydraulic characteristics“.

Volume flow - pressure characteristic curve
is only applicable for register 1.10 (continuous action directional control valves)

$Q = f(\Delta p)$

Dependence of the volume flow on the load pressure, with the input signal (I) as parameter. The curve at the maximum input signal forms the performance limit of the continuous action directional control valve.

The selection of the valve should be made in such a way, that the performance limits are not continually reached.

Minimum volume flow
is only applicable for register 1.10 (continuous action directional control valves)

Q_{min}

Minimum volume flow that can be set at p_{max}. Because of the leakage oil volume flow, a certain value cannot be fallen below, even with a minimum actuation force.

Leakage tightness
is only applicable for register 1.11 (poppet valves)

$Q_L = f(p)$

In the case of poppet valves one does not refer to a leakage volume flow but to leakage tightness. The leakage tightness of the poppet valves is dependent on many factors:
- the volume trapped
- viscosity
- contamination of the pressure medium

and therefore on the actual application.

2.2. Characteristic Values for Pressure Valves

The indications provided are exclusively applicable for Wandfluh pressure valves (pressure relief valves, pressure control valves, pressure sequence valves, backpressure valves and accumulator unloading valves) of the document registers 2.1 to 2.3.

2.2.1 Standard Values

Maximum pressure
Calculated pressure

p_{max}

Calculated pressure
Actuating elements, fixing elements, seals and wall thicknesses are designed for this pressure with the necessary safety margin.
This value must not be exceeded under static conditions (safety).

Maximum pressure
Pressure peaks (pressure pulses) can exceed this value, they should, however, be kept as small as possible with respect to their maximum value and their frequency of occurrence, in order to ensure an impeccable operation and a maximum service lifetime.

In the case of the pressure valves of Wandfluh AG, nominal pressure, calculated pressure and maximum pressure are one and the same value.

Maximum volume flow

Q_{max}

Value defined by the factory, which determines the maximum volume flow, which can pass through the valve.

This value is indicated in the header of the data sheets and indicated in the characteristic hydraulic values under volume flow or maximum volume flow.

Maximum nominal pressure rating

$p_{N\ max}$
$p_{N\ red\ max}$

Maximum nominal pressure rating
(also refer to **Nominal pressure ratings**)
Since in the case of most pressure valves the pressure changes in function of the volume flow, this value is lower than the maximum pressure, resp., than the calculated pressure.

This value is indicated in the header of the data sheets.

2.2.2 General Characteristic Values

Nominal pressure ratings

p_N
$p_{N\ red}$

Nominal pressure, which identifies the pressure valve. This pressure is reached in the corresponding connection at the minimum volume flow, when the valve is actuated to the maximum. The pressure set changes with the changing volume flow.

(Refer to the pressure - volume flow characteristic curve).
Because of manufacturing tolerances, the nominal pressure with minimum volume flow is reached with a tolerance of +15 % / -5 %.

Pressure - volume flow characteristic curve

$p = f(Q)$
$p_{red} = f(Q)$

Change of the set pressure in function of the volume flow.
Indicated are the maximum - and the minimum pressure which can be set (maximum and minimum actuation of the valve). The pressure setting range lies between the two curves. In case of actuations, which lie between the minimum and the maximum actuation, the change is proportional.

The values indicated are established with minimum banking-up pressures in the tank lines.

Pressure adjustment characteristic

$p = f(n)$
$p_{red} = f(n)$
$p = f(I)$
$p_{red} = f(I)$

With the actuation of the valve the set pressure changes. Indicated is the change **at the indicated volume flow.**

Leakage volume flow characteristic curve

$Q_L = f(p)$

Measured leakage volume flow, resp., control volume flow **between the indicated connections.**

Control volume characteristic curve

$Q_{st} = f(p)$

The values indicated refer to the indicated oil viscosity and not to the viscosity range indicated under "Characteristic hydraulic values". The enveloping curve takes into account the possible centricity, resp., eccentricity of the spool as well as the manufacturing tolerances of the valve bores and of the valve spools.

2.2.3 Special Characteristic Values

Pressure loss - volume flow characteristic curve
is only applicable for accumulator unloading valves

$\Delta p = f(Q)$

Pressure loss across the valve in accumulator unloading operation and therefore pressure-free circulation through the accumulator unloading valve.

Pressure losses of possible connection elements or pipeline, resp., hoses have to be taken into account in addition.

Minimum pressure
is only applicable for accumulator unloading valves

p_{min}

Value defined by the factory, which, corresponding to the respective pressure ratings, must not be fallen below in the operation of the valves.

2.3. Characteristic Values for Flow Control Valves

The indications provided are exclusively applicable for Wandfluh flow control valves (throttle valves, restrictor valves with reverse free flow) of the document registers 2.4 to 2.6.

2.3.1 Standard Values

Maximum pressure
Calculated pressure

p_{max}

Nominal pressure
Maximum static pressure, for which the valves are calculated in order to achieve the operatability.

Calculated pressure
Actuating elements, fixing elements, seals and wall thicknesses are designed for this pressure with the necessary safety margin.
This value must not be exceeded under static conditions (safety).

