Internal Gear Pumps for Variable Speed Drives

1 General

1.1 Pruduct description

As a result of increased environmental awareness and the growing competitiveness of rival drive technologies, the energy consumption and noise generation of plant and machinery have become decisive criteria. By using variable speed pumps, it is possible to create energy-efficient hydraulic drives in which, dependent on the machine cycle, the energy savings can be as much as 25% when compared to a metering-controlled drive. These are the results of comparative tests conducted by the Technical University of Dresden.

Losses are largely eliminated when the supply flow is matched to demand. An optimum solution is provided by a quiet-running internal gear pump driven by an electric motor that in turn is controlled by a frequency converter. Since the supply flow is proportional to the pump speed, the result is a variable flow from a fixed displacement pump.

1.2 Characteristics

1. Reduced energy requirement, especially so in part-load and no-load running conditions
2. Lower noise levels from the use of BUCHER internal gear pumps and by reducing the speed in part-load and no-load running conditions
3. Continuously variable flow rate (0% to 100%)
4. Dependent on model, it can perform any duty from that of unidirectional pump up to bi-directional pump/motor with pressure at either port
5. Intermittent operation at high pressure and low speed, pressure-holding with no net flow is possible
6. As determined by the dynamic requirements of the system, it can be driven by servo-motors or by a variety of asynchronous motors

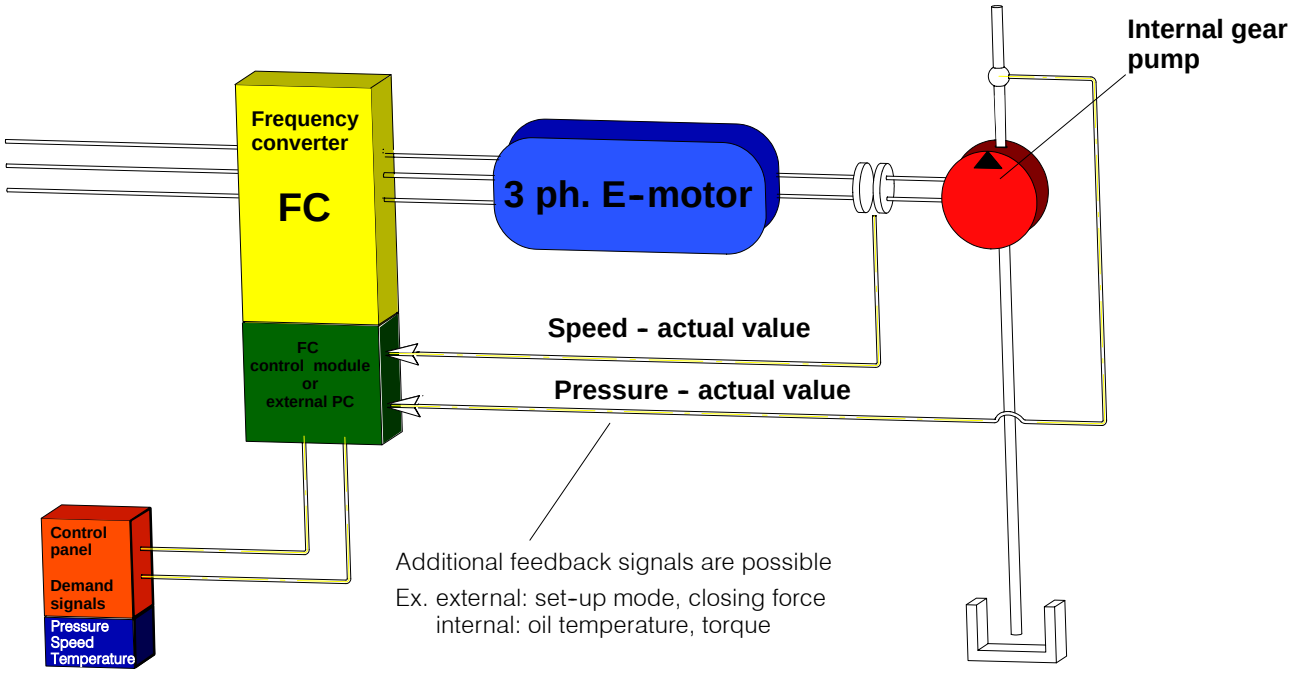
1.3 Schematic function

Variation in speed is achieved by varying the frequency of the power supply provided by the frequency converter.

