Defoamers & Formulation Aids for Pulp Processing
What is Foam?

- Foam is a mass of floating gas bubbles stabilized by surfactant double layers.
Mechanism of Defoamer Action

Defoamer Drops move into Foam Channel (Plateau Border)

Plateau border

Water drainage

Oil Bridge

Rupture

Drops get trapped in Plateau border

Drops Enter, Form Lens

Oil Bridge Forms, Foam Ruptures due to De-wetting

Defoamer Oil Droplet with hydrophobic particles

Typical data. Actual data may vary.
Requirements for Pulp Washing Defoamers

Why is foam undesirable?
Excessive foam can reduce productivity. Even small amounts of foam can…
- cause wide fluctuations in the line, causing wide swings in chemical consumption or product composition.
- lead to poor washing, filtration and drying results.
- reduce vessel capacity.
- prohibit distillations.
- increase packaging times.

Therefore a potent defoamer requires...
- Excellent knockdown.
- Excellent defoaming persistence: lower dosing, less consumption
- Excellent de-aeration and filtration.
- Pumpable viscosity.
- Compatible in pulp washing conditions
- Bulk stability to 50°C.
- Competitive cost-performance.

Typical data. Actual data may vary.
## Silicone vs. Organic Defoamer for Pulp Washing

**Silicone Defoamer**
- About 10x lower actives dosage (less waste)
- More environmental friendly (no dioxin)
- More effective in difficult systems (high soap or high hardness)
- Excellent knockdown
- Durable foam control
- Helps drainage
- More expensive unit price but superior cost-performance
- Silicone deposits needs to be avoided
- Due to high efficiency, difficult to dose

**Organic (mineral oil-base) Defoamer**
- Easier to manufacture
- Widely used; but has been replaced with silicones
- Good performance in low solids black liquor
- Excellent knockdown
- Poor durability
- Little effect on drainage
- Cheap unit price but inferior cost-performance
- Higher material exhaust into waste water

Typical data. Actual data may vary.
Silicone Compound Technologies for Pulp Washing Defoamer

Silicone Resin-based Defoamers
- Advantage: Superior defoaming persistence with good foam knockdown. Excellent cost-performance
- Disadvantage: Not readily emulsifiable due to high viscosity.

Dimethyl Silicone Fluid-based Defoamers
- Advantage: Easy to emulsify, Various viscosity producible.

Both silicone compounds to be emulsified due to 100% silicone actives not dispersible and/or soluble in aqueous foaming system. Typically 5~30% silicone actives.

Typical data. Actual data may vary.
• Momentive Performance Materials offers a range of pulp antifoams providing excellent foam knockdown and antifoam persistence combined with de-aeration and compatibility in black liquor washing process.

• The new silicone defoamer package consists of
  1) **Silicone resin-based compounds**: foam knockdown & persistence
  2) **Silicone-based surfactants**: de-aeration
  3) **Silicone-based emulsifiers**: emulsion stability & dispersibility

• They are active at very low use levels and show excellent performance in all types of surfactants (non-ionic, cationic and anionic) as well as at high and low temperatures and various pH-conditions.

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**Differentiated from Conventional Silicone Defoamers**

Typical data. Actual data may vary.
Product Overview

MPM silicone package used for pulp processing

Antifoam Compounds
- Y-14991, AMP-14 & Y-14829: Silicone Resin-based
- SAG47, Antifoam 100%: Silicone Fluid-based

Formulation Aids
- Silicone Emulsifiers: Silwet SPM-1, SPM-1, SPM-3
- Silicone De-aeration Inhibitors: Silwet DA-33, DA-40, DA-63

Typical data. Actual data may vary.
# MPM Silicone Antifoam Compounds - Overview

<table>
<thead>
<tr>
<th>Product*</th>
<th>Viscosity</th>
<th>Durability</th>
<th>Knockdown</th>
<th>Need of Silicone Emulsifiers?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y-14829</td>
<td>Soft gel</td>
<td>Excellent</td>
<td>Excellent</td>
<td>Essential</td>
</tr>
<tr>
<td>AMP-14</td>
<td>Soft Gel</td>
<td>Excellent</td>
<td>Very Good</td>
<td>Essential</td>
</tr>
<tr>
<td>Y-14991</td>
<td>250 000</td>
<td>Very Good</td>
<td>Excellent</td>
<td>Essential</td>
</tr>
<tr>
<td>AF 100%</td>
<td>5000</td>
<td>Moderate</td>
<td>Good</td>
<td>Desirable</td>
</tr>
<tr>
<td>Sag 47</td>
<td>2500</td>
<td>Moderate</td>
<td>Good</td>
<td>Desirable</td>
</tr>
</tbody>
</table>

*All products are 100% active.

