



Welcome!

Feed Manufacturing Summit

Unlocking the power of your feed mill

Meet Your Summit Team

Your central ECA organising team



Pieter Steyn



Arianna de Vries



Henri Rijnders



Lauren James



Monika Steffens

Meet Our Account Managers Joining Us

Your account management contacts



**Klaas Jan
Krijgsheld**



Wojciech Molenda



Stefano Busnari



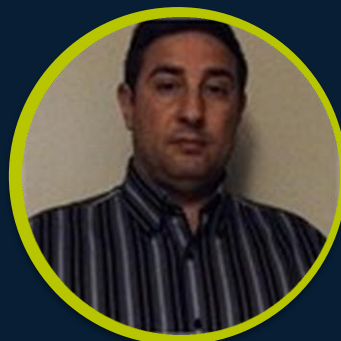
Liubomyr Dubiniak



Huw Jones



Felipe Sanchez



Carlos Rivas



Alberto Santos

Our Two-Day Journey

From expert insights to practical feed mill experience

TUESDAY • 13 OCTOBER

Day 1



-  Quality Starts Before Production
-  Achieving Mixing Efficiency and Uniformity
-  Optimizing Conditioning and Steam Quality
-  GMP, Process control & Microbial risks
-  Panel: Ask the Experts

EVENING • Stadium Santiago Bernabéu & dinner

WEDNESDAY • 14 OCTOBER

Day 2



-  Nanta Feed Mill Visit
-  Optimizing Dosing Performance
-  Interactive experience: Meet the Expert & 1:1
-  Key Takeaways

EVENING • Closing dinner & networking



Dirk Desmet

Feed Safety & Swine Director · Trouw Nutrition ECA

A warm welcome!



WELCOME

Feed Manufacturing Summit 2026

One shared ambition

EXCELLENCE IN FEED QUALITY → **OUTSTANDING ANIMAL PERFORMANCE**

Together, we turn precision in every feed mill step into stronger farm performance.

MADRID • 2026

PART OF SOMETHING BIGGER

One global family. One purpose. Feeding The Future.

SHV

Long-term family ownership



NUTRECO

Feeding the Future



TROUW NUTRITION

Animal nutrition, locally delivered



OUR REACH

65 Trouw Nutrition production facilities worldwide

100+ countries served

94 Nutreco production plants

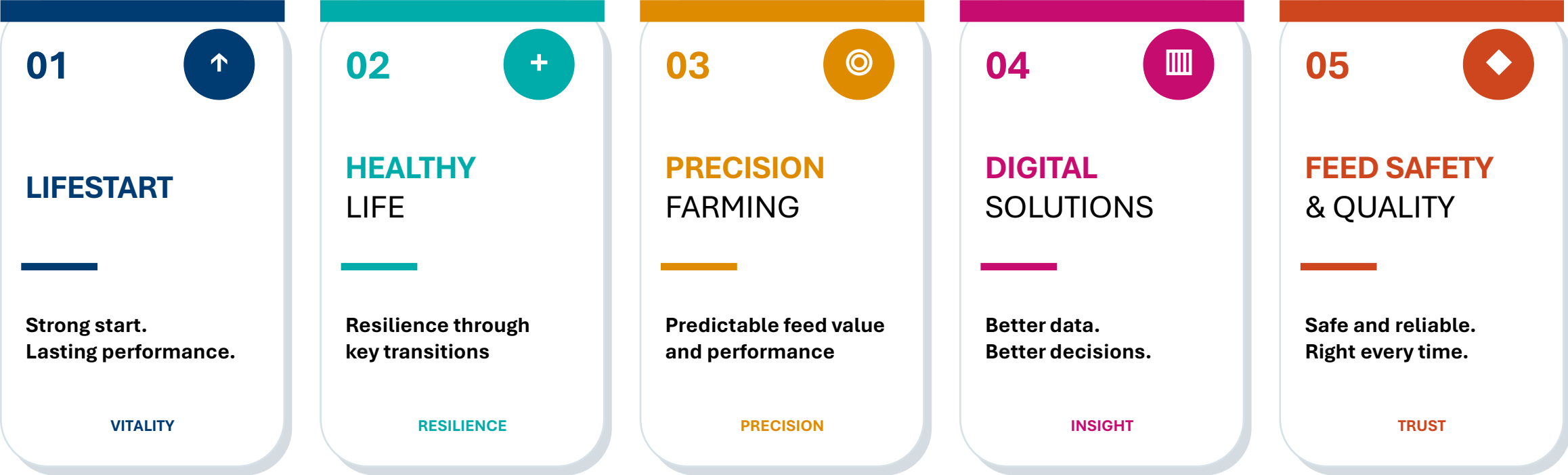
32 countries with Nutreco plants

GLOBAL SCALE. LOCAL EXPERTISE.

INNOVATION AT OUR CORE

From a strong start to a healthy life, enabled by precision, digital insight and feed safety.

FROM SCIENCE → TO PRACTICE → TO MEASURABLE VALUE



CONNECTED PILLARS • OUR SOLUTION FOR SUSTAINABLE FARMING

FEED SAFETY & QUALITY

Four connected pillars protecting feed value from raw material to finished feed.

Four connected pillars protecting feed value from raw material to finished feed.



01 | RAW MATERIAL QUALITY

Understand ingredient variability and safety before materials enter the process.

-  Supplier assessment
-  Contaminant analysis (mycotoxins, etc.)
-  Traceability & responsible sourcing
-  Only safe, high-quality ingredients



02 | FEED PROCESSING & QUALITY

Maintain feed quality while improving process control and milling efficiency.

-  Process control & optimization
-  Moisture management
-  Preservation & storage
-  Consistent quality and shelf life



03 | MYCOTOXIN RISK MANAGEMENT

Detect exposure, interpret the risk and apply targeted mitigation.

-  Advanced analytics & monitoring
-  Risk evaluation & forecasting
-  Mitigation solutions (e.g. binders)
-  Protect animal health & performance



04 | FOOD-TO-FEED QUALITY

Control microbial hazards across ingredients, production and finished feed.

-  Feed hygiene & biosecurity
-  Salmonella control
-  Monitoring & validation
-  Safe feed for a safe food chain

TOMORROW.



KNOW THE RISK



CONTROL THE PROCESS



PROTECT PERFORMANCE

UNLOCKING THE POWER OF YOUR FEED MILL

From essential process fundamentals to practical improvement on the production floor.



OUR SUMMIT AGENDA

FEED MILL **PRODUCTION FLOOR**
DOSING TECHNOLOGY **FEED SAFETY**
EXPERT TALKS **CONTAMINATION CONTROL**
OPERATIONAL EXCELLENCE **UNIFORMITY**
PELLET QUALITY **PRACTICAL APPLICATION**
MIXING EFFICIENCY **MILLING**
STEAM QUALITY **CRITICAL CONTROL POINTS**
FEED QUALITY **INSPIRATION**
CONDITIONING **SANITATION** **RAW MATERIALS**
MANUFACTURING **DOING ACCURACY** **KNOWLEDGE SHARING** **EFFICIENCY** **CUSTOMER VALUE** **PLANT DESIGN** **NETWORKING** **MADRID**

LEARN • EXCHANGE • APPLY • IMPROVE



MEET OUR SPEAKER



Vanessa Rodríguez

QUALITY & FEED SAFETY DIRECTOR · TROUW NUTRITION IBERIA

Quality Starts Before Production

A chemist specialising in feed safety, Vanessa brings over 20 years of experience in quality management and leadership across Spain and Portugal.

QUALITY STARTS BEFORE PRODUCTION

Quality protects the business



Quality starts before production

Quality protects the business

Plant performance depends on
consistent quality decisions.

