Flexographic Printing

Products, Features, Principles

- In-Line Type Press
- Stack Type Press
- Central Impression Press
- Cylinder Engagement
- Winder Automation
Flexographic Printing

Products

Typical Products of a Flexographic Web Press

- Flexible packaging materials (bags)
- Card board (liquid container, boxes)
- Labels (bottles)
- Paper (bags, wrapping paper)
Flexographic Printing

Features

Flexographic presses are divided into three classes depending how the print decks are located, Central Impression Cylinder (a), In-line type (b) and Stack type (c). These have the following common features:

- 4 to 10 print units/decks (up to 20 for b)
- The print format is adjusted by exchanging the format cylinder.
- The machines are extendable by additional converting units.
- Machine speeds from 150m/min (c) to 600m/min and more (a)
- Web width from 300mm (b) to 2000mm (a)

+ Low manufacturing costs of the plates
+ Stable register (a)
+ Fast changeover using sleeve technology
+ Printing technology changeable (b)
+ Variable number of colors per printed side selectable (c)

- Short lifespan of plate
- Lower print quality (compared to gravure and offset)
Flexographic printing is a letter press printing process. The printing plate is made out of a soft material. The low viscous ink is transferred by the anilox roller to the plate and from there directly with low impression to the printing substrate. One after the other the four elemental colors (cyan, magenta, blue black) and special or ornamental colors (like white, silver, gold, green) are printed. Single color solid motifs can be printed as well as multi color halftone print. The amount of ink transferred to the printing plate is controlled by the make up of the anilox roller. The print unit consist of ink supply, anilox roller, plate cylinder and impression cylinder. If impression is off and the ink supply is on, the anilox roller must turn to avoid the ink from drying in the cells.

In modern CI presses all cylinders are driven individually. In stack type and in-line presses one to three motors per print unit are common.

Flexographic Print Unit
1  Impression cylinder
2  Plate cylinder
3  Printing plate (soft)
4  Anilox roller
5  Ink supply (chambered doctor blade system)
6  Printing substrate
7  Elastic printing plate with raised image elements
8  Inked up image element
9  Cells of the anilox roller filled with ink
The impression cylinder transports the substrate and sometimes is equipped with a nip roller. The according motor has to be sized to max. Web tension as it acts as an infeed tension unit. In stack-type and in in-line flexographic presses only the impression cylinder of the first unit has a nip roller, if not the load torque is minimum. As the plate cylinder has only little impression, it can slip on the printing substrate. A length register movement has no influence on the web tension. Furthermore it is possible to change the printed format by a changing the speed of the plate cylinder, e.g. to compensate stretch and tolerances of the plate. Whatever movement of the plate cylinder, the anilox roller has to follow in synchronism to avoid wear and bad influence of the inking up.

**Flexographic Print Unit**
1. Impression cylinder
2. Plate cylinder
3. Printing plate (soft)
4. Anilox roller
5. Ink supply (chambered doctor blade system)
6. Printing substrate
7. Elastic printing plate with raised image elements
8. Inked up image element
9. Cells of the anilox roller filled with ink
In-Line Flexographic Web Press
7 Color Gidue E-Combat
In-Line Flexographic Web Press
Machine Elements and Features

- For label printing and liquid container printing.
- Modular construction enabling the combination of different printing methods in one machine.
- Modules of different printing methods sometimes can be exchanged during production.
- Low web speed in label printing web presses.
- Normally low degree of automation.
- Automation and drives have to cover the exchange of print deck mechanics.
- Manual cylinder positioning on narrow web presses, while wide web presses have positioning motors.
### Requirements and Solutions