Typical data. Actual data may vary.
Performance Positioning

• **Silicone Antifoam Compounds**
  – Silicone Resin-based
  – Dimethyl Silicone Fluid-based

• **Formulation Aids**
  – De-aeration Inhibitors: Silwet* DA-33, DA-40, DA-63
  – Silicone Emulsifiers: Silwet SPM-1, SPM-2, SPM-3

Typical data. Actual data may vary.
Silicone Resin-based Antifoam Compounds

**AMP-14, Y-14829 & Y-14991**

- Highly viscous liquids that can be emulsified using our silicone surfactants and emulsion technology
- High performance at low usage levels
- Outstanding persistence (durability) and good knockdown at low add-on levels
- Effective across wide pH range and high temperature
- Emulsions easily dispersed and thus no deposits on the media or the equipment
- Effective a broad set of process conditions
- Storage stable

<table>
<thead>
<tr>
<th>Typical Physical Properties</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>AMP-14</strong></td>
</tr>
<tr>
<td>Appearance</td>
</tr>
<tr>
<td>Actives Content</td>
</tr>
<tr>
<td>Viscosity @ 25/25°C</td>
</tr>
<tr>
<td>Density</td>
</tr>
<tr>
<td><strong>Y-14829</strong></td>
</tr>
<tr>
<td>Appearance</td>
</tr>
<tr>
<td>Actives Content</td>
</tr>
<tr>
<td>Viscosity @ 25/25°C</td>
</tr>
<tr>
<td>Density</td>
</tr>
<tr>
<td><strong>Y-14991</strong></td>
</tr>
<tr>
<td>Appearance</td>
</tr>
<tr>
<td>Actives Content</td>
</tr>
<tr>
<td>Viscosity @ 25/25°C</td>
</tr>
<tr>
<td>Density</td>
</tr>
</tbody>
</table>

Typical data. Actual data may vary.
Silicone De-aeration Inhibitors - Overview

Key Advantages of MPM Silicone De-aeration Inhibitors

- Significantly enhances **de-aerating** performance
- **Dispersibility** of defoamer in pulp washing process
- **Limited silicone deposition** in washing process
- Improve the **stability of antifoam emulsions**
- Increased **drainage in pulp washing**
- **Moderate antifoaming** at higher than cloud point
- May be compatible with silicone and organic antifoams

- Silicones differ from organics in the physical properties.
- We recommend to emulsify Silicone Antifoam Compounds with Silwet* DA-33, DA-40, DA63, silicone de-aeration Inhibitors that also improve the emulsifiability.
Silicone De-aeration Inhibitors - Chemistry

• Physical Properties can be affected by
  – varying the values of $x/y$ on the backbone
  – varying $a/b$ on the pendant
  – changing the nature of the capping group $Z$

Polyethylene-oxide (hydrophilic part):

Polypropylene-oxide (hydrophobic part):

Typical data. Actual data may vary.
Silicone De-aeration Inhibitors - Products

Silwet® DA Silicone Emulsifiers:
- Can improve the efficiency and de-aeration performance of Y-14991, AMP-14 and Y-14829 emulsions.
- Are used as emulsifier in combination with organic emulsifiers, defoamer and drainage aid for pulp and possibly in the paper line.
- Are silicone-polyethers like Silwet® SPM-1, SPM-2 and SPM-3, but with different composition and emulsification properties.
- Comply with FDA 21 CFR 176.210, for use as defoaming agents in the manufacture of paper and paperboard prior and during sheet forming.