Demand signal/actual value comparison of control parameters such as speed, flow rate and pressure is performed in either the control module of the frequency converter or an external PC.

A demand signal (set point) for one or more of these parameters is supplied to the frequency converter.

The motor speed is automatically controlled in accordance with the demand signals.



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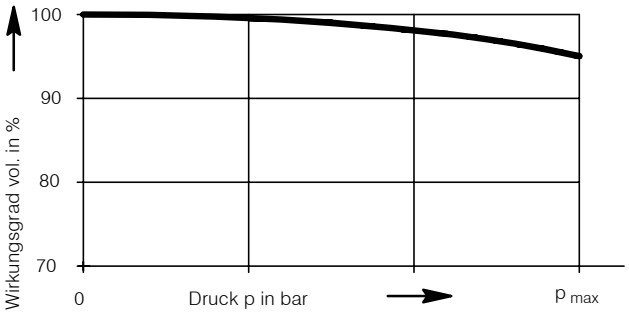
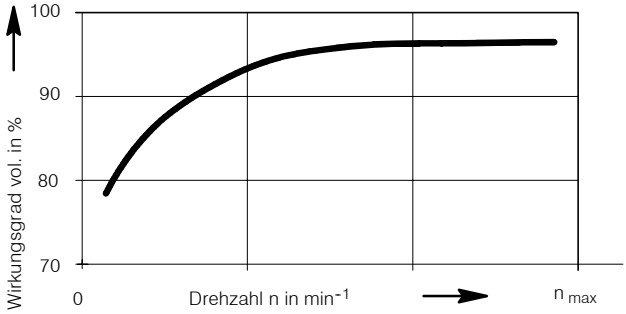
Reference: 100-P-000034-E-01 / 09.06

1.4 Performance graphs

1.4.1 Volumetric efficiency

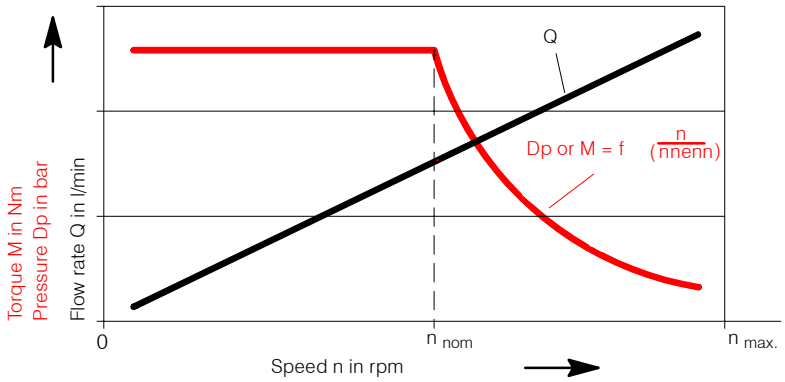
The volumetric efficiency of internal gear pumps is dependent on both pressure and speed. Internal gear pumps achieve high volumetric efficiencies because of the design features described in section 2.1





1.4.2 Speed - flow rate and speed - pressure

The flow rate is matched to demand by varying the speed. At below-nominal speeds, the maximum motor torque or, alternatively, the maximum continuous pump pressure can be used but thermal influences must be monitored (possible over-heating). At above-nominal speeds, care must be taken over the torque-limiting of the electric motor (weakening the magnetic field).



