Sustainability Advantages of Water-Based Laminating Adhesives

Water-based adhesives are an ecological and cost-efficient alternative for more sustainable packaging.
Lamination adhesives

Water-based adhesives are an attractive and sustainable alternative to solvent-based systems

- Cost reduction
- Time saving
- Increased flexibility
- Improved safety
OUR VISION OF A SUSTAINABLE FUTURE
Sustainability means satisfying our needs today in a way that future generations will still be able to satisfy their needs.

Industrialization and economic growth often lead to negative impacts on the environment.

Goal of a viable future with enhanced quality of life for everyone endangered.

Focus on sustainability in our actions and decisions along the value chain necessary.

2050:
More than 9 billion people (i.e. +25% over next 30 years), but just one world.

Vision
Sustainability concerns us all
Let’s take action!
Vision

Chemistry for a sustainable future
Taking action for real change

In 2050:

More than nine billion people but only one earth

Chemistry as enabler

Resources, environment and climate

Food and nutrition

Health and safety
Packaging and sustainability

**Time for responsibility in packaging**
How to make a change for the better?

- **Packaging** is part of the sustainability challenge as its demand grows with the population.

- Sustainability and packaging: Choose such packaging materials that have a low impact on the environment but are still economically viable.

- Additionally, health and safety aspects (e.g. reduction of migration potential) are increasingly growing in importance.

- In particular, the choice of the lamination adhesive technology can play a decisive role in the shift to greater sustainability.
Packaging and sustainability

A need for orientation
Shift to sustainable lamination – but how?

- Variety of lamination adhesive technologies (solventless, solvent-based, water-based) exist → Which is the most ecological and economical option?
- **Market pull**: Brand owners and the general public are increasingly looking for more ecological and safer options
- Traditionally used solvent-based or solvent-less adhesives are not always the best solution
- **Water-based adhesives** have achieved rapid success in past years → But what advantages do they actually offer?
A STUDY TO FIND THE BEST ADHESIVE SYSTEM
Eco-Efficiency Analysis (EEA)
Method / Tool for measuring sustainability

- EEA considers the **environmental** (Life cycle analysis) and **economic** (Life cycle costs) **impacts**
- Method follows ISO standards and is validated by NSF International
- In contrast to the “Carbon Footprint”: EEA considers more than just one ecological impact indicator since greenhouse gas emissions alone do not suffice for evaluating the sustainability of a product
- It is desirable that products with an inadequate eco-efficiency are replaced by more eco-efficient alternatives over time
Eco-Efficiency Analysis for lamination adhesives

A helpful study by BASF and Comexi
Orientation for a sustainable upgrade

- BASF (the world’s leading chemical company) and COMEXI (a leading supplier of converting solutions for the flexible packaging industry) wanted to find out which laminating adhesive technologies are the most eco-efficient.

- EEA study was started in 2013 and finished in 2015.

- The results of the study were critically reviewed and validated by a panel of independent experts led by TÜV Rheinland at the beginning of 2016.

- In May 2016, BASF was awarded the official TÜV certificate for this study.
Subject of the study was the production and disposal of 20,000 m² of film-to-film laminate (OPP-ink / adhesive / OPP-met)

All life cycle stages of the production of a flexible packaging were considered (i.e. from raw material production over manufacturing to disposal) → per life cycle stage: all relevant emissions and inputs were considered

Four adhesive systems were analyzed

- WB-PU: Water-based polyurethane (PU) system
- WB-A: Water-based acrylate system
- SB: Solvent-based polyurethane (PU) system
- SL: Solventless polyurethane (PU) system
04 HOW ECO-EFFICIENCY IS CALCULATED?
EEA in detail

The functional unit
Examined multi-layer structure
System boundaries
“Cradle-to-grave”

**Production stage**
- Adhesives*
  - Films
  - Inks

**Converting stage**
- Packaging*
  - Printing
  - Coating*
  - Lamination*
  - Curing*
  - Slitting

**Use stage**
- Use as food packaging
- Not included

**Disposal**
- Incineration

* Vary per adhesive system

Including all precursors and raw materials
## The 4 steps of an Eco-Efficiency Analysis

### Step 1: Goal and Scope
- Definition of the goal and scope of the study
- Definition of the functional unit – or customer benefit – and the product alternatives that can deliver it
- Definition of the system boundaries (“cradle to grave”)

### Step 2: Life cycle costs
- Determine the costs along the life cycle
- Calculate total lifecycle costs for each alternative

### Step 3: Ecological impact
- Determine, characterize and calculate the ecological impacts along the life cycle for each alternative
- Normalize, weight and aggregate the environmental impact results to a total environmental impact for each alternative

### Step 4: Graph
- Results are interpreted and illustrated in the “Eco-efficiency portfolio” (i.e. a two-dimensional graph showing costs and environmental impact)
## EEA in detail

### EEA – What is included?

In-depth research on eco-efficiency

### Considered factors*

<table>
<thead>
<tr>
<th><strong>Ecological factors</strong></th>
<th><strong>Economic factors</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>- Emissions (air, water, waste)</td>
<td>- Adhesive costs</td>
</tr>
<tr>
<td>- Abiotic resource consumption (minerals, metals, fossils)</td>
<td>- Machine speed</td>
</tr>
<tr>
<td>- Human toxicity of final product</td>
<td>- Coating weight</td>
</tr>
<tr>
<td>- …</td>
<td>- Energy costs</td>
</tr>
<tr>
<td>- …</td>
<td>- …</td>
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</tbody>
</table>