<table>
<thead>
<tr>
<th>Typical Physical Properties</th>
<th>Silwet DA-33</th>
<th>Silwet DA-40</th>
<th>Silwet DA-63</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cloud point, °F (°C)</td>
<td>104 (40)</td>
<td>77 (25)</td>
<td>&lt;77 (&lt;25)</td>
</tr>
<tr>
<td>Viscosity, cSt, @ 25 °C</td>
<td>3500</td>
<td>1000</td>
<td>1100</td>
</tr>
<tr>
<td>EO:PO weight ratio</td>
<td>40:60</td>
<td>20:80</td>
<td>20:80</td>
</tr>
</tbody>
</table>

Typical data. Actual data may vary.
Silicone Emulsifiers - Overview

Silwet* SPM-1, SPM-2 and SPM-3 are silicone polyether copolymers, 100% actives

Key Advantages of MPM Silicone Emulsifiers

- Improve **storage & dilution stability** of silicone antifoam emulsions

**Additionally provide** -

- Rapid and clear improvement on filter drainage
- Ability to run filters under lower pressure thus improving productivity
- Improved compatibility in brown stock liquors
- Significantly enhances de-aeration performance
- Improve defoamer dispersibility in pulp washing process
- Limited silicone deposition in washing process

Typical data. Actual data may vary.
Silicone Emulsifiers - Products

Silwet SPM Emulsifiers:
- Improve emulsifiability for high viscosity silicone antifoam compounds.
- Can provide excellent emulsion stability and dispersibility.
- Can prevent silicone separation and deposition.
- Are recommended to emulsify Silicone Resin-based Antifoam Compounds such as Y-14991, AMP-14 and Y-14829 because they are limited to be emulsified with conventional organic emulsifiers.

Typical Physical Properties

<table>
<thead>
<tr>
<th></th>
<th>Silwet SPM-1</th>
<th>Silwet SPM-2</th>
<th>Silwet SPM-3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Appearance</strong></td>
<td>Off-white wax (M.P. ~30-35 °C)</td>
<td>Clear viscous liquid</td>
<td>Liquid</td>
</tr>
<tr>
<td><strong>Viscosity, cSt</strong></td>
<td>1000 @ 35 °C</td>
<td>20,000 @ 25 °C</td>
<td>3000</td>
</tr>
<tr>
<td><strong>Ionic Nature</strong></td>
<td>Non-ionic</td>
<td>Non-ionic</td>
<td>Non-ionic</td>
</tr>
<tr>
<td><strong>HLB</strong></td>
<td>High</td>
<td>Medium</td>
<td>Low</td>
</tr>
</tbody>
</table>

*Typical data. Actual data may vary.*
Emulsification for MPM Silicone Antifoam Compounds

Overview

✓ AMP-14 and Y-14829 are soft Gels.
✓ Y-14991 are of high viscosity but free flowing.
✓ SAG 47 can be used to dilute Y-14991, AMP-14 and Y-14829 to reduce viscosity if required.
✓ Mixing with cowles blade or anchor blade or similar turns them into liquid in about 1-2 hours
✓ Cooling may be needed
✓ Liquefied compound has to be emulsified without storage
✓ Use Silwet* SPM-1, SPM-2 and SPM-3 (1:2:1), about 10~20% to the weight of antifoam compound
✓ Can be combined with other surfactants (Silwet* DA-additives) and additives like thickeners and biocides

Typical data. Actual data may vary.
Formulation Examples for Pulp Defoamer Emulsion

1) Y-14991 compound with Silwet* DA-63 de-aerator
2) Y-14991 compound with Silwet SPM emulsifiers
3) AMP-14 compound with Silwet DA-63 de-aerator & Silwet SPM emulsifiers
4) Y-14991/SAG47 compounds with Silwet SPM emulsifiers
Example(1) - Formulation for Pulp Defoamer Emulsion
How to make an antifoam emulsion using a Silicone De-aeration Inhibitor

- Example preparation of 20% actives antifoam emulsion using **Y-14991 & Silwet DA-63**
  - This recipe is only intended as guideline emulsification to test the performance of our antifoam compounds under laboratory conditions.
  - Formulation for 200g:

