ADDITIVES FOR HIGH SOLIDS AND WATER-BORNE COATINGS

Werner J. Blank
Rudy Berndlmaier & Dan Miller
King Industries Inc.
OUTLINE

FUNCTION OF ADDITIVES
TYPE OF ADDITIVES
CHEMICAL COMPOSITION
FORMULATION STRATEGIES
INTERACTION RESIN-ADDITIVES
PIGMENT - POLYMER

POLYMER - AIR

POLYMER - POLYMER

POLYMER - METAL

SURFACE COATING INTERFACES
ADDITIVE SELECTION FOR A BLACK BOX
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Regular</th>
<th>High Solids</th>
<th>Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>MW</td>
<td>1500-5000</td>
<td>300-1200</td>
<td>+1500</td>
</tr>
<tr>
<td>Viscosity 100 P, °C</td>
<td>50-120</td>
<td>10-50</td>
<td>50</td>
</tr>
<tr>
<td>OH #</td>
<td>50-100</td>
<td>120-300</td>
<td>0-100</td>
</tr>
<tr>
<td>COOH #</td>
<td>&lt;10</td>
<td>&lt;10</td>
<td>20-100</td>
</tr>
<tr>
<td>Solubility Parameter p</td>
<td>LOW</td>
<td>MEDIUM</td>
<td>HIGH</td>
</tr>
</tbody>
</table>
COATING FORMULATION

PAINT PREPARATION APPLICATION FILM FORMATION PERFORMANCE MECHANICAL ENVIRONMENTAL

RESIN CROSSLINKER PIGMENT SOLVENTS ADDITIVES
# Paint Preparation

## Grinding Paste
- Antisettling agents
- Binders
- Corrosion inhibitors
- Defoamer
- Extenders, flatting agents
- Lubricants, wax
- Pigments & colorants
- Solvents
- Stabilizers
- Thickener

## Let Down
- Binders
- Catalysts and driers
- Coalescing agents
- Coupling agents
- Crosslinking agents
- Flow control agents
- Plasticizers
- Solvents
- Tints
- UV absorbers & stabilizers
<table>
<thead>
<tr>
<th>Additives</th>
<th>Function</th>
<th>Chemical Composition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deaerators</td>
<td>Removes air</td>
<td>mineral oil, silicones</td>
</tr>
<tr>
<td>Defoamers</td>
<td>entrapped during</td>
<td>waxes, silica</td>
</tr>
<tr>
<td>Antifoams</td>
<td>pigment dispersion</td>
<td>and fatty acids</td>
</tr>
<tr>
<td>Dispersants</td>
<td>Lowers surface</td>
<td>Nonionic, anionic</td>
</tr>
<tr>
<td></td>
<td>tension</td>
<td>surfactant</td>
</tr>
<tr>
<td>Emulsifiers</td>
<td>adsorbs on pigment</td>
<td>block polymer</td>
</tr>
<tr>
<td>Surfactants</td>
<td>steric stabilization</td>
<td>polycarboxylate</td>
</tr>
<tr>
<td>Stabilizers</td>
<td>pH control</td>
<td>Amines, base</td>
</tr>
<tr>
<td>Requirement</td>
<td>Solution</td>
<td></td>
</tr>
<tr>
<td>-----------------------------------</td>
<td>-------------------------------</td>
<td></td>
</tr>
<tr>
<td>Application method</td>
<td>Rheology control</td>
<td></td>
</tr>
<tr>
<td>Environmental</td>
<td>Low VOC, toxicity</td>
<td></td>
</tr>
<tr>
<td>Stability requirement</td>
<td>Depending on enduse</td>
<td></td>
</tr>
<tr>
<td>Humidity</td>
<td>Control required</td>
<td></td>
</tr>
<tr>
<td>Substrate</td>
<td>Low surface tension</td>
<td></td>
</tr>
<tr>
<td>Contamination</td>
<td>additives to improve</td>
<td></td>
</tr>
<tr>
<td>Cure profile</td>
<td>Catalysis</td>
<td></td>
</tr>
</tbody>
</table>
VISCOSITY OF DISPERSION