Customer Trust

Reliable release, safe deliveries and traceability

Efficiency

Less variability, rework and waste

Margin

Quality-based purchasing and formulation

Continuity

Fewer disruptions and faster response

Quality across the value chain



Quality across the value chain

QUALITY SYSTEM

1 Enable operation

Prerequisites, good practices, HACCP, Nutrace® Standards

3 Protect performance

Nutrient profiles and formulation decisions

5 Right first time

Finished-feed specifications and delivery

2 Secure supply

Supplier qualification and raw-material risk

4 Control the process

Homogeneity, hygiene and contamination

6 Close the loop

Traceability, incidents and corrective actions

1. FOUNDATIONS

QUALITY SYSTEM

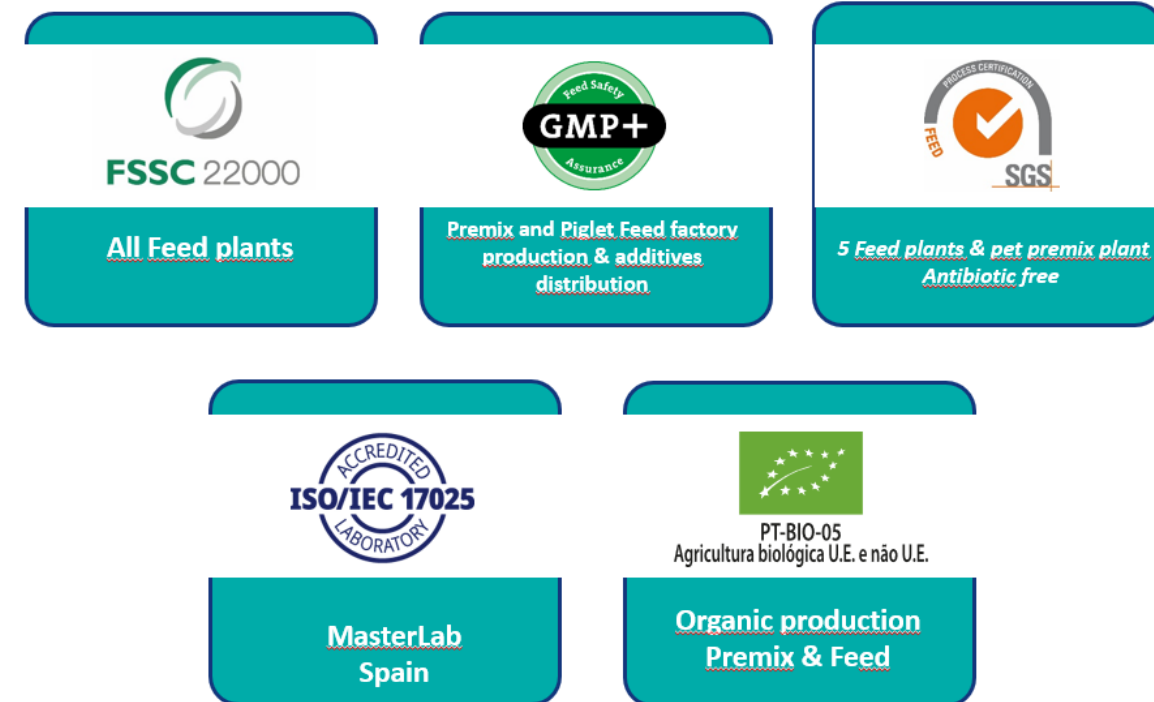
Licences and regulatory compliance

Prerequisite programmes and good practices

HACCP and raw-material risk assessment

Certifications and standardized quality practices

Build customer trust



2. SECURE SUPPLY

BEFORE INTAKE

Controls & Protection intensify with risk

Supplier qualification

Quality agreements and raw-material specifications

HACCP-aligned controls

At suppliers and at our sites

RM & supplier monitoring

According to your HACCP analysis & PCC



Calidad de: **TRIGO**

Materia prima para piensos

Definición: Granos de cereales de la especie *Triticum sativum*, *T. aestivum*, *T. durum*, *T. turgidum* y otras especies de trigo cultivadas en España, en países de la UE o en Terceros Países

PARÁMETRO	VALOR	MÉTODOS DE ANÁLISIS
HUMEDAD	13% máx. origen nacional 15% máx. origen importación	Reg. 152/2009 // NIR
PESO ESPECÍFICO	72 kg/hl mín.	
HONGOS	50.000 ufc/g máx.	PE 007/MS Cultivo Bacteriológico
E. COLI	10 ufc/g máx.	PE 003/MS Cultivo Bacteriológico
SALMONELLA	Ausencia en 25 g	PE 005/MS Seroaglutinación en placa

Especificaciones para micotoxinas:

Técnicas analíticas: Reg. 152/2009 // PE/087 // IO
ELISA-Microarray // HPLC // Test de inmunoensayo enzimático

	VALOR LÍMITE
AFLATOXINA B1	10 ppb
DON (DEOXYVALENOL)	1690 ppb
ZEARALENONA	390 ppb
T2+HT2	130 ppb
OCRATOXINA	325 ppb
FUMONISINAS TOTALES	3250 ppb

Análisis especiales para todas las plantas:

1

Mycotoxin risk management: an example

1. Identify rising risk using trend data, alerts and analytical results.
2. Review the HACCP assessment and update the monitoring plan.
3. Increase testing and apply risk-based mitigation, including testing before unloading.
4. Increase mycotoxin binder inclusion where appropriate.
5. Adjust formulations to reduce the inclusion of high-risk raw materials



**Quality strengthens profitability and customer success.
It differentiates us in the market.**

The potential reach of prevention



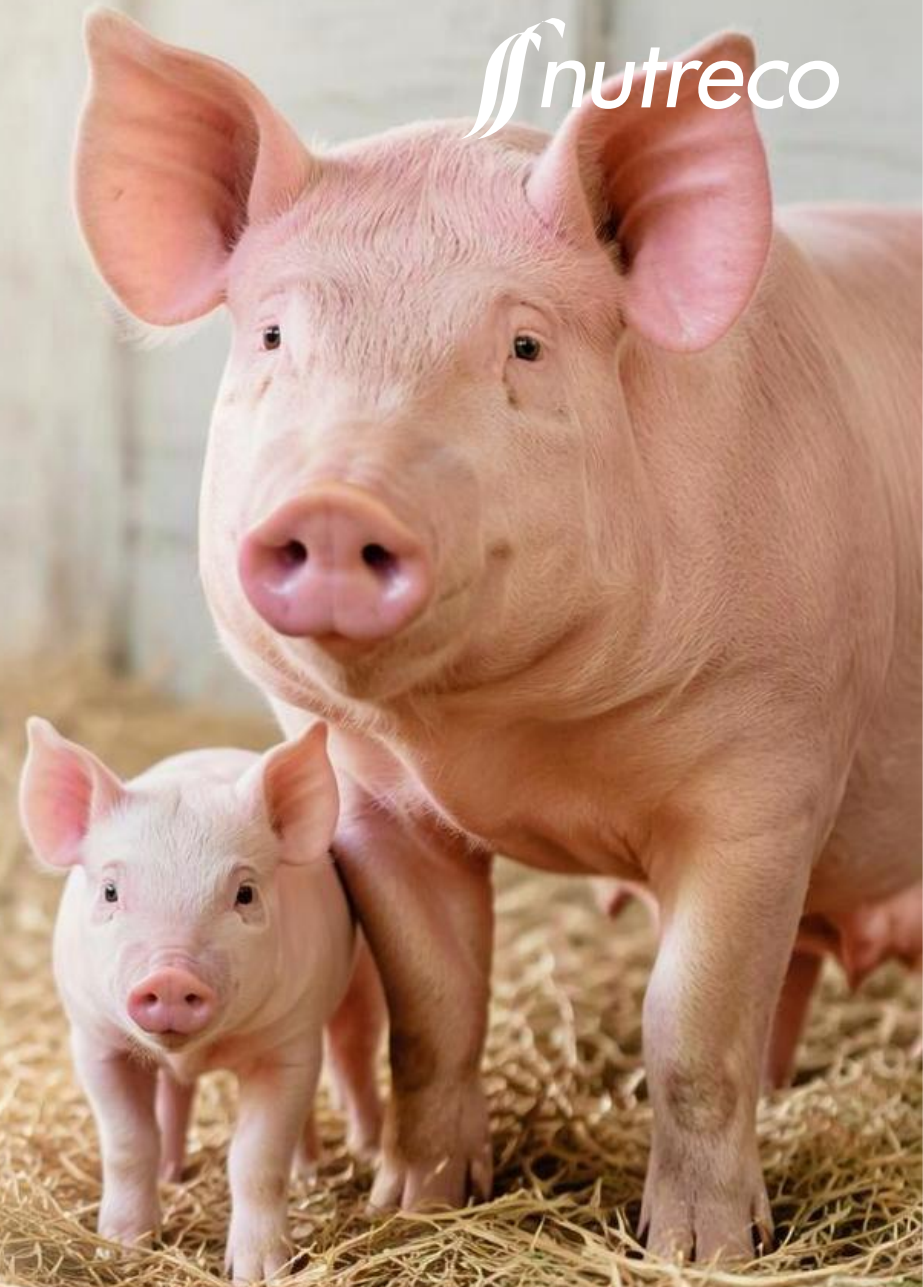
131 truckloads rejected

More than 3150 tonnes of Raw material rejected due to mycotoxins

16,000 tonnes of feed protected

Could affect the performance of:

≈ 648,000 piglets or 63,500 pigs



2. SECURE SUPPLY

Sampling at raw-material intake

The first control point

Sampling, testing and checks against specifications

Supplier and raw material risk assessment:

Reduction of risks : Addition of Fungicide, antioxidants...