<table>
<thead>
<tr>
<th>Raw Material</th>
<th>Supplier</th>
<th>Mass [g]</th>
<th>Approx. Wt.-%</th>
</tr>
</thead>
<tbody>
<tr>
<td>AF compound</td>
<td>Momentive</td>
<td>40.0</td>
<td>20.000</td>
</tr>
<tr>
<td>DA-63</td>
<td>Momentive</td>
<td>0.75</td>
<td>0.375</td>
</tr>
<tr>
<td>Brij™-72</td>
<td>Uniquema</td>
<td>1.75</td>
<td>0.875</td>
</tr>
<tr>
<td>Brij™-721</td>
<td>Uniquema</td>
<td>0.75</td>
<td>0.375</td>
</tr>
<tr>
<td>Propylene Glycol</td>
<td>Various</td>
<td>4.0</td>
<td>2.000</td>
</tr>
<tr>
<td>Thickener</td>
<td>Various</td>
<td>0.2-2</td>
<td>0.1-1</td>
</tr>
<tr>
<td>Water</td>
<td></td>
<td>~160</td>
<td>~80</td>
</tr>
<tr>
<td>Biocide</td>
<td>Various</td>
<td>~0.2</td>
<td>~0.1</td>
</tr>
</tbody>
</table>

Product formulations are included as illustrative examples only. Momentive makes no representation or warranty of any kind with respect to such formulations, including, without limitation, concerning the efficacy or safety of any product manufactured using such formulations.
Emulsification of Compounds: Lab Procedure

- Laboratory preparation of an emulsion based on Y-14991, AMP-14, Y-14829 and/or Antifoam 100% silicone antifoam compounds:
  - Example of a 200g laboratory preparation of an antifoam emulsion.
  - Prepare a stainless steel beaker and Cowles blade.

(I) steel beaker (250ml); (II) Cowles blade (1.5” diameter).

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Example - Procedure to make antifoam emulsion

How to make an antifoam emulsion using a Silicone De-aeration Inhibitor

1. Charge Y-14991
2. Charge Brij-72
3. Charge Brij-721
4. Charge Silwet DA-63
5. Charge Propylene Glycol
6. Charge Add Initial water (4wt%)
Example - Procedure to make antifoam emulsion

Continued….

7. Charge Kelzan® AR

8. With a suitable Cowles blade...

9. ...mix 5mins @ 60°C at 900 – 1000rpm

10. After 5mins @ 1000rpm it should begin to look smooth

11. Once smooth, remove water bath, mix at 1000rpm for a further 5mins

12. After 5mins @ 1000rpm it should begin to look smooth

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Example - Procedure to make antifoam emulsion
Continued….

From time to time, STOP the mixer and carefully and safely scrape any undispersed silicone back into reactor for remixing

13

Restart the Cowles at 1000rpm, add the final water slowly

14

Continue to add the final water. Add it ALL in about 2-3 mins

15

From time to time, STOP the mixer and carefully and safely scrape any undispersed silicone back into reactor for remixing

16

Mix the final emulsion for 5 mins @ 1000rpm. STOP. Emulsion should now be ready

17

Fill into container

18

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Example preparation of 15% actives antifoam emulsion using **Y-14991 & Silwet SPM emulsifiers**

– Formulation for 200g:

<table>
<thead>
<tr>
<th>Raw Material</th>
<th>Supplier</th>
<th>Mass [g]</th>
<th>Approx. Wt.-%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y-14991</td>
<td>Momentive</td>
<td>30.0</td>
<td>15.000</td>
</tr>
<tr>
<td>SPM-1</td>
<td>Momentive</td>
<td>0.75</td>
<td>0.375</td>
</tr>
<tr>
<td>SPM-2</td>
<td>Momentive</td>
<td>1.75</td>
<td>0.875</td>
</tr>
<tr>
<td>SPM-3</td>
<td>Momentive</td>
<td>0.75</td>
<td>0.375</td>
</tr>
<tr>
<td>Propylene Glycol</td>
<td>Various</td>
<td>4.0</td>
<td>2.000</td>
</tr>
<tr>
<td>Thickener</td>
<td>Various</td>
<td>0.2-2</td>
<td>0.1-1</td>
</tr>
<tr>
<td>DI Water</td>
<td>~160</td>
<td>~80</td>
<td></td>
</tr>
<tr>
<td>Biocide</td>
<td>Various</td>
<td>~0.2</td>
<td>~0.1</td>
</tr>
</tbody>
</table>

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Emulsification of Y-14991: Lab Procedure (1)

