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Aquafeed conditioning & pelleting – Optimising the process to improve pellet quality

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trouw nutrition
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Process & Quality control in shrimp feed production

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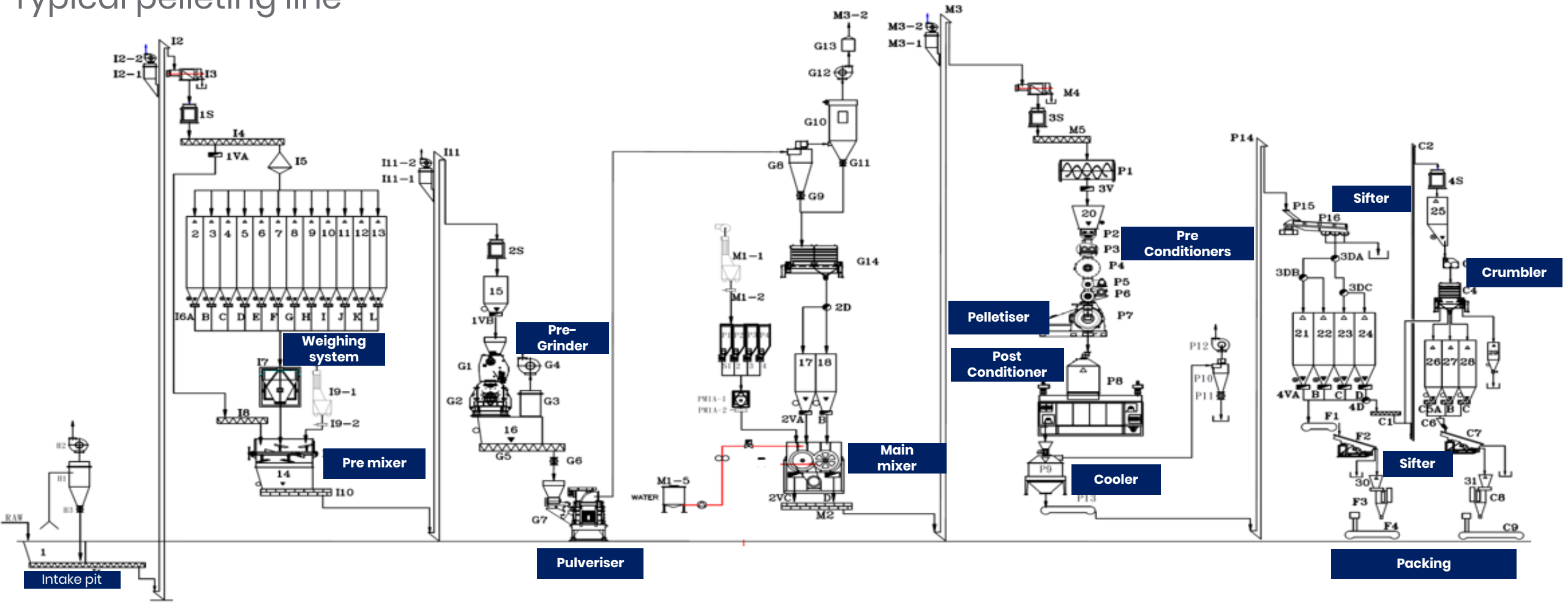
Shrimp feed production process

