OPERATING MANUAL

Black Bruin hydraulic motors

S-series model D

SAMPO-HYDRAULICS
www.blackbruin.com

Black Bruin
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1 GENERAL INSTRUCTIONS

1.1 About the manual

This manual contains the instructions for Black Bruin S-series model D hydraulic motors installation and use. Please read these instructions carefully before installing or commissioning the motor. In addition this manual contains the instructions for system design for the motor.

The following symbols are used in this manual:

Information!

Useful information.

Danger!

Danger of death or injury.

Attention!

May cause damage to the motor or the machine.

All information given in this manual is current and valid according to the information available at the time of publication. Sampo Hydraulics reserves the rights to implement changes without prior notice.

Please visit www.blackbruin.com for a product datasheet and the most recent version of this manual. Please ask Sampo Hydraulics for the product datasheets of custom models.

1.2 Revision comments

Week 49.2014 - This manual is published.

1.3 Applicability

This manual applies to Black Bruin S-series model D hydraulic motors manufactured after week 40.2014. Concerning older motors or custom models, please contact Sampo Hydraulics for more information.

1.4 Warranty

The maintenance and installation operations described in this manual do not affect the warranty of the product. The warranty is void if the housing of the motor has been opened prior arriving to the service.

Sampo Hydraulics is not responsible for damages resulting from misinterpreted, non-compliance, incorrect, or improper use of the motor that goes against the instructions given in this manual.

1.5 Product identification

The product identification data can be found on the nameplate attached to the motor.

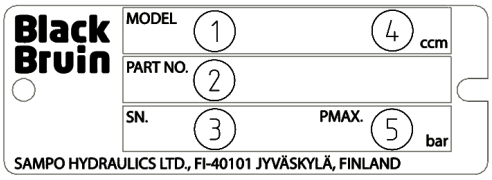

FIG. 1. Nameplate of the motor.

(1) Model
(2) Item number
(3) Serial Number
(4) Displacement per revolution
(5) Maximum allowed operating pressure

Information!

In addition to the nameplate, the serial number may also be found stamped on the housing of the motor. If required, a new nameplate may be delivered based on the serial number.

Information!

References to 1-, 2- and 3-row motors mean the type of the cylinder block in the motor. Please check the cylinder block type from the table below.

TABLE 1. Type of the cylinder block in the motor.

Motor cylinder block type	Motor displacements [ccm]
1-row motor	4000, 5000, 6300
2-row motor	8000, 10000, 12600
3-row motor	15000, 15800, 18900

2 INSTALLATION INSTRUCTIONS

2.1 Safety instructions

Danger!

The following instructions apply to all procedures associated with the motor. Read these instructions carefully and follow them closely.

- Use necessary personal protective equipment when working with the motor.
- Support the motor properly. Make sure, that the motor cannot fall over or turn around by accident.
- Use only appropriate equipment and attachments for lifting and transferring the motor.
- Always use the lifting equipment properly and check the load bearing capacity.
- Prevent unintended use of the motor during installation and maintenance procedures by preventing pressurization of the hydraulic lines.
- The operating temperature of the motor may be over 60 °C (140 °F), which is hot enough to cause severe burns. Beware of hot hydraulic fluid when disconnecting the hydraulic connections.

2.2 The weight, the lifting points and the supporting of the motor

Weight: 435 - 520 kg (1-row motor)
545 - 610 kg (2-row motor)
655 - 720 kg (3-row motor)

The motor is intended to be lifted using lifting belts or suitable lifting lugs from the following lifting points (see figures 2 - 4):

(1) Att. holes for motor flange mounting M24 tai 1-8 UNC
(2) Threads on the back side M16
(3) Att. holes for the SAE-flange M16

Attention!

When using the attachment holes of the SAE-flange, beware of damaging the contact surfaces of the seals of the SAE-flange.

