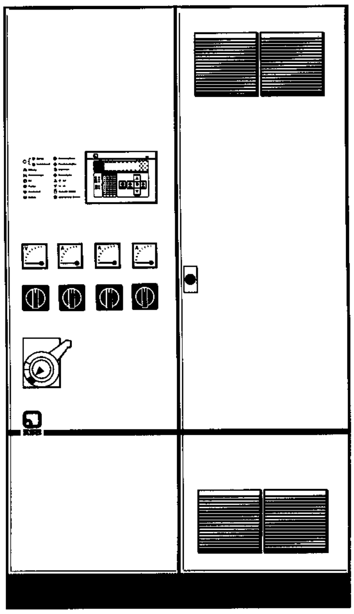
# Hyamaster® ISB



**Standardised single and multiple pump control systems with continuous speed control via one or two frequency inverters for up to 8 pump drivers with three-phase motors**

## Fields of Application

- Industry: Process loops, industrial water supply, cooling, lubrication and other process engineering applications. Water extraction, water treatment, water supply, waste water disposal.
- District heating: cogeneration plants, heat transfer stations

## Performance Data

Number of pumps: 1 to 8 pumps, different pump sizes possible.
Motor ratings: up to 400 kW
Number of frequency inverters: 1 or 2
Mains voltages: 3 x 400 V ± 10 %
3 x 500 V ± 10 %
Mains frequency: 50 Hz

## Functional Description

The Hyamaster ISB control system is specially designed for pumps with three-phase motors. It consists of the electronic control and monitoring unit and all necessary power components such as main switch, frequency inverter, contactors, fuses. All components are installed in a control cabinet. The design is based on a modular concept, thus achieving the necessary flexibility to provide solutions for all applications that occur. A manual-0-automatic switch for each pump provides for both manual and automatic operation.

**Closed loop control:** Transmitters installed in the plant transfer the current plant data to the control unit. This unit continuously compares the actual value with the set values and provides for continuously variable correction of any deviations.

**Open loop control:** The open and closed loop control system integrates process-related optimisations such as startup and shutdown of additional pumps and standby control which will be performed automatically depending on the process conditions. Pump change-over, periodic check of operation, and changing of set value can be freely selected using a realtime clock.

**Monitoring:** The components are monitored automatically by the electronic control system. In the event of any malfunctions, the process is maintained in operation as far as possible and the malfunction is reported and recorded.

**Low load operation:** Pumps with different performance characteristics, e.g. jockey or low load pumps, can be connected upstream of the main pumps in several combinations or can be operated in connection with the main pumps on a separate frequency inverter, if necessary.
The bad-value evaluation of a maximum of 3 measuring points assures optimum plant supply.

## Control Modes

- Pressure / differential pressure
- Pressure / differential pressure (flow-dependent set value)
- Flow
- Level
- Temperature / differential temperature (related to ambient temperature)
- Temperature / differential temperature (related to pressure / differential pressure)
- Bad-value evaluation of a maximum of 3 measuring points (optimum plant supply)

## Designation

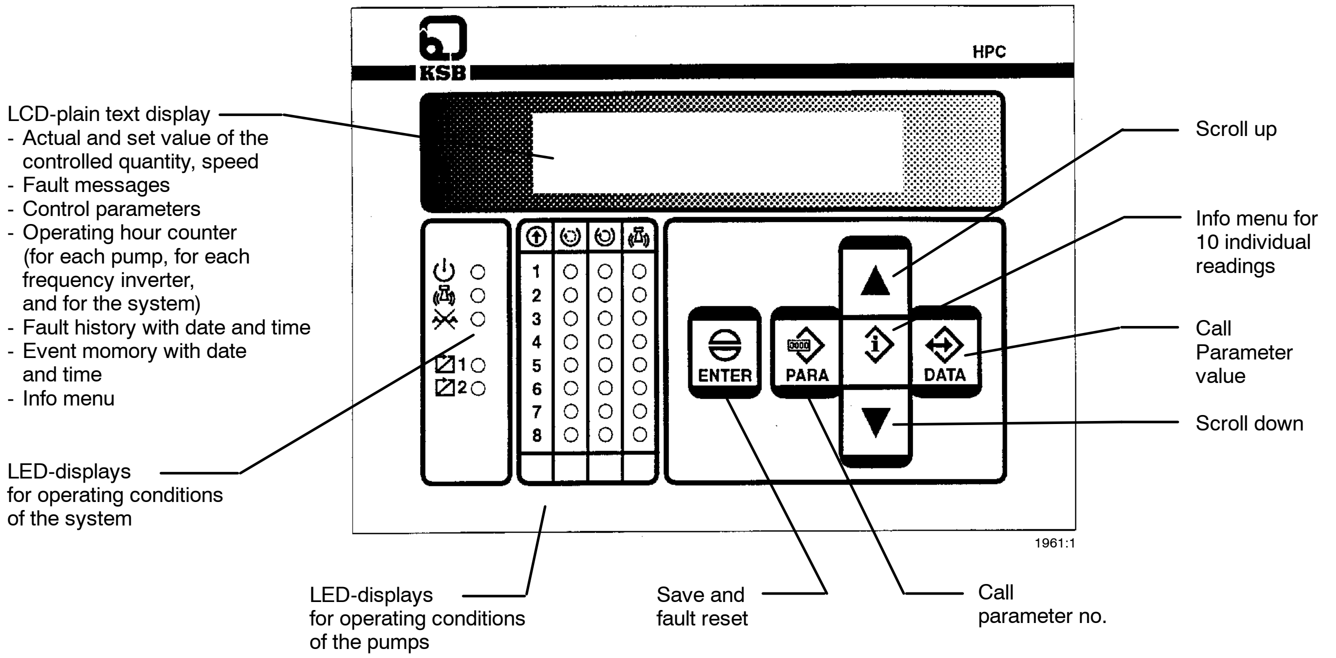
Hyamaster ISB 8 – 300 / 2

Type series — Hyamaster
Industry standard — ISB
Number of pumps — 8
Rating of the largest motor: kW x 10 (example: 30 kW) — 300
Number of frequency inverters — 2

