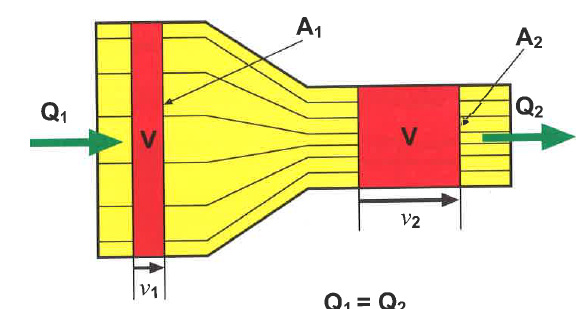
# Fundamental principles

## The Flow Law

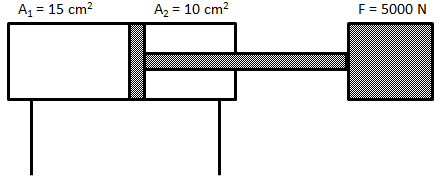


The flow rate Q1 entering a pipe, is equal to the flowrate Q2 leaving the pipe. The area A1 is ?? , the volume V1 is ?? , the velocity v1 is ?? and the area A2 is ??.

What is the velocity v2 of the fluid?

* W
* **G**
* **G**
* **G**

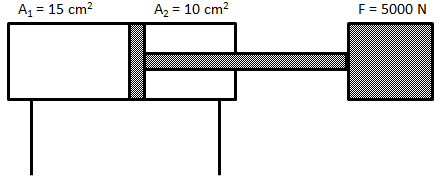
## Pressure



The flow in the system is 10 L/min. What are the 2 system pressures when the piston is moving in positive and negative direction? Husk daN

* **30 bar**
* **33 bar**
* **35 bar**
* **37 bar**

## Flowrate



The flow in the system is 10 L/min. How fast will the piston move in positive and negative direction?

Husk daN på tegningen

* **4 m/min**
* **5,5 m/min**
* **6,7 m/min**
* **7 m/min.**

## Hydraulic power

The oil flow thru the motor below is ?? L/min. and the system pressure is ?? bar.

What is the motors hydraulic power.

* **?**
* **?**
* **?**
* **?**

Hydraulisk effect:??:

# Hydraulic system components

## Flow control

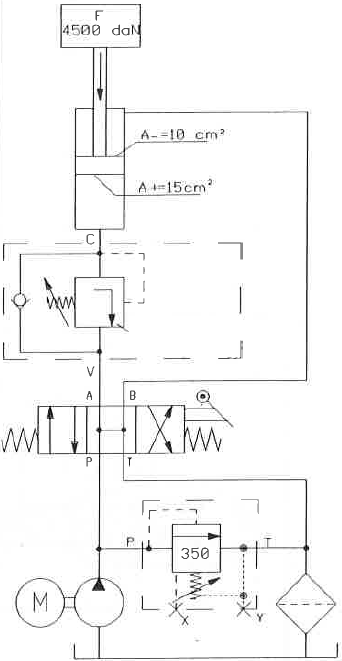
Which configuration would be most appropriate to use to control the piston speed in plus direction?

Husk daN på tegningen

|  |  |
| --- | --- |
| No. 1 | No. 2 |
|  |  |
| No. 3 | No. 4 |
|  |  |

* **No. 1**
* **No. 2**
* **No. 3**
* **No. 4**

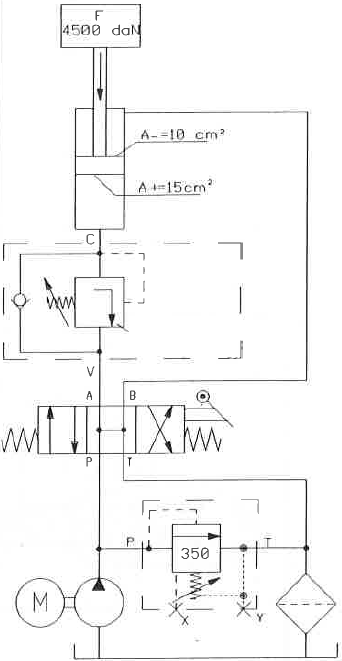
## Counterbalance valve



Which pressure can be measured in point C?

* **P = 200 bar**
* **P = 250 bar**
* **P = 300 bar**
* **P = 325 bar**

## Counter balance valve

The valves opening pressure should be adjusted to a higher value than the pressure from the load. How much higher should the opening pressure be adjusted to?