Maximum pressure
Pressure peaks (pressure pulses) can exceed this value, they should, however, be kept as small as possible with respect to their maximum value and their frequency of occurrence, in order to ensure an impeccable operation and a maximum service lifetime.

In the case of the flow control valves of Wandfluh AG, nominal pressure, calculated pressure and maximum pressure are one and the same value.

Maximum volume flow

Q_{max}

Value defined by the factory, which determines the maximum volume flow, which must not be exceeded in the operation of the valves.
This value refers to the controlled function of the valve. In case of valves, which can be subject to an uncontrolled reverse flow, resp., where this takes place through a non-return valve, the value could possibly be different. This can be seen from the corresponding diagrams.

This value is indicated in the header of the data sheets and under volume flow or maximum volume flow in the characteristic hydraulic values.

Maximum nominal volume flow rating

$Q_{N\ max}$

Maximum volume flow rating
(also refer to **volume flow ratings**)

This value is indicated in the header of the data sheets.

2.3.2 General Characteristic Values

Nominal volume flow ratings Q_N

Nominal volume flow, which identifies the flow control valve. In the case of most throttle valves and restrictor valves with reverse free flow, the nominal volume flow is reached at a Δp of 10 bar across the valve. (In the case of some valves with a different Δp, this is indicated on the data sheets).
In the case of flow control valves, the nominal volume flow corresponds to the maximum volume flow which can be set. With the changing pressure, the volume flow set in the case of throttle valves changes very much. In the case of flow control valves to a small degree.
(In case of flow control valves, **refer to the volume flow - pressure characteristic curve**)

Volume flow adjustment characteristic $Q = f(n)$ $Q = f(I)$

With the actuation of the valve, the volume flow set changes.

Leakage volume flow characteristic $Q_L = f(p)$ (Q_{min})

Measured leakage volume flow. The leakage volume flow restricts the lowest volume flow which can be set and therefore represents the minimum volume flow ($Q_{min)}$).

The values indicated refer to the indicated oil viscosity and not to the viscosity range indicated under "Characteristic hydraulic values".

The enveloping curve takes into account the possible centricity, resp., eccentricity of the spool as well as the manufacturing tolerances of the valve bores and of the valve spools.

2.3.3 Special Characteristic Values

Pressure loss - volume flow characteristic curve
only applicable for throttle valves and restrictor valves with reverse free flow

$\Delta p = f(Q)$

Pressure loss across the valve with differing volume flow. In the case of the throttling function, the throttle is completely open. In the case of restrictor valves with reverse free flow, in addition the Δp across the non-return valve function is indicated. In doing so,
the valve is closed at $Q = 0$.

Pressure losses of possible connection elements or pipelines, resp., hoses have to be taken into account in addition.

Volume flow - pressure characteristic curve
only applicable for flow control valves

$Q = f(p)$

Change of the volume flow set in function of the pressure.
Indicated is the maximum volume flow which can be set (maximum actuation of the valve). The volume flow set is only reached as from a certain pressure ($\Delta p = f(Q)$ of the valve). At $Q_{N,}$, depending on the type of valve and the nominal volume flow rating, this can amount to approx. 10…30 bar.

Opening pressure across non-return valve
Only applicable for restrictor valves with reverse free flow

$p_{ö}$

In case of the non-return valve function, the valve also in the case of a minimum volume flow only opens at a certain pressure because of the spring pre-tensioning.

2.4. Characteristic Values for Non-return Valves

The indications provided are exclusively applicable for Wandfluh non-return valves (non-return valves and pilot operated non-return valves) of the document register 2.7.

2.4.1 Standard Values

Maximum pressure
Calculated pressure
p_{max}

Nominal pressure
Maximum static pressure, for which the valves have been designed for achieving their operatability.

Calculated pressure
Actuating elements, fixing elements, seals and wall thicknesses are designed for this pressure with the necessary safety margin.
This value must not be exceeded under static conditions (safety).

Maximum pressure
Pressure peaks (pressure pulses) can exceed this value, they should, however, be kept as small as possible with respect to their maximum value and their frequency of occurrence, in order to ensure an impeccable operation and a maximum service lifetime.
In the case of the non-return valves of Wandfluh AG, nominal pressure, calculated pressure and maximum pressure are one and the same value.

Maximum volume flow
Q_{max}

Value defined by the factory, which determines the maximum volume flow, which under certain conditions can pass through the valve. The maximum volume flow is dependent on the pressure.

This value is indicated in the header of the data sheets and under volume flow or maximum volume flow in the characteristic hydraulic values.

2.4.2 General Characteristic Values

Pressure loss - volume flow characteristic curve
$\Delta p = f(Q)$

Pressure loss across the valve in the case of different volume flows.

Pressure losses of possible connection elements or pipelines, resp., hoses have to be taken into account in addition.

Opening pressure
$p_{ö}$

In case of the non-return valve function, the valve also in the case of a minimum volume flow only opens at a certain pressure because of the spring pre-tensioning.

2.4.3 Special Characteristic Values

Pilot ratio
only applicable for pilot operated non-return valves
$i = 1 : x$

In case of a pilot ratio of 1 : x, maximum one x-th of the pressure on the cylinder side is required to open the valve.