Typical pelleting line



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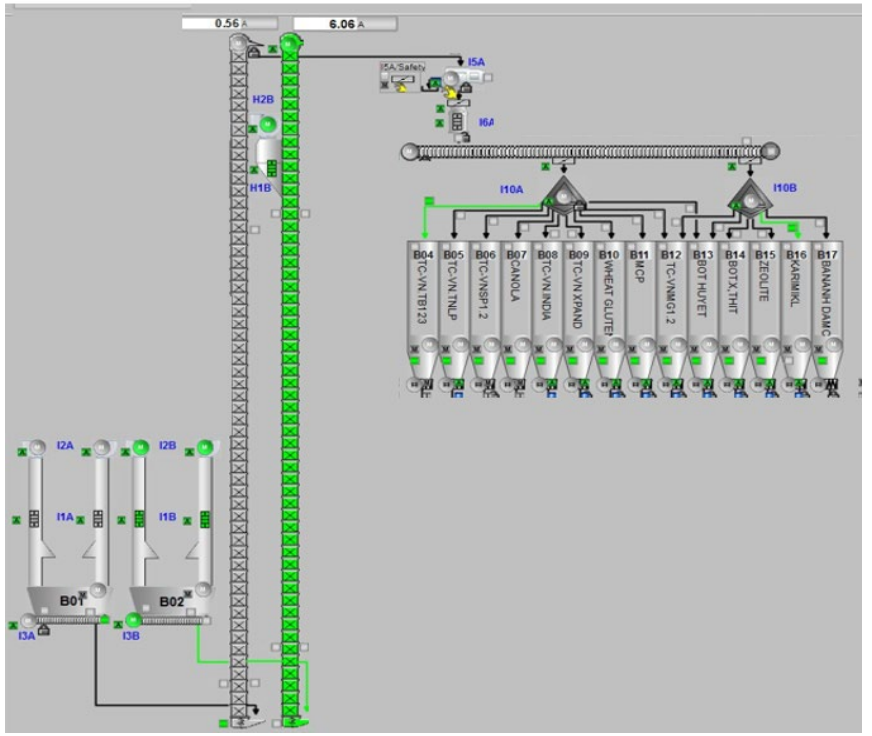
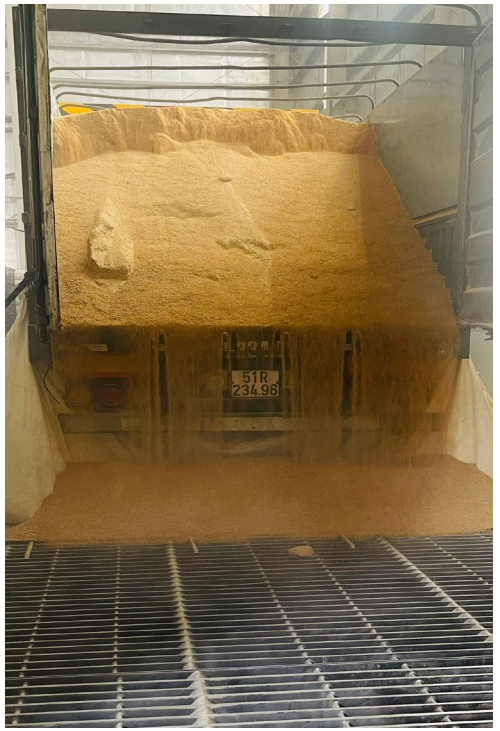
Intake

Raw materials are delivered to the factory, pass all quality specifications and then unloaded to the warehouse or conveyed to the dosing bins.

Practices:

- Dumping to the right bin
- No cross contamination
- Foreign objects must be removed by cleaners/magnets





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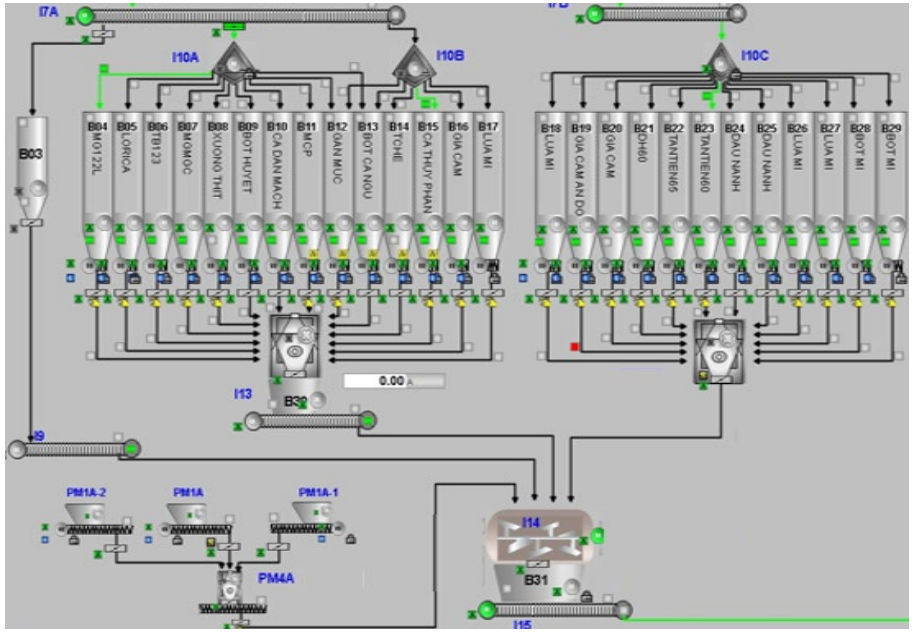
Dosing and weighing

