FEED TECHNO VISION 2024

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Drying aquafeed for high nutritional quality - challenges & solutions

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trouw nutrition
a Nutreco company

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Chapter overview

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01. Introduction

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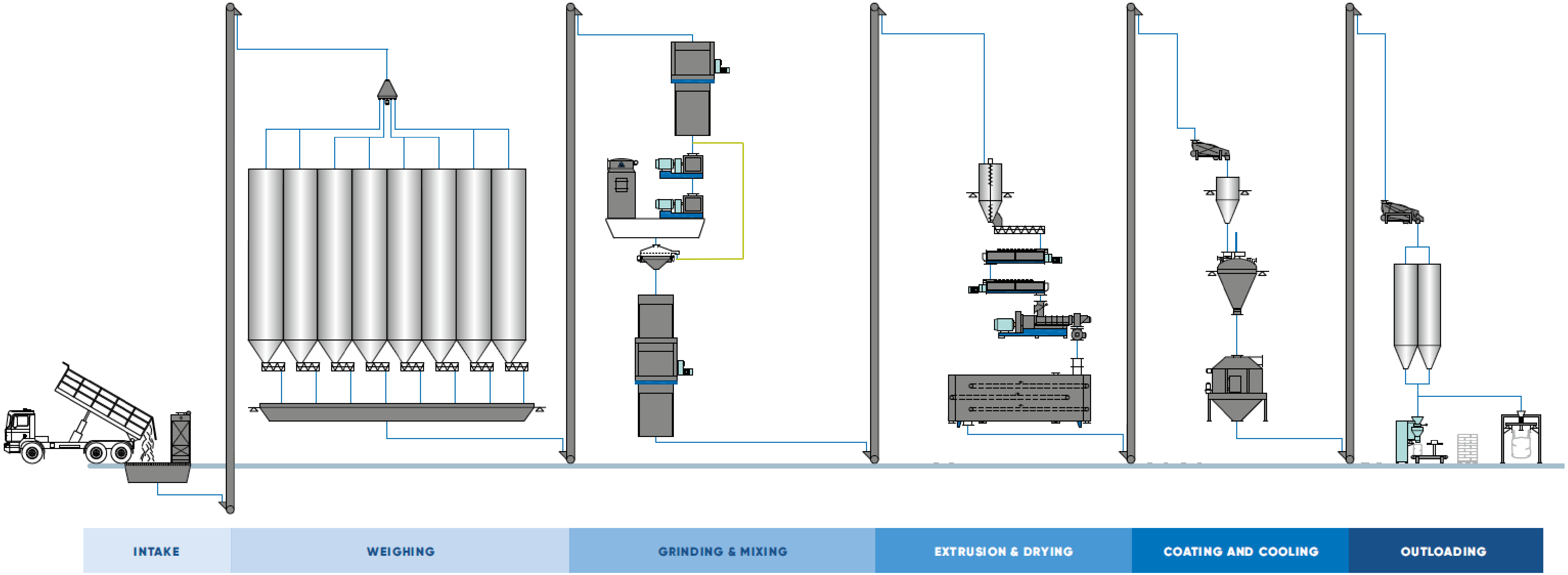
ANDRITZ standard aquafeed line

Simplified Extruded fish feed flow (sinking)



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Drying of aquafeed

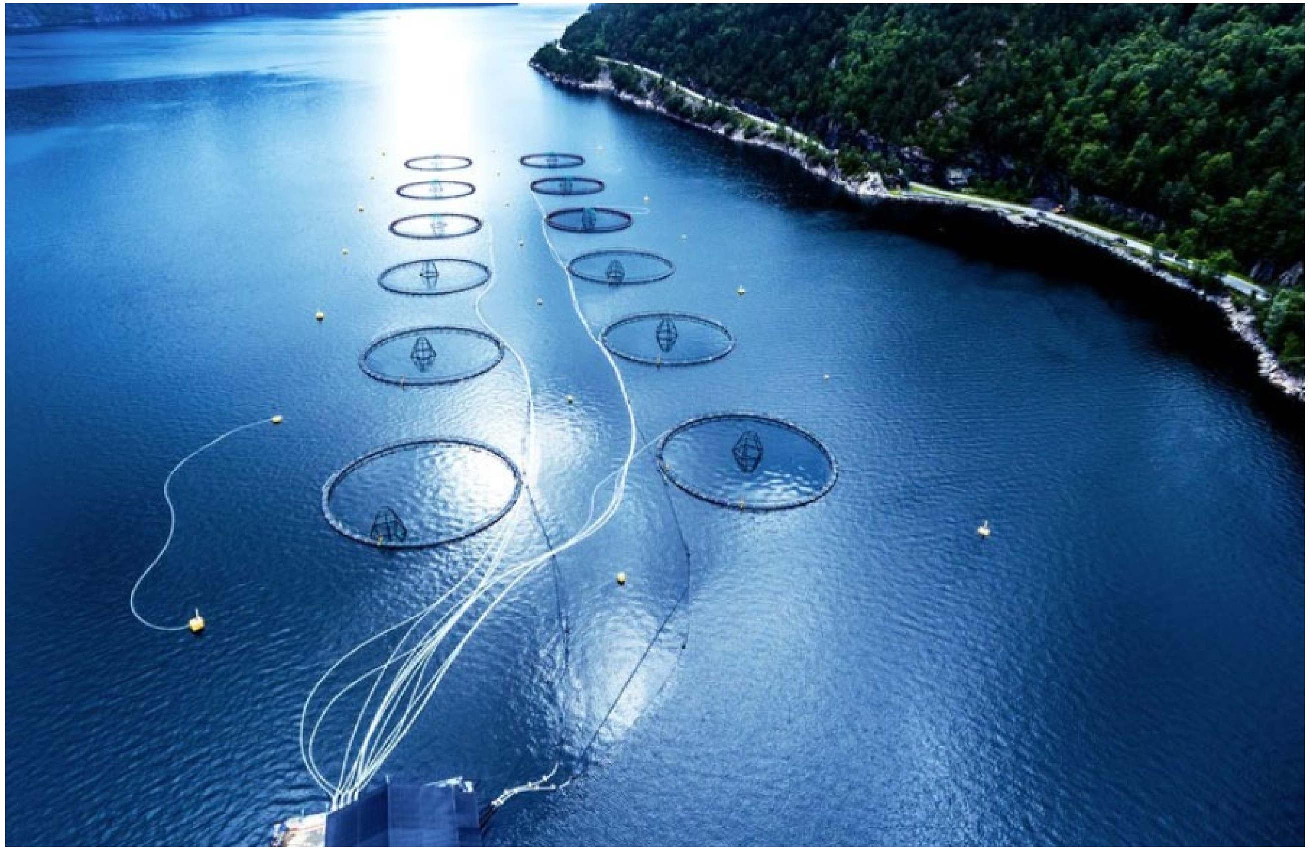
Why to dry?