## Variants on request

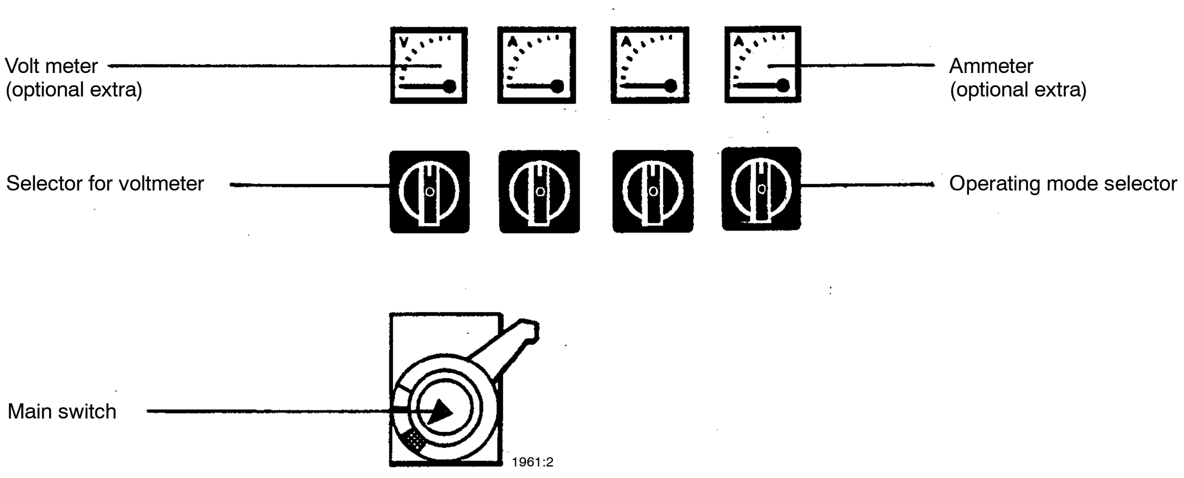
- Motor ratings
- Number of frequency inverters
- Voltage
- Enclosure
- Customer specification
- Hyamaster SPS with Siemens programmable logic controller Simatic S7 for systems with bus connection and more complex control tasks

## Display and operation on location




The electronic control unit is a powerful microcontroller based device for control and monitoring jobs with integrated display and manual control features.

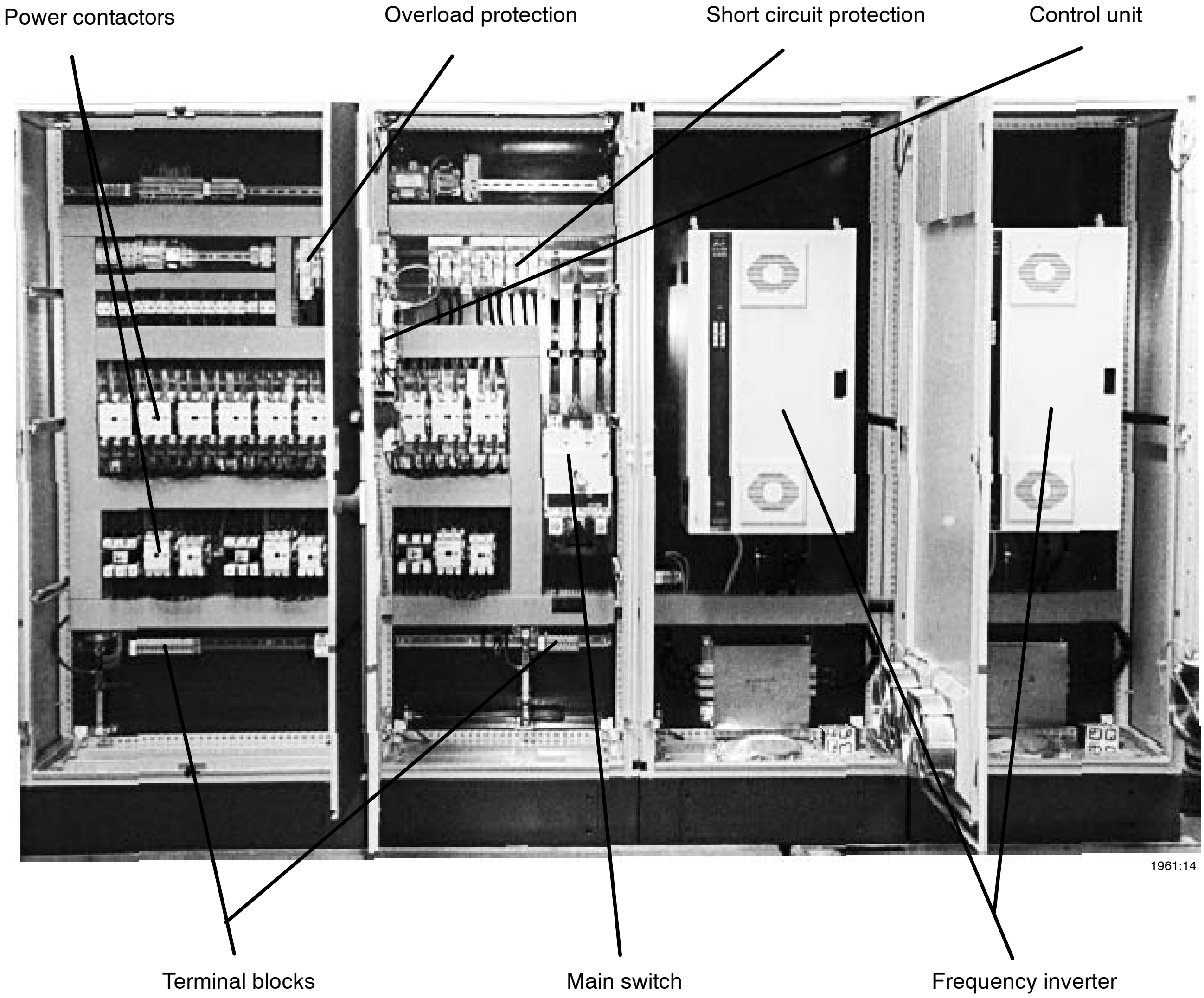
The **LCD plain text display** clearly shows the current system information. **Parameter setting** is menu-controlled via the keypad. The parameters are stored in non-volatile memory to prevent loss of data in case of a power failure. The **LED displays** show stand-by mode, operation or malfunction of the pumps and operation of the frequency inverters.




Equipment example for 3 pumps

An **operating mode selector** is assigned to each pump, thus enabling an individual pump to be excluded from the automatic process. The pump can be operated **manually** on the mains.

This manual operation is purely electromechanical without any electronic control system. This increases reliability, e.g. in the event of failure of the feedback value transmitter.