• Example preparation of 15% Actives Antifoam Emulsion
  – Weight 30g/l Y-14991 Silicone Resin-base Antifoam Compound into a clean stainless steel beaker

Y-14991 is a viscous compound that will slowly flow under gravity

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Emulsification of Y-14991: Lab Procedure (2)

– Add the emulsifiers and propylene glycol:
  • SPM-1 (Silicone Emulsifier) 0.75g
  • SPM-2 (Silicone Emulsifier) 1.75g
  • SPM-3 (Silicone Emulsifier) 0.75g
  • Propylene Glycol 4.00g

– Blend all additives together with the Cowles blade at 1000rpm until a homogeneous and smooth liquid is obtained (I to IV).

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Emulsification of Y-14991: Lab Procedure (3)

– Maintain the cowles rotational speed at 1000rpm and slowly add the thickener, followed by water until phase inversion occurs (drop in viscosity)
  • Thickener ~ 0.2-2g
  • Water ~ 160g

(I) Weighing water; (II) Slowly adding the water until a phase-inversion occurs; (III) After inversion, the remaining water is added at a controlled rate.

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Emulsification of Compounds: Lab Procedure (4)

– If needed, suitable biocides can be added to prolong the shelf-life of prepared antifoam emulsions.
  • ~ 0.2g preservative
– Blend at 1,000rpm for further 5-minute and fill into the final container.

(I) After the final shear the emulsion is filled into a clean jar.
(II) No silicone grease remains in the vessel.

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How to Apply Defoamer Emulsion using Y-14991/SPM Emulsifiers

- Typical dosing levels: 0.3~1 kg of 10% active emulsion per ton of pulp depending on mill conditions
- Recommended points to apply antifoam emulsions
  - Dose at the point of entry of the black liquor
  - Dose as early as possible and always just before the screens
  - Dose where there is foam
  - Dosing on the wash filters is desirable but not critical

Key Advantages of Defoamer Emulsion Using Y-14991 & Silwet* SPM Emulsifiers

- May reduce defoamer cost in pulp mills
- Improvement of drainage
- Elimination of micro-foam
- Help reliably control washing line

Typical data. Actual data may vary.
Example (3) - Formulation for Pulp Defoamer Emulsion

How to make an antifoam emulsion using Silicone Emulsifiers

- Defoamer emulsion containing **14% AMP-14 compound, 2.8% Silwet* SPM emulsifiers and 1% Silwet DA-63 de-aerator**.
  - Formulation for 1,000kg:

<table>
<thead>
<tr>
<th>Raw Material</th>
<th>Supplier</th>
<th>Mass [kg]</th>
<th>Approx. Wt-%</th>
</tr>
</thead>
<tbody>
<tr>
<td>AMP-14 compound</td>
<td>Momentive</td>
<td>140.0</td>
<td>14.0</td>
</tr>
<tr>
<td>SPM-1</td>
<td>Momentive</td>
<td>7.0</td>
<td>0.7</td>
</tr>
<tr>
<td>SPM-2</td>
<td>Momentive</td>
<td>14.0</td>
<td>1.4</td>
</tr>
<tr>
<td>SPM-3</td>
<td>Momentive</td>
<td>7.0</td>
<td>0.7</td>
</tr>
<tr>
<td>Propylene Glycol</td>
<td>Various</td>
<td>40.0</td>
<td>4.0</td>
</tr>
<tr>
<td>Thickener</td>
<td>Various</td>
<td>25.0</td>
<td>2.5</td>
</tr>
<tr>
<td>Silwet DA-63</td>
<td>Momentive</td>
<td>10.0</td>
<td>1.0</td>
</tr>
<tr>
<td>DI Water</td>
<td></td>
<td>756</td>
<td>75.6</td>
</tr>
<tr>
<td>Biocide</td>
<td>Various</td>
<td>~1.0</td>
<td>~0.1</td>
</tr>
</tbody>
</table>

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Emulsification of AMP-14 in Cowles Mixer - Overview

- Example preparation of 28% actives antifoam pre-emulsion, and then let down to 14% silicone actives in the final stage

Key Point: Agitate AMP-14 only in cowles mixer for ~55 minutes

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Emulsification of AMP-14 in Cowles Mixer: Step 1