Raw materials are dosed individually according to the formulation to make a dry batch.

Some raw materials are weighed from large silos and some raw materials from smaller weighing systems.

The raw materials will come together in the pre-mixer to form a batch.



Dosing stage

Macro dosing scale

Medium dosing scale


Micro dosing scale

First mixer

The batch must be mixed before the grinder.
Having a well mixed batch is very important for grinder performance.
CV for the mixer should be below 5%.

Horizontal paddle mixer

Bomb door mechanism

Grinder

The function of grinders is to reduce the particle size of the meal.

Benefits:

- Improve pellet quality – better steam penetration, better cooking.
- Increase production rate, reduce die blockage.
- Increase bulk density.
- Additionally, shrimp require a small particle size for optimal growth.

QC checks:

- Particle size should be 100% below 210 micron.

Hammer mill

Pulveriser

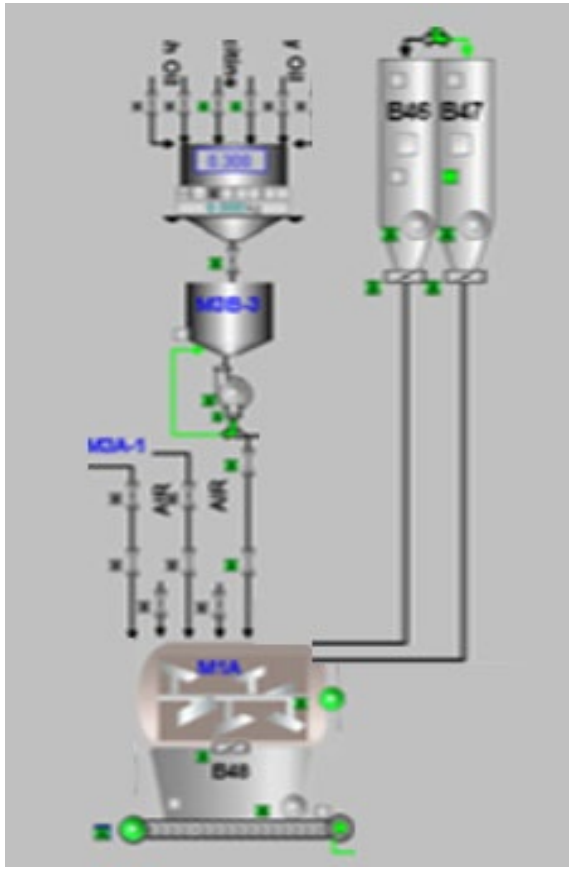
Second mixer

The second mixer is used to homogenise the batch after the grinder.

- Some fine ingredients can be added directly into the second mixer without grinding.
- Liquids including oil, water, additive added into the main mixer.

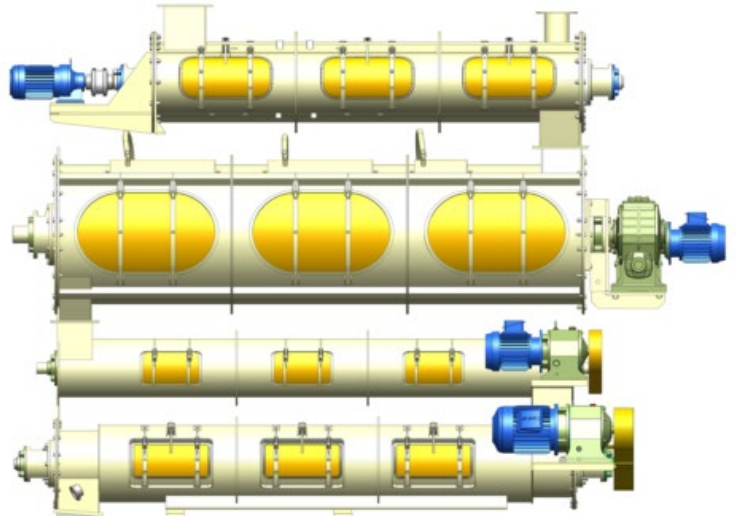
Good practices:

- The sequence of liquid addition is very important for shrimp feed (dry mixing, water, oil, wet mixing).
- In line NIR can be installed after the 2nd mixer to make sure the nutrient, particle size and moisture are stable.



Main mixer

Pre-conditioner



Pre-conditioning – Why?

- To hydrate (diffuse moisture to the interior of the particles).
- To heat (transfer heat energy from steam to the particles).
- To mix (water, steam and oils with the mash).

Best practices/parameter:

- Steam pressure is as low as possible (2-3 bars depends on throughput).
- Steam should be aded 100% in the DDC to improve the gelatinization rate. Indirect steam can be used at the preconditioners before pellet press to maintain high temperature.
- Increase and control conditioning time (>300 sec).
- Temperature is as high as possible (more than 100 degree C).

Pelletiser

The pellet press pushes meal through a large rotating die ring.

Adjustable knives cut pellets into the desired length.

Good practices:

- Good cutting is important for a low level of dust and for a good appearance.
- Gap between the die and rolls should slightly touch each other.
- Amps and temperature are the key parameter for pellet press.

QC checks:

- Moisture (14-15%)
- PDI (98%)
- Visual (cuts, color, dust, pellet uniformity)

Pellet mill troubleshooting

1. Capacity reduction
Common reasons:
- The gap between the die & rollers is too large
- Rollers wears or rollers not running smoothly
- Die wears
- Meal is too dry or too wet

2. Water stability is not good
Common reasons:
- The pellet die becomes thinner because of wearing
- Throughput is too high
- Temperature is not high enough
- Post conditioner issues (low temperature or low cooking time)

3. Uneven length, dusty pellets
Common reasons:
- Cutter is worn out
- Throughput is too high
- Rollers adjustment is not proper
- Water and temperature is improper

4. Obstruction of the pellet die:
Common reasons:
- Meal is too dry or too wet
- The cone of the die wears
- The gap between the die and rolls is too large or rollers issues
- Throughput is too high