* **1,10 x P**
* **1,20 x P**
* **1,25 x P**
* **1,30 x P**

## Hydraulic symbols

The 4 drawings show different hydraulic symbols. Write the drawing number next to the correct reference in the table below.

|  |  |
| --- | --- |
| No. 1 | No. 2 |
|  |  |
| No. 3 | No.4 |
|  |  |

|  |  |
| --- | --- |
| **Valve no.** | **The correct term for the valve** |
|  | Variable displacement pump  with pressure compensator,  1 direction of flow,  1 direction of rotation,  case drain port |
|  | Variable displacement pump,  2 directions of flow,  1 direction of rotation,  case drain port |
|  | Fixed displacement  pump/motor,  1 direction of flow,  1 direction of rotation |
|  | Fixed displacement motor,  2 directions of flow,  2 directions of rotation |

# Pumps and associated control systems

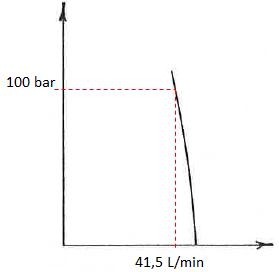
## Automatic pressure and flow compensating pumps

The 3 drawings show different pump compensating systems. Write the drawing number next to the correct reference in the table below.

|  |  |
| --- | --- |
| No. 1 | No. 2 |
|  |  |
| No. 3 |  |
|  |

|  |  |
| --- | --- |
| **Pump no.** | **The correct term for compensation** |
|  | Pressure compensation |
|  | Flow compensation |
|  | Load sensing |

## Pump characteristic - Volumetric efficiency



A pump´s displacement is 50 L/min. But when testing the pump at 100 bar pressure, the flow is 41,5 L/min. What is the pumps volumetric efficiency at 100 bar?

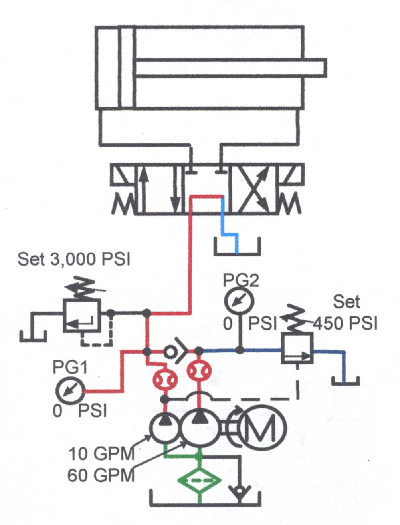
* **0,72**
* **0,75**
* **0,81**
* **0,83**

## Pump Characteristic – Total efficiency.

The pump from previous task has a mechanical efficiency at 0,81 What is the pumps total efficiency at 100 bar?

* **0,65**
* **0,67**
* **0,81**
* **0,82**

## HI –LO pump



F = 2000 daN

When the piston is moving in positive direction, the friction, and weight of the piston generate a force of 100 daN. When the piston reach the box, a force of 2000 daN is generated.

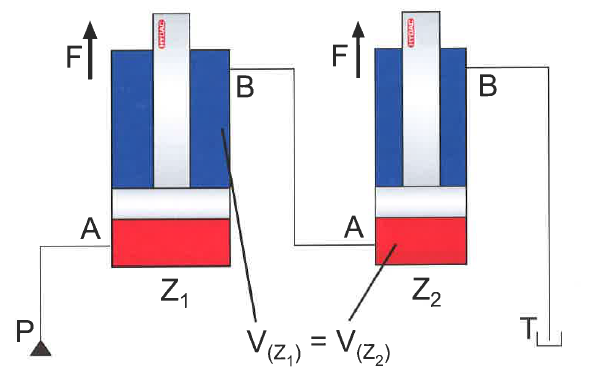
What would be the correct adjustment for pressure relieve valve 1 and 2?

|  |  |  |  |
| --- | --- | --- | --- |
| **Pressure relive valve 1** | | **Pressure relieve valve 2** | |
|  | 19 bar |  | 2 bar |
|  | 37 bar |  | 3 bar |
|  | 40 bar |  | 4 bar |
|  | 42 bar |  | 5 bar |