Control cabinet Hyamaster ISB
for 3 pumps with 75 kW each and 2 frequency inverters

The control system is completely equipped and wired. The steel sheet housing complies with enclosure IP 54 with internal components in IP 41. The components are selected under consideration of pump-specific requirements and with a view to the highest possible reliability. The control system is designed according to DIN VDE 0660, part 500 / DIN EN 60439, part 1; DIN VDE 0113 / part 1 / DIN EN 60204 / part 1, DIN VDE 0470 / IEC 70/ VBG 4; EN 50081 and EN 50082.

The frequency inverter is the control element for speed adjustment of the pump motor. The variable pump performance curve generated in this way allows for continuously variable and therefore optimal operation throughout the entire control range. All the frequency inverters used in the Hyamaster ISB system have been adapted to the most varying pump designs with a view to noise level, mains feedback, radio interference level etc.

## Basic Equipment

**Housing and Internal Parts**

- Steel sheet housing, colour to RAL 7032, IP 54, for indoor installation without base
- Main switch (load switch) to be operated from the front, can be locked
- Ventilation of control cabinet with filter fan (including thermostat)
- Protective devices (fuses, motor protection)
- Frequency inverter
- Control transformer; control voltage 230 V AC, 24 V DC
- Electronic control equipment (installed in front panel)
- Manual-0-automatic switch for each pump (installed in front panel)

**Analogue input connections**

- Feedback value 1 (controlled quantity) 0/2 - 10 V or 0/4-20 mA, resistance KTY 10
- Feedback value 2 (overlay quantity – e.g. flow rate, reproduction of pipeline curve etc.) 0/2 - 10 V or 0/4-20 mA, resistance KTY 10
- External set value 0/2-10 V or 0/4-20 mA, resistance KTY 10

**Digital input connections**

- Automatik-on-off, 24 V DC
- PTC resistor or clixon cut-out under automatic operation
- Dry run protection under automatic operation, off-load voltage 24 V DC
- Change-over to second parameter set 24 V DC
- Remote reset of general fault message contact via impulse, 24 V DC
- Peak load release 1-7 pumps, 24 V DC
- External pump change-over via impulse, 24 V DC

**Digital output connections**

- Relay output connections 250 V AC, 1 A (zero potential)
- General fault message as change-over contact
- Control unit operational message as change-over contact

**Interfaces**

RS 232/485, D-Sub 9 female

**Auxiliary energy**

- for transmitter 24 V DC, max. 100 mA

**Safety concept for the complete system**

**Monitoring the pumps and the hydraulic system**

- Overcurrent monitoring
- Full motor protection with PTC resistors or bimetal switches for automatic operation, monitoring and message for manual operation
- Dry run protection

**Reaction in case of faults**

- Change-over to standby pump in case of failure of one pump set.
- On failure of a frequency inverter: change-over to mains operation of the motors or shut-down of all pumps or change-over to second frequency inverter (if available)
- Measuring signal monitoring with Life-Zero (4-20 mA) or (2-10 V)
  If the measuring signal fails:
  Message, fault contact, maintaining the pump speed or shutdown of the system (user-definable)

**Protective measures to prevent malfunction**

- Pump change-over periods can be defined by the user
- Intervals for periodic check of operation can be defined by the user

## Optional Extras

**Display and Operation (Installed on front panel)**

- Operating hour counter for each pump
- Ammeter for each pump
- Signal lamps for operation and fault including thermistor relay for each pump
- Signal lamps for operation and fault for each frequency inverter
- Manual speed adjustment via potentiometer
- Voltmeter with phase change-over
- Phase lamps
- Lockable front frame with transparent window (IP 54)
- Frequency inverter display

**Remote transmission on terminal blocks (DDC-messages)**

- Operation and fault for each pump, zero-potential, max. 230 V, max. 1 A
- Operation and fault for each frequency inverter, zero-potential, max. 230 V, max. 1 A
- Position report of manual-zero-automatic switch for each pump, zero-potential, max. 230 V, max. 1 A
- Repair switch for each pump (at the pump)
- Buffer amplifier for analogue input/output: Feedback value 1, feedback value 2, external set value
- Remote interference option: automatic-off and remote-on-off for mains operation of each pump

**Internal parts in control cabinet**

- Double marking of component
- Light and socket connected before the main switch for each control field
- Lightning (overvoltage) protection of power input
- Mains monitoring: phase failure/phase inversion; under-/overvoltage
- Mains monitoring: voltage asymmetry
- Control cabinet heating with thermostat
- Wire marking with terminal number
- Wiring layout matched to circuit diagram layout

**Variants on request**

- Other voltages
- Higher powers
- Additional DDC messages
- Higher enclosures
- Soft starter
- Different motor ratings
- Motor gate valve control
- Component specifications

# Notes for Planning

**Caution** **Special VDE guidelines and regulations of the local energy supply companies as well as local requirements must be adhered to.**

**Measurement and control lines**

| | | | |
|---|---|---|---|
| Actual value transmitter (type 16D) | 3 x 0.75 $mm^2$ | shielded | max. 100 m |
| Actual value transmitter (other) | ... x 0.75 $mm^2$ | shielded | max. 100 m |
| PTC resistor (per motor) | 2 x 0.75 $mm^2$ | shielded | |
| DDC lines, digital (24 V, DC) | ... x 0.75 $mm^2$ | shielded | |
| DDC lines, digital (220 V, AC) | ... x 0.75 $mm^2$ | | |
| DDC lines, analogue (0/2-10 V or 0/4-20 mA) | ... x 0.75 $mm^2$ | shielded | max. 100 m |

**Motor power cables for standardised motors 3 ~ 400 V/50 Hz**

| M kW | ≈ A | Minimum cross-section $mm^2$ | Starting | Minimum design-base cross sections |
|---|---|---|---|---|
| 1.1 - 4 | 2.6 - 8.5 | 4 x 1.5 | direct | DIN VDE 0100, part 430, supplement 1; current-carrying capacity of PVC-insulated cables and conductors, type of installation B 2 for an ambient temperature of 30 °C. |
| 5.5 - 7.5 | 11.5 - 15.5 | 2 x 4 x 1.5 | Y Δ | |
| 11 | 22.5 | 2 x 4 x 2.5 | | |
| 15 - 18.5 | 30 - 36 | 2 x 4 x 4 | | |
| 22 | 43 | 2 x 4 x 6 | | |
| 30 | 58 | 2 x 4 x 10 | | |
| 37 - 45 | 72 - 85 | 2 x 4 x 16 | | |
| 55 | 104 | 2 x 4 x 25 | | |
| 75 | 142 | 2 x 4 x 35 | | |
| 90 | 169 | 2 x 4 x 50 | | |
| 110 - | on request | | | |

**Shielding of the motor power cables** is required for observing the radio-interference suppression level, e.g. type NYCY or NYCWY. For cable lengths of 15 m and less, normal installation cables can be routed through steel armoured conduit or flexible metal tubing. Ducts and tubing made of plastic are unsuitable.

