Extruded aqua feed quality management

Relations between technology and Extruded aqua feed quality
Extruded feed quality management

Agenda

1. Fish feed quality management

2. Presentation of Thomas Ellegaard Mohr and ANDRITZ

3. Outline of extruded fish feed production flow

4. Definitions of good fish feed quality

5. ANDRITZ machines and technologies for fish feed production
One of the keys to successful fish farming lies in correctly adapted feed formulas, high quality fish ingredients, controlled homogenous content and optimum physical feed pellet properties.

In order to keep pace with these increasing demands, industrially produced feed is undergoing a continuous quality improvement process. The different types of fish feed are subject to different demands, the feed’s function on the farms in terms of floatability or sink ability and the pellets durability to assist mechanical handling without generating of fine.
What is good quality and how to affect it is the main subject in aqua feed production lines. The technical quality in the different areas in the feed/production line includes fine grinding, conditioning before the extrusion process, extrusion, drying, vacuum coating and pellets cooling etc.

Technical quality means for example: Density, sinking or floating ability, fat, moisture, dimensions (length, diameter), dust etc.

Chemical quality can mean many things: How to protect nutrient agents from damage in the aqua feed processing line and in the storage prior to the feeding.

Challenges with new raw material: The traditional aqua feed ingredients are limited. How to adapt to new ingredients and raw material and get the most out of them.

Increased focus on food safety: Aqua feed ingredients and process traceability.

How to ensure high-quality feed at minimum operating costs
Extruded feed quality management
Process flow from raw material intake to finished feed bagging
ANDRITZ Feed & Biofuel
ANDRITZ Technologies for the extrusion feed industry
2.5 Presentation of company: ANDRITZ Feed & Biofuel
ANDRITZ Technologies for the fish feed industry

Hammermill
Extruder
Dryer
Coater
Automation

Feed ingredients
Aquatic feed factory
Aquatic feed
Fish Farming
Fish processing
Human food
Chemical quality is mostly related to the challenge of optimization of available raw material to match the requirements of each species of animal:

- Recipe in respect to agreement between the manufacturer and “customer” (fish farmer, marketing, veterinarian)
- Raw material/recipe in respect to accessibility, prizes
- Crude protein, crude lipids %, digestible protein, digestible energy, moisture, ash, etc.
- Feed micro ingredients: Vitamins, minerals, digest and other.
- In the processing of feed the protection of various ingredients, in fish feed proteins and amino acids is of high essence. This means management of temperature, time and moisture.
Change in feed ingredients concepts

1) Less marine proteins and oils
2) Increased inclusion of vegetable proteins and oils and food by-products

Reduced environmental impact from fish farming through environmental friendly aquatic feed

New fish species requiring different feed formulas and physical properties

Increased focus on food safety, feed ingredients and process traceability

Increased focus on industrial plant efficiency, process cost reductions and plant emissions.
# Extruded aqua feed quality management

## Feed ingredients relations to quality and drying properties

<table>
<thead>
<tr>
<th>Feed ingredient</th>
<th>Impacting substance</th>
<th>Effect</th>
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</thead>
<tbody>
<tr>
<td>Marine proteins</td>
<td>Water soluble protein</td>
<td>Seals surface blocking for evaporation</td>
</tr>
<tr>
<td>Animal proteins</td>
<td>Water soluble protein</td>
<td>Seals pellets surface</td>
</tr>
<tr>
<td>Veg prot. concentrate</td>
<td></td>
<td>Binds water</td>
</tr>
<tr>
<td>Oil seeds</td>
<td>Fat content</td>
<td>Hinders move of water and evaporation</td>
</tr>
<tr>
<td>Grains</td>
<td>Type / quality of starch / Gluten</td>
<td>Limits evaporation</td>
</tr>
<tr>
<td>Starch concentrate</td>
<td>Type / quality of starch</td>
<td>Seals pellet surface</td>
</tr>
<tr>
<td>Gluten</td>
<td>Type / quality of gluten</td>
<td>Cellular structure</td>
</tr>
<tr>
<td>Marine oils</td>
<td>Fat content</td>
<td>Hinders move of water and evaporation</td>
</tr>
<tr>
<td>Vegetable oils</td>
<td>Fat content</td>
<td>Hinders move of water and evaporation</td>
</tr>
</tbody>
</table>

Combination of difficult to extrude and dry feed ingredients and addition of oils in the mixer or into the extruder results in substantially longer drying time. +20-100%, Need for bigger dryers, and higher temperature oxidation / thermal degradation of feed nutrients.
Extruded feed quality management

What is good technical quality:

- Durability, density, floating / sinking, avoiding broken pellets and dust, securing uniform and smooth surface of the pellets.