Primary objective:

- To increase shelf life of product;
- Decrease water activity (aw)

Other objectives:

- Change palatability – crispness;
- Reduce shipping costs.



Demands on formulation

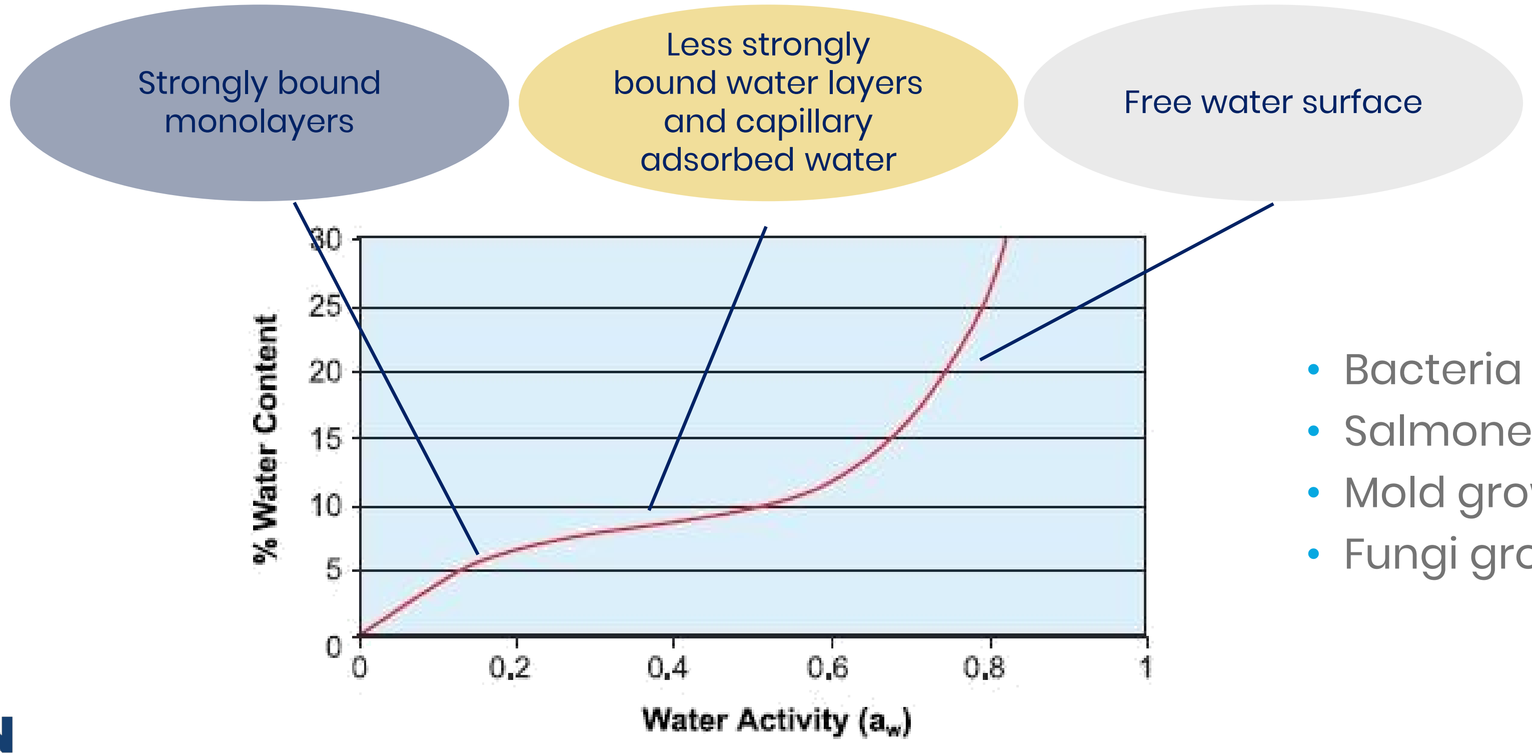
Considerations

- Contribution to nutritional objectives
- Impact on final flavor, palatability and / or color
- Impact on feed pellet physical properties – binding / durability / water stability / density
- Expansion – floating / sinking / slowly sinking
- Impact on process

Water activity (a_w)

Relation between water activity and water content

- Molecularly bound water cannot be removed from the product;
- Free ‘active’ water is available to microorganisms for growth and can be removed from the product by drying. The free water content is expressed as ‘water activity’, a_w.

