Energy saving hydraulic drives
Energy and the Environment – The Drivers

Manufacturing systems life cycle costs (TCO)

80...95%
Initial startup
Training
Spare parts
Maintenance
Labor costs
Taxes
Insurances

Energy costs
~ $5,950 (96%)

Cost price
~ $250 (4%)

5...20%
Machinery & Equipment

5 year running time
Three phase motor 1 kW

Example
Growth in energy costs will continue
# Technology Change and reduction in hydraulic expertise

<table>
<thead>
<tr>
<th>Drive</th>
<th>Power Transmission</th>
<th>Properties</th>
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<tbody>
<tr>
<td><strong>Constant speed electric motor</strong></td>
<td><img src="image" alt="Hydraulic pump control motor/cylinder" /></td>
<td><strong>Power density, robustness</strong>&lt;br&gt;<strong>Controllability</strong>&lt;br&gt;<strong>Multiple consumers possible</strong></td>
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<td><img src="image" alt="Classic hydraulics" /></td>
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<td><img src="image" alt="Noise" /> <img src="image" alt="Energy efficiency" /></td>
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<tr>
<td><strong>Variable speed motor drive</strong></td>
<td><img src="image" alt="Hydraulic pump with/without valves" /> <img src="image" alt="Motor/cylinder" /></td>
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<td><img src="image" alt="Variable speed pumps" /></td>
<td><img src="image" alt="Electro-mechanic" /> <img src="image" alt="Spindle drive" /></td>
<td><img src="image" alt="Controllability" /> <img src="image" alt="Noise" /> <img src="image" alt="Energy efficiency" /> <img src="image" alt="Multiple consumers not possible (or very difficult)" /> <img src="image" alt="Power density" /></td>
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Energy saving potential

- Classic Solution

- Full motor speed during part load operation.
- Pump mechanical losses caused by high rotation speed
- Lower motor and pump efficiency during part load operation
- High throttling losses caused by proportional valves

```
Total energy

Motor losses

Pump losses

Throttling losses

Useful energy
```
Technology Change

Energy saving potential

- Variable Speed Pump Drives

- No throttling losses from proportional valves
- 40-70% speed reduction during part load operation
- Increased pump and motor efficiency during part load operation
- Reduced pump losses by lowering average motor RPM
- Additional inverter losses
Pump selection

Quadrants of operation

Internal gear pump
- e.g. PGH

Axial piston pumps
- e.g. A10 VZO

Axial piston pumps
- e.g. A10 FZG / VZG (for closed circuits)
Noise Reduction

Noise reduction

- Pump noise depends on:
  - Pump construction
  - Speed and pressure
  - …
Variable Speed Pump Drives for Industrial Machinery

Hydraulic applications for $P_{\text{constant}}$, e.g. conventional technology for HPUs
Variable Speed Pump Drives for Industrial Machinery

Traditional Pump Motor Group

Swept volume \( V \sim \alpha \)

\[ \text{Efficiency} [\%] \]

\[ \text{Load of Motor} \ M_{\text{M_nenn}} [\%] \]

\[ \text{Swivel Angle} [\%] \]
Energy saving for constant pressure systems

- Typical flow rate profile for $p_{\text{constant}}$ (e.g. technology for HPUs)
- High energy saving potential
  - Reduced motor speed $\rightarrow$ decreasing of installed energy
  - Using components in ideal degree of efficiency
Energy saving by reducing motor speed

Power consumption of electric motor during pressure holding (Q=0 GPM)

\[ \eta = \frac{\text{Hydraulic Output Power}}{\text{Electric Input Power}} \]

- pump A4 125cc
- 100 HP AC motor

Syronix DFeN 5000

Rexroth Bosch Group

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Sytronix - Variable Speed Pump Drives

Potential for energy savings

Comparison of conventional and variable speed drives:

Energy saving in pressure hold mode and reduced flow up to 80% (depends on cycle time and basic rate of $Q_{sys/min}$).
System Variants- SVP

**SvP 7000 – High performance**

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<tr>
<th>control functions</th>
<th>svp 7000</th>
<th>sample application</th>
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<td>- high performance required</td>
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**quadrants**

- pressure
- flow

**Axis control**

- high performance required
- pressure control
- flow rate control
- force control
- speed control
- position control
SvP 7000 – High performance

Important!!
Pressure control at reduced speed

![Graph showing pressure and speed over time]

- Pressure reaches 150 bar in 150 ms.
- Speed remains low during pressure hold.

T<sub>95%</sub> = 150 ms
DFEn – Advanced performance

**System Variants- DFEn**

**DFEn 5000**
- 2 independent hydraulic circuits possible

**control functions**
- pressure control
- flow rate control
- force control
- speed control
- position control

**quadrants**
- pressure
- flow

**sample application**
- injection molding machine

**Axis control**
- advanced performance required
- pressure control
- flow rate control

**constant pressure system**
- advanced performance required
- pressure control
Variable speed mode and constant speed mode

**Constant speed mode**
- Speed
- Flow
- Swivel angle

**Variable speed mode**
- Speed
- Flow
- Swivel angle
Application: John Lewis

Log loading device J. Lewis

Aggregate before retrofit
- Pressure $p = 120$ bar by $60$ l/min/pump with $120$ l/min by $1800$ rpm
- „Pressure controlling“ via pressure limitation valve

Energy consumption 44,000 kWh/a

Sytronix SVP 7000
- Internal gear pump on servomotor via FU
- 4 Liter accumulator for safeguarding 97 bar
- selectable throttle point for min. speed of the pump

Energy consumption 4,000 kWh/a

Saving 40,000 kWh/a
5,600 €/a **

CO₂-Saving* 24,5 t/a

– 71 %

* Energy mix, Germany concerning GEMIS version 4.2 in the comparison year 2004: 0.613 kg CO₂/kWh
** Current price 0.14 €/KWh incl. 3.592 ct/KWh EEG-allocation, 24h/day, 260 days/year
Thank you for your attention!

Rodney Trail
Bosch Rexroth Canada
Industry Sector Manager SET23
Canadian Sytronix Manager