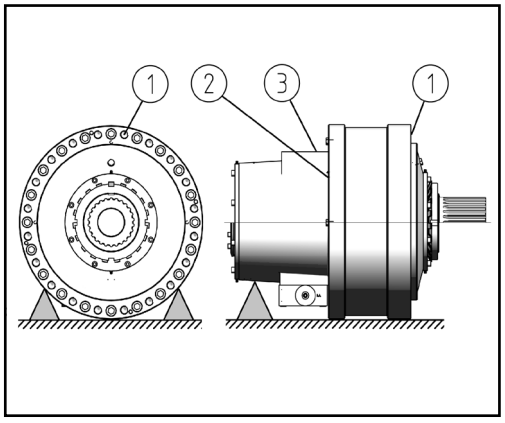

FIG. 2. Horizontal position.

When the motor is set horizontally, support it by the back side of the motor and prevent it from moving sideways.

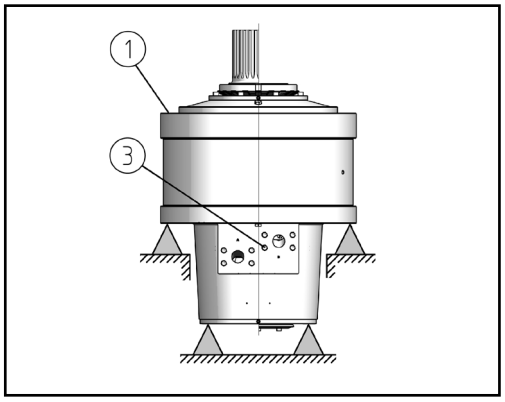

FIG. 3. Vertical position, the shaft upwards.

When the motor is set upwards, support it by the rim of the back side or from the bottom. Also, prevent the motor from falling over.

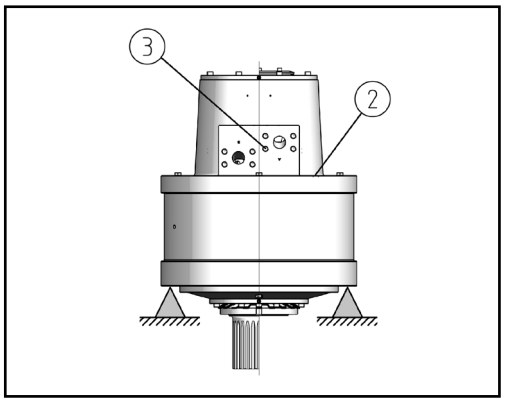

FIG. 4. Vertical position, the shaft downwards.

When the motor is set downwards, support it by the rim of the front side. Also, prevent the motor from falling over.

2.3 Mounting the motor

2.3.1 Flange mounting

The housing of the motor (1) is attached to the flange (2) with a screw connection (4). Take into consideration the following things concerning the screw connection:

- Check, that the counter surfaces are clean and even.
- Recommended roughness for the flange surface is 12,5 µm (Ra).
- The inner edge of the flange opening should have a 2 mm chamfer.
- Use screws at least of strength grade 10.9. (ISO 898-1 grade 10.9 or SAE J429 grade 8).
- Check that the screws are of suitable size and length.
- Clean and oil the screws lightly before installing them.
- Tighten the screws evenly to a torque of 930 ± 70 Nm.

Information!

When replacing fastening screws with new ones, replace all the screws at the same time.

2.3.2 Shaft connection

The shaft of the motor (1) is connected to the driven axle (3) by male or female spline.

- Clean the spline with acetone or similar agent.
- Lubricate the spline thoroughly with gear lubricant.

Information!

Use only high grade (API GL-4 or GL-5) lubricants (for example Mobil Mobilube 1 SHC 75W-90).

Attention!

The spline connection of the shaft is designed to supply the torque generated by the motor. The connection is not designed to carry high radial or axial loads.