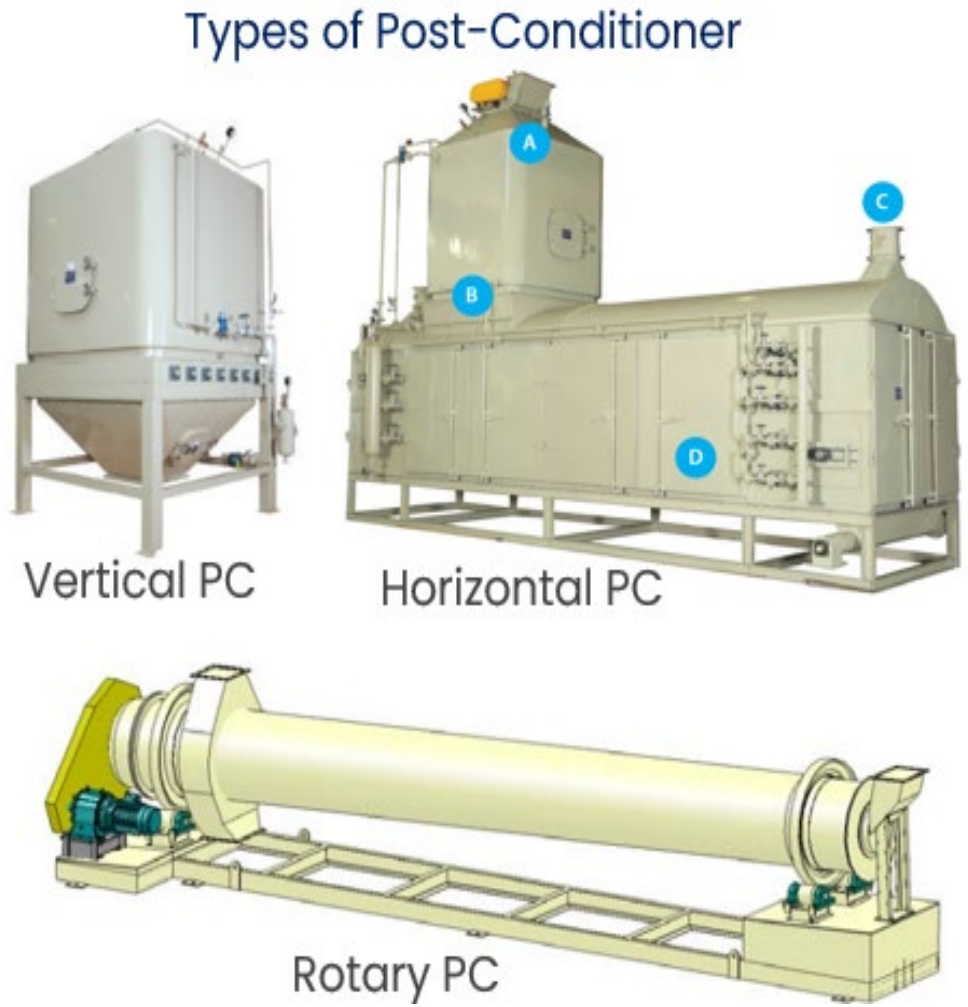
Post-conditioner

Why post conditioning?

- Increase the water stability and digestability
- Increase PDI, reduce dust
- Remove moisture of the feed
- CCP of the process

Parameter:

- Cooking time: 45-60 minutes
- Temperature: 95 -100 degree C



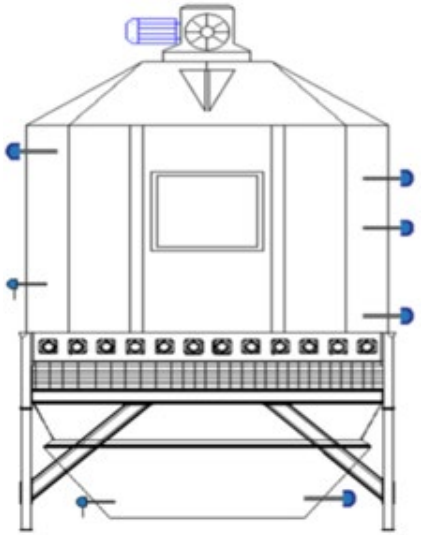
Cooler

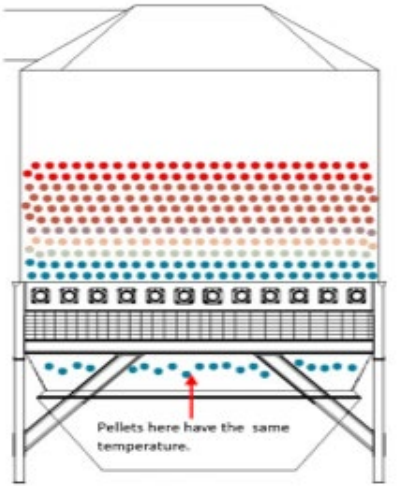
The main reason for cooling is to reduce the pellet temperature before packing.

Pellets that are packed too warm can result in mold growth (and fat leakage in FF high fat).

Good practices:

- The cooler must have temperature sensors for both the product and ambient.
- The cooler must have the low level sensor, high level sensor and high-high level sensor.
- It is important that air enters from at least two sides of the cooler, air should be clean.
- An even product bed is critical for even cooling.