RELEASE OR BLOCK



3. Protect performance

Quality control at raw-material intake

A sample before the decision

Nutritional analysis:

NIR online for raw materials and NIR desktop for incoming raw materials

Mycotoxin analysis:

Rapid Mycotoxin screening before unloading high risk ingredients

Organoleptic and physical controls.

Check results against raw-material specifications.



4. y 5.Process consistency and feed safety

IN-PROCESS CONTROLS

HACCP and measurement

Hazards, limits, monitoring and deviation response. Calibration and equipment verification.

Mixing and dosing

Homogeneity, dosing accuracy and **cross-contamination** controls and moisture control.

Physical quality

Particle size, durability and fines.

Hygiene

Facilities, equipment and silos. Pest control, water and personnel practices.

Storage and handling

Raw materials and additives. Transport and environmental conditions.

Finished-feed release

Control plan and specifications. Segregation of non-conforming product and controlled rework.

4. CONTROL THE PROCESS

FACTORY CONTROLS: MOISTURE MANAGEMENT

Moisture control through the process

Moisture control in the mixer to evaluate against formula content

Control finished-feed moisture and **reduce process losses.**



4. CONTROL THE PROCESS

FACTORY CONTROLS

Finished-feed physical quality

Representative finished products sampling

- Particle size distribution,
- Durability & fines (Holmen)
- Organoleptic control



5. FIRST TIME RIGHT

FACTORY CONTROLS

- Nutritional analysis with NIR for finished products
- Mycotoxins, microbiological and other analysis to verify the correct performance of your plant
- Evaluate results against specifications.
- Verification of your processes



COST OPTIMIZATION

Analytics and nutrition can turn data into margin

- Formula performance review : **Actual nutrients, better decisions**
- Adjust formulations to the current raw materials received.
- Legal compliance with labelling

QUALITY DATA FOR FORMULATION

- 
- A photograph of several pigs in a facility, possibly a laboratory or processing plant. The pigs are white and are standing on a metal grate floor. One pig in the center is looking directly at the camera. The background shows industrial equipment and a chain hanging from above. The image has a blue and yellow color overlay.
- Consistency, feed safety and expected performance

**Every delivery proves
the strength of the system**

People and quality governance

DAILY DISCIPLINE

Quality becomes a daily routine

Transparency, vigilance
and **first time right**

Teams and culture

Training in Hygiene, feed safety and good-practice

Assurance

Internal audits and third-party qualification

Cross-functional ownership

Connect Quality, Operations, Purchasing, Nutrition,
Logistics and Commercial

Performance review

Objectives, risks, complaints to drive improvement

**Quality strengthens profitability and customer success.
It differentiates us in the market.**

Leadership in action

Quality starts with **us**



Our daily decisions make quality a priority.

Thank you



Quality:
Powering Performance

leadership improvement
responsibility preferred supplier
excellence
focus
collaboration customer
initiative team vision
service innovation value
commitment **quality**
goal inspiration
strategy trust

MEET OUR SPEAKER

Alex Ammann

PROCESS TECHNOLOGIST & TRAINER · BÜHLER / SFT

Achieving Mixing Efficiency and Uniformity & Optimizing Conditioning and Steam Quality

With over 30 years in feed and food milling, Alex brings international expertise in feed manufacturing and process technology.



AGENDA

01 Basic requirements and ingredients

02

03

04 Size reduction

05

Mixing

06

Conditioning and pelletizing

07

Summary

08



01

BASIC REQUIREMENTS AND INGREDIENTS



PROCESS VARIABILITY: PRACTICAL EXAMPLES

Examples of Mill Variability and Animal-Level Effects

Processing Issue	Feed Effect	Animal Effect
Inconsistent grinding	Variable particle size	Sorting, uneven digestion
Poor conditioning	Weak pellets	More fines, lower intake
Excessive heat	Vitamin/enzyme loss	Lower nutrient availability
Poor mixing	Uneven additives	Variable response
Incorrect liquid coating	Uneven palatability/additive dose	Irregular intake
Poor cooling	Mold risk, moisture variation	Health and intake issues

WHAT IS A FEED MILL?

To produce a compound feed that is as homogeneous as possible, and which meets the animal's feed performance expectations.

-  Every animal should receive daily all the nutrients and active ingredients required by the formula in the prescribed quantity and quality.
-  The definition of a mixture for absolute homogeneity is determined by the coefficient of variation.



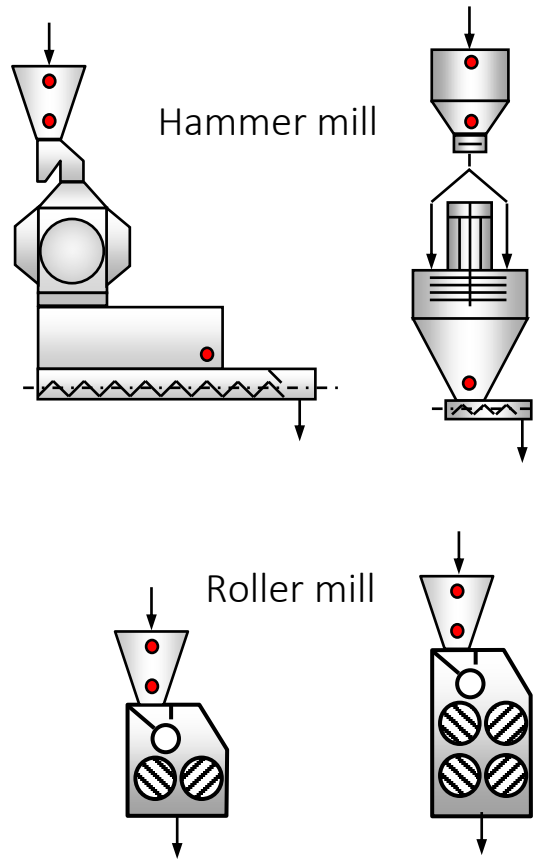
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GRINDING PROCESS / SIZE REDUCTION



COMPARISON

Hammer mill vs. Roller mill



Advantages

- High throughput rates
- Universal application
- Easy to maintain / operate
- Simple design

Disadvantages

- Wide particle size distribution
- High power consumption

Advantages

- Narrow particle size distribution
- Low power consumption
- Low heat generation
- Gentle treatment of raw material

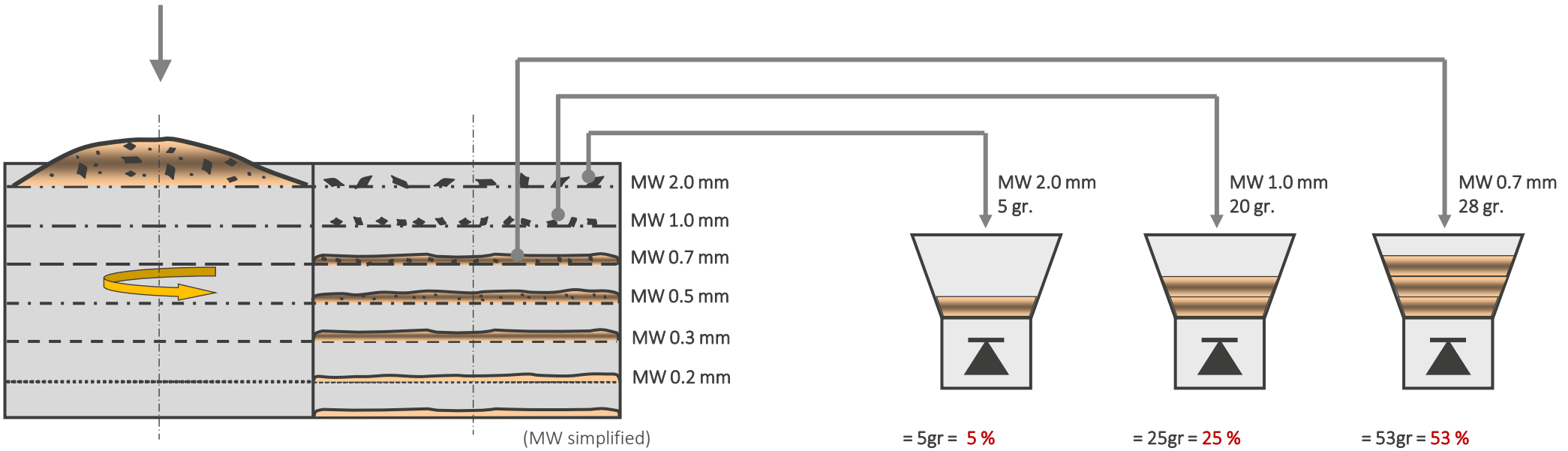
Disadvantages

- High capital cost
- Unsuitable to grind fiber
- Limited particle size intake

DETERMINATION OF THE PARTICLE SIZE BY SIEVE ANALYSIS

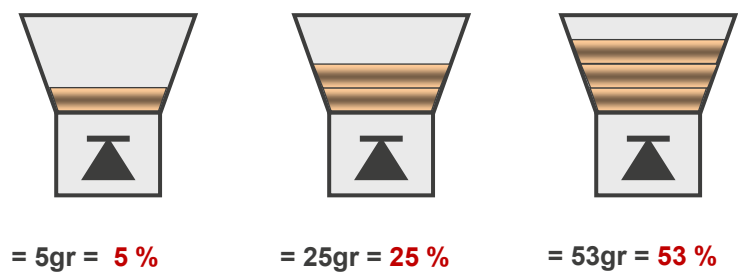
Step 1: Sieve the sample of 100 g = 100 % on a laboratory sifter during three minutes

Step 2: Weigh each fraction (overs) obtained and add up.