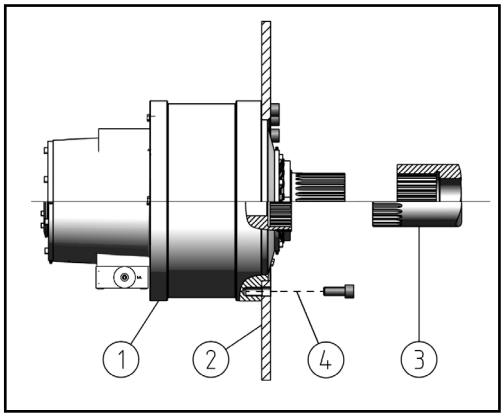

FIG. 5. Motor mounting.

If the motor mounting differs significantly from the above, please confirm it from the manufacturer.

2.4 Demounting the motor

Take into consideration the following things when demounting the motor for service or replacement:

- Release the pressure in the hydraulic lines and let the motor cool down.
- Disconnect all the hydraulic lines from the motor and plug all openings and hoses.
- Demount the motor and lift it away from its position.
- Clean the outside of the motor thoroughly, but do not use any solvents.
- Check, that counter surfaces, shaft spline, screws and threaded holes are intact.
- Protect the cleaned motor from corrosion.
- If possible, drain all the hydraulic fluid from the motor.

Information!

Dispose of hydraulic fluid should be done appropriately.

2.5 Hydraulic connections

2.5.1 Working line ports A and B

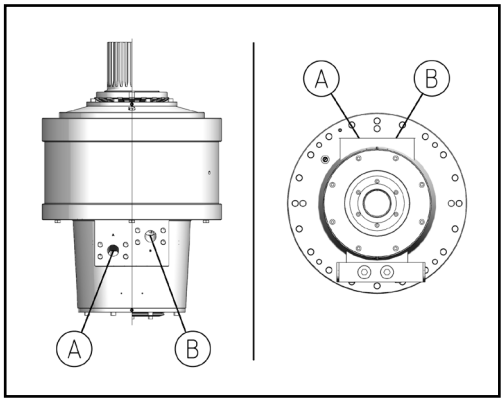

FIG. 6. Working line ports.

Port connection:

- 1 1/2 SAE flange (6000 psi)

The working lines, aka the feed and return lines of the motor are high pressure lines meant for driving the motor. The working line ports are located on a flat surface on the side of the motor.

The ports are marked with “A” and “B”.

2.5.2 Flushing line port C1

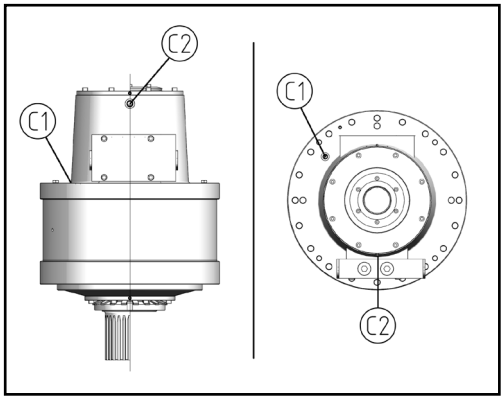

FIG. 7. Flushing and case drain line ports.

Port connection:

- 9/16-18 UNF-2B (o-ring sealing)

Flushing line is a feed line for case flushing. Flushing line port is located on a flat surface on the back side of the housing.

2.5.3 Case drain line port C2

Port connection:

- 3/4-16 UNF-2B (o-ring sealing)

The case drain line is the return line of the housing cavity. The port of the case drain line is located at side of the back of the motor.

2.5.4 Pilot line ports Y1 and Y2

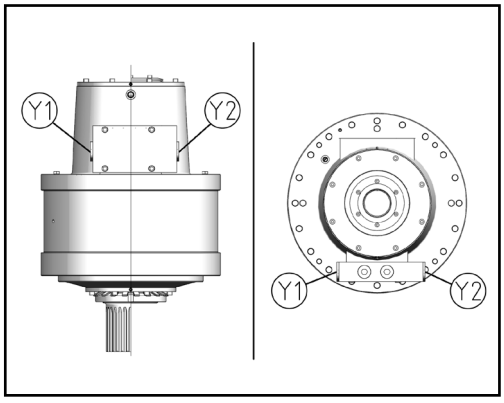

FIG. 8. Pilot line ports.