VISCOSITY

VOLUME FRACTION

SPHERE
SPH SW
SPH FLOC

SL2094
RHEOLOGY MODIFIER

- ATTAPULGITE
- SMECTITE
- ASSOCIATIVE SILICA
- TITANATE
- POLYESTER
- POLYACRYLATE
- POLYOLEFIN
- ORGANO CLAY
- ORGANO SULFONATE
- POLYAMIDE
- CASTOR DERIVATIVE
- POLYUREA
- CATIONIC OLIGOMER
VISCOSITY OF HIGH SOLIDS COATING DURING CURE AND CROSSLINKING

VISCOSITY LOG POISE

BAKING TIME, MINUTES

- PTSA
- PTSA SCA
- PTSA BL1
- PTSA BL2
ASSOCIATIVE THICKENER
VISCOSITY -- LOW SHEAR RANGE
LATEX MAINTENANCE

STORMER 80-85 KU

HEUR
HMHEC
Alkali Swellable

SL2098
FILM FORMATION

PROBLEMS & REMEDIES

Atmosphere, dry, moist, gas heated
Coalescence
Flash off time, blistering
Film thickness
Flow and leveling

Humidity control, catalysis
Controlled of Tg
Release of solvent
Reaction products
Surface tension
Cure profile
SURFACE TENSION
WATER SOLVENT

METHANOL

PROPANOL

SOLVENT, %
FOAM-SURFACE TENSION, VISCOSITY
WETTING
DEWETTING
TELEGRAPHING
FAT EDGE
FILM PROPERTIES

PROPERTY
- Appearance Gloss
- Hiding power, Color
- Hardness/Flexibility
- Mar-abrasion resistance
- Environmental resistance

INFLUENCED BY
- Pigment dispersion.
- Surface smoothness
- Polymer & crosslinker degree of cure
- Elasticity, slip
- Adhesion, PVC
<table>
<thead>
<tr>
<th>Improving Film Properties</th>
<th>Additives Needed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hardness</td>
<td>Resin &amp; Crosslinker</td>
</tr>
<tr>
<td>Flexibility</td>
<td>Catalyst, stabilizer</td>
</tr>
<tr>
<td>Impact resistance</td>
<td>Polymer modifier</td>
</tr>
<tr>
<td>Coefficient of friction</td>
<td>Adhesion promoter</td>
</tr>
<tr>
<td>Mar &amp; abrasion resistance</td>
<td></td>
</tr>
</tbody>
</table>
FLOW AND LEVELING
ORANGE PEEL
BERNARD CELL
### ADDITIVES to IMPROVE FILM PROPERTIES

<table>
<thead>
<tr>
<th>Environmental resistance</th>
<th>Resin &amp; Crosslinker</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salt spray</td>
<td>Corrosion inhibitor</td>
</tr>
<tr>
<td>Humidity</td>
<td>Catalyst</td>
</tr>
<tr>
<td>Exterior durability,</td>
<td>UV absorber</td>
</tr>
<tr>
<td>Acid etch resistance</td>
<td>Additives</td>
</tr>
</tbody>
</table>
ADDITIVES to IMPROVE FILM PROPERTIES

Hardness
Flexibility
Impact resistance
Coefficient of friction
Mar & abrasion resistance

Resin & Crosslinker
Catalyst, stabilizer
Polymer modifier
Adhesion promoter
SURFACES ARE DIFFERENT
INTERFACE METAL-POLYMER
INTERFACIAL ADHESION
WEAK BOUNDARY LAYERS
INTERCOAT ADHESION