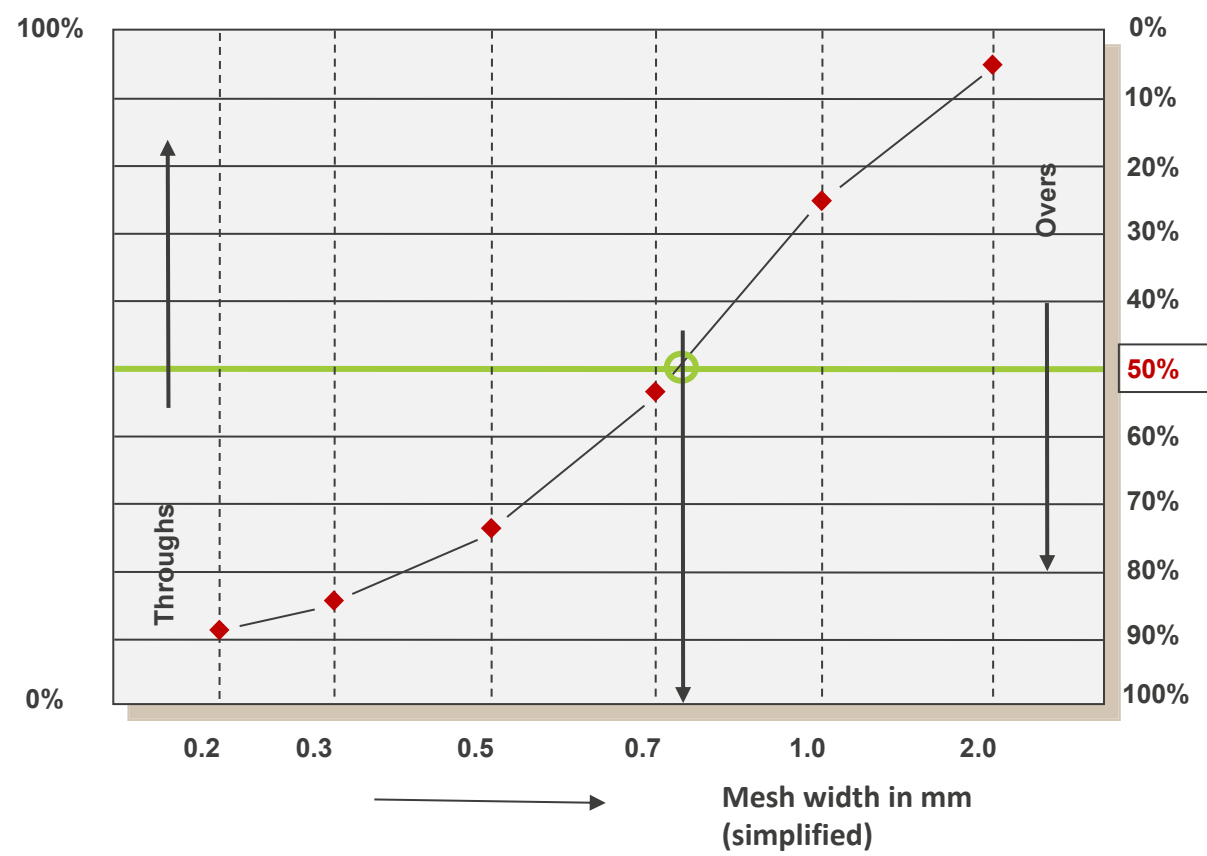
DETERMINATION OF THE PRODUCT FINENESS BY SIEVE ANALYSIS

Step 3: Enter the individual values in the particle size grid and connect the points

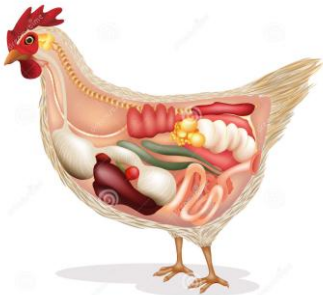
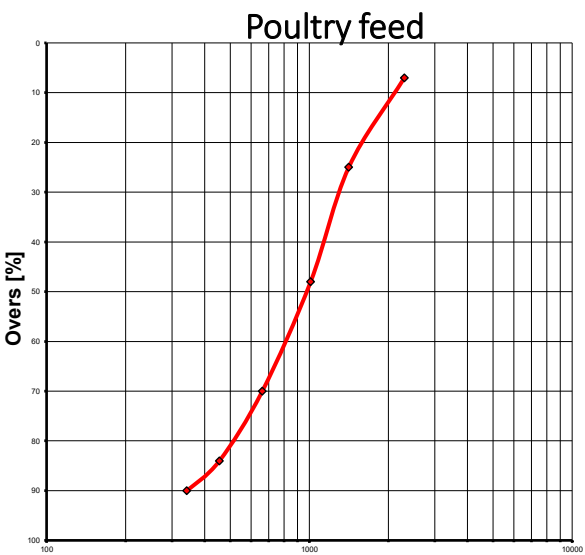
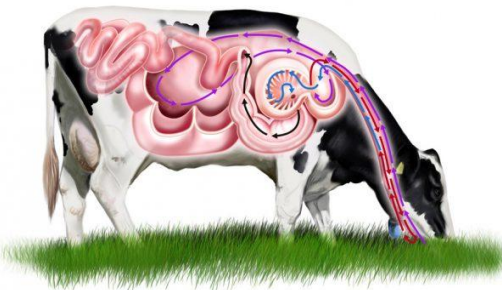
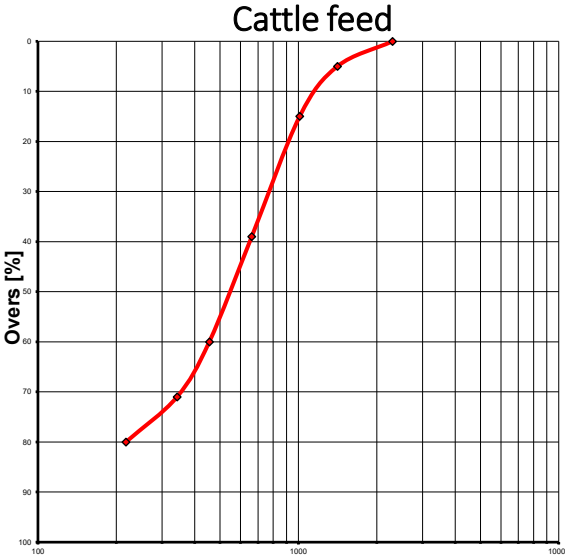
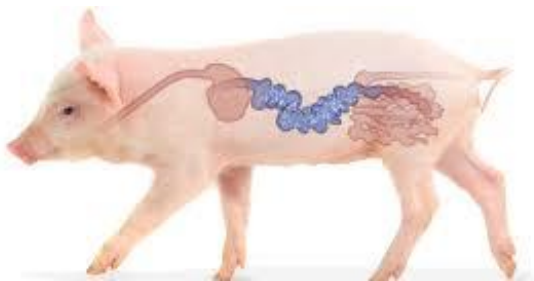
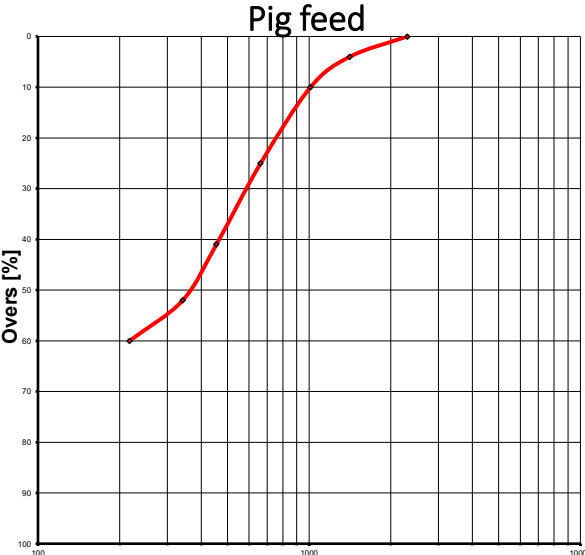