Port connection:

- 7/16-20 UNF-2B (o-ring sealing)

The pilot lines are meant for the pilot pressure, which is used to control the 2-speed function. The pilot line ports are located at the ends of the 2-speed block, which is attached to the side of the motor.

The ports are marked with ”Y1” and ”Y2”.

2.5.5 Air bleed screws E

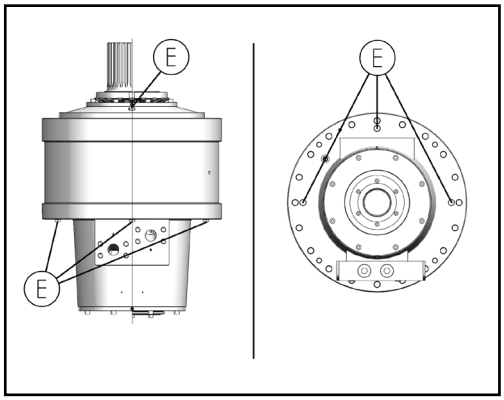

FIG. 9. Air bleed screws.

Air bleed screws are special hex head M10 screws with copper ring sealing.

The air bleed screws are meant for removing the air inside the housing during air bleeding procedure. The air bleeding screws are located at the front and back sides of the housing.

Information!

If necessary, check the port sizes and dimensioning from the product datasheet.

3 OPERATING INSTRUCTIONS

3.1 Commissioning procedure

Ensure that the following things are in order before starting a new or replaced motor:

- The hydraulic circuit of the motor is flushed.
- Motor is installed appropriately.
- Air bleeding procedure is carried out.
- The reservoir of the hydraulic system is full.

In addition during the initial stages use, take the following things into consideration:

- Do not run the motor immediately with full power. Increase the load and speed of rotation gradually.
- Observe the motor and the hydraulic system for external leaks or abnormal noises during the commissioning procedure.
- Start the motor break-in.

Attention!

Do not start the motor, if the air bleeding procedure has not been carried out.

Stressing an unused motor with full power may cause premature wear or failure of the motor.

Information!

During all installation and service procedures, plug any open ports and hoses.

When filling the reservoir, add oil through a filter.

3.2 Flushing the hydraulic system

Prior to connecting the motor as part of the hydraulic system, the hydraulic circuit of the motor must always be flushed by circulating hydraulic fluid through a filter installed in place of the motor.

The flushing is carried out by circulating hydraulic fluid through the entire system with a minimum pressure for at least an hour.

- After flushing, renew all filters.

Information!

Flushing the hydraulic system should also be performed after every system modification or repair.

3.3 Air bleeding procedure

Air bleeding procedure is carried out to fill the housing of the motor completely with hydraulic fluid. Air is removed from the housing with air bleeding screws as follows:

Connect the port C2 to a drain line and feed hydraulic fluid into the motor via port C1 throughout the air bleeding procedure.

- Locate the topmost air bleed screw of the housing.
- Unscrew the air bleeding screw by half a turn and let air escape from the housing.
- Close the screw when only hydraulic fluid is pouring through it.
- Tighten the screw to a torque of 39 ± 3 Nm.

Information!

If feed pressure is not available, fill the housing manually by pouring hydraulic fluid in the motor through the topmost opening of the housing.

3.4 Break-in period

The motor achieves its final properties during the first hours of use. Therefore all new and reconditioned motors should go through an initial break-in period.

Things to be considered during break-in period:

- The break-in period should last for at least first eight hours (8 h) of use.
- The power output should remain under 50 % of the maximum power capacity of the motor.
- The power output is limited by limiting the working pressure, the speed of rotation or both.
- The working pressure should be limited so, that pressure peaks which last over two seconds (2 s) remain under 75 % of the allowed pressure.