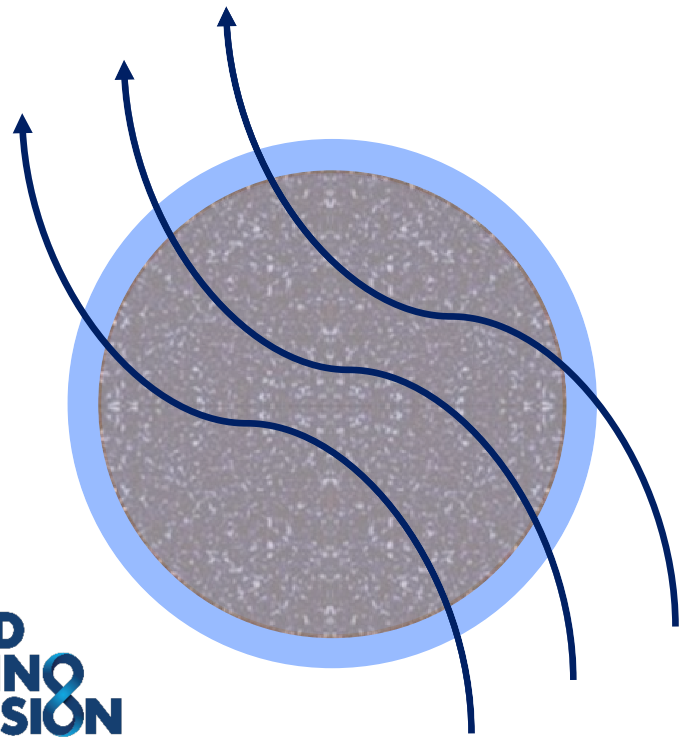


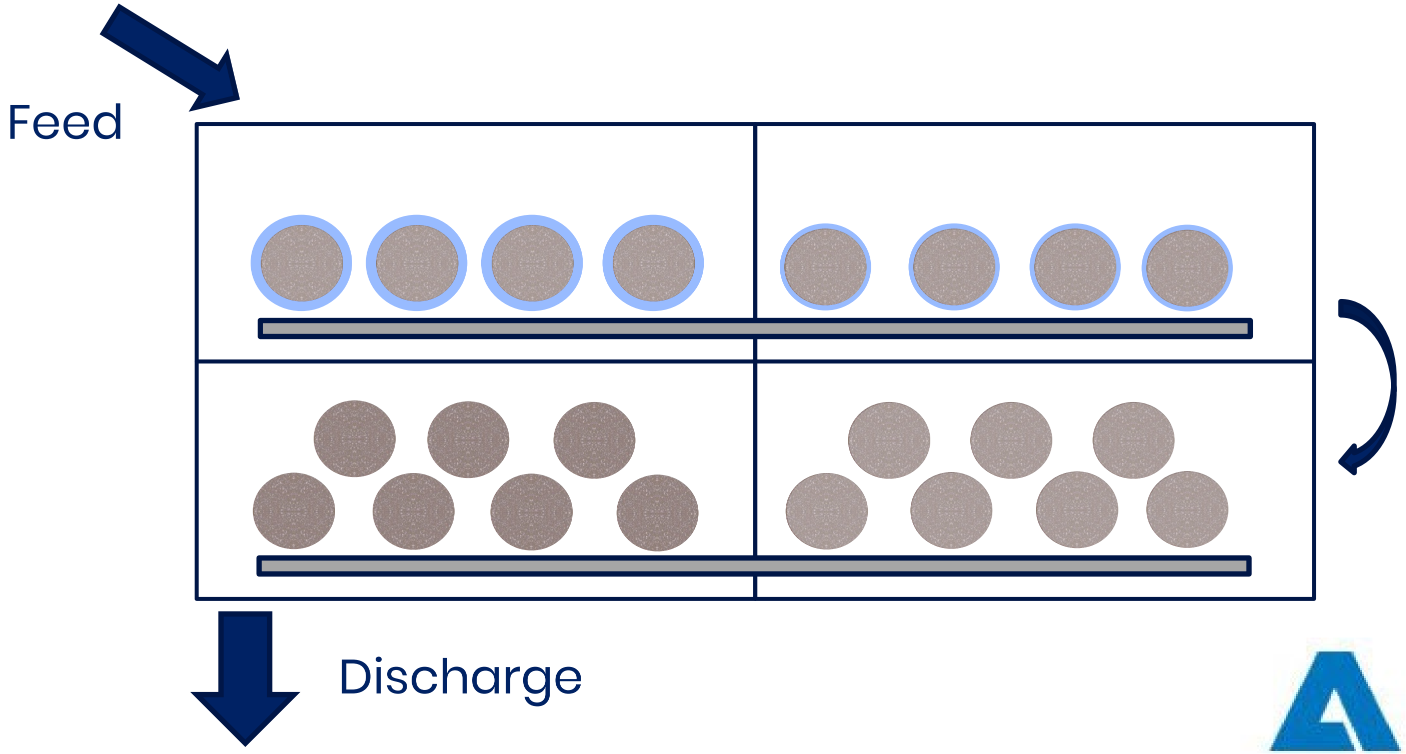
- Bacteria growth: $a_w > 0.86$
- Salmonella growth: $a_w > 0.92$
- Mold growth: $a_w > 0.83$
- Fungi growth: $a_w > 0.6$