# Hydraulic actuators

## Cylinder

Master and slave cylinders



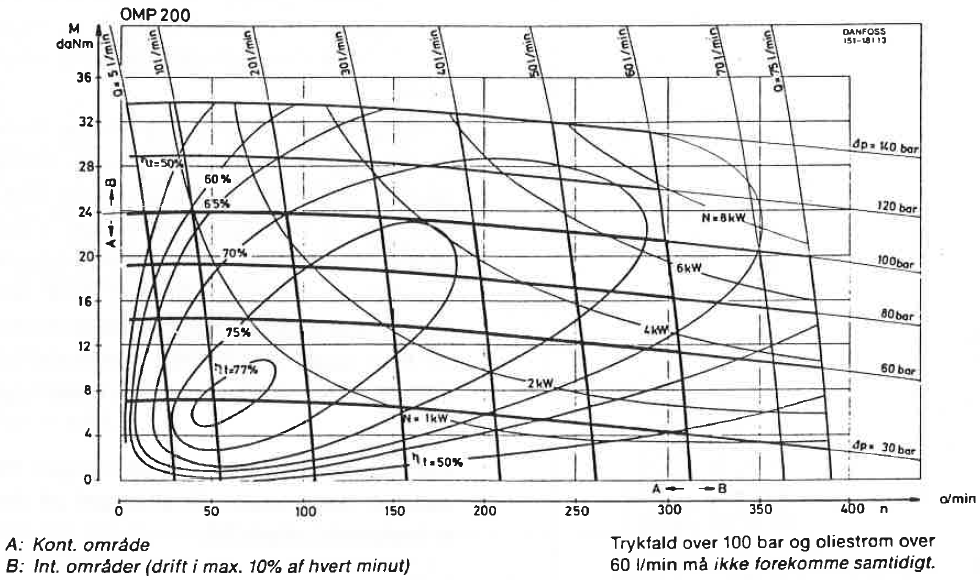
The flow into the master cylinder is 20 L/min.

The area of the piston on the master is 100 cm2. The piston rod is 25 cm2.

How fast will the slave cylinder move?

* **1 m/min.**
* **1,25 m/min.**
* **1,33 m/min.**
* **1,5 m/min.**

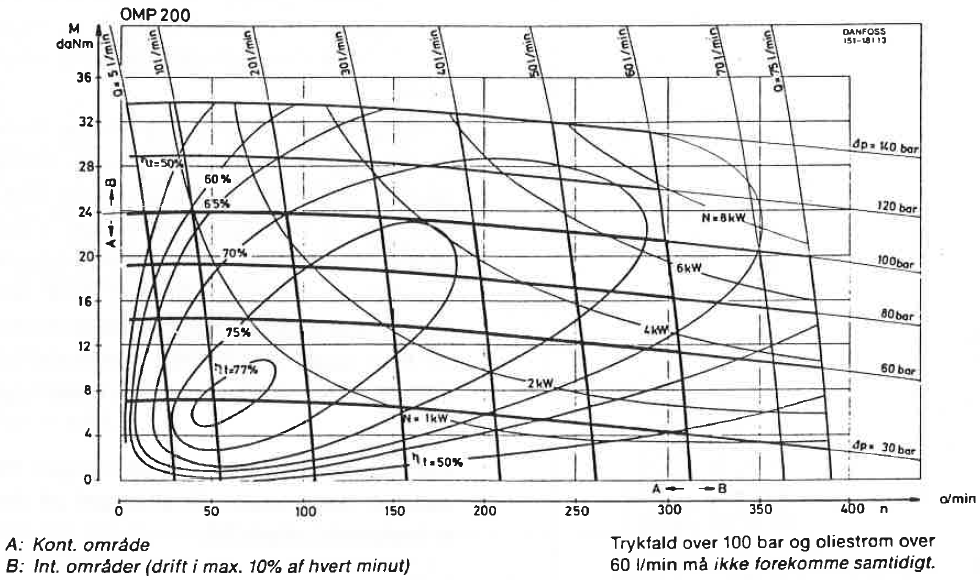
## The mussel diagram



The mussel diagram above shows a performance of a Danfoss ORBIT motor. The motor shall deliver a torque of 16 daNm. The oil flow is 40 L/mi. How fast will the motor turn?

* **144 rpm**
* **175 rpm**
* **200 rpm**
* **210 rpm**

## The mussel diagram



Use the mussel diagram to answer the question.  
If the oil flow is set to 30 L/min and the system pressure is 80 bar, how much power will the motor then deliver?