Information!

During the break-in period, the moving parts of the motor wear against each other so, that the wear of the parts sets to a stable state for the entire service life of the motor.

3.5 Storage

During short term storage of the motor, the following should be taken into consideration:

- Cover any pressure openings and open threaded holes with suitable caps.
- Protect the unpainted surfaces from dirt and moisture.
- Store the motor in a dry place with relatively stable temperature.
- The motor should not be stored in a same place as substances with aggressive corrosive nature (solvents, acids, alkalis and salts).
- The motor should not be exposed to strong vibrations.

Information!

For long-term storage (over 9 months) the following additional actions are recommended:

- Damages to surface paint must be repaired.
- Protect the unpainted surfaces with suitable anti-corrosion treatment.
- Fill the motor completely with hydraulic fluid.

If these instructions are followed, the motor may be stored for approximately two years. However, as storage conditions do have a significant effect, these times should only be considered as guide values.

4 INSTRUCTIONS FOR SYSTEM DESIGN

4.1 Hydraulic fluid

4.1.1 Hydraulic fluid type

Black Bruin hydraulic motors are designed to work with hydraulic fluids based on mineral oil. The following requirements should be considered when choosing hydraulic fluid:

- Hydraulic oils in accordance with ISO 6743-4 are recommended to be used.
- Motor oils in accordance with API-grades SF, SG, SH and SL may also be used.
- Fire resistant hydraulic fluids HFB and HFC or similar may be used under certain circumstances.

Information!

Please consult Sampo Hydraulics or its representative, if other than mineral oil based hydraulic fluids are to be used.

4.1.2 Hydraulic fluid properties

Take into consideration the following requirements concerning the hydraulic fluid properties:

- The recommended fluid viscosity range for constant use is 25 - 50 cSt.
- The minimum permissible intermittent viscosity is 15 cSt.
- The maximum permissible viscosity during motor startup is 1000 cSt.
- The viscosity index must be at least 100.
- The water content of hydraulic oil should be less than 500 ppm (0,05 %).
- The hydraulic fluid must reach score 10 on a wear protection test FZG A/8,3/90 in accordance with ISO 14635-1 (DIN 51354)

Take into account that the effect of the additives improving the viscosity index can decrease during operation.

Information!

Temperature has a significant effect on the viscosity and the lubricating capability of the hydraulic fluid. Take into consideration the real or assumed operating temperature when defining the fluid viscosity.

The need for service and the overall service life may be improved by using hydraulic fluids with higher viscosity. In addition higher viscosity may improve the running smoothness.

4.1.3 Hydraulic fluid cleanliness

Hydraulic fluid must fulfill cleanliness level 18/16/13 in accordance with ISO 4406 (NAS-1638 grade 7).

Information!

The purity of the hydraulic fluid has a significant effect on the need for service and the overall service life of the motor.

4.2 Operating temperature

The operating temperature means the internal temperature of the motor. Take into considerations the following requirements for the operating temperature:

- For improved service life, avoid over 70 °C (158 °F) operating temperature.
- The highest permissible intermittent operating temperature is 85 °C (185 °F).
- The lowest permissible operating temperature is -35 °C (-31 °F).
- The temperature difference between the motor and the hydraulic fluid should be under 60 °C (140 °F).
- Use the case flushing when necessary.

The operating temperature may be measured from the hydraulic fluid returning from the motor. Take into account the temperature of hydraulic fluid returning from the drain line (C2) and from the return line (A or B).

Information!

The operating temperature is affected by the surrounding temperature, the power output and the temperature of the circulating hydraulic fluid.

4.3 Operating pressures

4.3.1 Charge pressure

The charge pressure is used to ensure that the pistons of the motor stay constantly engaged to the cam ring. Depending on the operating function, the charge pressure is required either in the feed or return line (working line ports A or B).