Drying of aquafeed

The drying theory

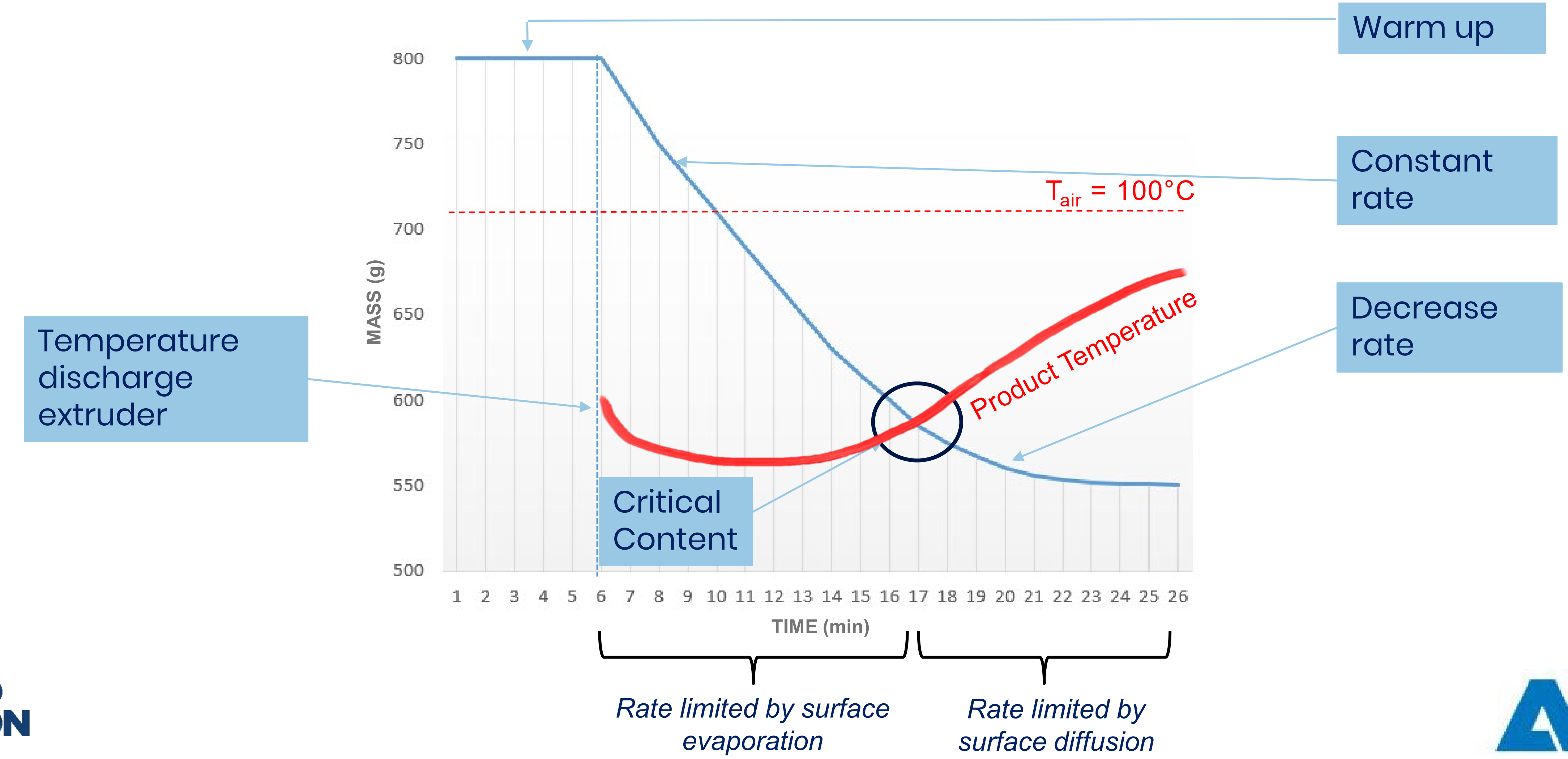
- Step 1 – Water evaporates from the surface of the pellet;
- Step 2 – Vapour is carried away by the process air;
- Step 3 – Moisture diffuses to the surface of the pellet to replace the evaporated water.





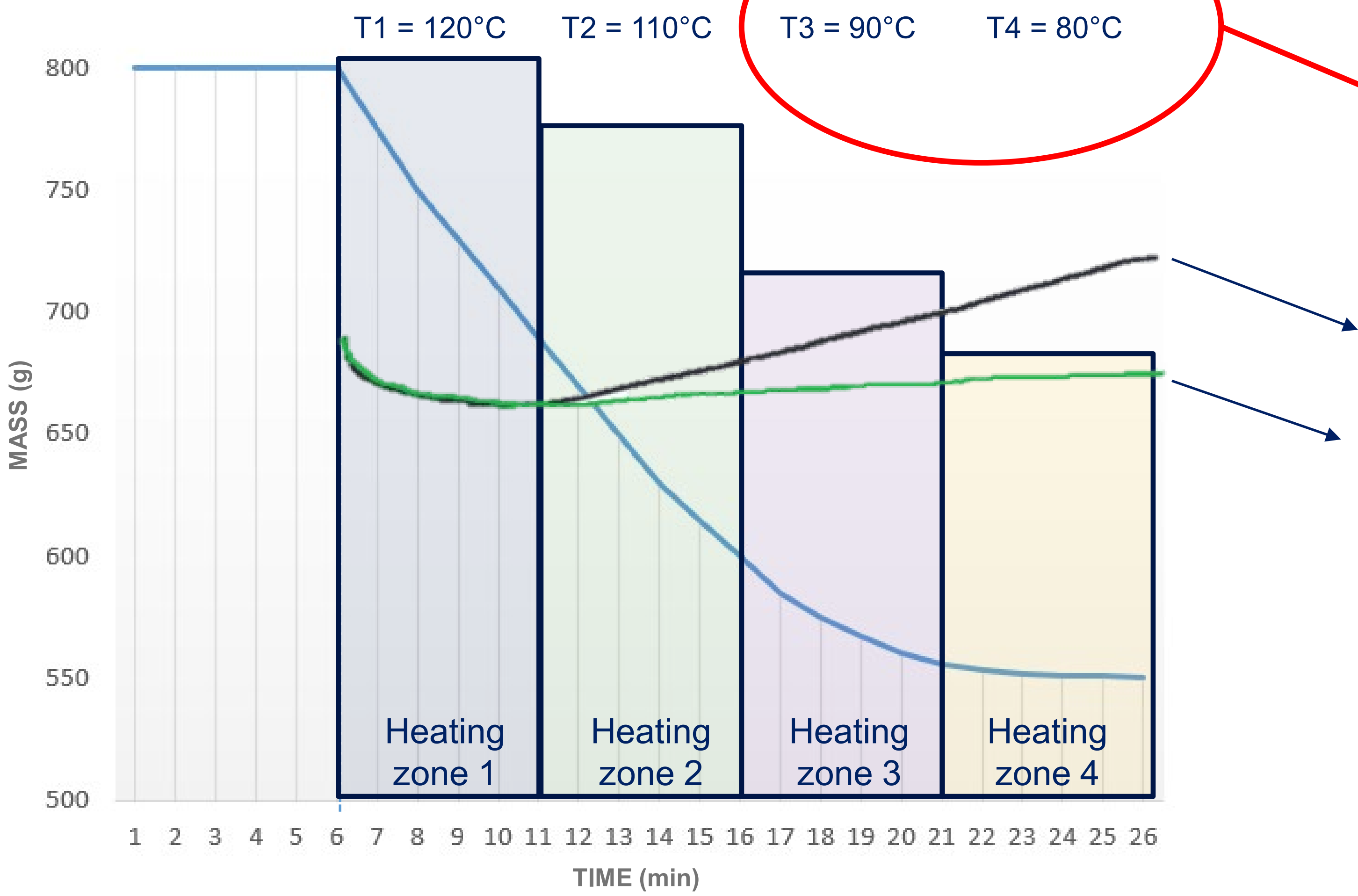
Typical drying curve – T_{air} (cte) = 100°C

Correct dryer sizing is critical for achieving the highest Efficiency & Quality



Drying of aquafeed

Process air temperatures



Avoid to use high process temperatures in decreasing rate period because it does heat up the product.