The particle size distribution chart indicates:

- Average particle size: « d_{50} »
- Percentage of fine particles
- Percentage of coarse particles



GRINDING PROCESS OBJECTIVES



REPLACE BEATERS AND BOLTS FREQUENTLY

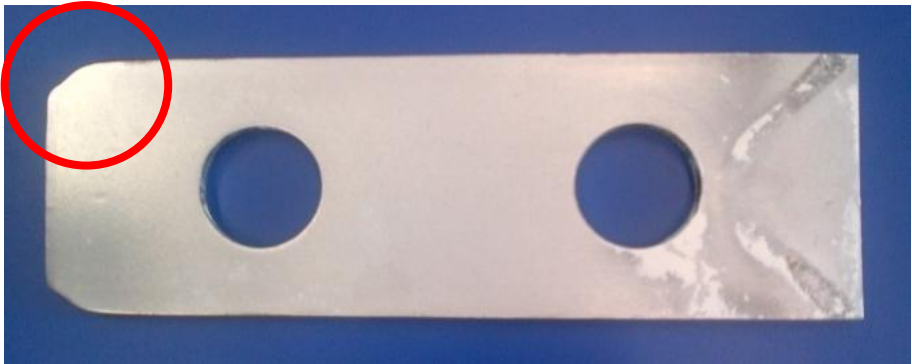
Maximum of lifetime exceeded



Replace bolt when gap is >3mm



End of lifetime not reached



End of lifetime reached



05

MIXING OF INGREDIENTS



WHY NUTRIENT DISTRIBUTION MATTERS?

Uniformity affects performance and safety

Poor mixing can cause:

- Under-dosing of vitamins, minerals, enzymes, or medication
- Over-dosing of sensitive additives
- Variable growth rates
- Higher risk of health issues
- Reduced feed efficiency
- Inconsistent product quality

Key message:

Feed formulation defines the target, but mixing determines whether animals receive it.



WHY YOUNG ANIMALS ARE ESPECIALLY SENSITIVE?

Young animals have low intake and high nutrient needs

Young animals are more vulnerable because:

- They consume **small amounts of feed**
- Their digestive and immune systems are still developing
- They require precise levels of nutrients and additives
- Small mixing errors can lead to large intake differences

Examples include:

- Piglets
- Chicks
- Calves
- Young aquaculture species



CRITICAL INGREDIENTS IN YOUNG ANIMAL FEED

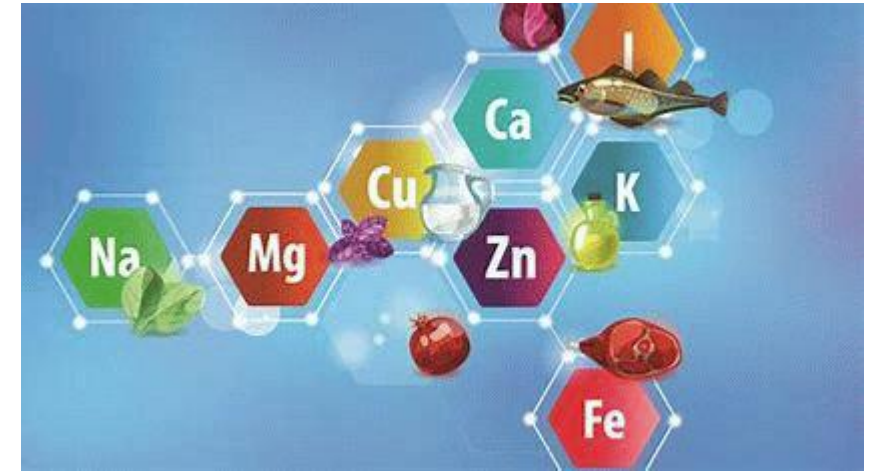
Micro-ingredients must be evenly distributed

Important components include:

- Vitamins
- Trace minerals
- Amino acids
- Organic acids
- Enzymes
- Probiotics
- Coccidiostats or medications, where applicable
- Specialty functional additives

Risk:

These ingredients are often included at very low levels, making them harder to distribute uniformly.



FACTORS THAT INFLUENCE MIXER CV

Good mixing depends on process control

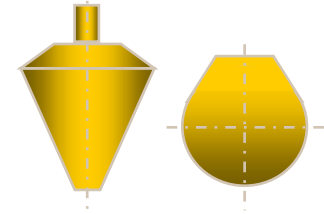
Key factors include:

- Mixer type and design
- Batch size and fill level
- Mixing time
- Ingredient particle size, density and flowability
- Liquid addition
- Addition sequence
- Wear condition of mixer parts
- Carry-over and residue control

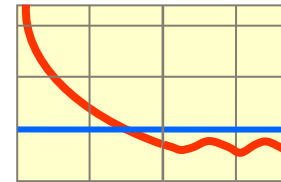
Key message:

Even a good mixer needs the right operating conditions.

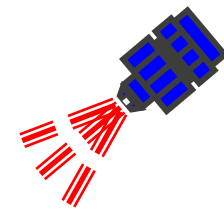
Mixer type
Mixer design.
Rotor configuration.



Mixing time
Horizontal mixers.
Vertical mixers.

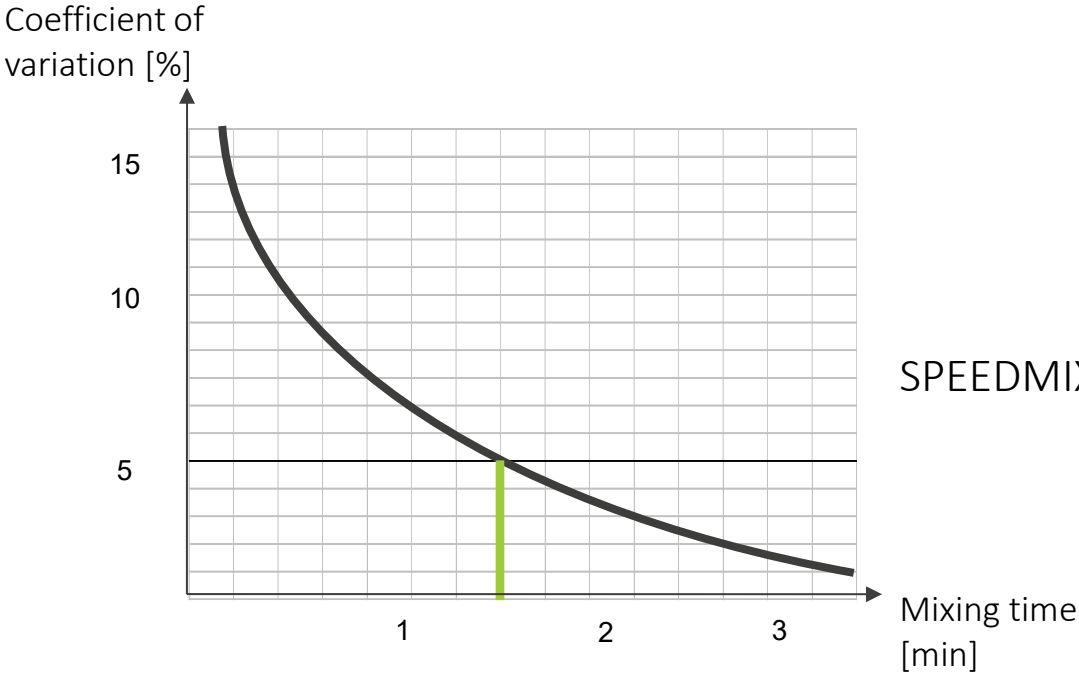


Liquid addition
Place / time of addition.
Lump formation.