The recommended charge pressure is 15 to 30 bar higher that the case pressure. The actual required charge pressure depends on the viscosity and flow rate of the hydraulic fluid.

The required charge pressure in the return line (back pressure) is only 5 bar higher than the case pressure, if the motor is NOT switched to partial displacement or short circuit connection.

Information!

A charge pump is used to generate the charge pressure on closed circuit hydraulic systems.

The charge pressure required in the return line (back pressure) on open circuit hydraulic systems may be generated with a pressure limiting valve.

The charge pressure and flow rate required with hydrostatic braking on open circuit hydraulic system requires a separate pressure supply to the feed line.

Attention!

Too low charge pressure may cause the pistons to disengage from the cam ring causing clattering noise when the pistons re-engage.

Constant use with too low charge pressure may cause premature wear or failure of the motor.

4.3.2 Case pressure

The pressure inside the housing of the motor affects the sealing lifetime and the required charge pressure. It is recommended to maintain as low case pressure as possible.

When the motor is running, the permissible constant case pressure is 0 - 2 bar and the highest permissible intermittent case pressure is 10 bar.

When the motor is not running, the highest permissible case pressure is 10 bar.

When necessary, the case pressure may be measured from the ports C1 or C2 as close to the motor as possible.

4.3.3 Working pressure

The working pressure is the high pressure that generates the output torque of the motor. Depending on the operating function, the working pressure is either in the feed or return line. The working pressure should be used only in the working line ports A and B.

The following maximum values for the working pressure are given on the motor datasheet:

PEAK PRESSURE VALUE

The value of the peak pressure is the maximum allowed value of the working pressure. The working pressure may not exceed this value under no circumstances.

INTERMITTENT PRESSURE VALUE

The value of the intermittent pressure is a permissible value of the working pressure for a reference period of one minute. The working pressure may exceed this value for 10 % of the time during the reference period (for 6 seconds).

Information!

The output torque generated by the motor depends on the pressure difference over the feed and return lines. Take into account the effect of charge pressure to the output torque.

4.3.4 Pilot pressure

The pilot pressure is used to control the 2-speed function and it may be applied to ports Y1 and Y2.

The recommended pilot pressure is 20 to 50 bar and the maximum allowed pilot pressure is 350 bar.

Information!

When using over 50 bar pilot pressure, it is recommended to lightly throttle the pilot lines.

4.4 Operating profile

The operating profile describes the work done by the motor during operation.

The operating profile is defined by measuring or estimating the speed of rotation and the working pressure during different operational states. Also the average percentage of the different operational states is estimated.

TABLE 2. Example of operating profile.

Operation	Pressure [bar]	Speed [rpm]	Percent [%]
Acceleration	350 - 400	0 - 10	10
Rotation	100 - 250	20 - 40	55
Deceleration	250 - 300	0 - 20	35

Attention!

Take into account the restriction of working pressure, rotating speed and output power in each operating state. The permissible values for these are given in the motor datasheet.

Information!

The operating profile can be used to estimate the service interval and the total service life of the motor. Please consult Sampo-Hydraulics or its representative for more information.

4.5 Case drain line

The case drain line is the return line of the housing cavity. The case pressure can be controlled by the pressure in the case drain line.

The case drain line is connected from the port C2 to the reservoir of the hydraulic system. Take the following things about the case drain line into consideration:

- The size of the case drain line should be adequate enough not to raise the case pressure.
- Take into account the case leakage and possible case flushing.
- A momentary value of 15 l/min (4 GPM) may be used for the case leakage to size the case drain line.

Information!

If the motor is located above the reservoir, it is recommended to install a check valve with 1 bar opening pressure to the case drain line.

4.6 Case flushing

The case flushing is used, if the case leakage is not adequate enough to control the operating temperature. In addition, the case flushing can be used to heat up the motor before starting.

MOTOR COOLING

For the best cooling performance, the case flushing should be implemented by feeding the flushing flow in the motor from the port C1.