<table>
<thead>
<tr>
<th>Requirements</th>
<th>Solutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>High print quality is determined</td>
<td>by the control quality of impression und plate cylinder</td>
</tr>
<tr>
<td></td>
<td>- virtual master for each axis</td>
</tr>
<tr>
<td></td>
<td>- fast control with DSC</td>
</tr>
<tr>
<td>Connection of external systems</td>
<td>for web inspection and register control</td>
</tr>
<tr>
<td></td>
<td>- encoder-emulation with TM41 for the virtual axis as well</td>
</tr>
<tr>
<td>High number of axes</td>
<td>of equal power</td>
</tr>
<tr>
<td></td>
<td>- double-axis motor modules with minimal need of space</td>
</tr>
<tr>
<td></td>
<td>- S120 compact motor modules</td>
</tr>
<tr>
<td>Long motor cables</td>
<td>at common DC-Link</td>
</tr>
<tr>
<td></td>
<td>- active interface technology (AIM) with active line infeed modules (ALM) for a clean line</td>
</tr>
<tr>
<td></td>
<td>- low price basic line infeed modules (BLM)</td>
</tr>
<tr>
<td>Variable format-cylinder</td>
<td>with variable moments of inertia</td>
</tr>
<tr>
<td></td>
<td>- mechatronic tools</td>
</tr>
<tr>
<td></td>
<td>- fast control with DSC</td>
</tr>
<tr>
<td>Different printing methods</td>
<td>combined in one machine</td>
</tr>
<tr>
<td></td>
<td>- AC single-axis motor-module can be mixed with DC motor-modules</td>
</tr>
<tr>
<td></td>
<td>- deactivating of components for the exchange of printing-modules</td>
</tr>
</tbody>
</table>
Automation Concept
Label Printing Press (Low-End, Decentralized Automation)

- Unwinder
- Infeed
- 1 to n flexographic printing units
- Laminating unit
- Offset printing unit
- Outfeed
- Rewinder

Ethernet for supervisory level, engineering, remote diagnostics

PROFIBUS for synchronization of machine motions

Winder + feed units
Centralized arranged

Printing units + additional converting units
Decentralized arranged
Automation Concept
Label Printing Press (High-End, Centralized Automation)

PROFINET for supervisory level, engineering, remote diagnostics and for synchronization of machine-motions

unwinder infeed 1 to n flexographic printing units laminating unit outfeed rewind

winder + feed units + automation printing units + additional converting units one module for 2 printing units
Stack Type Flexographic Web Press
Machine Elements and Features

- Low-end flexographic press for packaging paper, plastic bags and sacks.
- Low degree of automation often without automatic splicing
- Print units normally still synchronized with mechanical line shaft, belts or pulleys.
- 4 to 8 colors.
- Web can be printed on both sides.
  (The web can be extracted after any print deck and pass the remaining print decks in the opposite direction)
- High-End machines with high level of automation are built as well.
### Stack Type Flexographic Web Press

**Requirements and Solutions**

<table>
<thead>
<tr>
<th><strong>Requirements</strong></th>
<th><strong>Solutions</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Flexible kinds of productions</td>
<td>for reverse side printing</td>
</tr>
<tr>
<td></td>
<td>- electronic line shaft simplifies the mechanic construction for reverse side printing</td>
</tr>
<tr>
<td>Connection of external systems</td>
<td>for web inspection and register control</td>
</tr>
<tr>
<td></td>
<td>- encoder-emulation with TM41 for the virtual axis as well</td>
</tr>
<tr>
<td>Short product runs</td>
<td>require low waste rate</td>
</tr>
<tr>
<td></td>
<td>- fast preset register by electrical synchronization</td>
</tr>
<tr>
<td>High number of axes</td>
<td>of equal power</td>
</tr>
<tr>
<td></td>
<td>- double-axis modules with minimal need of space</td>
</tr>
<tr>
<td>Long motor cables</td>
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<td></td>
<td>- mechatronic tools</td>
</tr>
<tr>
<td></td>
<td>- fast control with DSC</td>
</tr>
<tr>
<td>Positioning in register</td>
<td>of impression and plate cylinder</td>
</tr>
<tr>
<td></td>
<td>- positioning-tracking and storage for different formats with absolute encoders</td>
</tr>
</tbody>
</table>
Stack Type Flexographic Web Press (Low-End)
6-Colour Giave ARES
Automation Concept
Low-End Machine with one Drive per Printing Unit