**Step 1: Make a pre-emulsion containing 28% AMP-14 in Colwes mixer**

<table>
<thead>
<tr>
<th>Agitation Time (minutes)</th>
<th>Agitation Speed (r.p.m.)</th>
<th>Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>250</td>
<td>Discharge 28kgs AMP-14 and start agitating</td>
</tr>
<tr>
<td>15</td>
<td>300</td>
<td>Keep agitating. Cowles blade to be stayed to work at <strong>only upper part</strong>, i.e., top 5~10cm of 28kgs AMP-14.</td>
</tr>
<tr>
<td>20</td>
<td>400</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>500</td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>600</td>
<td></td>
</tr>
<tr>
<td>35</td>
<td>800</td>
<td>At this point, Cowles blade to be down to the mid-part, i.e., top 20~25cm</td>
</tr>
<tr>
<td>40</td>
<td>1,000</td>
<td>Keep agitating at the mid-part</td>
</tr>
<tr>
<td>45</td>
<td>1,200</td>
<td>At this point, Cowles blade to be stayed at bottom part of 28kgs AMP-14</td>
</tr>
<tr>
<td>55</td>
<td>1,200</td>
<td>Keep agitating at the bottom part</td>
</tr>
</tbody>
</table>

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Emulsification of AMP-14 in Cowles Mixer: Step 2

**Step 2: Discharge Silwet* SPM emulsifiers and water while keeping the agitation**

<table>
<thead>
<tr>
<th>Agitation Time (minutes)</th>
<th>Agitation Speed (r.p.m.)</th>
<th>Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>55</td>
<td>1,200</td>
<td>Add 7kgs Silwet SPM-1</td>
</tr>
<tr>
<td>57</td>
<td>1,200</td>
<td>Add 14kgs Silwet SPM-2</td>
</tr>
<tr>
<td>59</td>
<td>1,200</td>
<td>Add 7kgs Silwet SPM-3</td>
</tr>
<tr>
<td>61</td>
<td>1,200</td>
<td>Slowly add 40kgs Propylene Glycol</td>
</tr>
<tr>
<td>63</td>
<td>1,200</td>
<td>Slowly add 10kgs thickener</td>
</tr>
<tr>
<td>65</td>
<td>1,200</td>
<td>Start slowly adding 20kgs water</td>
</tr>
<tr>
<td>67</td>
<td>1,200</td>
<td>Very slowly add 262kgs water at ~10 liter per minute speed</td>
</tr>
<tr>
<td></td>
<td>600</td>
<td>Reduce the agitating speed if getting a phase-inversion while adding the water</td>
</tr>
</tbody>
</table>

Product formulations are included as illustrative examples only. Momentive makes no representation or warranty of any kind with respect to such formulations, including, without limitation, concerning the efficacy or safety of any product manufactured using such formulations.
Emulsification of AMP-14 in Cowles Mixer: Step 3 & 4

**Step 3: Prepare a blend of water, thickener & Silwet* DA-63 in a separate open mixer**

<table>
<thead>
<tr>
<th>Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>i) Discharge 474kgs water</td>
</tr>
<tr>
<td>ii) Add 15kgs thickener while agitating at 400rpm</td>
</tr>
<tr>
<td>iii) Add 10kgs Silwet DA-63, and keep agitating for 10 minutes</td>
</tr>
</tbody>
</table>

**Step 4: Make the final emulsion containing 14% AMP-14 compound**

<table>
<thead>
<tr>
<th>Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>i) Start slowly adding the blend of water, thickener and Silwet DA-63 into the pre-emulsion (in step 2) while keeping the agitation at 400rpm.</td>
</tr>
<tr>
<td>ii) Further agitating at 400rpm after completely adding the blend</td>
</tr>
<tr>
<td>iii) Add ~1kg biocide and keep agitating at 400rpm for 60 minutes</td>
</tr>
</tbody>
</table>

**Typical Physical Properties of the Final Emulsion**
- pH: 7~8  
- Viscosity: 1,000~2,500 cps  
- Solid contents: 16~20%

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Example (4) – Formulation for Pulp Defoamer Emulsion

Reduce Y-14991 viscosity in combination with SAG47. Minimize impacting Y-14991 defoaming persistence.