TABLE 3. Recommended flushing flow (35 cSt).

Cylinder block type	Case flushing	
	[l/min]	[US gpm]
1-row motor	3,8 - 5,7	(1,0 - 1,5)
2-row motor	5,7 - 7,6	(1,5 - 2,0)
3-row motor	7,6 - 9,5	(2,0 - 2,5)

The recommended values for case flushing are given in the table above. However, the case flushing is very application specific and given values should only be considered as guide values.

MOTOR HEATING

Please take the following things into consideration, when using the case flushing to heat the motor before starting:

- The flow resistance of cold hydraulic fluid may increase the case pressure. Ensure that the case pressure remains permissible.
- The temperature difference of hot hydraulic fluid and cold motor may cause localized thermal expansion. Ensure that the temperature difference remains permissible.

4.7 Motor functions

4.7.1 Running the motor

When running the motor, the output torque is generated by applying working pressure in the feed line and maintaining charge pressure (back pressure) in the return line.

RUNNING DIRECTION

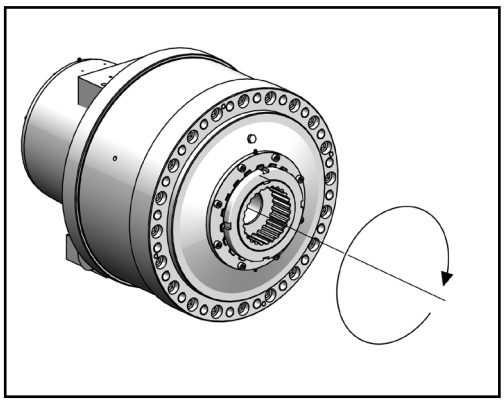

FIG. 10. 1-speed motor, working pressure in line A.

The running direction is determined by the direction of rotation of the motor shaft viewed from the front, when the pressure is applied in the port A:

- The running direction of 1-speed motor is clockwise (CW) and the motor has no preferred running direction.
- The running direction of 2-speed motors is specified in advance and it is the preferred running direction of the motor.

ROTATING SPEED

The desired rotating speed is determined by the displacement of the motor and flow in the working lines. The permissible values for the rotating speed are given in the motor datasheet.

Information!

The speed of rotation affects the required charge pressure. Use sufficient charge pressure especially with high rotating speed.

If the desired constant rotating speed is under 1 rpm, please consult Sampo Hydraulics or its representative for more information.

4.7.2 Freewheeling

The freewheeling is used to minimize the running resistance of the motor, when an external load is rotating the motor. In addition a disengaged motor may be rotated with higher rotating speeds than engaged motor.

If freewheeling is required, please consult Sampo Hydraulics or its representative for more information.

4.7.3 Hydrostatic braking

The hydrostatic braking means using the output torque of the motor to decelerate an external load.

During hydrostatic braking, the output torque of the motor is generated by closing the return line and maintaining charge pressure and flow in the feed line. When the return line is closed, a working pressure is formed in the return line.

Danger!

Do not use the hydrostatic braking without relief valves in the working lines. When an external load is rotating the motor, the hydraulic pressure may increase indefinitely. This leads to danger if a hydraulic hose or component brakes under high pressure.

4.7.4 Short circuit connection

The short circuit connection is used if the motor is required to rotate faster than the hydraulic system can supply, when external load is rotating the motor.

The short circuiting is done by connecting the return line of the motor to the feed line and maintaining charge pressure in both working lines.

A motor in short circuit connection may be switched directly to running operation or hydrostatic braking.

Attention!

During short circuit connection, a sufficient case flushing must be ensured. When the flow is connected from the return line to the feed line, the operating temperature may raise significantly.

Avoid running the motor constantly in short circuit connection.

4.7.5 Counter pressure operation

The counter pressure operation may be needed in some special situations. The counter pressure operation is done by restricting the flow in the return line, which raises the back pressure.

