TOYOINK Products for Future Printing

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Printing market overview at present

US automobile industry $ 1.1tr

Printing Industry $ 898 b

Newspapers & Magazines $ 111 b
Labels $ 35 b
Packaging $ 301 b

Global music industry $ 15 b

Growth forecast of 2% annual (to 2020)
Mainly driven by packaging and emerging economies

Source: Smithers Pira
Declining Continuous growth:
- Low migration ink for food packaging (driven by B.O., not by printers, converters or country regulations)
- Inks for flexible packaging.
- Energy curing inks.
- Narrow web & labels inks.

Source: Smithers Pira

Trend and Future Printing

• Y2016Drupa

Conventional moving to Digital
Digitalization is integrating to Packaging Printing

• Offset Printing machinery digital support
• Ink Jet Reincarnation
• Evolution of the digital packaging progress

Aim should be clear !!
Trends for printing industry in the future

- Environmental trends
  - VOC emissions reduction
  - Carbon footprint reduction
  - Bio-based materials
- Energy-saving trends
  - UV technologies
    - LED
    - Highly reactive UV inks
  - EB technologies
- Food packaging innovations
  - Low migration
  - Shelf-life prolongation
  - Barrier coatings
    - UV, oxygen, moisture, scavenging
- Other areas
  - Printed electronics
  - Universal Design

Environmental trends

**VOC emissions reduction**
- Changing from solvent-based to water-based
- Changing from gravure to flexo

※Volatile Organic Compounds

Carbon footprint reduction
- Changing printing methods
- Changing lamination methods

Bio-based materials
- Vegetable oils
  - Rice inks
  - Soy inks
Benefits and challenges of water-based ink (vs. solvent-based ink)

**Benefits**
- It can be a countermeasure for VOC emission regulations (revised Air Pollution Control Law)
  - VOC treatment equipment is not required in Japan if emission concentration is lower than 700 ppmC
- Relaxation the regulation on the Fire Service Act (inventory)
- Huge reduction on fire risks
- Improvement on the printing work environment (Workers)
- Low environmental impact (LCA, CO₂ emissions)
- Since there are less static electricity problems, there are less printing problems
- Less amount of residual solvents in the packaging materials
  - No residual solvents other than water-alcohol → «clean packaging»
- Improvement of print quality (fine resolution on sophisticated images, ink stability on highlight areas)

**Challenges**
- Worst drying properties due to slow drying.
  - Less productivity (printing speed)
  - Improvement of drying capacity is required (raise on energy costs)
  - Shallow cylinder is required
- Wettability of film decreases since surface tension of water is higher.
- Since water resistance is lower, range of applications is limited.

In order to improve the work environment, there is an increasing demand for VOC reduction, therefore an expectation for higher demand of water-based inks in the future.
Toyo Ink proposal

<table>
<thead>
<tr>
<th>Ink type</th>
<th>Printability</th>
<th>Productivity (m/ min)</th>
<th>Environmental impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Toyo Ink oil-based gravure</td>
<td>Very good</td>
<td>150~300</td>
<td>Average</td>
</tr>
<tr>
<td>Toyo Ink water-based gravure</td>
<td>Very good</td>
<td>120~230</td>
<td>Good</td>
</tr>
<tr>
<td>Competitors water-based flexo</td>
<td>Not good</td>
<td>150~200</td>
<td>Good</td>
</tr>
<tr>
<td>Toyo Ink water-based flexo</td>
<td>Good</td>
<td>150~300</td>
<td>Very good</td>
</tr>
</tbody>
</table>

- **Concentration**: Collaboration proposal for high-concentration ink TW201 Series and plate materials.
- **Color gamut**: Color management proposal (5 colors + «Chiarossier»)
- **Productivity**: W&H Miraflex + High speed TW021 series proposal
- **Environment**: Proposal of low VOC emissions by water based flexo inks

Results of VOC and CO₂ emissions reduction by water based printing

**Concentration of VOC emissions during printing process**

<table>
<thead>
<tr>
<th>Ink type</th>
<th>Concentration of VOC emissions (ppmC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solvent based</td>
<td>~1200</td>
</tr>
<tr>
<td>Water based</td>
<td>~85% down</td>
</tr>
<tr>
<td>Water based flexo</td>
<td>~58% down</td>
</tr>
</tbody>
</table>

**Amount of CO₂ emissions during the manufacturing of 1 bag of «sasa-mask»**

<table>
<thead>
<tr>
<th>Ink type</th>
<th>CO₂ emissions amount (g/1bag)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solvent based</td>
<td>~12.1</td>
</tr>
<tr>
<td>Water based</td>
<td>~10.3</td>
</tr>
<tr>
<td>Water based flexo</td>
<td>~6.8</td>
</tr>
</tbody>
</table>

CFP value is calculated based on the emissions of CO₂ during the processes of plate making, ink production, printing, lamination and bag manufacturing.
Toyo Ink water based gravure ink lineup

With the advantage of our own developed resin (water based urethan-acrylic) and our synthesis technology, we created a high level water based gravure ink. Combined with solvent-free adhesives, «clean packaging» can be implemented.

