Defoamers and Deaerators

Chemistry, Mechanisms and Analytical Techniques

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Outline

- Definition
- Air introduction into a PM
- Stabilization mechanisms
- Mechanisms of defoamers and deaerators
- Physical and chemical properties of deaerators
- Analytical techniques
What is foam?

Natural foam structures

- Cork
- Sponge
- Coral
- Tree leaf
- Balsa wood
- Plant stalk

Natural cellular materials
Aqueous foam

Sources of entrained air

Air introduction
- White water
- Pumps
- Cascades
- Broke
- Dissolved air from fresh water

Stabilization
- Ligninsulfonate
- Emulsifiers (e.g. deinking process)
- Pitch
- Oligo/Polysaccharides

Consequences
- Higher volume
- Decreased efficiency of pumps/deculators
- Surface foam
- Flotation
- Pinholes
- Drainage problems
Stabilization of air bubbles

In pure water
No foam

In paper stock
Stable foam

Structure of a stabilized foam lamella

Air bubble

Amphiphilic character
Stabilization of bubbles – Gibbs’ effect

Surface energy increases

Expansion of lamella

Stabilization of foam – Marangoni effect

Expansion of lamella

Increase of surface tension

Decrease of surface tension over time

Diffusion
Methods of deaeration

Physico-mechanical
- Deculator (vacuum)
- Centrifugal cleaners (vacuum)
- High-power ultrasound – rare

Chemical
- Hydrophobic particles
- Surfactants
- Spreading agents
- Oil

Structure of defoamers and surfactants

Hydrophobic hydrocarbon chain = –CH₂ – CH₂ –

Hydrophilic group = –OH, –COOH, –EO, –NR₂, –SO₃H

Non-emulsifiable  ↔  emulsifiable  →  water soluble
Deaerator/defoamer  Surfactant
Difference between defoamer and surfactant molecules

**Defoamer molecules**
- Hydrophobic
- Insoluble in water

**Surfactant molecules**
- Amphiphilic, micelle-forming
- Decrease surface tension

Mechanisms of defoamers – Part 1

Defoamer

Surfactant

Ruptured surfactant film
Mechanisms part 2 – Aggregation model

Definitions

<table>
<thead>
<tr>
<th>Active substance</th>
<th>Formulation</th>
<th>Classification</th>
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<tbody>
<tr>
<td>Liquid</td>
<td>100%</td>
<td>Oil defoamer</td>
</tr>
<tr>
<td>Solid</td>
<td>Emulsified</td>
<td>Defoamer emulsion</td>
</tr>
<tr>
<td></td>
<td>Dispersed</td>
<td>Deaerator dispersion</td>
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</tbody>
</table>
Defoamer/deaerator formulations

Non-emulsifiable oil  
Emulsifiable oil  
Dispersion

Deaeration vs. chemical properties

Deaeration performance

Emulsion-forming tendency

Deaeration performance vs. chemical properties
Impact of temperature on deaeration

![Graph showing the impact of temperature on deaeration performance for Deaerator A and Deaerator B.]

Impact of furnish on deaerator consumption

Afranil SLO consumption in different model stocks
SONICA air content 0.3%

- 100% TMP
- 70/30 Langfaser - Kurzfaser; *
- 2kg 70/30 Langfaser - Kurzfaser; *
- Holzschliff Rückseite + Einlage; Decke 60/40 - Kiefer/Buche
- Wellpappe
- 50% Steinschliff / 50% gebl. Sulfit
- Typ - 100 % Steinschliff

* gebleichter Zellstoff + Stärke (Oberfläche)
Impact of wet-end chemicals on deaerator consumption

Impact of paper chemicals on performance of deaerator dispersions at 50°C (Sonica)

- 2% Fastusolgelb PR 8176
- 0.75% Basazolrot 40L
- 0.75% Basazolviolett 46L
- 0.75% Basazolgelb 46L
- 8% Luresin KTU
- 0.8% Luresin KTU
- 2% Solvitose
- 0.5% Solvitose
- 1% Ligninsulfonat
- 2% Harzl.+Alaun pH 5
- 0.1% Harzl.+Alaun pH 5
- 2% Harzlem
- 0.1% Harzlem
- 3% Basoplast 265 D
- 1% Basoplast 265 D
- 0.5% Basoplast 2030 LC
- 10% CaCO₃+ 0.2% Poly SK
- 10% CaCO₃ PCC
- 0.2% Polymin KE 2020
- 1% Polymin SK
- 0.1% Polymin SK
- ohne Zusatz