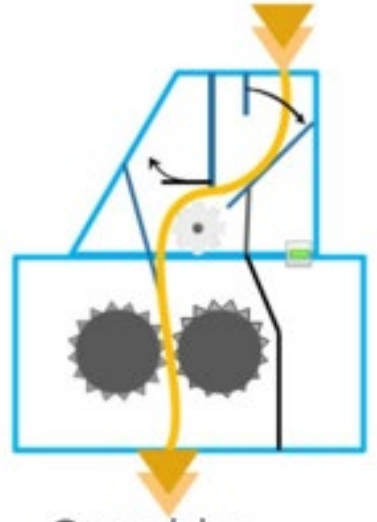


Crumbler

Sizes below 0.8 mm need to be crumbled.

The SFP enters the 2 crumbler gears and then classifies them into different sizes at the sifter below.

Depending on the market, we can have 2-3 sizes for crumble products.



Crumbler

Classifying sifter

Good practices:

- Regularly monitor the performance of both the crumbler and the sifter.
- Adjust the gap between the two rolls to match the designed capacity and sizes.

Sifting and Packaging

- The sifter after the cooler is for removing the dust & lumps.
- The sifter before bagging is the last chance to remove dust from the feed

Quality checks:

- NIR scan for every pallet (or per ton).
- Water stability checked by visual, water absorption, and DML.
- Physical quality checks: Size, length, color, uniformity (from pelleting to bagging).
- Dust & PDI checked (Dust: 0.02 max, PDI: 98.5%min).

Sifter

Packing

Palletiser

Storage

2. Extruded vs pelleted shrimp feeds

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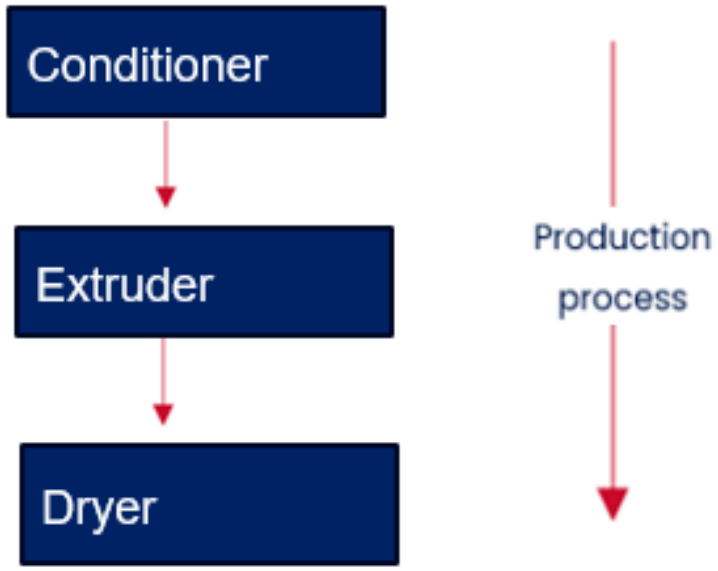
Extruded vs pelleted shrimp feeds

Main differences in the process:

Extrusion is a high temperature short time heating process that requires high level of moisture, heat and pressure. A dryer is required for extruded pellets.

Pelleting utilizes a pelletiser to compress meal with low level of moisture (14 -15%), pellets are further cooked in the Post-Conditioner .



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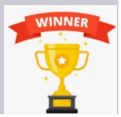
Extruded vs pelleted – Physical quality

	Color	Visual	Smell	Sinking rate	Water stability	Turbidity	Pathogen safety
Extruded	Naturally darker colored which is preferred in most market	Uniform, smooth, No dust Varied diameter	Normal fishy smell	100% sinking	Good, low DML, stay stable and together	Limited turbidity	As product is heated up at high temperature, more anti nutritional factors are broken down
Pelleted	Naturally lighter color	Sharp cuts Some dust Fixed diameter	Stronger fishy smell	100% sinking	Good, water absorption is a bit lower but DML is a bit higher	Higher turbidity, leading to more dirty water	Product is heated up as high as extrusion process
	Extruded	Extruded	Pelleted	No winner	Extruded	Extruded	No winner

The extruded product is better in most of product characteristics compared to pelleted product

Extruded vs pelleted shrimp feed – Others

Extruded

vs

Pelleted

- Product of choice in American shrimp market
- Allows for more RM flexibility
- Formulations are cheaper
- Capex for a plant construction is high
- High production cost

- Product of choice in Asian shrimp market
- Less flexibility
- Formulations are more expensive
- Capex is medium
- Lower production cost

The choice is yours!