**Total rated power**

Total rated power = Motor rating x number of motors (incl. standby units, if any)

**Heat losses**

The heat losses generated by the frequency inverters dissipate into the **control unit room** via filter fans. It may be necessary to extract some or all that heat from the room. The relevant heat generation can amount to roughly 3-5 % of the motor rating.

# Control cabinet dimensions

## Hyamaster ISB with one frequency inverter

| M kW | with 2 pumps W H D mm | with 3 pumps W H D mm | with 4 pumps W H D mm | up to 8 pumps |
|---|---|---|---|---|
| 1.1 - 4 | 600 800 250 | 600 1000 250 | 600 1000 250 | on request |
| 5.5 - 7.5 | 800 1000 300 | 800 1200 300 | 800 1200 300 | on request |
| 11 - 15 | 800 1800 400 | 800 1800 400 | 1200 1800 400 | on request |
| 18.5 | 800 1800 400 | 800 1800 400 | 1200 1800 400 | on request |
| 22 - 30 | 1200 1800 400 | 1200 1800 400 | 1800 2000 500 | on request |
| 37 | 1200 1800 400 | 1200 1800 400 | on request | on request |
| 45 | 1800 2000 500 | 1800 2000 500 | on request | on request |
| 55 - 75 | 1800 2000 500 | 2000 2000 500 | on request | on request |
| 90 | 2000 2000 600 | 2000 2000 600 | on request | on request |
| 110 | on request | on request | on request | on request |

## Hyamaster ISB with two frequency inverters

| M kW | with 2 pumps W H D mm | with 3 pumps W H D mm | with 4 pumps W H D mm | up to 8 pumps |
|---|---|---|---|---|
| 1.1 - 4 | 800 1200 300 | 800 1200 300 | 800 1200 300 | on request |
| 5.5 - 7.5 | 1200 1800 400 | 1200 1800 400 | 1200 1800 400 | on request |
| 11 - 15 | 1200 1800 400 | 1200 1800 400 | on request | on request |
| 18.5 - 22 | 1600 1800 400 | 1600 1800 400 | on request | on request |
| 30 - 37 | 1600 1800 400 | 1800 2000 500 | on request | on request |
| 45 | 1800 2000 500 | 2000 2000 500 | on request | on request |
| 55 - 75 | 2400 2000 500 | 2800 2000 500 | on request | on request |
| 90 | on request | on request | on request | on request |

# Accessories

### Pressure transmitter

| | Measuring range (bar) | Max. pressure (bar) |
|---|---|---|
| Auxiliary energy 24 V DC (available from open and closed loop control unit) | 0 - 1 | 25 |
| Analogue output; 4 - 20 mA; two-conductor cable, max. working resistance 600 Ohm | 0 - 2.5 | |
| Ambient temperature -20 °C to +70 °C | 0 - 4 | |
| Pressure connection via olive-ring pipe union for 6 mm pipe | 0 - 6 | |
| Product temperature -20 °C to +100 °C | 0 - 10 | |
| | 0 - 16 | |

### Pressure / Differential pressure transmitter

| | Measuring range (bar) | Max. pressure (bar) |
|---|---|---|
| (Wall mounted) | 0 - 1 | 16 |
| Auxiliary energy 24 V DC (available from open and closed loop control unit) | 0 - 2.5 | 25 |
| Analogue output; 4-20 mA; three-conductor cable, max. working resistance 500 Ohm | 0 - 4 | 25 |
| Ambient temperature -10°C to + 50 °C | 0 - 6 | 25 |
| Pressure connection via olive-ring pipe union for 6 mm pipe | 0 - 10 | 25 |
| Max. product temperature +70°C | 0 - 16 | 25 |

### Flow rate transmitter

| | Measuring range ($m^3$/h) | DN | PN |
|---|---|---|---|
| Magnetic-inductive measuring principle (MIF): | 12 | 25 | 30 |
| Compact design | 24 | 32 | 30 |
| Auxiliary energy 230 V AC | 36 | 40 | 30 |
| Analogue output; 0/4-20 mA; adjustable, max. working resistance 750 Ohm | 60 | 50 | 30 |
| Pulse output; adjustable; 0-1000 pulses/unit | 120 | 65 | 30 |
| Conductivity of medium handled ≧ 5 µ s/cm | 180 | 80 | 30 |
| Flanged connection | 240 | 100 | 16 |
| Ambient temperature -10°C to + 60 °C | 420 | 125 | 16 |
| Product temperature -25°C to +130 °C | 600 | 150 | 16 |
| | 1080 | 200 | 10 |
| | 1800 | 250 | 10 |
| Ultrasonic measuring principle: | 18 | 32 | 40 |
| - Measurement pick-up | 30 | 40 | 40 |
| Flanged connection | 45 | 50 | 50 |
| Product temperature - 20 °C to +100 °C | 75 | 65 | 16 |
| - Measuring transducer (wall mounted) | 100 | 80 | 16 |
| Auxiliary energy 230 V AC | 180 | 100 | 16 |
| Analogue output 0/4-20 mA, max. working resistance 1000 Ohm | 260 | 125 | 16 |
| Frequency output 0 - 3.3 kHz | 700 | 150 | 16 |
| Pulse output 0 - 15 Hz | 1500 | 200 | 16 |
| | 2000 | 250 | 16 |

### Flow control device

| | Setting range (cm/s) | |
|---|---|---|
| Calorimetric measuring principle, for dry running protection incl. transducer<br>- Measurement pick-up<br>Sensor connection G 1/2 A<br>Product temperature -25 °C to +80 °C<br>- Measuring transducer (mounted in control cabinet)<br>Auxiliary energy 230 V AC<br>Zero-potential output; one change-over contact; max. 230 V, max. 1 A | ca. 3 - 300 | |