<table>
<thead>
<tr>
<th>Raw Material</th>
<th>Supplier</th>
<th>Approx. Wt.-%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y-14991</td>
<td>MPM</td>
<td>40</td>
</tr>
<tr>
<td>SAG47</td>
<td>MPM</td>
<td>40</td>
</tr>
<tr>
<td>SPM-1</td>
<td>MPM</td>
<td>5</td>
</tr>
<tr>
<td>SPM-2</td>
<td>MPM</td>
<td>10</td>
</tr>
<tr>
<td>SPM-3</td>
<td>MPM</td>
<td>5</td>
</tr>
</tbody>
</table>

### Procedure

1) Mix Y-14991 and SAG47 homogenously
2) Melt SPM-1/-2/-3 (if need), then add into the mixed compound in the above
3) Mix it until obtaining the homogeneous blend. (check the appearance judged by experience)
4) Antifoam concentration is ready.

---

### B. Emulsification Step for the Mixed Compounds

<table>
<thead>
<tr>
<th>Raw Material</th>
<th>Supplier</th>
<th>Approx. Wt.-%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compound mixed</td>
<td>MPM</td>
<td>20</td>
</tr>
<tr>
<td>Propylene Glycol</td>
<td>Various</td>
<td>2</td>
</tr>
<tr>
<td>Thickener*</td>
<td>Various</td>
<td>0.1~1.0</td>
</tr>
<tr>
<td>Water</td>
<td></td>
<td>~80</td>
</tr>
<tr>
<td>Preservative</td>
<td>optional</td>
<td></td>
</tr>
</tbody>
</table>

### Procedure

1) Prepare thickener solution (either CMC, Xanthan gum or polyacrylic acid thickener)
2) Discharge the mixed compound in the thickener solution under stirring
3) Add polypropylene glycol and preservative (if required)
4) Stir it very homogenously and packing

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Appendix:
- MPM’s Test Methods for Defoaming Performance
- Typical Dosing Points for Defoamer in Pulp Processing
Recirculation tester

Test Procedure:

- Recirculation of foaming liquor at 80°C creates a column of foam
- Pump: 0.74 gallons/min (typical)
- Foam solution: anionic surfactant, pH 13
- With the pump on, dose antifoam and record lowest foam height and time to collapse (knockdown)
- Record time to reach again reference foam height and rate of foam increase (durability)
The antifoam is automatically injected without stopping the recirculation.
Recirculation Test

Foam knock-down

Typical data. Actual data may vary.
Recirculation Test

Antifoam Persistence (Durability)

Typical data. Actual data may vary.
Defoaming Performance Evaluated with a Nordic Black Liquor

![Graph showing foam volume over time for different solutions. The graph includes a legend for Competitor (8ppm), Y-14991 (8ppm), Competitor (27ppm), and Y-17164 (8ppm). The graph indicates that Y-17164 is not commercially available.]

*Y-17164 is not commercially available*
Application Examples of MPM Silicones in Pulp Processing

Antifoam Compounds & Silwet SPM

Silwet DA

Typical data. Actual data may vary.
• Recommended Addition Points for Pulp Defoamers:

- Filter Tank:
  - 85% of Black Liquor goes to Diffusion Washer

- Diffusion Washer:
  - 10% Pulp content
  - Foam results in poor drainage

- Knot reject washer:
  - 1% pulp content before screening

- Screening to remove knots (normally 3 stage screening operation):
  - 2.4% pulp content

- Black Liquor:
  - 15% of Black Liquor goes to Knotters Tower

- Black Liquor:
  - Black Liquor being recirculated

- Filter Tank:
  - 5000m³ of which 60% is full

1 = most important dosing position for AF
2 = 2nd most important dosing position for AF
3 = 3rd most important dosing position for AF
4 = 4th most important dosing position for AF

Spray from the 2nd filtration tank:

Typical data. Actual data may vary.
Defoamer Dosing Points in Typical Pulp Washing Process

- Counter flow system, rotary vacuum washers:

  - Drum A
  - Drum B
  - Drum C
  - Drum D

  Brown stock influent

  Recycled Fluid

  Waste water plant

  Fresh water

  1st Defoamer feed

  2nd Defoamer feed

  Drum picks up pulp

  Pulp Product

Typical data. Actual data may vary.
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