3. Energy efficiency in aquafeed plants

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Energy efficiency in aquafeed plants

Two main reasons why we are focusing on improving energy efficiency:

- Opex reduction
- Environmental reasons

Energy cost reduction strategies are vital to staying competitive!

Thermal energy

Includes heating air for dryers, process steam…

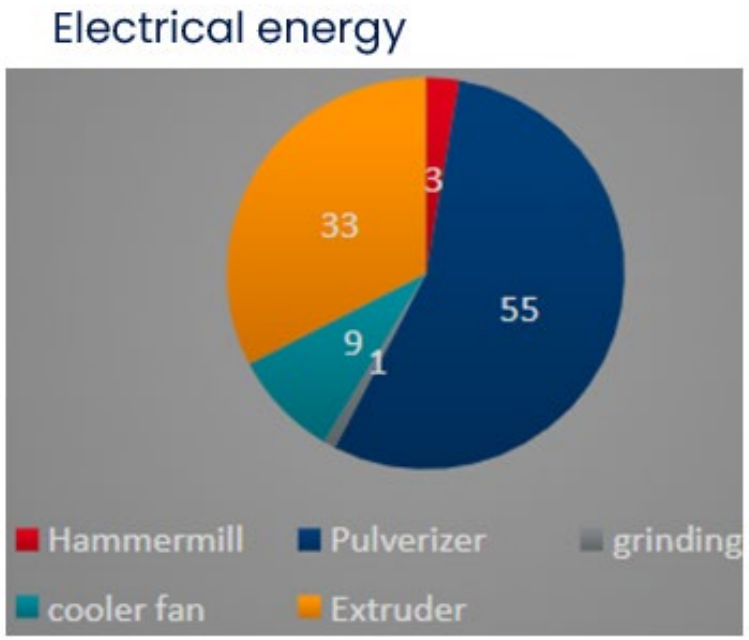
Electrical used for heating is considered as thermal energy.

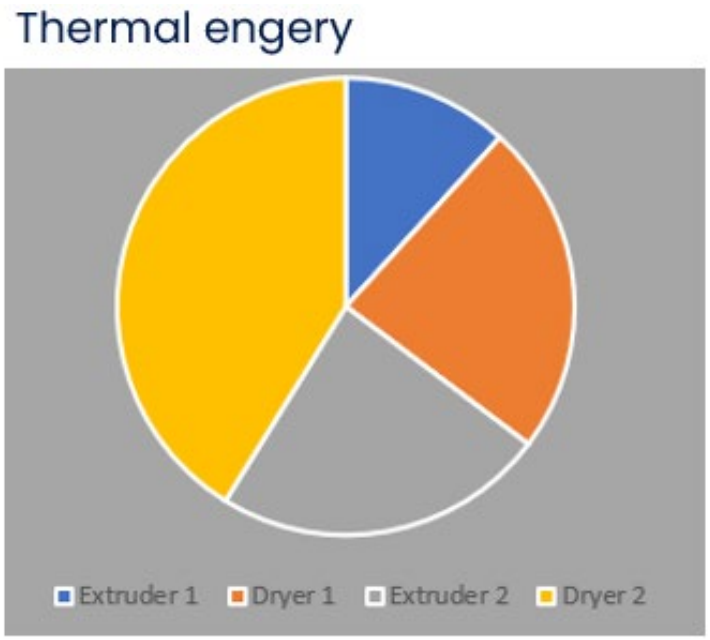
Electrical energy

Motors, fans, pumps, air-compressors, chillers, lighting, electrical appliances…

How can we improve energy efficiency?

1. Separating the electrical and thermal energy.
2. Breaking down consumption of different areas in the plant to find out the main consumers and where we should focus to reduce the energy consumption.





Where can we improve energy efficiency?