* **2 kW**
* **3 kW**
* **4 kW**
* **5,1 kW**

## Motor types

The 4 drawings show different motor types. Write the drawing number next to the correct reference in the table below.

|  |  |
| --- | --- |
| No. 1 | No. 2 |
|  |  |
| No. 3 | No.4 |
|  |  |

|  |  |
| --- | --- |
| **Motor no.** | **The correct term for the motor** |
|  | Gear motor |
|  | Vane motor |
|  | Swash plate motor |
|  | Radial piston motor |

# Circuitry and control features

## Hydraulic symbols

The 4 drawings show different hydraulic symbols. Write the drawing number next to the correct reference in the table below.

|  |  |
| --- | --- |
| No. 1 | No. 2 |
|  |  |
| No. 3 | No.4 |
|  |  |

|  |  |
| --- | --- |
| **Valve no.** | **The correct term for the valve** |
|  | Pressure relief valve,  directly operated,  internal pilot oil supply  external drain port |
|  | *Pressure control valves*  Pressure relief valve,  directly operated,  internal pilot oil supply |
|  | 3-way pressure reducing valve,  directly operated,  internal pilot oil supply |
|  | 2-way pressure reducing valve,  directly operated,  internal pilot oil supply |

## Hydraulic symbols

The 4 drawings show different hydraulic symbols. Write the drawing number next to the correct reference in the table below.

|  |  |
| --- | --- |
| No. 1 | No. 2 |
|  |  |
| No. 3 | No.4 |
|  |  |

|  |  |
| --- | --- |
| **Valve no.** | **The correct term for the valve** |
|  | 2-way flow control valve,  pressure compensated |
|  | Throttle check valve |
|  | 3-way flow control valve,  pressure and temperature  compensated |
|  | Flow divider |

## Solenoids

# Hydraulic fluids

## Carrier of contaminants

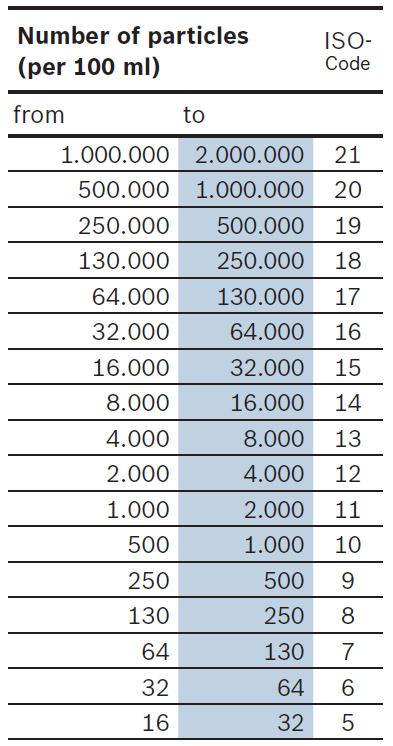
## Viscosity

## Oxidation

## Emulsion

## ISO 4406 cleanliness code

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Sample no. | Particles ≤ 4 µm / 100 ml | Particles ≤ 6 µm / 100 ml | Particles ≤ 14 µm / 100 ml | ISO Code |
| 1 | 190.000 | 58.600 | 1.525 |  |
| 2 | 250.000 | 64.000 | 3.700 |  |
| 3 | 77.600 | 17.000 | 1.500 |  |



In the table above, is the result of 3 oil samples showing the number of found particles in different size.