Ethernet for supervisory level, engineering, remote diagnostics
PROFIBUS for synchronization of machine motions

printing unit drive  
PU 1...6
rewinder +  
outfeed and infeed
Power Infeed Concept
Low-End Machine – one drive per printing unit

- common DC-Link as well for decentralized cabinets
- or
- decentralized power infeed per cabinet

DC bus bars or cables

printing unit drive
PU 1...6

rewinder + outfeed and infeed
Stack Type Flexographic Web Press (High-End)
6-Colour Giave Mizarflex
Automation Concept
High-End Machine with gearless System and cylinder positioning
Automation Concept
High-End Machine with gearless System and cylinder positioning

Ethernet for supervisory level, engineering, remote diagnostics

PROFIBUS for synchronization of machine motions
Central Impression Flexographic Web Press
10-Colour Comexi FW 2110
Central Impression Flexographic Web Press
Machine Elements

1. Non-stop unwinding unit
2. Web tension measurement and control system for the unwind and infeed unit
3. Automatic web guiding system with web monitoring prior to printing
4. Central impression frame for 8 printing units and temp. controlled impression cylinder
5. Printing unit with doctor blade inking unit
6. Drying tunnel
7. Recirculating air drying system
8. Chilling unit
9. Web tension measurement and control system for rewind and outfeed unit
10. Non-stop rewinding unit
11. Container for drive and automation system
Central Impression Flexographic Web Press
Machine Elements and Features

- high-end flexographic press for packaging materials
- highly automated press with automation and drives located in a self contained cubicle
- Gearless drive systems are standard for printing units
- 6 to 10 colors
- in-line printing units (gravure or flexographic) are possible
- web of ½ width can optionally be printed on both sides (Web is printed on one side of the CI, turned upside down afterwards, shifted aside and printed on the back on the same CI)
- in some countries these machines are still built with mechanically synchronized printing units
Central Impression Flexographic Web Press
Requirements and Solutions (1/2)

<table>
<thead>
<tr>
<th>Requirements</th>
<th>Solutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>High print quality is determined</td>
<td>by the control quality of central impression cylinder</td>
</tr>
<tr>
<td></td>
<td>- directly driven central impression cylinder</td>
</tr>
<tr>
<td></td>
<td>- directly mounted, high precision measuring system</td>
</tr>
<tr>
<td></td>
<td>- virtual master for each axis</td>
</tr>
<tr>
<td>Connection of external systems</td>
<td>for web inspection and register control</td>
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<tr>
<td></td>
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</tr>
<tr>
<td>Long motor cables</td>
<td>at common DC-Link</td>
</tr>
<tr>
<td></td>
<td>- BLM reliable non regenerative unit</td>
</tr>
<tr>
<td></td>
<td>- ALM + AIM for clean power consumption</td>
</tr>
<tr>
<td>Variable format-cylinder</td>
<td>with variable moments of inertia</td>
</tr>
<tr>
<td></td>
<td>- mechatronic tools</td>
</tr>
<tr>
<td></td>
<td>- fast control with DSC</td>
</tr>
</tbody>
</table>
## Central Impression Flexographic Web Press
### Requirements and Solutions (2/2)

<table>
<thead>
<tr>
<th>Requirements</th>
<th>Solutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cylinder engagement with motorized spindles and absolute position feedback</td>
<td>demands high accelerating torque at slow speed and low holding torque</td>
</tr>
<tr>
<td></td>
<td>- real multi-turn encoder</td>
</tr>
<tr>
<td></td>
<td>- 1FK7 with high overload factor</td>
</tr>
<tr>
<td></td>
<td>- customized slow speed winding for low currents</td>
</tr>
<tr>
<td>Explosion proof environment</td>
<td>for solvent based ink, depending on mounting position</td>
</tr>
<tr>
<td></td>
<td>- low cost option for motors in zone 2</td>
</tr>
<tr>
<td></td>
<td>- 1FS6 EEx-d motors for zone 1</td>
</tr>
</tbody>
</table>
Automation Concept
Modular Design with PROFINET