Process temp = constant
high product temperature

Decreasing process temp =
low product temperature

ATTENTION: overheat the product may decrease its nutrition value!

Drying of aquafeed

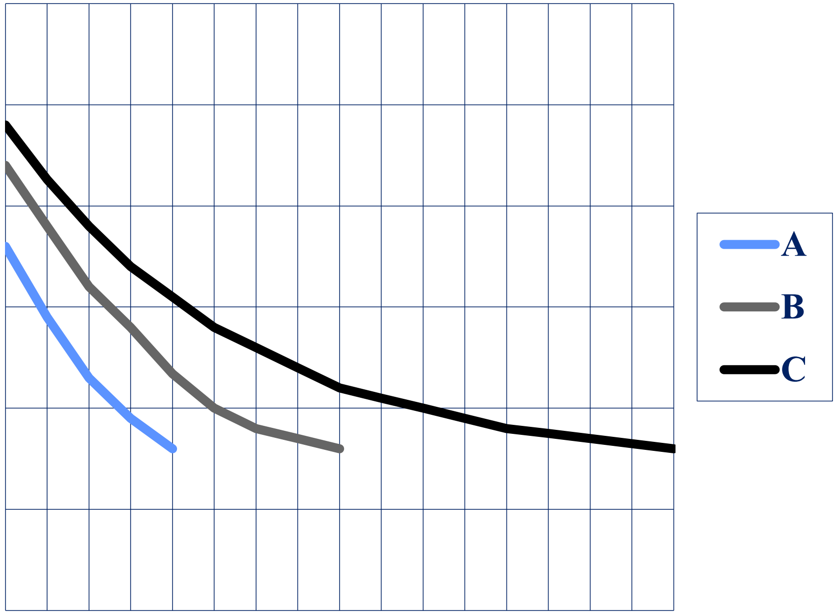
Retention time for different products

Product A B C

Different products will take different time to dry;

The retention time will be a function of (mainly):

- Product size
- Moisture content in/out
- Bulk density



02. Drying process parameters

Process parameters

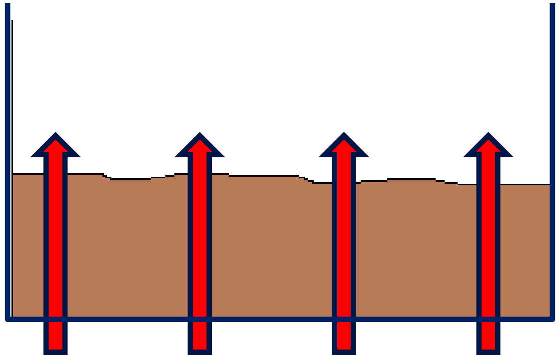
Process control variables

1) Retention time (belt speed)
    a. Bed loading – as even as possible
    b. Bed depth

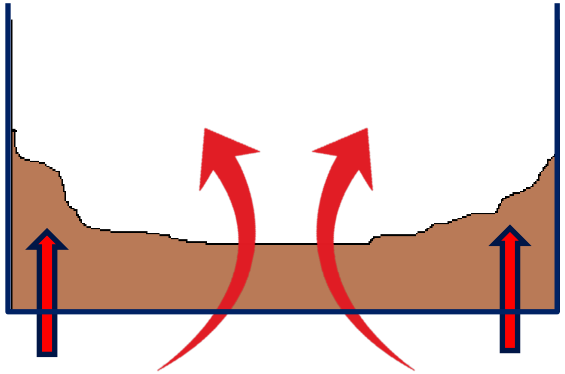
2) Airflow
    c. Direction
    d. Volume
    e. Humidity (% recirculation)
    f. Temperature