Q = V x n

n = speed (variable)

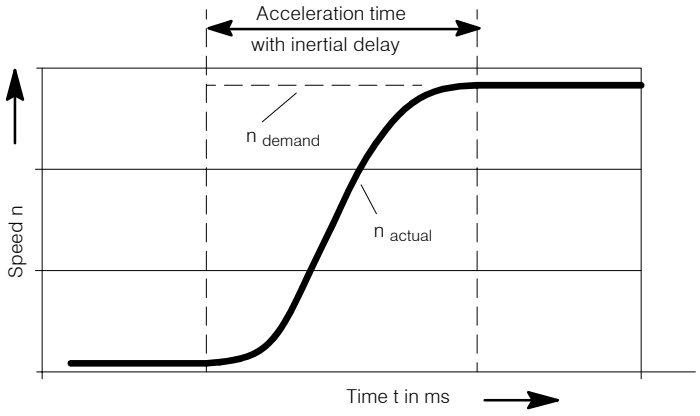
V = displacement volume, determined by the geometric dimensions

$$M = \frac{Dp \times V}{20 \times p \times h_{mech}}$$

h_{mech} = mechanical efficiency

1.4.3 Speed - step response

Depending on the system requirements for acceleration- and braking times, various types of frequency converters and electric motors can be used.



Components:

1. Converter - standard -vector controlled
2. Motor - asynchronous, standard - asynchronous, low inertia - AC servo motor

2 Design features of internal gear pumps

2.1 General design features

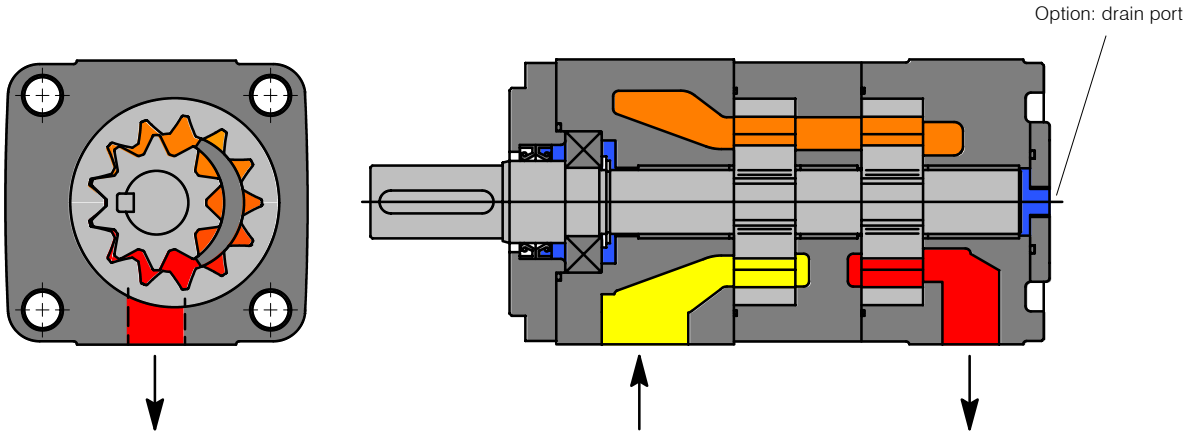
Low-noise internal gear pumps are particularly suitable for variable speed applications. Their quiet running characteristics and - even at low speeds - the low-pulsation output provide the ideal solution.

2.2 QX series medium - and high pressure internal gear pumps

- pressures up to 400 bar
- special tooth profile gives good suction characteristics
- can operate as reversible pump/ motor with pressure capability at either one port or both ports.

