

# 活塞泵浦的智能控制







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# 1. 活塞泵浦的結構與控制

# 2. 智能(節能)控制





# 活塞泵浦的原理與智能控制 泵浦結構介紹



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活塞泵浦的原理與智能控制受力分析







# 活塞泵浦的原理與智能控制 靜液壓軸承支撐









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# 活塞泵浦的原理與智能控制 內部結構特點

- 1. 封閉式中空活塞
- 2. 鍛造銅滑靴
- 3. 花齒鍵球型彈簧保持器
- 4. 氮化處理的蜂巢
- 5. 配流盤固定螺絲
- 6. 帶保持軸承
- 7. 陶瓷套
- 8. 内部油循環沖洗
- 9. 外部油循環沖洗
- 10. 油封
- 11. 3孔配流盤



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### 活塞泵浦的原理與智能控制 壓力控制 DR and DRG







# 活塞泵浦的原理與智能控制 泵浦控制方式





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### 活塞泵浦的原理與智能控制 壓力控制DR的作動

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#### 活塞泵浦的原理與智能控制 遙控壓力控制 DRG





#### 活塞泵浦的原理與智能控制 遙控壓力與流量控制 DFR





#### 活塞泵浦的原理與智能控制 負載流量控制





#### 活塞泵浦的原理與智能控制 負載流量與遙控壓力控制





# 活塞泵浦的原理與智能控制智能控制主題

- 1. 智能系統特點
- 2. 產品系列 Sytronix
- 3. 壓力控制 DRn
- 4. 壓力與流量控制 DFEn 、HS5n
- 5. 應用案例





# 活塞泵浦的原理與智能控制智能系統特點



 Reduced energy consumption in part-load operation up to 80% 在負載時減少能源消耗

→ Reduced energy costs, lower carbon footprint 減少能 源損耗與碳足跡

 Significantly less heating by lowering the average pump drive speed according to the reduced energy consumption 藉由較低的平均速度減少能源消耗,可讓 泵浦較少發熱量

→ Reduced effort to cool down the HPU 減少冷卻油箱

- Lower noise emission 較低噪音
  → Easier integration into machine without secondary noise reduction measures 不需要額外降噪系統
- Condition monitoring and diagnosis 狀態監控
  → More reliable operation 增加可靠操作



# 活塞泵浦的原理與智能控制 控制器特點



- The PID controller with modification for hydraulic behavior reduces the pressure drop and necessary accumulator size (根據油壓特性調校PID,降低壓降 和所需求的蓄壓器尺寸)
- Switchable pressure and flow command values reduce engineering effort 可切換壓力或流量命令
- Accumulator charging and hydraulic soft start extend the life time of hydraulic components 軟啟動延長壽命
- In partial load operation, hydraulic gear in system DRn and DFEn is able to reduce the motor torque by controlling the pump displacement. In many cases, it is possible to downsize the motor by using hydraulic gear (在部分負載運行中,系統DRn和DFEn中的液壓 變速能夠通過控制泵排量來降低馬達轉矩,降低馬達 規格)



## 活塞泵浦的原理與智能控制 油電泵浦系列

#### Sytronix

Pre-configured standard sets	Pressure Control Systems (p) 壓力控制	Pressure / Flow 壓力/流量 控制 Control Systems (p/Q)	Pressure / Flow & Position 壓力 / 流量 & 位置 控制 Control Systems (p/Q, F/x)
	DRn 5020 4.0 ~ 160 kW	DFEn 5020 / 7020 HS5n 15 ~ 315 kW	SvP 7020 9 ~ 80 kW
	FcP 5020 0.4 ~ 18.5kW		



# 活塞泵浦的原理與智能控制 油電泵浦產業應用



SvP 7020 p/Q-control, position control 9 ~ 80 kW

SY(H)DFEn p/Q-control 15 ~ 315 kW





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控制方式: 壓力將由液壓控制器控制。 泵的傾轉角度將通過電動馬達扭矩和壓力進行計算, 電動馬達的轉速將會改變,以保持最佳傾轉角度。

IndraDrive / EFC5610

Technology function



$$T = \frac{V_g * \Delta P}{20 * \pi * \eta_{mh}}$$

T = 扭力  $V_g$  = 每轉cm<sup>3</sup>  $\Delta P = 壓力差$  $\eta_{mh}$  = 機械與油壓效率



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Hydraulic gear	固定排量pump FcP		可變排量pump DRn	
This example shows the motor load for pump systems with fixed and variable displacement pump Drive torque $T = \frac{V_g \cdot \Delta p}{20 \cdot \pi \cdot \eta_{mh}}$ [Nm]	250 150 150 150 0 0 50 0 50 0 50 f	motor 37kW pump 71cc 100 150 200 low [lpm]	250 Leg 200 au 150 50 0 50 0 50 flot	motor 37kW pump 71cc
Flow 流量	pressure 10 lpm	full 120 lpm	pressure 10 lpm	full 120 lpm
Pressure 壓力	holding 160 bar	flow 160 bar	holding 160 bar	flow 160 bar
Time 作功時間	40 s	20 s	40 s	20 s
Speed 轉速	150 rpm	1800 rpm	500 rpm	1800 rpm
Swivel angle 排量角度			30%	100%
Continuous pressure capability 持壓能力	195 bar	162 bar	>>280 bar	162 bar
Motor load (act pressure / pressure capability)	82 %	98 %	<30 %	98 %
RMS load 平均負載 $\sqrt{\frac{I_1^2 * t_1 + I_2^2 * t_2}{t1 + t2}}$	88 %		62 % Downsizing possible?	