Additional consumption of deaerator dispersion

Analytical methods of air measurement in suspensions

- Compression and expansion (1953)
- Density changes (1951)
- Optical methods, bubble count (1970)
- Light scattering (1982)
- Ultrasound

- Indirect air measurement on PMs via
  - speed of mixing pump
  - vacuum levels in process equipment (deculator)
  - foam volume
Air content measurement in the laboratory

Temperature control

Air content analyzer

Pump

45°C

Air content measurement by ultrasound – SONICA instrument

Pressure indicator

Piston

Valve

Transmitter

Receiver

From head box
Mütek – GAS 60
gas determination by compression

- Lab test for gas determination similar to SONICA
- Measurement of dissolved gas by expansion
- Measurement of dispersed gas by compression
- Sampling rate 2 min, slower than sonica

Entrained gas tester –
Gas measurement by compression

- Bleed valve
- Lid
- Bubble chamber
- Sample cylinder
- Piston
- Cap with graduation
- Knob
- O-ring
- 1 atmosphere mark
BASF foam tray

SITA foam tester
**SITA foam tester**

![SITA foam tester graph](image)

**BASF Defoamers and Deaerators: Afraniil®**

**Stock deaeration using quality BASF products**

- Inhibits foam
- Improves retention
- Enhances stock dewatering on the wires and in the wet presses
- Reduces pinholes and surface roughness of the paper
- Results in considerable energy savings when pumping the furnish and pumps
- Has a positive effect on paper machine runnability and productivity
- Enhances the efficiency of other process chemicals such as retention aids
BASF Defoamers and Deaerators: Afranil®

Customer benefits

<table>
<thead>
<tr>
<th>Benefit</th>
<th>Graphical Representation</th>
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<td>Stock deaeration</td>
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<tr>
<td>Foam inhibition</td>
<td></td>
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<tr>
<td>Fiber and filler retention</td>
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<td>Dewatering on the wire</td>
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<td>Dewatering in the wet press</td>
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<td>Energy savings when pumping the furnish</td>
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<tr>
<td>Paper quality</td>
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<tr>
<td>Runnability/productivity</td>
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<td>Performance enhancement of other process chemicals</td>
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Oil based products

**Defoamers**
- Destroying surface foam

Emulsion type products

**Deaerators**
- Preventing foam formation

<table>
<thead>
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<th>Product</th>
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<tr>
<td>Afranil® RS</td>
<td></td>
</tr>
<tr>
<td>Afranil® F fluid,</td>
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<tr>
<td>Afranil® T fluid,</td>
<td></td>
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<tr>
<td>Afranil® AW</td>
<td></td>
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<tr>
<td>Afranil® PR 8177</td>
<td></td>
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<tr>
<td>Afranil® SLO</td>
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<tr>
<td>Afranil® MG</td>
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Temperature [°C]

20 30 40 50 60 70
BASF Defoamers and Deaerators: Afranil®

Application range for deaerators

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<tr>
<td>Temperature</td>
<td>20 70 30 40</td>
<td>50 60</td>
<td>40</td>
<td>40 50</td>
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Special applications

BASF Product Portfolio Defoamer Oil

Afranil® F Liquid
- Can be used in groundwood and sulphite pulping
- Also acts as stock deaerator
- Can be metered direct via pumps or by drip feed

Afranil® T Liquid BGVV/FDA
- Also acts as stock deaerator
- Can be metered direct via pumps or by drip feed
- Dangerous to the environment

Afranil® AW
- Mainly used against surface foam
- Can be metered directly
BASF Defoamers and Deaerators: Afranil®

Afranil® dosing system of BASF

- Prepares the product
- Regulates the flow rate
- Mixes the deaerator with fresh water
- Supplies the mixture

```
Afranil®
Transfer pump
Undiluted product
Stirrer
Flow meter
set at 3.5l/h
Metering pump
with MI flow
meter
Fresh water
200-400l/h
Afranil®
mixer
To the dosing point
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