# Accessories

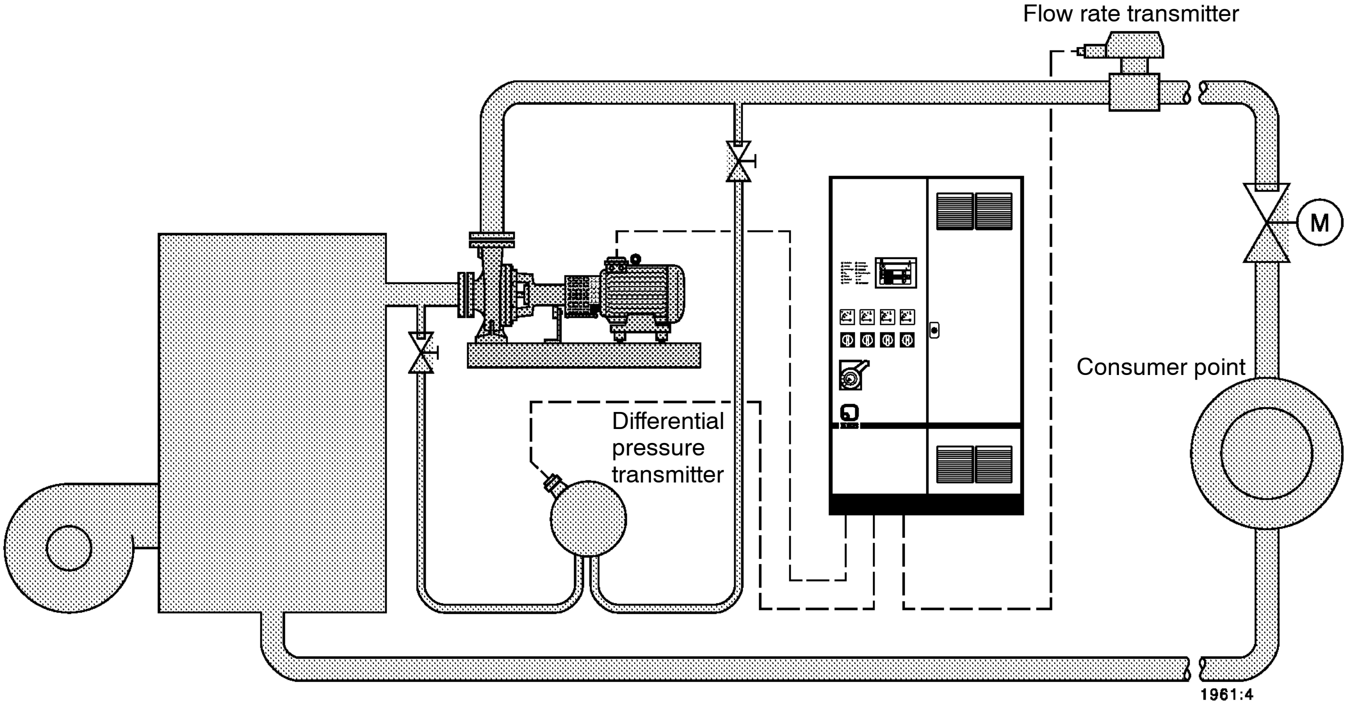
### Level transmitter

| | Measuring range (mm) | |
|---|---|---|
| Capacitive measuring principle<br>Auxiliary energy 24 V DC (available from open and closed loop control unit)<br>Analogue output; 4-20 mA; two-conductor cable, max. working resistance 600 Ohm<br>Threaded connection G 1 1/2 A<br>Ambient temperature -10 °C to +60 °C<br>Product temperature -50 °C to +100 °C<br>Bar electrode made of steel; fully insulated | 1000 to 4000<br>(please indicate required bar length in the purchase order) | |
| | Measuring range (bar) | |
| Hydrostatic measuring principle<br>Auxiliary energy 24 V DC (available from open and closed loop control unit)<br>Analogue output; 4-20 mA; two-conductor cable, max. working resistance 600 Ohm<br>Threaded connection G 1 1/2 A<br>Pressure transmitter for vertical installation<br>Length of connecting pipe: 1 m to 20 m<br>Ambient temperature -20°C to + 60 °C<br>Product temperature -20°C to +80°C | 0 - 0.1 to 0 - 20<br>(Please indicate required measuring range and length of connecting pipe in the purchase order) | |

### Temperature sensor

| | Measuring range (°C) | |
|---|---|---|
| Clip-on sensor | 0 to +120 | |
| Immersion-type sensor<br>with 100 mm stainless steel immersion sleeve ∅ 15 R 1/2 A<br>Max. test pressure 25 bar | 0 to+120 | |
| Immersion-type sensor with transducer<br>with 160 mm stainless steel protective sleeve ∅ 9 PN 16 | -20 to +350 | |

# Example: Heat / District heat supply system with DFS curve

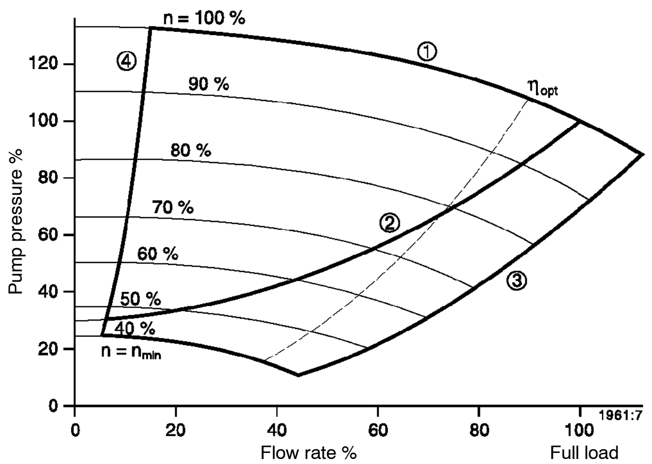


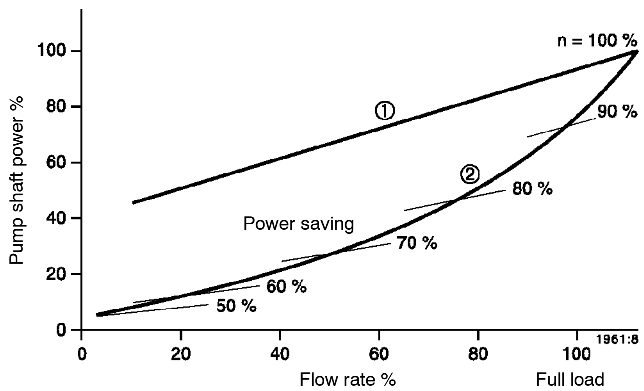

**Control task:**

Maintaining the differential supply pressure at all bad-value points, even with changing operating conditions and interferences, without requiring measuring points at the far end of the heating system.