Sample: pressure cmd fixed: p\_cmd stored in parameter F1.05 壓力命令固定



Sample: Pressure switchable with DRG-controller and switch valve 壓力可切換



Sample: pressure variable with DRG controller and DBETA 壓力變化的





#### DRn 用於可變排量泵

#### 優點 Axial piston pumps reduces the displacement in part-load operation 可變泵在負載時,調整斜盤角度

- → Less motor heating 馬達較少熱損耗
- → Higher energy efficiency 較佳效率

# 低轉速運轉 Pump reduce displacement in part-load operation, motor runs with min speed, cooling is guaranteed due to leakage port

可變泵在負載時減少斜盤角度,馬達可運轉於最低轉速,泵的冷卻透過leakage孔回至油箱。

	A10 DR/DRG	A15 DR/DRG	A4 DR/DRG
額定壓力	最高 280 bar	最高 350 bar	最高 350 bar
最高流量	324 l/min	504 l/min	1125 l/min
手冊	RE 91485	RE 92800	RE 92050

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- Advantage: Good energy efficiency, pump delivers only the pressure which is needed for movement: Power = Flow \* pressure 優點:較佳能源使用效率,泵只在油缸動 作時提供壓力
- p/Q control is possible 壓力與流量控制
  - if pump runs only one cylinder or 假如泵只供給一支油壓缸 或
  - if cylinders can run step by step 多支油壓缸分時序控制
- Energy efficient soution: 能源效率方案
  - Sytronix SYDFEn
  - HS5n



#### 活塞泵浦的原理與智能控制 力與流量控制 – DFE、HS5



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#### 活塞泵浦的原理與智能控制 壓力與流量控制 – DFEn、HS5n



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R901413449	VT-HPC-1-1X/M-0-00/00	IndraWorks
R901413446	VT-HPC-1-1X/M-P-00/00	IndraWorks

NG 40/125/180	R902471376	AWAX004D03
NG 71	R902471374	AWAX004D02
NG 250 -1000	R902471372	AWAX004D02

NG 40 – 180	R901391845	4WRPH 6 C A24L-2X/G24Z4/V-855
NG 250 -1000	R901391846	4WRPH 6 C A40L-2X/G24Z4/V-855



#### 活塞泵浦的原理與智能控制 壓力與流量控制 – DFEn、HS5n



**HS5n**  
Flow: 
$$Q = n \cdot V_0 \cdot a$$

 $\implies \frac{dQ}{dt} = \frac{dn}{dt} \cdot V_0 \cdot a + n \cdot V_0 \cdot \frac{da}{dt}$ 

Version HS5n: Bosch Rexroth is optimizing between swivel angle and speed (also suitable as retrofit-solution)



# 活塞泵浦的原理與智能控制 應用案例: 鋼廠加熱爐



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# 活塞泵浦的原理與智能控制 應用案例:鋼廠加熱爐

#### Installed power: 安裝動力

- 1.) 6 X 75 kW 作功泵浦 驅動加熱爐的工作 2.) 3 X 22 kW 進料泵浦
  - 2 X 5,5 kW 引導壓泵浦
  - 1 X 7,5 kW 循環泵浦
- 3.) 5 X 37 kW 出料泵浦
- → Sum installed power 安裝動力總合: 718,5 kW
- → permanently used 使用動力: 580 kW

#### Hydraulic data:

5 working pumps 320l/min at 100 bar 4 working pumps 150l/min at 130 bar

#### Cylinder:

4 x lift cylinder (80mm/s, Qmges = 1544 l/min) 1 x thrust cylinder (900mm/s Qm= 434 l/min) 4 x cylinder outfeeding device (300 l/min) 2 x cylinder door opener





Working time: 24h/360 Tage = 8640h/a Part load operation time: ca. 6300h/a



# 活塞泵浦的原理與智能控制 應用案例:鋼廠加熱爐

#### **Installed Sytronix DFEn 5000:**

5 x 75 kW – working pump (A4VSO250DFEn) 1 x 75 kW – reserve pumps (A4VSO250DFEn) 1 x 11 kW standard asynchronous motor for oil circulation



→ Sum installed power 安裝動力: 461 kW
 → permanently activated 使用動力: 386 kW







Components



Energy on Demand

#### advantages with Sytronix

- Q-control  $\rightarrow$  no throttling losses
- Not required pumps can be swivelled back
- Pressure step adjustment
  - $\rightarrow \Delta p$  saving



## 活塞泵浦的原理與智能控制 應用案例:鋼廠加熱爐



former solutionRexroth Sytronix solution

base: \*\* 10ct/kWh \*\*\* 400g / kWh



#### 活塞泵浦的原理與智能控制 DRn 實際案例 – 水刀切割機



#### hydraulic power units for Water cutting machines

- 37kW 非同步馬達
- 可變柱塞泵 A10-DRG, 71 cm<sup>3</sup>
- 伺服驅動器IndraDrive內建DRn程式





已在西班牙客戶運轉測試省能結果 Long time field test at an end customer in Spain



Energy System Design



Components

Efficient

b Energy on Demand

- 50 %