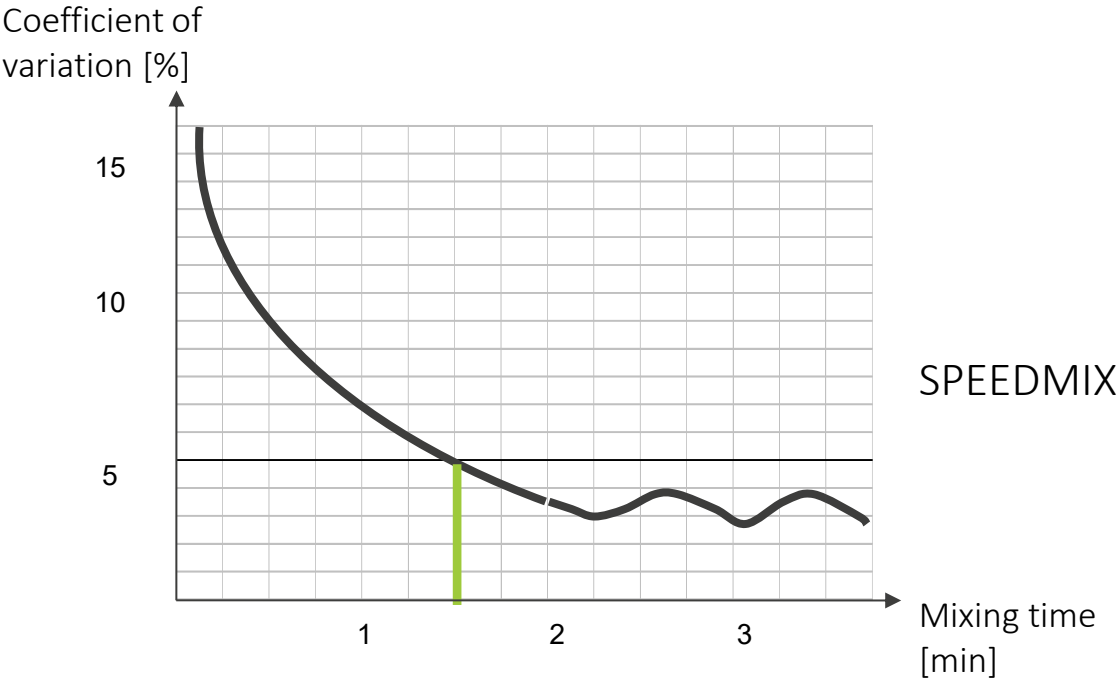


HOMOGENEITY IN FUNCTION OF MIXING TIME

Theory



Practice



HOMOGENEITY TEST

How to check the mixing accuracy?

The homogeneity is determined by means of an indicator which is added to a component. e.g. micro tracer

The mixture is therefore reduced to a two-component mixture.

Key message:

Run an additional test at commissioning and after changes that could affect mixing, such as mixer repairs, changes to mixing time or batch size, or significant formulation changes. If a test fails your site's CV limit, correct the cause and retest before returning to the normal schedule.

Your quality program, customer requirements, or local regulations may set a stricter frequency.



05 INCORRECT MIXING

Uneven nutrient distribution

- Short mixing time leads to poor homogeneity
- Overmixing can cause segregation
- Micro-ingredients, additives, enzymes, and minerals may not be evenly distributed

Impact on performance:

Some animals receive too much or too little of critical nutrients.



EVALUATION OF MIXING ACCURACY BY MEANS OF A HOMOGENEITY TEST

How to proceed

Points to be considered for a homogeneity test

- Tracing of all ingredients in each sample would be very difficult and time consuming.
- In practice only one substance is identified in all samples, serving as a representative for all others.
- Indicator might be already in the mixture, or a foreign substance (methyl violet) will be added.
- Adding point of indicator
- Sample taking scheme
- Sample size (10g - 50 g for laboratory analysis)
- Number of samples (10 to 25 depending on mixer size)
- Analysis method

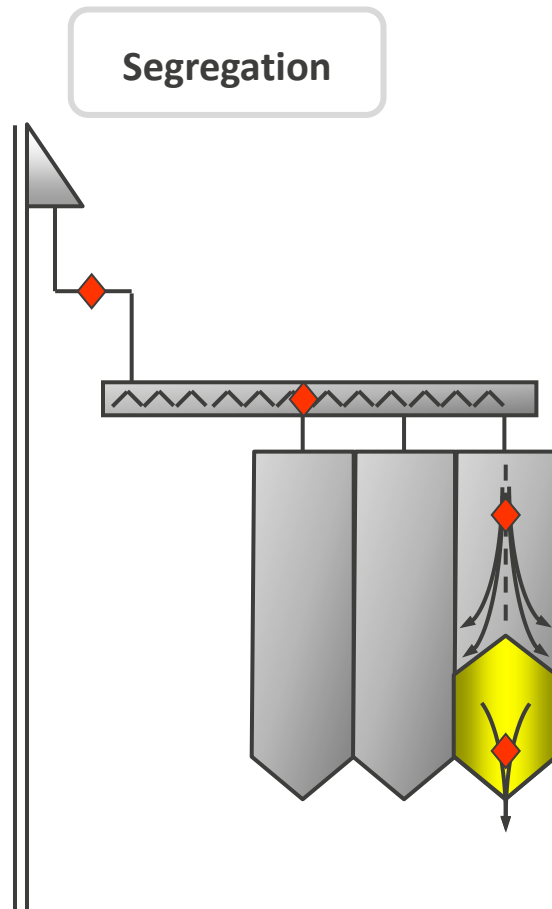
COMPARISON OF DIFFERENT INDICATORS

How to check the mixing accuracy?

Indicator type	Quantity / sample size	Notes
Methyl violet	1:100'000 10 g/t 0.00001% → 50g Sample size (size for laboratory) 	▪ Standard indicator ▪ Methyl violet must be finely ground (particle size 50 micron) and must be sieved with a 100-micron sieve before the homogeneity test. ▪ Not suitable for food ▪ Test recipe should not contain grass flour or alfalfa ▪ No addition of liquid allowed ▪ Maximum particle size 2mm
Salt	0.5 – 2% with the recipe	▪ Actually, not suitable for homogeneity testing as it isn't a micro-component. ▪ Food quality
Iron powder pigmented with watercolors / micro tracer	1:100'000 10 g/t 0.00001% → 50g Sample size (size for laboratory) 	▪ Verification of cross-contamination ▪ Food quality

TRANSPORT OF MIXTURES

Potential consequences



Partial division of a homogeneous mixture into its individual components caused **due to excessive product movements**.

- Long mechanical transports
- High product drops in spouts and bins
- Filling / discharge behavior of bins and silos.

An unbalanced nutrition leads to performance depressions on the animal.

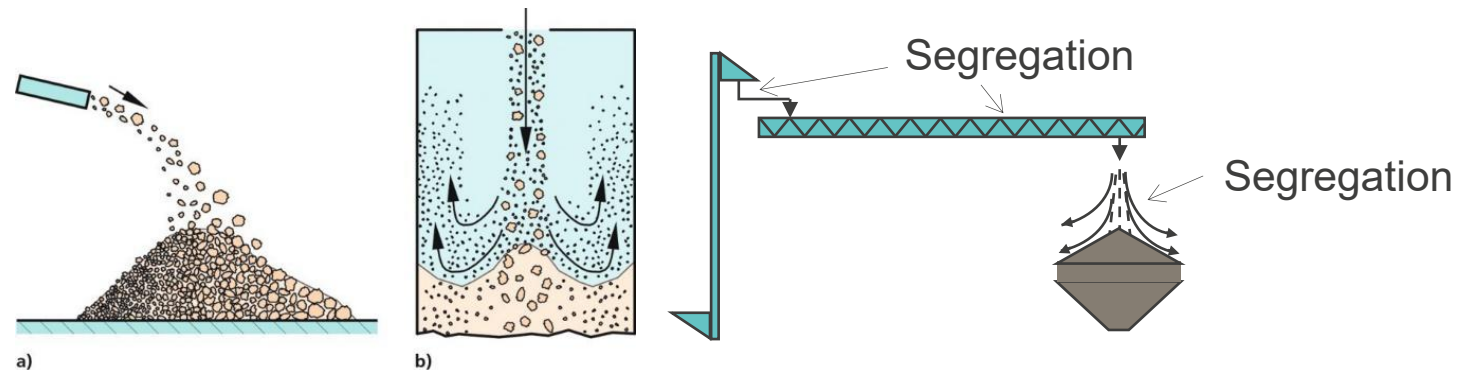
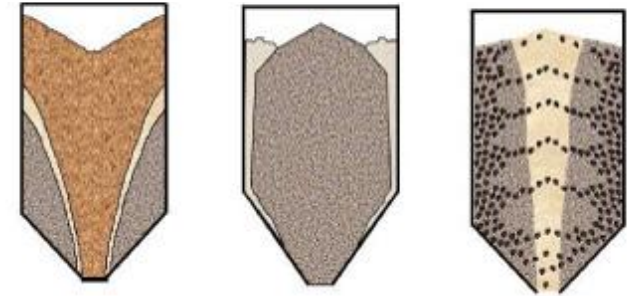
MIXING ACCURACY

Prevent segregation

- Similarity of particle sizes and specific weights
 - vertical process line
- Avoid large drop heights
- Minimization of transport ways
 - vertical process line
- Addition of liquid after mixing
- Liquid addition with adhesive properties
 - Molasses
- Pelletizing the mixture

Segregation in hoppers with funnel flow

Funnel flow,
Poor emptying



CONTAMINATION AND CARRY-OVER

Definitions, regulations, consequences

Residues in batch mixer



Residues in chain conveyer



Residues in conditioner



LIQUID ADDITION - INTRODUCTION

Reasons for the addition of liquid

Energy enrichment	Fat, Oil
Compensation of protein content	Amino acids
Improvement of palatability	Molasses, Aroma
Reduction of dust formation	Water, Oil
Increase of humidity	Water
Preservation	Propionic acid
Addition of additives	Vitamins, Enzymes