Dryer

Single largest energy use, 40% energy consumption

Good practices:

- Use as little water as possible without compromising quality and keep the moisture as close to the target as possible.
- The parameters must be adequate (fan speed, bed speeds, temperature).
- Mechanical inspection (well maintained, free of leaks, heat exchangers in good condition, no air shortcut, zones divided for good control and the bed plates clean.

Boiler

Improve boiler efficiency by installed:

- Condensate return
- Preheating of feedwater (by using economizer)
- Blowdown control, and recover flash steam from boiler blowdown
- Insulation of boiler and steam distribution lines

Where can we improve energy efficiency?

Steam

Steam is used in the cooking process, heat exchangers, post conditioners...

Good practices:

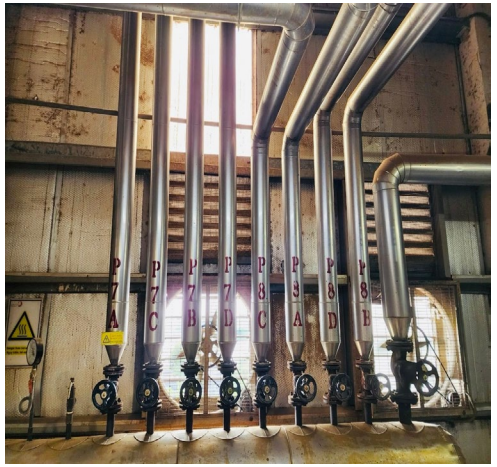
- Using dry saturated steam, not wet saturated steam as it carries less energy.
- Steam should be available at the point of use in the correct quatity & pressure.
- Heating oil or water with steam is not recommended, the best way is to use hot water or recover heat from other processes.

Insulation and leaks

Steam and compressed air leaks and lack of line insulation are causing losses.

Good practices:

- Insulation of pipes can have a payback of less than 9 months.
- Regular maintenance of steam, hot water and compressed air lines is crucial to avoid pressure drop and energy loss.
- Daily inspections to detect leaks in compressed air and steam lines.



Properly insulated steam pipes

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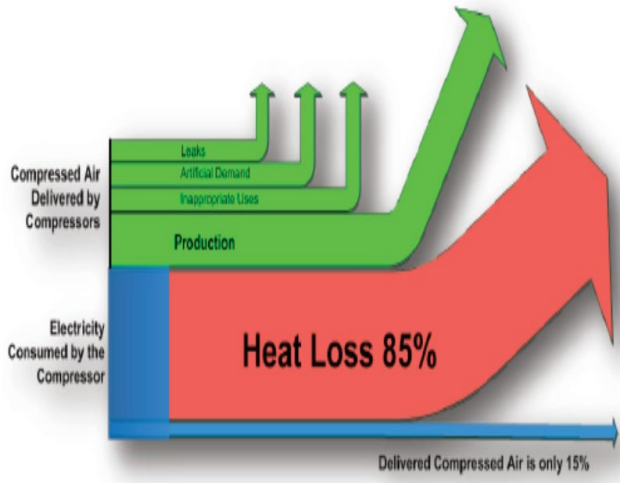
Where can we improve energy efficiency?

Compressed air

Good practices:

- Never be used for cleaning or cooling.
- Reduce compressed air pressure to the minimal operating pressure.
- Any leaks in the system should be repaired immediately.
- If possible, utilizes the heat generated by the compressor.



Factory shutdown

Good practices:

- Avoid pressurized steam distribution during factory shutdown. If possible, stop the boiler.
- Stop running the equipment as soon as its not needed.
- Procedure for shutdown sequence must be implemented.

Where can we improve energy efficiency?

Heat recovery

- Best practices:
- Cooler exhaust air can be used as dryer makup air.
- Barrel cooling water can be used as boiler feed water or process water.
- Heat from gearbox cooling oil can be used to preheat process water.
- Knifehood heat can be recovered and used for preheating process water.

Other

- Define the minimum particle size needed from the process and quality point of view.
- High quality LED lights must be selected, light control should be equipped for major area.
- Cooler fan speed should be reduced when coolers are empty.
- Use heat recovery to produce hot water for the conditioner, increasing water temperature can reduce the steam addition.

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Thank you

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