PROFINET for supervisory level, engineering, remote diagnostics and for synchronization of machine-motions

PU 1/2  PU 3/4  PU 5/6  PU 5/6  PU 9/10  machine  unwinder  rewinder
Automation Concept
Automation Module for two Printing Units – Print Deck

Digital I/O

PROFINET

Print deck 1

Automation modul for two print decks

PROFIBUS

Print deck 2

Anilox roller

Form cylinder

Anilox roller

Form cylinder

Digital I/O
Power Infeed Concept
Flexible Concept – centralized or decentralized

- common DC-Link as well for decentralized cabinets
- decentralized power infeed per cabinets
Simulation of the stiffness frequency response
The stiffness frequency response describes the error subject to the disturbance torque (μm/Nm in dB) in the frequency domain

- Geared drive with pinion
CI Direct Drive
Torque Motor – Note: this solution might be protected by patent

Simulation of the stiffness frequency response
The stiffness frequency response describes the error subject to the disturbance torque (μm/Nm in dB) in the frequency domain

- Geared drive with pinion
- Direct drive with torque motor
CI Direct Drive
Torque Motor

Stator and rotor are pre-assembled using transport locks

*) Axial cable outlet or Radial cable outlet

Connection *): Power Cable
(Temperature sensor and switches)

Connection *): Signal Cable

Mounting flange

Rotor
With Permanent Magnets

Stator

Cooler connection:
(For power cooler and optional independent flange cooler)
CI Direct Drive
Torque Motor

- Heidenhain high precision measuring system
  (RCN727: 32768 sin/cos, +/-2”, 27bit
  RCN226: 16384 sin/cos, +/-2.5”, 26bit
- Absolute encoder for torque motors
  (provides the commutation signal after power up)
- Hollow shaft design 25mm, 60mm, 100mm
- Integrated stator coupling
CI Direct Drive
Torque Motor

Article published in "Flexo & Gravure Int'l" 3-2004 by Bernhard Dirsch, Siemens AG

CI Direct Drive Torque Motor

More print quality for flexo printing with direct drives

Bernhard Dirsch

General cylinder flexo printing machines have established themselves in the field of large-format printing. Due to their economic performance, they are increasingly used in the packaging industry. In this context, the direct drive for the control cylinder offers a significant advantage in terms of cost effectiveness and reliability. The Article published in "Flexo & Gravure Int'l" 3-2004 by Bernhard Dirsch, Siemens AG.

CI Direct Drive - the time of direct driving

The direct drive of the control cylinder has been made possible by the introduction of sensorless vector control. This revolutionary drive technology has led to a major step forward in the field of flexo printing. The control cylinder can be driven with a high degree of precision and flexibility, allowing for a wide range of applications.

CI Direct Drive Torque Motor

CI Direct Drive Torque Motor

Article published in "Flexo & Gravure Int'l" 3-2004 by Bernhard Dirsch, Siemens AG.

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Motor for Cylinder Engagement
Positioning motor with multi-turn encoder and low current requirement
Motor for Cylinder Engagement