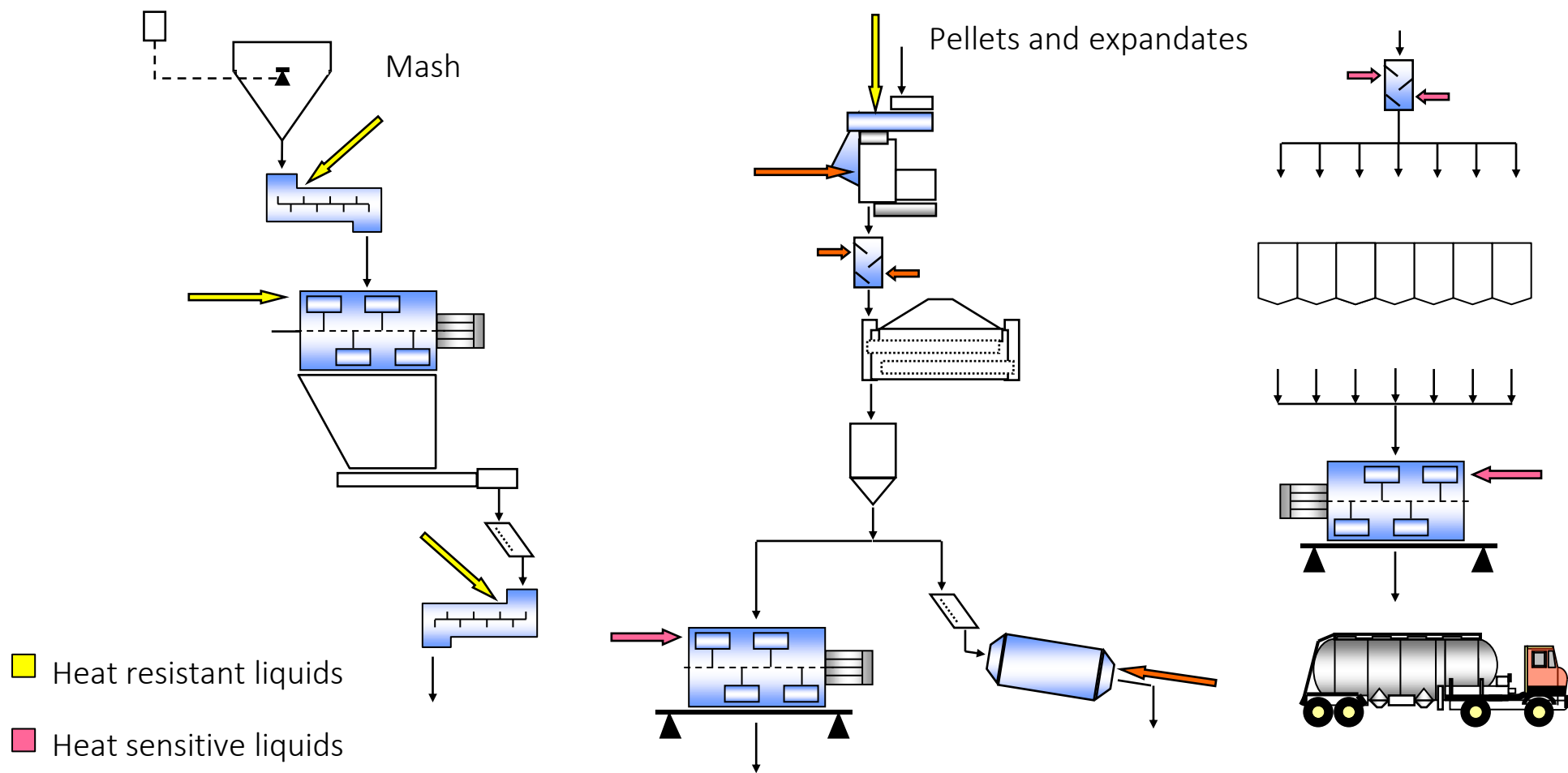
Possibilities for liquid addition

Batch mixer	1 - 5%
Homogenizer	3 - 12%
Conditioner before pellet mill	1 - 4%
(Die pellet mill)	(0.5 - 1%)
Cascade after pellet mill	2 – 4%
Coating drum	5 - 10%
Special spraying system, PPA	ppm

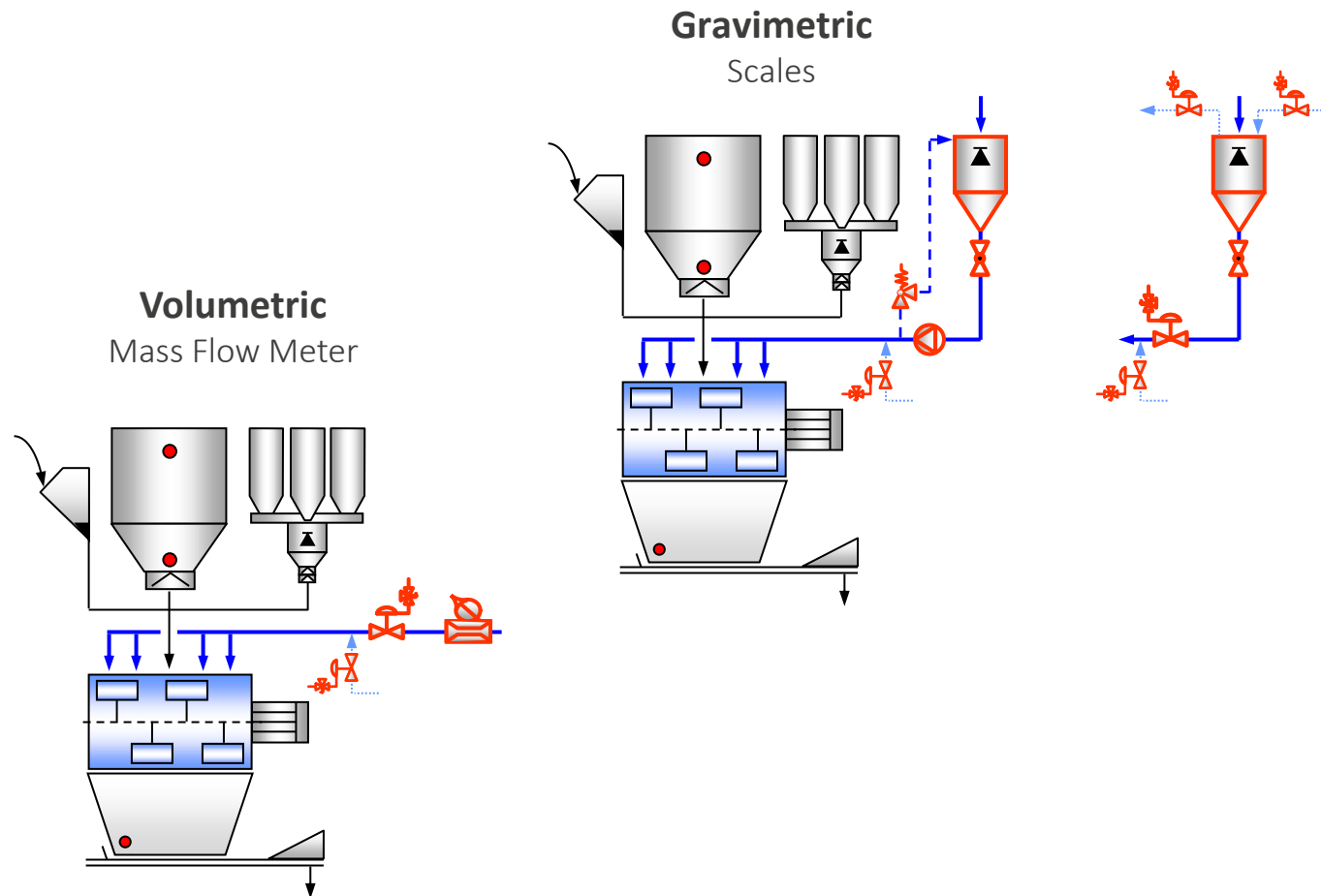
To ensure a sufficient liquid addition process the following requirements must be taken into account:

- Amount of liquid to be added in correlation to the absorption rate of the bulk material
- Ensure the needed functionality of the liquid within the final product
- Liquid distribution as homogenous as needed

