Electro-Hydrostatic Drive Concept for the Ring Rolling Process

Ekhard Siemer
Christoph Boes
Ralf Bolik
Electro-Hydrostatic Drive Concept for the Ring Rolling Process

Agenda

- Motivation
- Ringrolling Process
- Electro-Hydrostatic Drive Concept
- First Results and Feedback
Motivation

Bringing together ecology and economy is one of the greatest challenges in the 21st century.

„The most eco-friendly and cheapest kilowatt-hour is the one we don’t consume in the first place.“

Quote Federal Ministry for Economic Affairs and Energy, BMWi

- European Community’s ECO Design Directive 2009/32/EC
- German law on the environmentally friendly design of energy-related products (Energieverbrauchsrelevante-Produkte-Gesetz - EVPG)
Comparison of Energy Efficiency

Performance of hydrostatic drives at constant volumetric flow

Energy Savings
- partial load: 75%
- full load: 30%

Quelle: Backé, W.; Berbuer, J., Neue Schaltungskonzepte für hydrostatische Getriebe, o+p ölhydraulik und pneumatik 31, (1987), Nr. 6
The main objectives of this new development were

- Increased energy efficiency with process-related widely differing possible working points
- Drastically reduced central hydraulics and pipework in the field
- Cost optimization through reduced assembly and commissioning times
- Built-in condition monitoring
EPU Product Family Moog

<table>
<thead>
<tr>
<th>Pump Vol. [cm³]</th>
<th>Q max [l/min]</th>
<th>p max [bar]</th>
</tr>
</thead>
<tbody>
<tr>
<td>19</td>
<td>85</td>
<td>350</td>
</tr>
<tr>
<td>32</td>
<td>118</td>
<td>350</td>
</tr>
<tr>
<td>80</td>
<td>216</td>
<td>350</td>
</tr>
<tr>
<td>140</td>
<td>322</td>
<td>350</td>
</tr>
<tr>
<td>250</td>
<td>450</td>
<td>350</td>
</tr>
</tbody>
</table>

- Radial Piston Pump (max. pressure 350 bar) with option dual displacement
- Pump design is optimized for 4Q operation, position and speed control
- No limitation for pressure holding
- Defined interface for mounting on manifolds
- Direct motor-pump connection (no rubber or plastic coupling in the drive train)
Electric - Hydraulic Drive Concept

Valve Manifold
Radial Piston Pump
Adapter Flange
Servomotor

Pump Flow: $Q \ [l/min] \sim V \ [cm^3] \times n \ [rpm]$
Motor Torque: $M \ [Nm] \sim V \ [cm^3] \times p \ [bar]$
Drive Power: $P \ [kW] \sim Q \ [l/min] \times p \ [bar]$
Typical Working Points of the Drive Unit

forming speed
425 rpm/104 Nm
@ 19 ccm (theoretical working point, without dual displacement)

forming speed
1700 rpm/26 Nm
@ 5ccm

rapid speed
4200 rpm/13 Nm
@ 19ccm
Communication Structure of the Drive System

- Regenerative power supply unit
- Servo drives control in 4-Q mode
- Direct power exchange among each other through DC-Bus
- Communication via EtherCAT field bus
Structure of Close-Loop Control

- SMS group motion controller
- MSD drive
- position and force control
- servomotor
- piston pump and cylinder

Block diagram showing the control loop with symbols and equations.
Production Cycle of the Ring Rolling Process

- Rapid speed to rolling position
- Ring rolling forming cycle
- Rapid speed to loading position
Pressure Pulsation

- Pressure pulsation is less than +/- 0.5 bar
Accuracy of the Position Control

- Deviation of the position control during rolling < +/- 0.1 mm
- Deviation of the position control during rapid speed appr. +/- 0.8 mm
Temperature Behavior during Pressure Holding

Pressure holding @

n = 220 1/min

p = 80 bar (M = 7 Nm)
First Experience with the EH Compact Drives

- **Outstanding controllability**
  - of position and force
  - high resolution at very slow motion for forming speed (dual displacement)
  - high speed motion für positioning speed

- **Simple and fault resistant system**
  - reduced number of components
  - no electrical controlled valves
  - minimal piping work and less foundation needs
  - short installation and commissioning times

- **Environment – friendly design**
  - Reduction of the energy consumption up to 70%
  - Reduction of the oil volume up to 80 %
  - Reduction of the noise emission up to 30%
Thank you for your attention!

Contact:

- ekhard.siemer@sms-group.com
- cboes@moog.com
- ralf.bolik@sms-group.com

- www.sms-group.com
- www.moog.com/industrial