### Not Considered factors*

- Risks resulting from improper product handling (e.g. off-spec risk, risk of primary aromatic amines)
- Risks of toxic ingredients
- …

* a complete listing is not possible
## Total environmental impact
Normalization, Weighting, Aggregation

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><strong>Normalization per impact category</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total EU value of impact category per year ([x])</td>
<td>4.6e12 CO(_2)e/a</td>
</tr>
<tr>
<td></td>
<td>Total EU population ([y])</td>
<td>505 million people</td>
</tr>
<tr>
<td></td>
<td>Total EU value per person and year per impact category ([z = x / y])</td>
<td>9,097kg CO(_2)e/(person*a)</td>
</tr>
<tr>
<td></td>
<td>Value of impact category for product alternative (as calculated) ([k])</td>
<td>1,000kg CO(_2)e</td>
</tr>
<tr>
<td></td>
<td>Conversion into person time per category (normalized values - (n_i)) ([n = k / z])</td>
<td>(n_i = 0.1\text{ person*a})</td>
</tr>
<tr>
<td>2</td>
<td><strong>Weighting of all impact categories</strong></td>
<td>(w_i = 21%)</td>
</tr>
<tr>
<td></td>
<td>• Weighting factors per category ((w_i)) are obtained from representative public opinion polls run by TNS Infratest on behalf of BASF</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• They reflect the importance society attaches to the different forms of environmental impacts</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td><strong>Aggregation of categories to total impact</strong></td>
<td>(\sum(w_i n_i))</td>
</tr>
</tbody>
</table>
EEA in detail

Environmental impact categories and weighting factors

- Human toxicity: 22%
- Climate change: 21%
- Eutrophication: 17%
- Resource depletion: 16%
- Acid rain: 14%
- Summer smog: 10%
WHAT IS THE MOST ECO-EFFICIENT OPTION?
Results of Eco-Efficiency Analysis

**WB-Adhesives highly eco-efficient**

The Eco-Efficiency Portfolio
Water-based Epotal® lamination adhesives offer significant advantages over solvent-based adhesives.

Compared to solventless adhesives: the two water-based systems have a comparable eco-efficiency (i.e. the differences do not reach the significance level of the analysis method).

Main driver of the environmental differences among all considered alternatives is the production of the organic solvent of the solvent-based PU adhesive system.

Results of Eco-Efficiency Analysis
WB-Adhesives highly eco-efficient
Interpretation of the results
Relative results – smaller values indicate better performance. All product systems are normalized between 0 and 1 by the product system with the highest impact per impact category.
ADDITIONAL BENEFITS OF WB-ADHESIVES
### Typical problem sources of solventless and solvent–based adhesives

<table>
<thead>
<tr>
<th>Problem Source</th>
<th>Result</th>
<th>Risk with WB **</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insufficient cure time</td>
<td>Migration of PAAs</td>
<td>Low</td>
</tr>
<tr>
<td>Poor drying of solvents</td>
<td>High retained solvents, De-lamination</td>
<td>Medium</td>
</tr>
<tr>
<td>Poorly managed mixed ratio</td>
<td>De-lamination, PAA risk</td>
<td>Low</td>
</tr>
<tr>
<td>Poor temperature management of nip rollers and adhesive</td>
<td>Low green strength</td>
<td>Low</td>
</tr>
<tr>
<td>Material stored in cold conditions after lamination</td>
<td>Longer curing time required</td>
<td>Low</td>
</tr>
<tr>
<td>High moisture</td>
<td>Bubbles</td>
<td>Low</td>
</tr>
<tr>
<td>Poor green strength</td>
<td>Telescoping</td>
<td>Low</td>
</tr>
</tbody>
</table>

**Source:**
* Packaging Films 4-2015: “Specific challenges of laminating“;
** Exclusive Market Study for BASF
**Additional benefits of water-based adhesives**

**WB systems are highly attractive**

**Benefits vs. solventless and solvent-based adhesives**

### Benefits of water-based Epotal® adhesives

**Cost reduction**
- Easier, faster handling
- Reduced off-spec risk

**Increased flexibility / Time saving**
- “Lean production”
- No interim storage necessary
- Shortest lead times

**Improved safety**
- No aromatic isocyanates
- No organic solvents, low VOCs
- Very low residual odor / taste

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**Your advantage:**

Laminate and deliver within one day!

- **Water-based Epotal® adhesives:**
  - **Laminating**
  - **Delivering**
  - **1 day**

- **Traditional solvent-based / solventless adhesives:**
  - **Laminating**
  - **Curing**
  - **Delivering**
WB-ADHESIVES FOR A SUSTAINABLE FUTURE!
Flexibility

Be smart, switch to water-based adhesives!
Water-based adhesives complement digital printing

- Customized printing
- Fast changes
- From file to pouch making in 24h
- Fast curing required
- Instant slitting
- Fast set-up with low waste
- Excellent lamination quality and transparency
More sustainable packaging is now easy and affordable

Make your contribution to a safe and sustainable future – **switch to water-based lamination!**

Water-based adhesives are an **attractive and sustainable alternative** to solventless and solvent-based adhesives

**Compostable** version supports zero-waste flexible packaging
Next steps
For sustainable packaging solutions

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