Process parameters

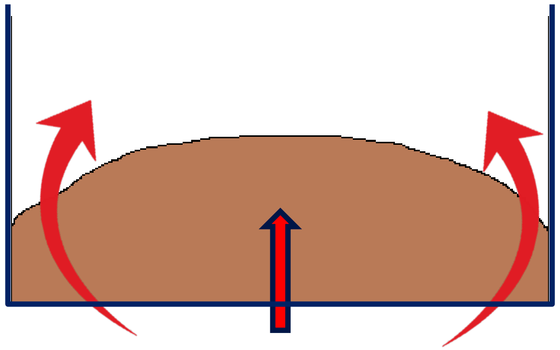
Even bed loading

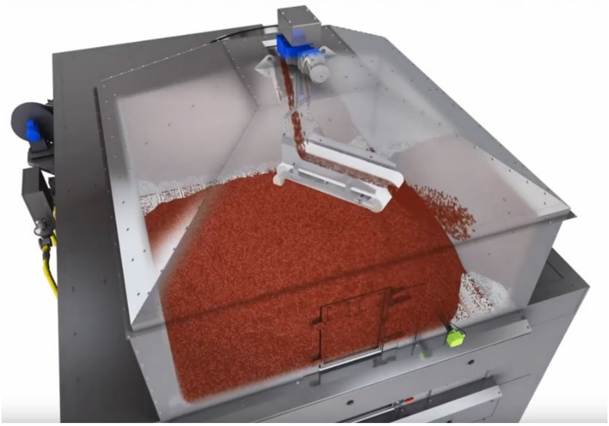


ANDRITZ servo motor



Mechanical distributor





Vertical dryer

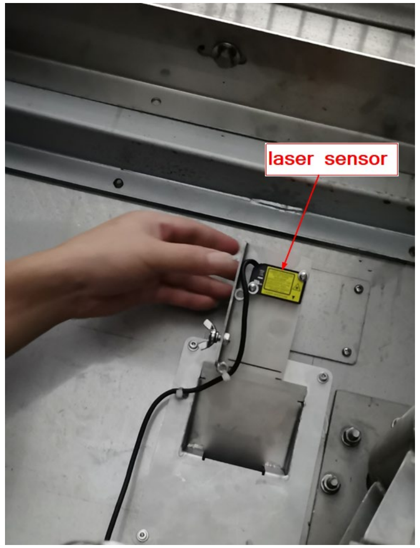
Process parameters

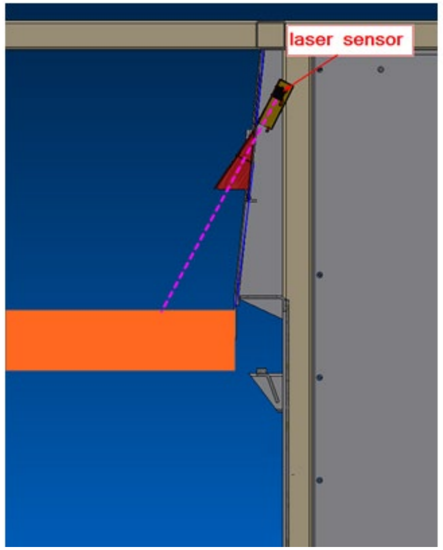
Retention time

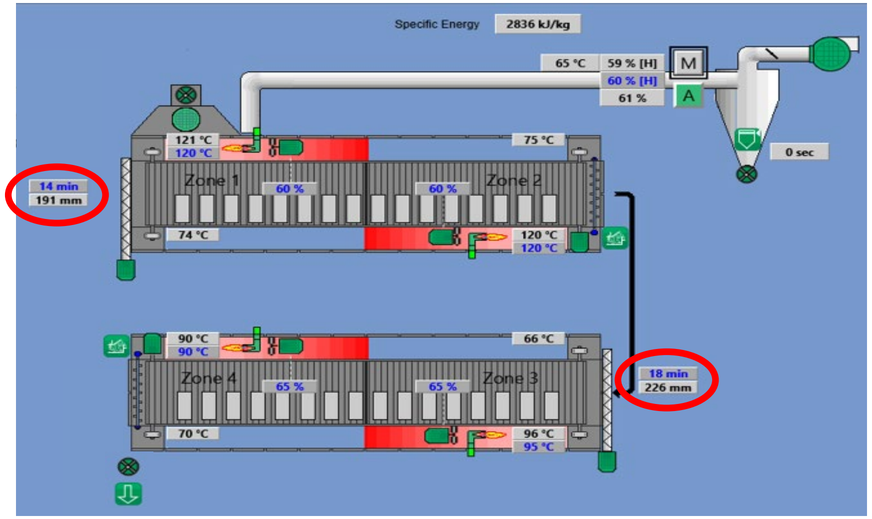
- The bed speed is adjusted to a given setup retention time;

- Level sensor monitoring product level at each deck;
-
  Close to product inlet for immediate registration of variations in depth of product;

- Individual retention times at each deck.







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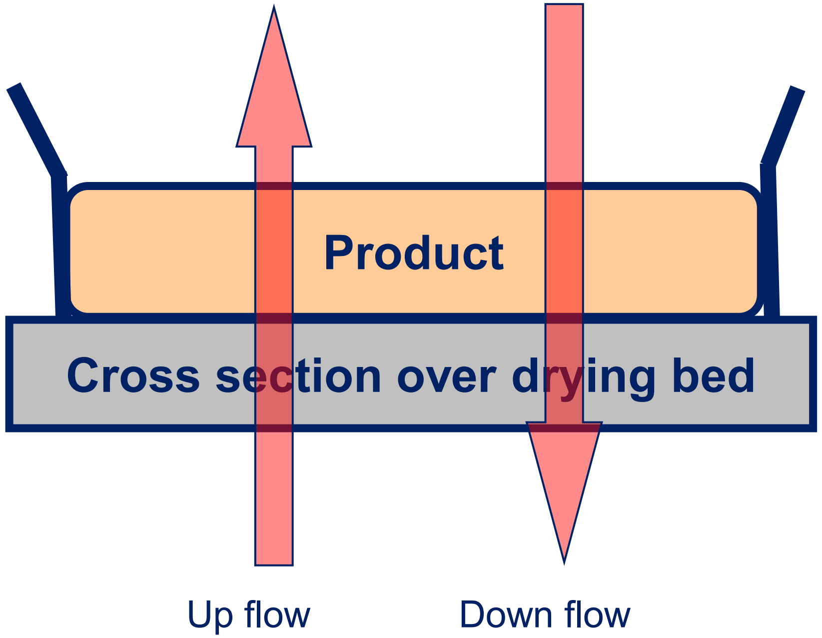
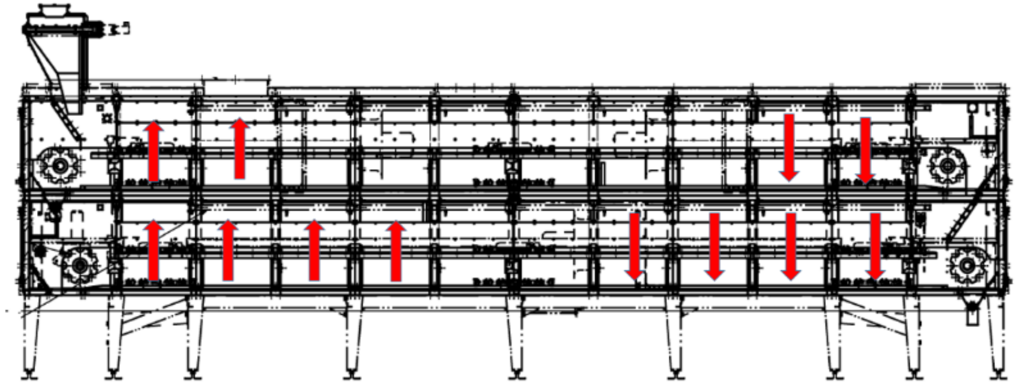
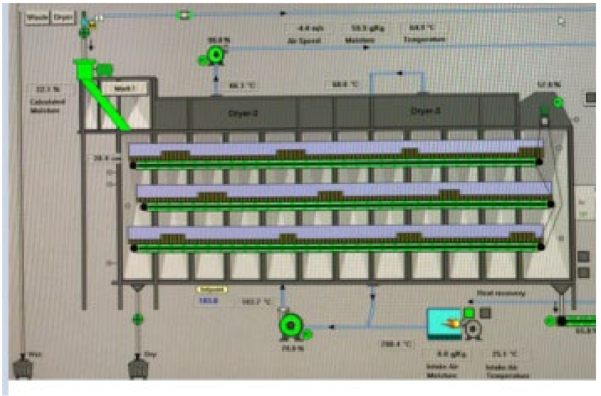
Process parameters