The highest operational reliability at low speeds is ensured by:

- single- or two stage pump, depending on themaximum pressure
- the external drain port ensures good heat removal
- pressure flushing of the plain bearings



3 Selection tables for internal gear pumps

3.1 Hochdruck-Innenzahnradpumpe Baureihe QX 1)

3.1.1 Druckbereich 2

Displacement volume	Speed		Type	Pressure rage in bar (for n > 700 rmp)		Torque 3)	Power consumption 4)
	min	max		Cont. press.	Max. Int. press. 2)		
cm³/rev	rmp			bar	bar	Nm	KW
20,4	Speed for pressure - holc (Q = 0 l/min) 5)	3600	QX42-020	210	250	68	10,8
25,1			QX42-025			84	13,4
32,4			QX42-032			108	17,2
39,3		3000	QX52-040	210	250	132	21,5
50,6			QX52-050			170	26,9
63,7			QX52-063			213	33,9
80,2		2300	QX62-080	210	250	268	43,0
101,0			QX62-100			338	53,8
124,8			QX62-125			417	67,2
163,0		1800	QX82-160	210	250	544	86,1
201,3		1800	QX82-200			672	107,6
249,2		1700	QX82-250			833	134,5

3.1.2 Druckbereich 3

Displacement volume	Speed min	Speed max	Type	Pressure rage in bar (for n > 700 rmp) Cont. press.	Pressure rage in bar (for n > 700 rmp) Max. Int. press. 2)	Torque 3)	Power consumption 4)
cm^3/rev	rmp			bar	bar	Nm	KW
20,4	Speed for pressure - holc (Q = 0 l/min) 5)	3600	QX43-020	320	400	104	16,4
25,1			QX43-025			128	20,5
32,4			QX43-032			165	26,2
39,3		3000	QX53-040	320	400	200	32,8
50,6			QX53-050			258	41,0
63,7			QX53-063			321	51,6
80,2		2300	QX63-080	320	400	409	65,6
101,0			QX63-100			514	82,0
124,8			QX63-125			636	102,5
163,0		1800	QX83-160	320	400	830	131,2
201,3		1800	QX83-200			1025	163,9
249,2		1700	QX83-250			1270	205,0

1) for other flow rates, see QX brochure P00021.
Alternatively, QT series pumps can also be used (brochure 414.08.200)

2) maximum 20 sec. but not more than 10% of the duty cycle

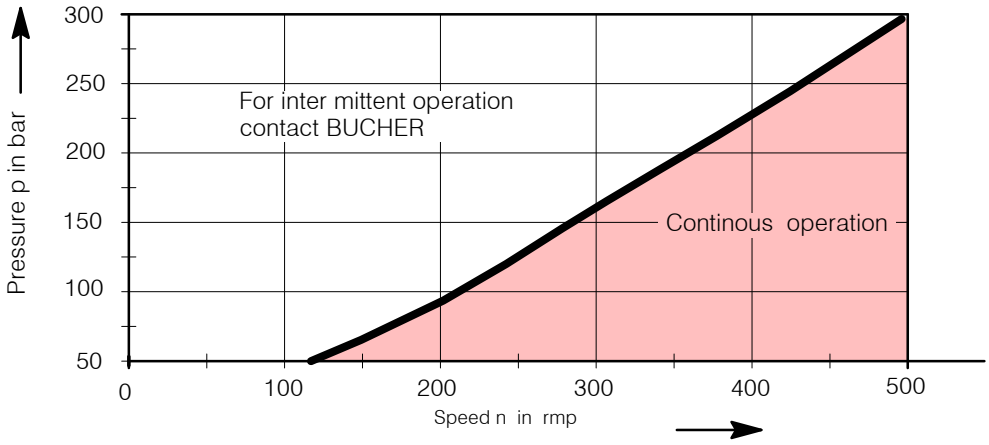
3) theoretical value at continuous pressure rating

4) at continuous pressure rating and shaft speed n = 1450 rpm

5) the speed required to compensate for internal leakage - is pressure-dependent and for a limited time only