- Texture profile analyses of stress relaxation test

- Weight, dimension length / diameter

<table>
<thead>
<tr>
<th></th>
<th>Diameter:</th>
<th>Dimension:</th>
<th>Dimension length:</th>
<th>Density:</th>
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<tr>
<td></td>
<td></td>
<td>Min</td>
<td>Norm</td>
<td>Max</td>
</tr>
<tr>
<td>99%</td>
<td>sinking</td>
<td>1.3</td>
<td>1.1</td>
<td>1.3</td>
</tr>
<tr>
<td></td>
<td>sinking</td>
<td>1.5</td>
<td>1.3</td>
<td>1.5</td>
</tr>
<tr>
<td></td>
<td>sinking</td>
<td>2</td>
<td>1.7</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>sinking</td>
<td>3</td>
<td>2.7</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>sinking</td>
<td>4</td>
<td>3.6</td>
<td>4</td>
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<tr>
<td></td>
<td>sinking</td>
<td>5</td>
<td>4.5</td>
<td>5</td>
</tr>
<tr>
<td></td>
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<td>5.4</td>
<td>6</td>
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<td></td>
<td>sinking</td>
<td>7</td>
<td>6.3</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>sinking</td>
<td>9</td>
<td>8.1</td>
<td>9</td>
</tr>
</tbody>
</table>
Extruded feed quality management

Quality management

1. Visual control:
   - Uniformity
   - Surface
   - Smoothness
   - Sharpness of cutting
   - Texture

2. Measure control:
   - Length - Diameter
   - Floating - Sinking

3. Oil content
   - Sinking
   - Humidity

4. Oil content
   - Sinking velocity
   - Humidity
   - Durability
   - Temperature

5. Fines
   - Sinking velocity
   - Protein - Fat
   - Fibre - Ash - H₂O
   - Durability/Hardness

[Diagram showing the quality control process]
Extruded feed quality management

Grinding Andritz Hammer Mill

In extrusion processes, each sub-process impacts the performance of the next step in the process.

- Finished product quality
- Fine structures
- Reduce fines
- Easier access to carbohydrates via smaller practical
## Extruded feed quality management

### Demand for fine grinding in Fish Feed Production

<table>
<thead>
<tr>
<th></th>
<th>Typical requirements</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shrimp feed</td>
<td>95 % &lt;700µm</td>
<td></td>
</tr>
<tr>
<td></td>
<td>50% &lt; 220µm</td>
<td></td>
</tr>
<tr>
<td>Small fish feed pellets ø0.6-1.2</td>
<td>95 % &lt;500µm</td>
<td>Sieve often used</td>
</tr>
<tr>
<td></td>
<td>50 % &lt;220µm</td>
<td></td>
</tr>
<tr>
<td>Fish feed ø 2-16mm Salmon / trout /sea bass</td>
<td>95 % &lt;800µm</td>
<td></td>
</tr>
<tr>
<td></td>
<td>50 % &lt;220µm</td>
<td></td>
</tr>
<tr>
<td>Fish feed ø2-16mm Tilapia, Pangasius etc.</td>
<td>95 % &lt;800µm</td>
<td>Sieve often used</td>
</tr>
<tr>
<td></td>
<td>50 % &lt;220µm</td>
<td></td>
</tr>
</tbody>
</table>
Extrusion feed quality management

- Controllability
- Flexibility
- Productivity
Extrusion cooking parameters influence on the final product

The extruder is a flexible tool, allowing for making the feed in different ways. Although with substantial differences in moisture content before drying:

- Shear cooking
- Steam cooking
- Combined steam and shear cooking

- 6% less moisture before drying means:
  - Reduction of drying costs by 33%
  - Reducing size of dryer needed by 1/3
  - In a 50.000 T/pa. feed plant, 3.3 Mill. Kgs per year less water to evaporate ~ 400.000 kgs of oil saved per year.
- Step by step reducing drying zone temperature as the pellets dries
- High temp of drying air whilst large amounts of moisture to evaporate
- The high evaporation of surface moisture in pellets at dryer inlet keeps pellets cold
- Reduced temp when pellet moisture gradually reduces and it takes longer time for remaining moisture to move from the center to pellet surface
Extruded feed quality management
Uniform drying is crucial to uniform floating or sinking properties

Test samples from:
- A Extruder Discharge
- B Dryer Discharge
- C Fat Coater Discharge
- D Cooler Discharge

Example 1
Low energy feed
18-22% oil
-12% added

Set value

1.20 Pelleted feed
1.15
1.10
1.05 Extruded feed
1.00
0.95

SEAWATER

% H₂O

%
Extruded feed quality management

Uniform drying is crucial to uniform oil absorption in the coating process

The higher moisture pellets soaks less oil

- Uneven sinking/ floating properties
- Uneven nutritional values
- Visible difference in color

Too high drying temp forms "skin"
Slows down oil absorption without Vacuum
Extruded feed quality management
Quality in coating

- Gentle handling
- No oil leaking from pellets
- Dry surface
- No fines
- No breaking pellets
- Uniformity of product
Extruded feed quality management
Quality in coating - vacuum coater process

The ANDRITZ system provides accurate control of:

- Vacuum pressure
- Liquid addition
- Cycle time

Resulting in flexibility and repeatability in terms of absorption and penetration.
Extruded feed quality management
Extruded feed technology solutions – we offer...

**High capacity fine milling** of aquatic feed formulas with high inclusion of vegetable proteins, oil seeds and by-products

**Extrusion technologies**, with increased versatility and improved controllability
High capacity extrusion and drying technologies with - Minimized negative thermal impact to feed nutrients - Improved total energy efficiency and reduced emissions

Vacuum coater and MFS, Liquids, powder, fats, oils and micro additives

Process automation - securing process stabilization = consistent feed quality - objective process data recording = total cost management - feed ingredients and process traceability = contribution to food safety