Airflow direction

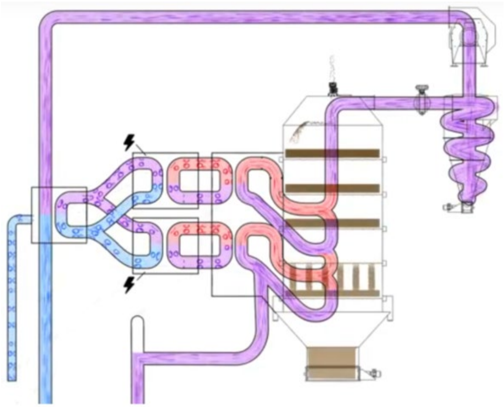




Heat zone 1	Upflow
Heat zone 2	Downflow
Heat zone 3	Downflow
Heat zone 4	Upflow



Horizontal only upflow



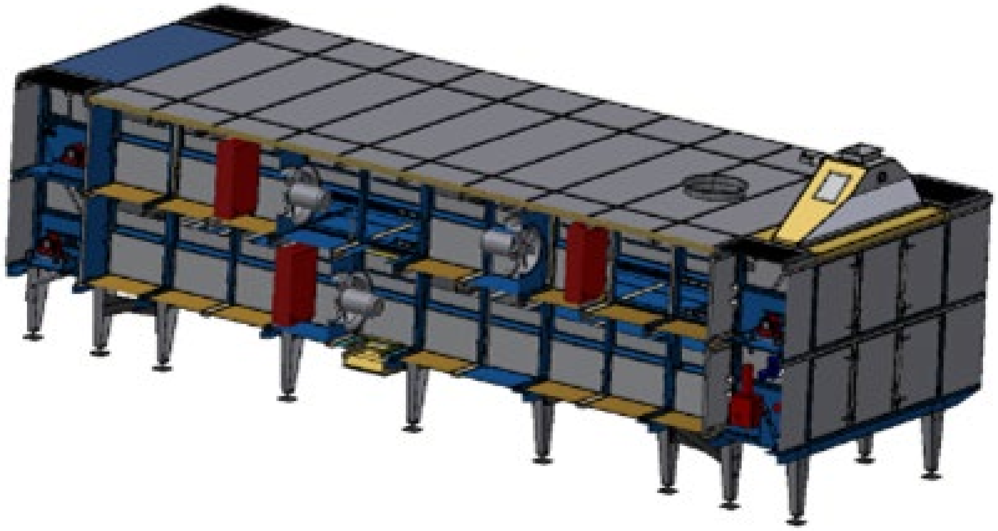
Vertical only upflow

Process parameters

Process air volume

VFD installed in each fan to control the process air volume:

- Maximum airflow for big size products > 4-5mm.



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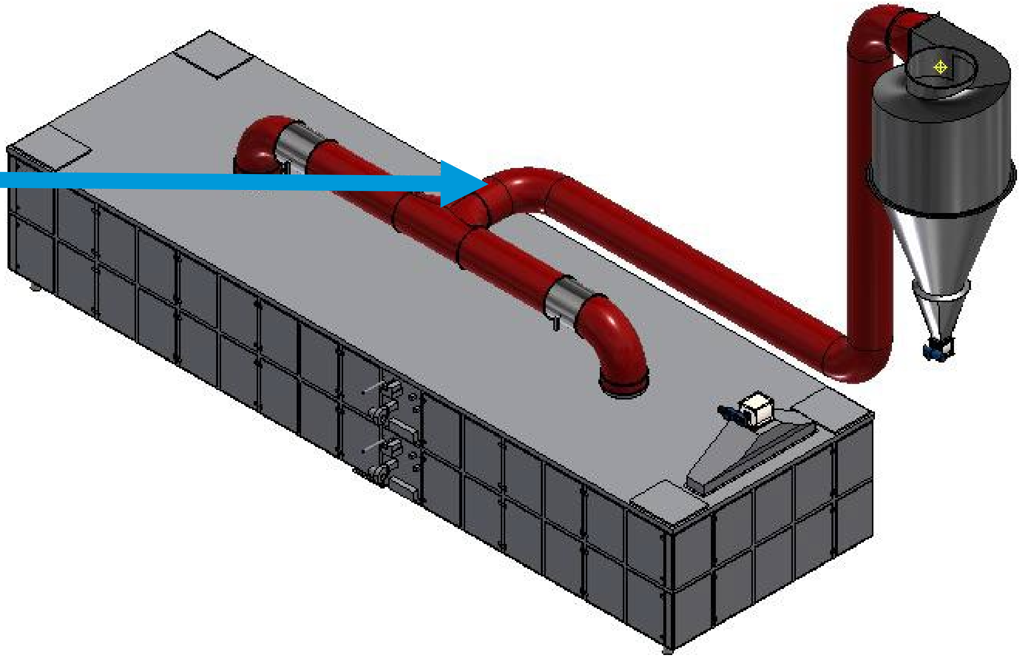
Process parameters