Regarding to ISO 4406 insert the correct ISO Code for each oil sample

## Air in fluid



1

2

3

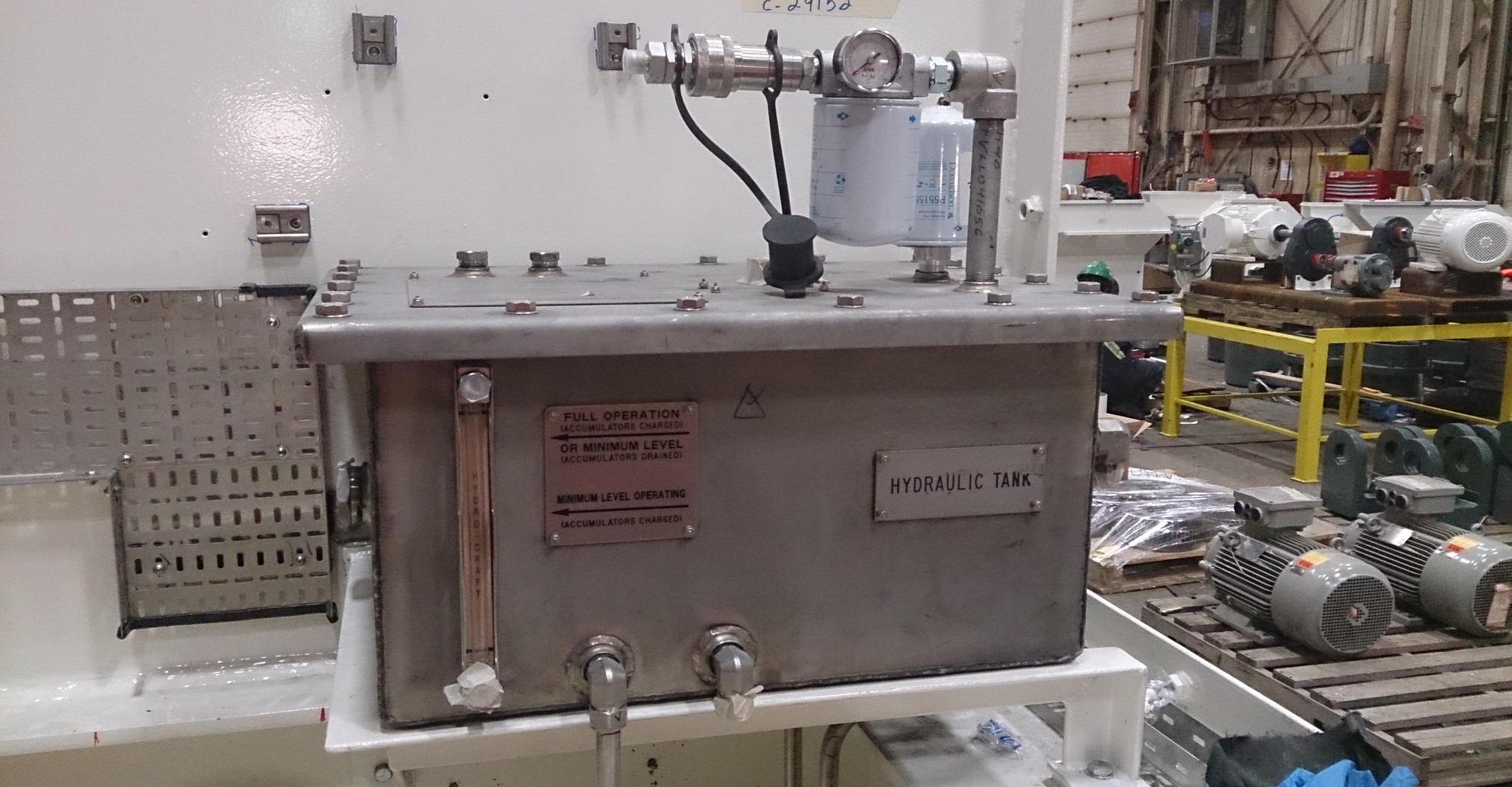
The 3 pictures show different kind of air in operating fluid. Write the drawing number next to the correct reference in the table below.

|  |  |
| --- | --- |
| **Example no.** | **Form of air in the fluid** |
|  | Air-in-oil dispersion |
|  | Surface foam |
|  | Dissolved air |

## 

# Reservoirs and auxiliary equipment

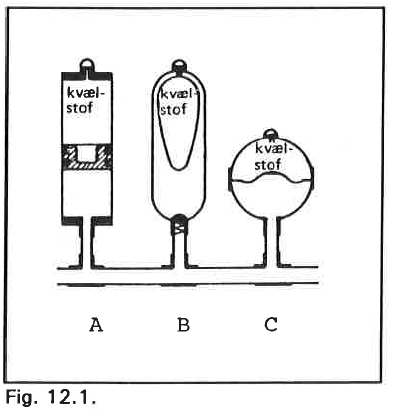
## Reservoir size



The size of a hydraulic tank for an open system should be:

* **Same size as the pump flow**
* **20 % bigger than the pump flow**
* **2 – 3 times bigger than the pump flow**
* **50 % bigger than the pump flow**

## Accumulator type



The drawing shows different accumulator types. Write the drawing number next to the correct reference in the table below.

|  |  |
| --- | --- |
| **Accumulator no.** | **The correct term for the accumulator** |
|  | Bladder accumulator |
|  | Piston accumulator |
|  | Diaphragm accumulator |

## Working range for accumulator

The piston accumulator is commonly used for

* **All round systems**
* **Low pressure systems**
* **Medium pressure systems**
* **High pressure systems**

# Contamination control

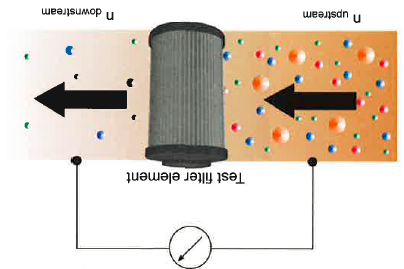
## Cleanliness target

## Sampling and measurement

## Filter performance

## Beta value

When testing the filter shown below, 100.000 particles are flowing upstream into the filter and only 1.000 particles are counted downstream.



What is the filters Beta value?

* **20**
* **75**
* **100**
* **200**

## ISO code

# Maintenance monitoring and fault finding