Positioning motor with multi-turn encoder and low current requirement

Drehstrom - Servomotor 1FK7042 - 5AC71

<table>
<thead>
<tr>
<th>Technische Daten</th>
<th>Zeichen</th>
<th>Einheit</th>
<th>Wert</th>
</tr>
</thead>
<tbody>
<tr>
<td>Projekterungsdaten</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drehmomentdrehzahl</td>
<td>n₀</td>
<td>1/min</td>
<td>2000</td>
</tr>
<tr>
<td>Polzahl</td>
<td>ZP</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Beurkeurungsmoment (100K)</td>
<td>Mₑ (100K)</td>
<td>Nm</td>
<td>2.5</td>
</tr>
<tr>
<td>Beurkeurungssstrom (100K)</td>
<td>Iₑ (100K)</td>
<td>A</td>
<td>1.5</td>
</tr>
<tr>
<td>Stillstandsdruckmoment (60K)</td>
<td>Mₑ (60K)</td>
<td>Nm</td>
<td>2.5</td>
</tr>
<tr>
<td>Stillstandsdruckmoment (100K)</td>
<td>Mₑ (100K)</td>
<td>Nm</td>
<td>3</td>
</tr>
<tr>
<td>Stillstandsdruckstrom (20K)</td>
<td>Iₑ (20K)</td>
<td>A</td>
<td>1.5</td>
</tr>
<tr>
<td>Stillstandsdruckstrom (100K)</td>
<td>Iₑ (100K)</td>
<td>A</td>
<td>1.8</td>
</tr>
<tr>
<td>Tragheitsmoment (mit Bremse)</td>
<td>Jₑ</td>
<td>10⁷kgm²</td>
<td>3.73</td>
</tr>
<tr>
<td>Tragheitsmoment (ohne Bremse)</td>
<td>Jₑ</td>
<td>10⁷kgm²</td>
<td>3.01</td>
</tr>
</tbody>
</table>

Optimaer Betriebspunkt

Optimale Drehzahl | nₑ | 1/min | 2000 |
Optimale Leistung | Pₑ | kW | 0.59 |

Grenzdaten

Maxima zul. Drehzahl (mech.) | nₑ max | 1/min | 5000 |
Maxima zul. Drehzahl (Ummacher) | nₑ max U | 1/min | 4700 |
Maximaes Drehmoment | Mₑ max | Nm | 10.5 |
Maximastrum | Iₑ max | A | 5.8 |

Physikalische Konstanten

Drehmomentekonstante | kₑ | Nm/A | 1.9 |
Spannungskonstante | kₑ | V/1000 min⁻¹ | 121 |
Wicklungswiderstand bei 20°C | Rₑ | Ohm | 9.5 |
Drehfeldübergang | Lₑ | mH | 49 |
Elektrische Zeitkonstante | Tₑ | ms | 1.4 |
Mechanische Zeitkonstante | Tₑ mech | ms | 2.36 |
Thermische Zeitkonstante | Tₑ θ | min | 30 |
Wechselstromkennlinie | Cₑ | Nm/rad | 10000 |
Gewicht mit Bremse | Mₑ | kg | 5.1 |
Gewicht ohne Bremse | Mₑ | kg | 4.9 |

empfohlenes Motor Modell | 6SL312 - TE13-00A |
Bemessungssstrom Ummacher | Iₑ | A | 3 |
Maximalstrom Ummacher | Iₑ max | A | 6 |
Max. Drehmoment bei Iₑ max | Mₑ max | Nm | 10.5 (≈ Mₑ max) |
Compact Drive for Cylinder Engagement
SINAMICS S120 Double Motor Module BOOKSIZE Compact
## Technische Daten