Exhaust air humidity

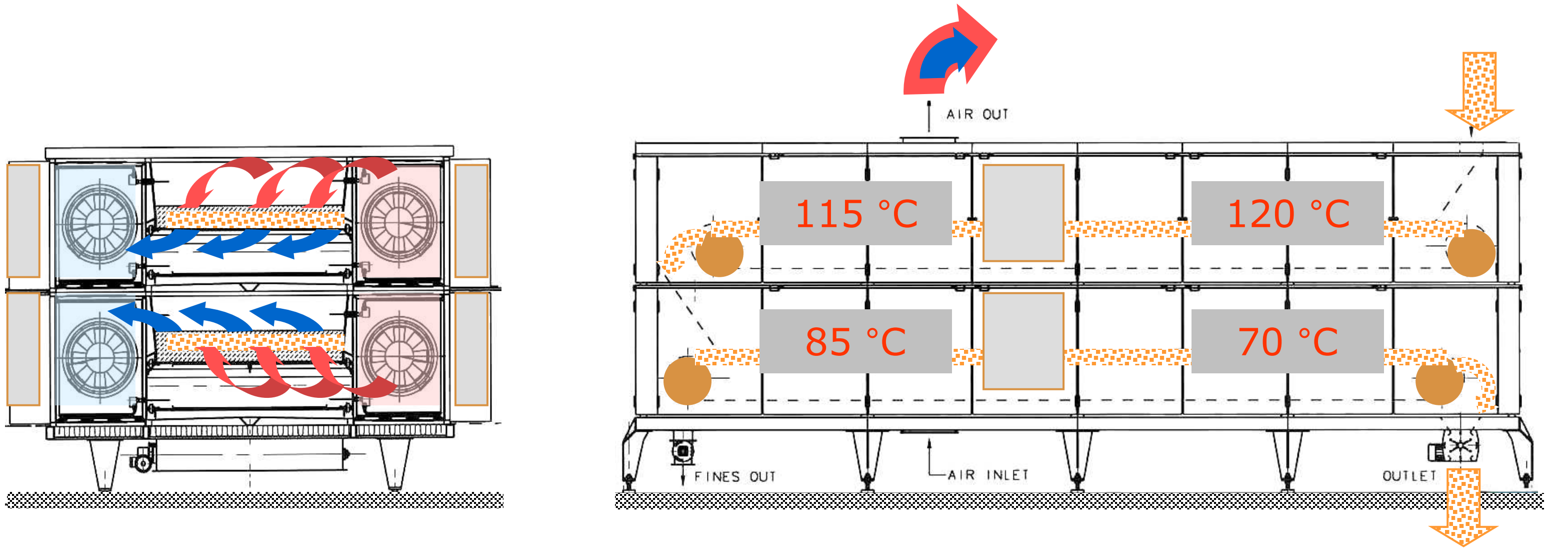
Recirculation of internal process air maximizes energy utilization

- Exhaust humidity sensor
- Online energy monitoring



Process parameters

Process temperatures



- Individual control of temperature and air flow in each drying zone
- Optimal flash-off which contributes to optimal drying efficiency

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03. Quality → homogeneity

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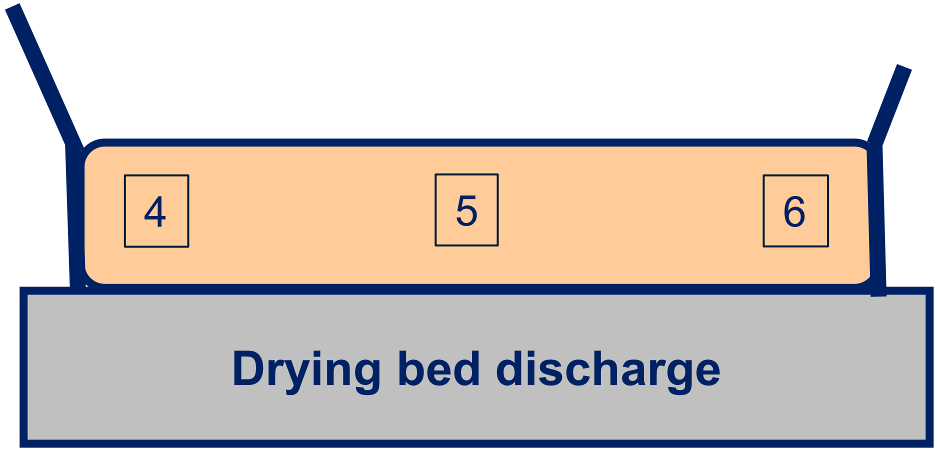
Process parameters

Moisture profile analysis



Product	Top	Bottom	Turnover moisture			Discharge moisture		
	Bed depth 1	Bed depth 2	1	2	3	4	5	6
Floating feed 4/6 mm	118	172	9,8	10,8	9,8	5,7	7,0	6,5
Floating feed 4/6 mm	110	161	9,7	10,5	9,7	6,5	7,0	6,5
Floating feed 4/6 mm	100	150	9,8	10,2	9,9	6,7	7,1	6,8

Δ = 1,0%

Δ = 1,3%

Δ = 0,4%

04. Homogeneity → profitability

Profitability

Financial advantages

1. Exhaust humidity control

- The exhaust volume is controlled by the setpoint reference online measured by the humidity probe.
- Optimized process conditions for every season (summer/winter)
- Avoiding risks of condensation/corrosion in the equipment

2. Moisture homogeneity

- Low product moisture deviation at the dryer discharge < ±0.5%
- Increased production gain margin
- Improved use of the energy (steam/gas)

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Gains with optimized drying process

Profitability

Type	CZD dryer with servo motor distributor	Conveyor dryer with mechanical distributor	Vertical dryer with rotary distributor
Capacity (t/month)	6000	6000	6000
Moisture in (%)	24.0	24	24
Moisture Quality (%)	8.5	8.5	8,5
Moisture Uniformity (%)	0.5	1.0	1,5
Moisture Production (%)	8.0	7.5	7,0
Production lost (t/month)	-	30	60
Energy consumption	-	3%	6%
Production lost (USD/month)	-	45000	90000
Gas costs (USD/month)	9408	9690	9972
Drying costs (USD/month)	9408	54690	99972

CZD3X12XW price	770000	USD
Price product	1500	USD/t
Price gas	3.00	USD/GJ*
Gas consumption	7.31	GJ/h

* https://www.cre.gob.mx//IPGN/

05. Conclusion

Conclusion

Optimized drying process

- Have a dryer schedule maintenance: keep it clean and in good mechanical conditions;
- Drying best practices: (i) even product distribution, (ii) bed depths according to the product size; (iii) exhaust air volume and (iv) process temperatures;
- Typical energy consumption found in drying installations = 3000 – 4000 kJ/kg removed water (efficiency 60 – 80%)

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Thank you!

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