TPO-PE
DISPERSANTS EFFECT ON ADHESION

RSO₃ Me
NO DISP.
RCOOA
<table>
<thead>
<tr>
<th>Property</th>
<th>Ideal behavior</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potlife</td>
<td>No effect</td>
</tr>
<tr>
<td>Reactivity</td>
<td>Highly catalytic</td>
</tr>
<tr>
<td>Chemical resistance</td>
<td>Excellent</td>
</tr>
<tr>
<td>Exterior durability</td>
<td>No effect</td>
</tr>
<tr>
<td>Color</td>
<td>No discoloration</td>
</tr>
<tr>
<td>Pigment interaction</td>
<td>No absorption</td>
</tr>
<tr>
<td>Compatibility</td>
<td>Wide compatibility</td>
</tr>
</tbody>
</table>
HDT-LV ISOCYANATE
WATER (2%)  0.0045 % Me

K-KAT XC-4205   DBTDL
<table>
<thead>
<tr>
<th>Property</th>
<th>Desired Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Molecular weight</td>
<td>400-800, narrow MW dist.</td>
</tr>
<tr>
<td>Functionality</td>
<td>2-3</td>
</tr>
<tr>
<td>Type of functional group</td>
<td>OH, COOH, epoxy</td>
</tr>
<tr>
<td>Viscosity, (100 %), cps</td>
<td>500-5000</td>
</tr>
</tbody>
</table>
MOLECULAR WEIGHT DISTRIBUTION
RESIN - CROSSLINKER

VISCOSITY/SOLIDS
FUNCTIONAL GROUPS
  HYDROXYL, CARBOXYL
FUNCTIONALITY
MOLECULAR WEIGHT / DISTRIBUTION
SOLUBILITY PARAMETER (HANSEN)
COMPATIBILITY
PERFORMANCE PROFILE
PIGMENTS & FILLER

SURFACE AREA
OIL ABSORPTION
PARTICLE SIZE / DISTRIBUTION
pH IN WATER
SOLUBLE CONTENT / COMPOSITION
DENSITY
SURFACE TREATMENT
ADDITIVE

CHEMISTRY
FUNCTIONAL GROUPS
MOLECULAR WEIGHT
SOLUBILITY PARAMETER
SURFACE TENSION
MODE OF ACTION
POTENTIAL SIDE REACTIONS
RELATIVE PERFORMANCE TO OTHER ADDITIVES
RECOMMENDATIONS

& KEEP IT SIMPLE
& USE ADDITIVES ONLY IF NECESSARY
& A SIMPLE FORMULATION IS EASIER TO TROUBLESHOOT
& ADDITIVES SOLVE AND CREATE PROBLEMS
& TRY TO UNDERSTAND THE PROBLEM
& KNOW ALL THE COMPONENTS
& KNOW THE PHONE NUMBER OF YOUR ADDITIVE SUPPLIER
ACKNOWLEDGEMENT

LEN CALBO    BOB COUGHLIN

KING INDUSTRIES
SPECIALTY CHEMICALS

The conditions of your use and application of our products, technical assistance and information (whether verbal, written or by the way of product evaluations), including any suggested formulations and recommendations, are beyond our control. Therefore, it is imperative that you test our products, technical assistance and information to determine to your own satisfaction whether they are suitable for your intended uses and applications. Such testing has not necessarily been done by King Industries, Inc. ("King"). The facts, recommendations and suggestions herein stated are believed to be reliable, however, no guarantee or warranty of their accuracy is made. EXCEPT AS STATED: THERE ARE NO WARRANTIES, EXPRESSED OR IMPLIED, OF MERCHANTABILITY, FITNESS OR OTHERWISE. KING SHALL NOT BE HELD LIABLE FOR SPECIAL, INCIDENTAL, CONSEQUENTIAL, OR EXEMPLARY DAMAGES. Any statement inconsistent herewith is not authorized and shall not bind King. Nothing herein shall be construed as a recommendation use any product(s) in conflict with patents covering any material or its use. No license is implied or granted under the claims of any patent. Sales or use of all products are pursuant to Standard Terms and Conditions stated in King sales documents.