High back pressure stresses the motor significantly while the power output of the motor decreases due to low pressure difference over the working lines.

Attention!

Make sure that the combined pressure in the working lines during counter pressure operation does not exceed the permissible values of the working pressure.

4.7.6 Two speed function

The 2-speed function changes the displacement of the motor by altering the number of working pistons. The 2-speed function is used in the same manner as gear shifting, when the rotating speed or the output torque is to be increased without adding capacity to the hydraulic system.

SHIFTING TO PARTIAL DISPLACEMENT

The motor is switched from full to partial displacement by connecting the pilot pressure to the port Y1.

The recommended pressure difference over ports Y1 and Y2 is 20 bar, when shifting to partial displacement. When the motor is not running, a 10 bar pressure difference is enough to switch the 2-speed valve.

SHIFTING TO FULL DISPLACEMENT

The motor is switched from partial to full displacement by releasing the pilot pressure in the port Y1.

When shifting to full displacement while the motor is running, it is recommended to connect the pilot pressure to the port Y2. The required pressure difference over ports Y2 and Y1 may be as high as 50 bar depending on the flow rate in working lines and on the fluid viscosity.

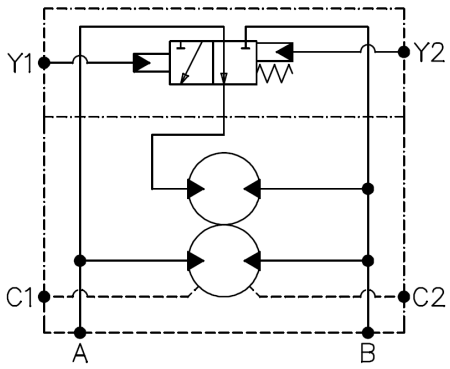

FIG. 11. Hydraulic chart of 2-speed motor.

Attention!

Take the following things into consideration, when changing the displacement while running the motor:

- The working pressure and the rotating speed should be under 50 % of the permissible values, when shifting to partial displacement.
- The rapid change of displacement may cause momentary jerking motion to the motor. This is avoided by throttling the working lines lightly.
- Hydraulic system supply must adjust to the rapid change of the motor displacement.

Running the motor on partial displacement affects the permissible output power. This is because the number of working pistons is altered.

In addition, running the motor constantly on partial displacement against the preferred rotating direction is not recommended. In which case, some of the motor's pistons are working against the rotating direction, which may raise the operating temperature and reduce the overall efficiency of the motor.

Information!

Check the motor datasheet for permissible the values of output power and rotating speed as well as displacement when the motors is switched to partial displacement.

5 DECLARATION OF INCORPORATION

Declaration Of Incorporation 1(1)
Original

2014-01-10

DECLARATION OF INCORPORATION (in accordance with EC Machinery Directive 2006/42/EC, Annex II B)

Manufacturer	Sampo Hydraulics Ltd.
Address	P.O. Box 633 FI-40101 Jyväskylä, FINLAND
Product description	Black Bruin hydraulic motor series: – BBC – BB – S

We hereby declare that the product(s) specified above is intended to be incorporated into machinery or to be assembled with other machinery to constitute machinery covered by EC Machinery Directive 2006/42/EC, as amended.

And that the following harmonised standards have been applied:

- EN ISO 4413:2010 (Hydraulic fluid power - General rules and safety requirements for systems and their components)
- EN ISO 12100:2010 (Safety of machinery – General principles for design – Risk assessment and risk reduction)

And furthermore declares that the product(s) covered by this declaration must not be put into service until the final machinery into which it is to be incorporated has been declared in conformity with the provisions of EC Machinery Directive 2006/42/EC.

The product(s) must be applied and installed in accordance with all the technical documents applicable to the product(s).

This document supersedes all previous releases to this subject.

Place and date	Jyväskylä, 2014-01-10

On behalf of Sampo Hydraulics Ltd.

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