<table>
<thead>
<tr>
<th>Zwischenkreisspannung DC 510 ... 710 V</th>
<th>Double Motor Module Bauform Booksize Compact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interne Luftkühlung/ Cold-Plate-Kühlung</td>
<td>6SL3420-2TE11-7A0A</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Ausgangsstrom</strong></td>
<td></td>
</tr>
<tr>
<td>• Benennungsstrom $I_N$ A</td>
<td>$2 \times 1,7$ A</td>
</tr>
<tr>
<td>• bei S6-Betrieb (40 %) $I_{S6}$ A</td>
<td>$2 \times 2$ A</td>
</tr>
<tr>
<td>• Grundlaststrom $I_{G}$ A</td>
<td>$2 \times 1,5$ A</td>
</tr>
<tr>
<td>• $I_{max}$ A</td>
<td>$2 \times 5,1$ A</td>
</tr>
<tr>
<td><strong>Leistung</strong></td>
<td></td>
</tr>
<tr>
<td>• auf Basis $I_N$ kW</td>
<td>$2 \times 0,9$ kW</td>
</tr>
<tr>
<td>• auf Basis $I_{G}$ kW</td>
<td>$2 \times 0,9$ kW</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Drosselung</strong></td>
<td></td>
</tr>
<tr>
<td>• Drosselungsfrequenz kHz</td>
<td>0 kHz</td>
</tr>
<tr>
<td><strong>Zwischenkreisstrom $I_{m}$ A</strong></td>
<td>$4,1$ A</td>
</tr>
<tr>
<td><strong>Strombelastbarkeit</strong></td>
<td></td>
</tr>
<tr>
<td>• Zwischenkreisschienen A</td>
<td>100 A</td>
</tr>
<tr>
<td>• DC-24 V-Schienen A</td>
<td>20 A</td>
</tr>
<tr>
<td><strong>Zwischenkreiskapazität $u_F$</strong></td>
<td>$110$</td>
</tr>
<tr>
<td><strong>Strombedarf</strong></td>
<td></td>
</tr>
<tr>
<td>bei DC 24 V, max. A</td>
<td>1 A</td>
</tr>
<tr>
<td><strong>Verlustleistung</strong></td>
<td></td>
</tr>
<tr>
<td>• bei interner Luftkühlung im Schaltanzeiger kW</td>
<td>$0,11$ kW</td>
</tr>
<tr>
<td>• bei Cold-Plate-Kühlung kW</td>
<td>$0,040 / 0,07$ kW</td>
</tr>
<tr>
<td>• Thermische Widerstand $R_T$ kW</td>
<td>$0,22$ kW</td>
</tr>
<tr>
<td><strong>Kühlflächenbedarf</strong> m²</td>
<td>$0,008$ m²</td>
</tr>
<tr>
<td><strong>Schalldruckpegel $L_A$ (1 m dB)</strong></td>
<td>$&lt; 60$ dB</td>
</tr>
<tr>
<td><strong>Motoranschluss U2, V2, W2</strong></td>
<td>2 × Stecker (X1, X2) mit Schraubklemmen</td>
</tr>
<tr>
<td>• Anschlussspeerschnitt mm²</td>
<td>$0.2 ... 6$ mm²</td>
</tr>
<tr>
<td><strong>Schirmanschluss</strong></td>
<td>im Stecker (X1, X2) integriert</td>
</tr>
<tr>
<td><strong>PE-Anschluss</strong></td>
<td>Schraube M5</td>
</tr>
<tr>
<td><strong>Motorenanschluss</strong></td>
<td>Stecker (X11, X12), DC 24 V, 2 A</td>
</tr>
<tr>
<td><strong>Motorleistung, max.</strong></td>
<td></td>
</tr>
<tr>
<td>• geschrägt m</td>
<td>50 m</td>
</tr>
<tr>
<td>• ungeschrägt m</td>
<td>75 m</td>
</tr>
<tr>
<td><strong>Schutzart</strong></td>
<td>IP20</td>
</tr>
<tr>
<td><strong>Maße</strong></td>
<td></td>
</tr>
<tr>
<td>• Breite mm</td>
<td>75 mm</td>
</tr>
<tr>
<td>• Höhe mm</td>
<td>270 mm</td>
</tr>
<tr>
<td>• Tiefe mm</td>
<td>226 mm</td>
</tr>
<tr>
<td><strong>Gewicht, ca. kg</strong></td>
<td>3,4 kg</td>
</tr>
</tbody>
</table>
Unwinding and Rewinding Units
Automation and Power Infeed Concept

Additional Options:
- Swivel arm drive of turret butt integrated in SIMOTION / SINAMICS
- Infeed and outfeed can be integrated into the respective winder module