In many heat / district heat supply systems, it is difficult to detect bad-value points (points where the supply pressure is too low at times) in the piping system. The **DFS** curve (**d**ifferential pressure control with **f**low-dependent **s**et point adjustment) allows optimised control without information about bad-value points.

With the help of differential pressure and flow rate measurements, the flow-dependent influence of pipe friction losses is compensated. The pumps are in continuously variable operation from low-load operation with small pump heads to full-load operation with high heads. The feedback signals can be tapped in the pumping station, obviating the complex and defect-prone transmission of measurements taken at the bad-value points.




$\eta_{opt}$ Optimum pump efficiency curve

① Pump characteristic curve at fixed speed (n = 100 %)

② Duty point curve of pump in controlled operation on frequency inverter (n = variable)

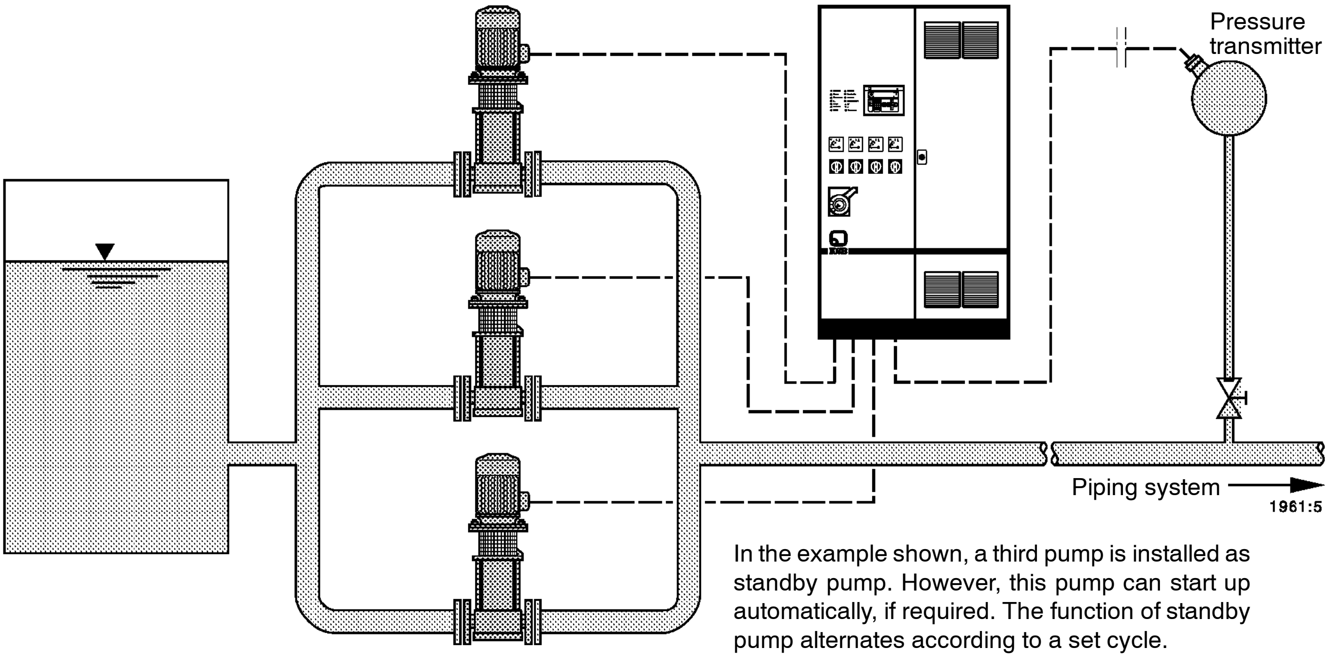
③ Limit for continuous operation (max.)

④ Operating limit (min)

① Pump power input curve at fixed speed (n = 100 %)

② Pump power input curve for controlled operation at frequency inverter (n = variable)

## Example: Supply system with peak-load operation



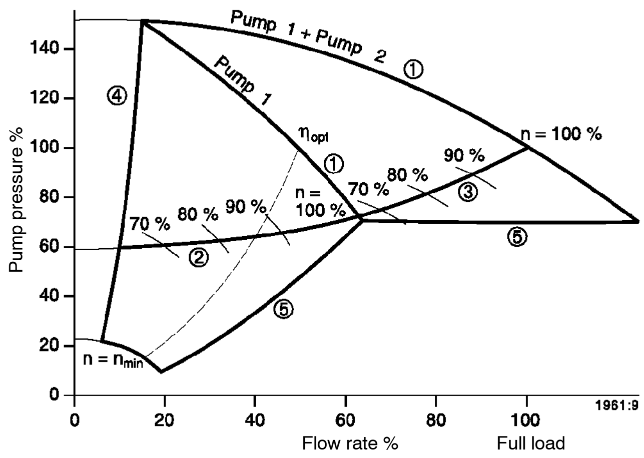

In the example shown, a third pump is installed as standby pump. However, this pump can start up automatically, if required. The function of standby pump alternates according to a set cycle.

**Control task:**

Maintaining constant pressure at a point of reference despite widely differing and fluctuating consumption.

Splitting the total flow rate onto several pumps allows a proportionate reduction in pump and frequency inverter power. Efficiencies in part-load operation are higher than when using a full-load pump. Pressure is kept constant by infinitely variable speed adjustment of one pump.

This base-load pump provides the required flows up to its max. capacity. For higher consumption, a peak-load pump is switched on automatically. Pressure, however, is still controlled by the base-load pump. Pressure deviations, which occur when the peak-load pumps are switched on or off, generally do not affect the process.