4 Performance graphs

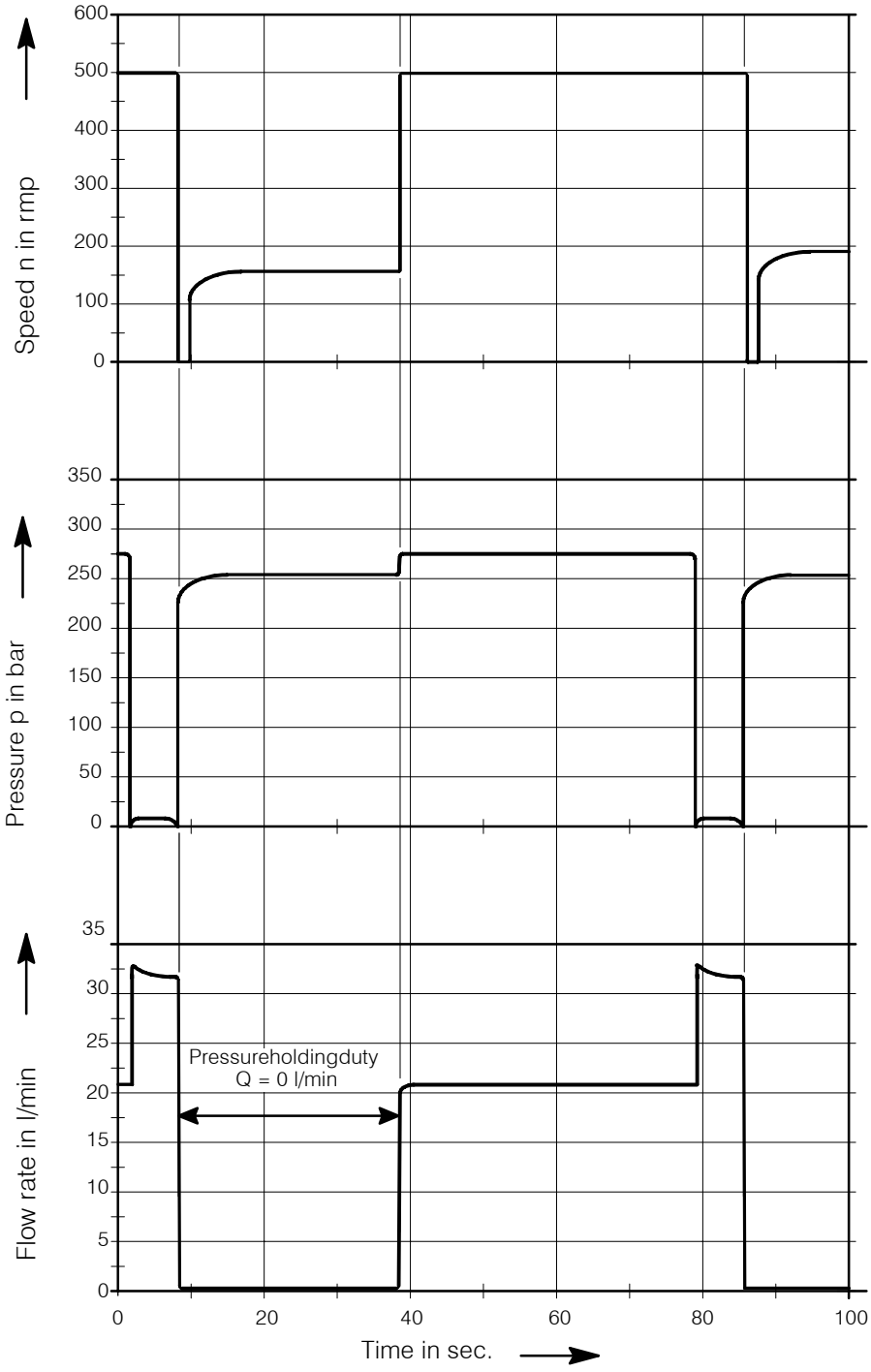
4.1 Minimum speeds as a function of pressure



4.2 Example of load cycle for a BUCHER internal gear pump with variable speed drive

Max. time for pressure holding duty (Q = 0 l/min) is dependent on pressure, duty cycle and pump type.

Pump type QX53-063 with separate drain port,
measured with: oil viscosity 20 mm^2/s (cSt)



5 Application examples

- plastic injection moulding maschines
- rubber presses
- sheet metal processing machines
- waste paper presses

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