<table>
<thead>
<tr>
<th>Application areas</th>
<th>Product name</th>
<th>Ink features</th>
<th>Target applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Film reverse</td>
<td>AQUAECOL</td>
<td>Suitable for snack, boil or retort packages Adhesives (DL, NSDL, water based)</td>
<td>Snack, boil and retort packages</td>
</tr>
<tr>
<td>Film surface</td>
<td>AQUAFRONTEN</td>
<td>High properties (heat resistant, abrasion) Printability</td>
<td>Bread, Rice balls (onigiri) Candy packaging</td>
</tr>
<tr>
<td>Paper</td>
<td>AQUABRIGHT</td>
<td>High concentration Printability Suitable for post-process</td>
<td>Candy packaging General paper packaging</td>
</tr>
</tbody>
</table>

Toyo Ink water based flexo ink lineup

Using the know-how from, gravure water based ink, high properties can be achieved. Combined with CTP pre-press, high level of reproducibility can be reached. Combination of water based ink and solvent-free adhesives enable the production of «clean packaging».

<table>
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<th>Application areas</th>
<th>Product name</th>
<th>Ink feature</th>
<th>Target applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Film reverse</td>
<td>AQUALIONA</td>
<td>Suitable for lamination Boil, retort(up to 120°C) Adhesives (DL, NSDL, Water based)</td>
<td>Snack packages Boil-retort packages</td>
</tr>
<tr>
<td>Film surface</td>
<td>AQUAGRACE</td>
<td>High properties (heat resistant, abrasion) Printability</td>
<td>Bread, rice balls (onigiri), Candy packaging</td>
</tr>
<tr>
<td>Breathable PE</td>
<td>AQUADURAN</td>
<td>High properties (heat resistant, abrasion) High speed printability</td>
<td>Sanitary related (paper diapers and non food related)</td>
</tr>
<tr>
<td>Thin paper</td>
<td>AQUAPAPIA</td>
<td>High concentration, printability heat resistant</td>
<td>Bread, rice balls (onigiri), Candy packaging General paper packaging</td>
</tr>
</tbody>
</table>
Advantages of PU resin based inks

Polyurethane (PU) Resin-based Inks

TOYO INK technology
Unique technology
Wide range of applications

Suitable for snack, boilable retort packaging...
Thanks to internal flexibility and membrane strength. High performance

TOYO INK technology
Unique technology

Polyurethane resin technology

Low technology

Eco-friendly
Low VOC
Excellent adhesion. Low odor (lower residual solvent).

Comparison of PU resins

Merits of PU resins

Advantages of PU resin based inks

Bio-based inks
LED and highly reactive UV inks

LED Curable / Highly Reactive UV Offset Inks

FLASH DRY-LED / LPC Series

Increases productivity and reduces printing defects by instant curing.
Reduces electric power energy with less LED lamp / UV lamp use.
Wide range of printable substrates for value added printing.

<table>
<thead>
<tr>
<th>Drying system</th>
<th>Substrates</th>
<th>Ink Series</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>LED</td>
<td>Paper</td>
<td>FD LED Series</td>
<td>Process and spot colors, Covers full spectrum of LED-UV wavelengths</td>
</tr>
<tr>
<td></td>
<td>Metalized paper</td>
<td>FD LED AD Series</td>
<td>Achieves higher adhesion property and LED curing process and spot colors</td>
</tr>
<tr>
<td></td>
<td>Paper</td>
<td>FD LPC Series</td>
<td>Highly reactive UV Offset inks, Process and spot colors</td>
</tr>
<tr>
<td></td>
<td>Metalized paper</td>
<td>FD LPC AD Series</td>
<td>Process and spot colors, Possible to use with normal UV lamp as higher curing ink</td>
</tr>
<tr>
<td></td>
<td>Special inks (for ozone)</td>
<td>FD HS SILVER Series</td>
<td>Highly reactive UV Offset Silver ink, Higher brightness and storage stability</td>
</tr>
<tr>
<td></td>
<td></td>
<td>FD HS GOLD Series</td>
<td>Highly reactive UV Offset Gold ink, Higher brightness and storage stability</td>
</tr>
<tr>
<td></td>
<td></td>
<td>FD HS PEARL Series</td>
<td>Highly reactive UV Offset Pearl ink, Higher brightness and storage stability</td>
</tr>
<tr>
<td></td>
<td></td>
<td>FD HS LUMINA Series</td>
<td>Highly reactive UV Offset Fluorescent ink, Less misting, higher chromogenic effect</td>
</tr>
</tbody>
</table>

EB Technology for Food Packaging

Features
- Easy Operation
- Safe and Clean
- High Quality
- Green

Comparison VS conventional systems
- Conventional Flexo
- Conventional Gravure
- EB Flexo & Offset

First ever
- No VOC
- No Water

New Release
- EB Flexo
- EB Coating
- EB Offset
**Electron Beam (Flexo)**

All inks are dried (cured) by EB (electron beam) at the end of press.
No dryers required (between units nor final dryer).

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**Future Direction**

- **Toluene base Ink**
  - Cost Merit
  - Conventional
  - Revised Air Pollution Control Law
- **Non- Toluene based Ink**
  - Revised Air Pollution Control Law
    - Non- Toluene based Ink + Solvent recycle type
      - (mono-solvent, limited number of solvent)
    - Revised Air Pollution Control Law
      - (Voluntary activity)
      - Reduction VOC usage
- **Air Pollution Control Law**
  - PRTR Law
    - (Pollutant Release and Transfer Register Law)
- **Water based Ink**
  - Revised Air Pollution Control Law
    - Improvement for Working place
    - End-user’s Policy
  - Reduction of CO2 emission
  - National User’s requirement
- **Biomass Ink**
  - Combine with Digital
- **Inks which are complied with Swiss Ordinance**
  - Shallow depth cylinder + High concentrate Ink