$\eta_{opt}$ Optimum pump efficiency curve

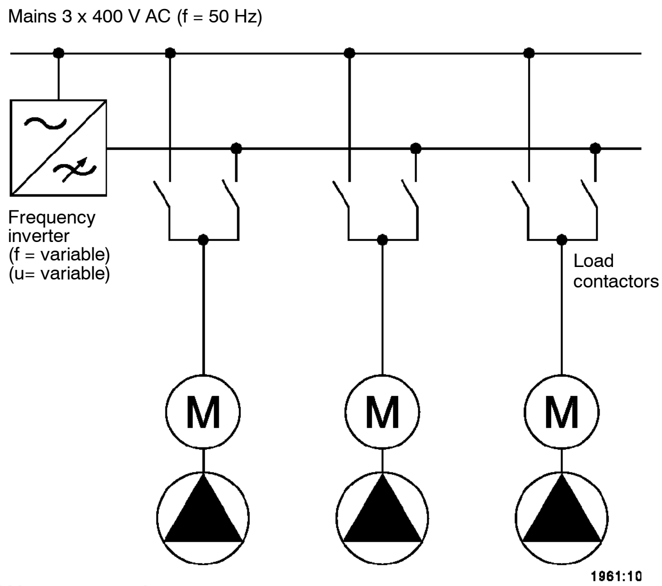
① Pump characteristic curve at fixed speed (n = 100 %)

② Duty point curve of pump in controlled operation at base load on frequency inverter (n = variable)

③ Duty point curve for controlled operation with
1 peak-load pump directly connected to the mains (n = 100 %)
1 base-load pump connected to a frequency inverter (n = variable)

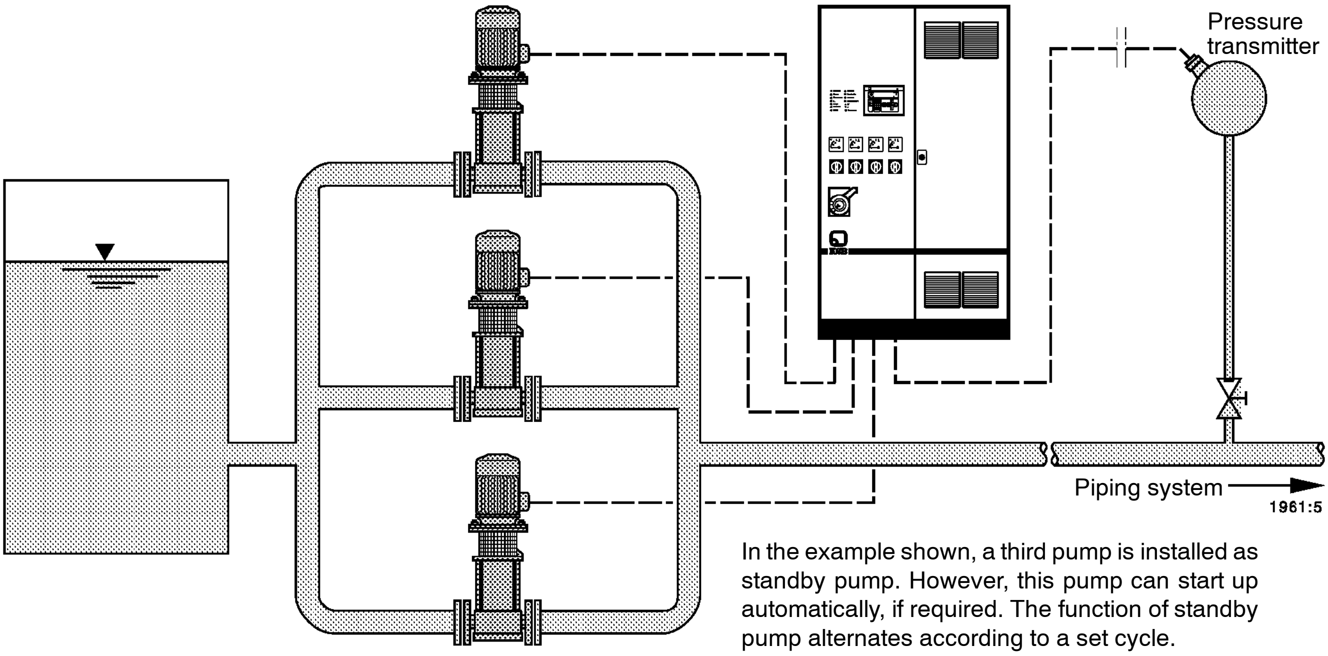
④ Limit for continuous operation (min)

⑤ Operating limit (max)




Wiring principle

# Example: Supply system with two frequency inverters



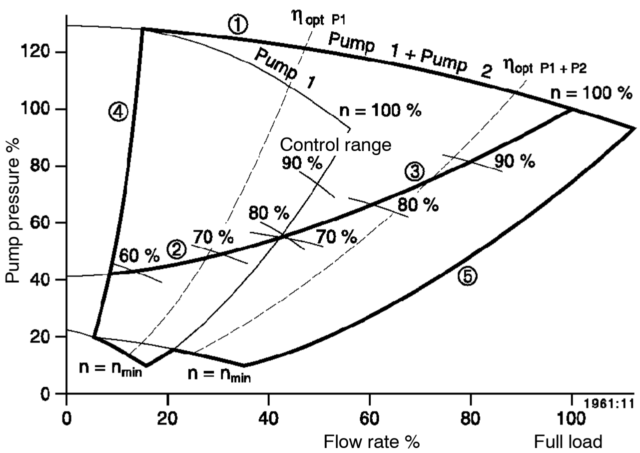

In the example shown, a third pump is installed as standby pump. However, this pump can start up automatically, if required. The function of standby pump alternates according to a set cycle.

**Control task:**

Maintaining constant pressure at a point of reference, even with changing operating conditions and interferences.

In conventional pumping systems, unwanted pressure fluctuations occur, due to changes in inlet pressures, quantities tapped and pressure losses in the supply system, which are compensated by a high-level distributing tank.

In the present expample, the Hyamaster ISB takes on the function of the high-level tank in maintaining a constant supply pressure at a point of reference. Two pump sets with one frequency inverter each, running both in single and parallel operation, cover the entire flow range from minimum flow to full load. The pumps operate in the best-efficiency range. The second frequency inverter also serves as a standby unit.




$\eta_{opt}$ Optimum pump efficiency curve

① Pump characteristic curve at fixed speed (n = 100 %)

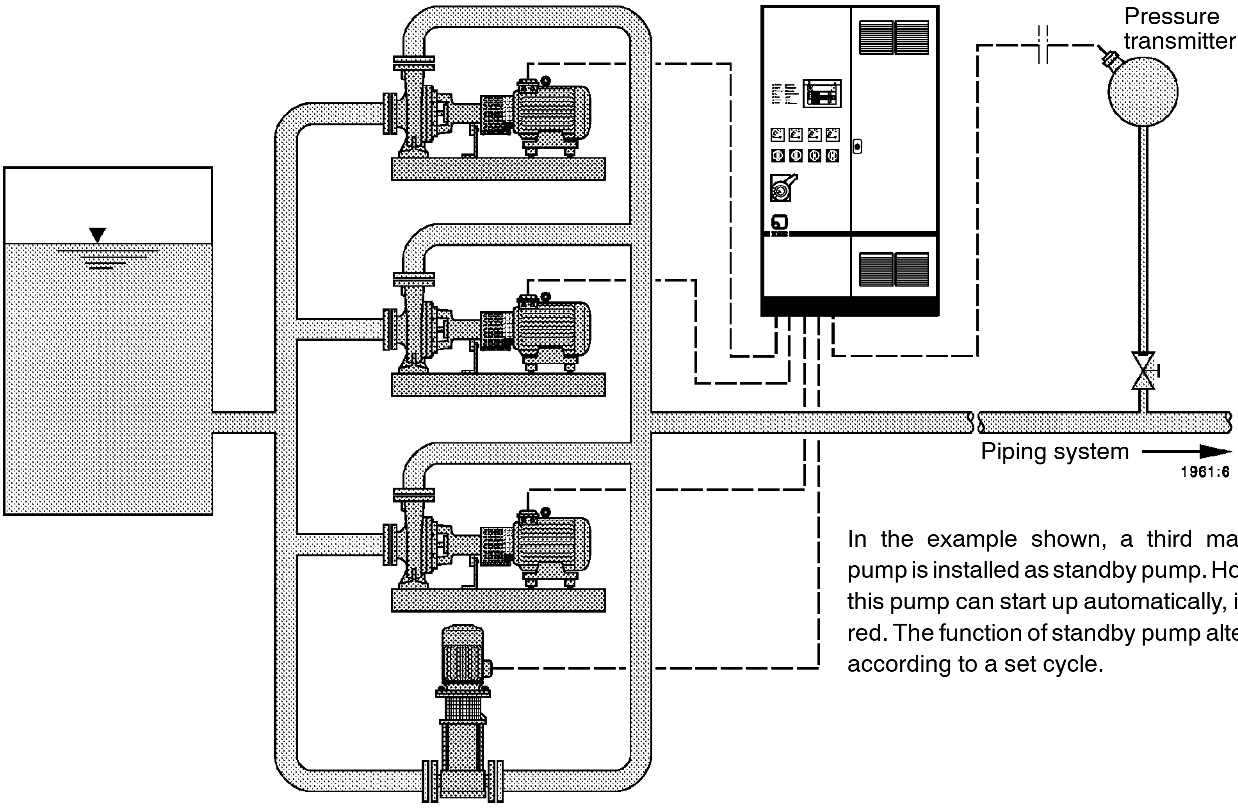
② Duty point curve of pump in controlled operation at base load on frequency inverter (n = variable)

③ Duty point curve of two parallel pumps in controlled operation at peak load on two frequency inverters (n = variable)

④ Limit for continuous operation (min)

⑤ Operating limit (max)

# Example: Low-load and main-load pumps with up to 2 frequency inverters



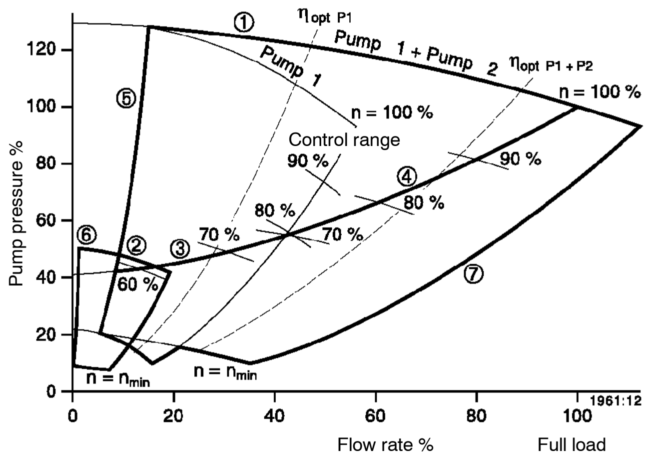

In the example shown, a third main-load pump is installed as standby pump. However, this pump can start up automatically, if required. The function of standby pump alternates according to a set cycle.

**Control task:**

Optimising the low-load operation of the hydraulic system.

Even at low speeds, continuously speed-controlled pumps require a certain minimum flow rate. In many cases, however, these minimum flows are much too high. To avoid pump damage in the long run, the flow rate must not fall below this limit in continuous pump operation. In the low-load range below this limit, a hydraulic bypass is normally used.

However, the flow routed through this bypass cannot be used. A low-load pump which is rated for this flow range and operates at optimum efficiency, can expand the control range of the entire system to include this low-load range.




$\eta_{opt}$ Optimum pump efficiency curve

① Pump characteristic curve at fixed speed (n = 100 %)

② Characteristic curve of low-load pump (n = 100 %)

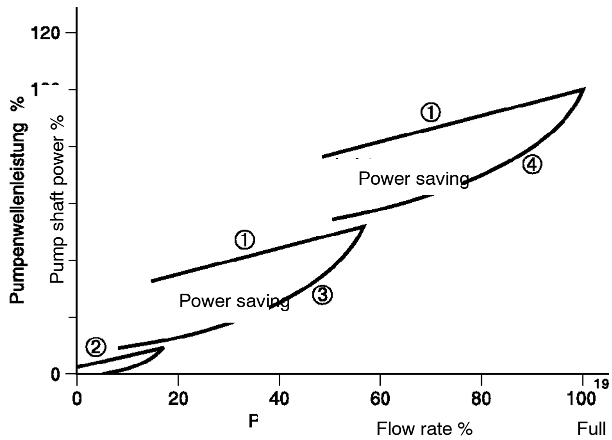
③ Duty point curve of main-load pump in controlled operation at base load on frequency inverter (n = variable)

④ Duty point curve of two parallel main-load pumps in controlled operation at peak load with two frequency inverters (n = variable)

⑤ Limit for continuous operation (min), main-load pump

⑥ Limit for continuous operation (min), low-load pump

⑦ Operating limit (max)




① Pump power input curve at fixed speed (n = 100 %)

② Power curve curve of low-load pump (n = 100 %)

③ Power curve of pump in controlled operation at base load with 1 main-load pump on frequency inverter (n = variable)

④ Power curve of pump in controlled operation at peak load with 2 main-load pumps in parallel on two frequency inverters (n = variable)

Subject to technical modifications.

1.2.2001 XBS d/2

**KSB Aktiengesellschaft**
67225 Frankenthal, Johann-Klein-Str. 9, 67227 Frankenthal (Germany)
Tel.: (+49) 62 33/86-0 · Fax: (+49) 62 33/86-34 01 · www.ksb-industry.com