POSSIBILITIES OF LIQUID ADDITIVES

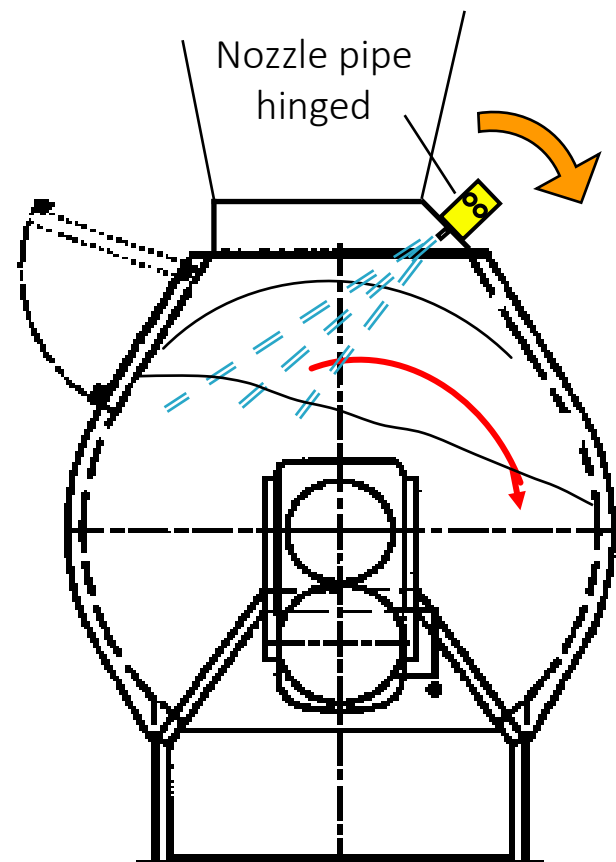


LIQUID ADDITION INTO BATCH MIXER

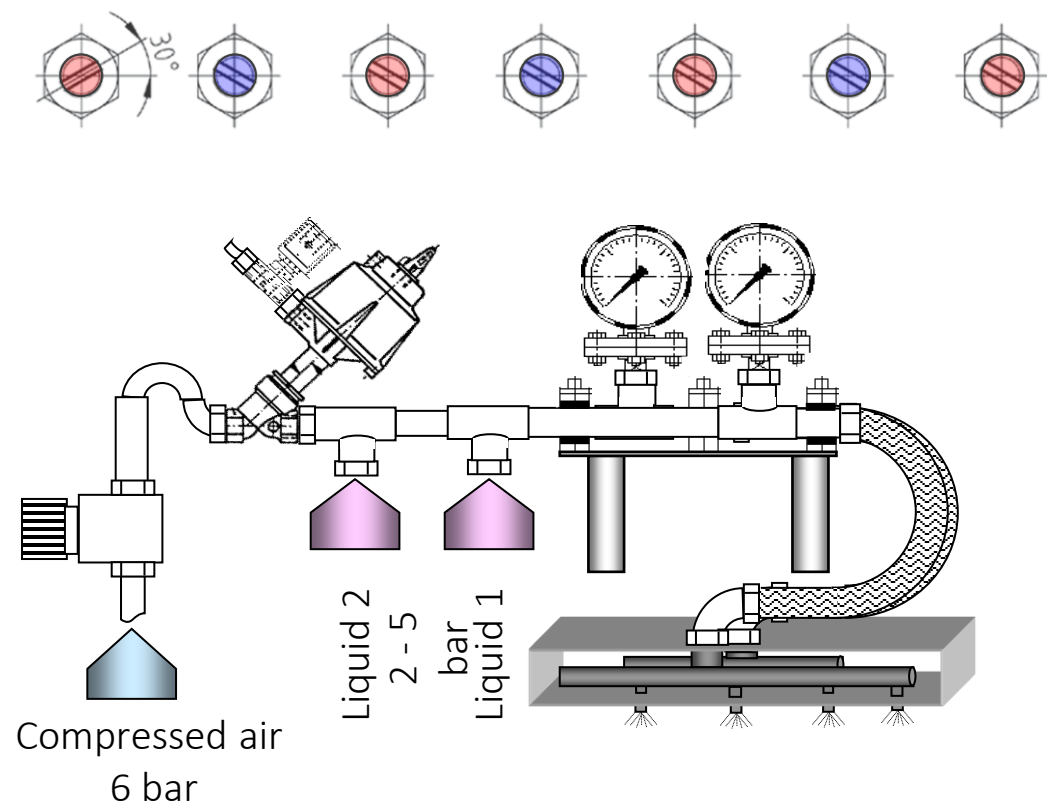


- **High accuracy**
- **Inexpensive, simple installation**
- Addition limited at 5%
- Risk of lump formation
- Increase of power consumption
- Product build up – high amount of residue
- Partial batches not possible

LIQUID ADDITION INTO BATCH MIXER



Arrangement of nozzles



LIQUID ADDITION IS POOR

If liquid addition is poor—especially if it is uneven—the finished feed may have inconsistent quality from batch to batch or within a batch. Some portions may receive too little oil, molasses, or other liquid ingredients, while others receive too much.

That can lead to:

- Uneven nutritional value and inconsistent animal performance
- More dust or poor pellet quality where too little liquid is applied
- Clumping, sticky feed, or handling problems where too much is applied
- Reduced shelf life if excess moisture encourages mold or spoilage

The most serious disadvantage depends on which liquid is being added. For example, uneven dosing of a liquid nutrient or medication can also mean animals receive the wrong amount.

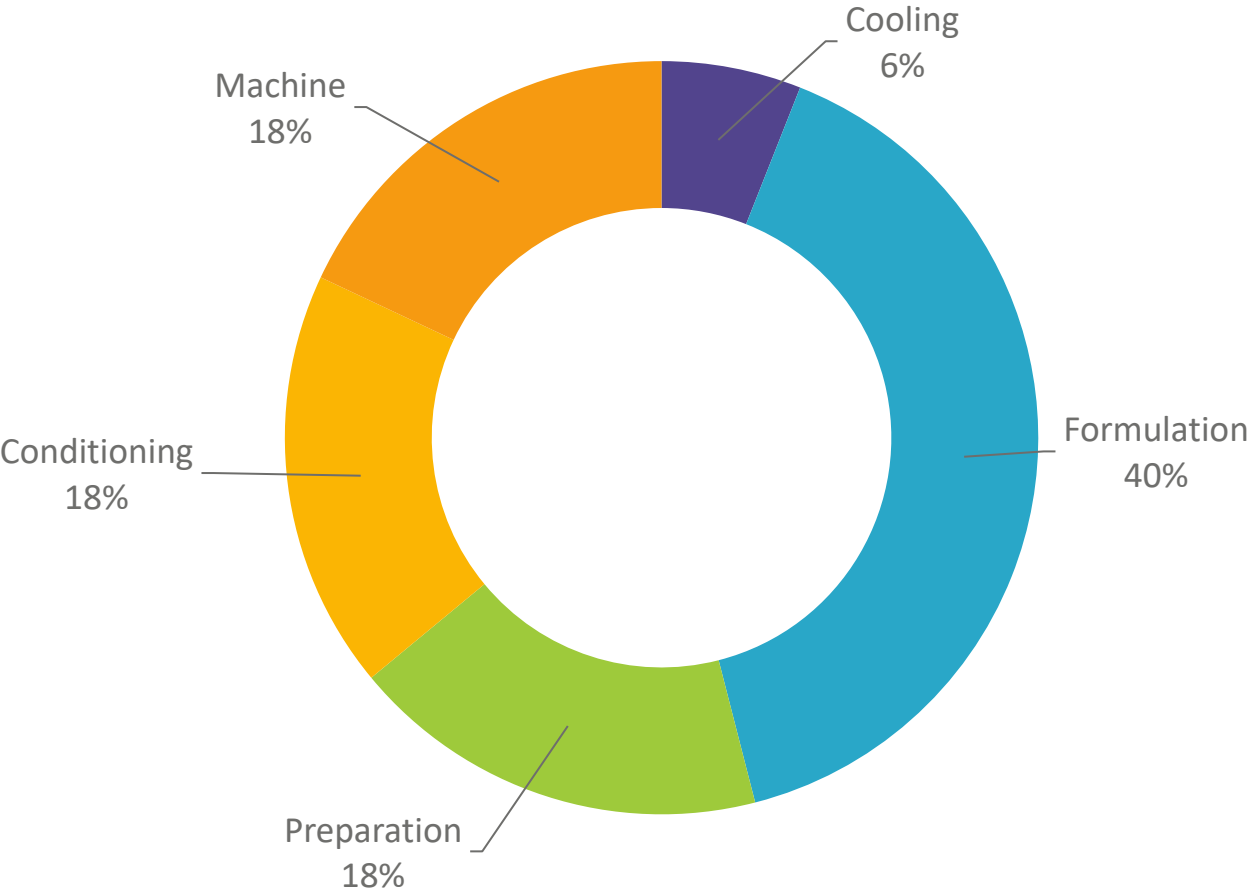


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CONDITIONING AND PELLETIZING

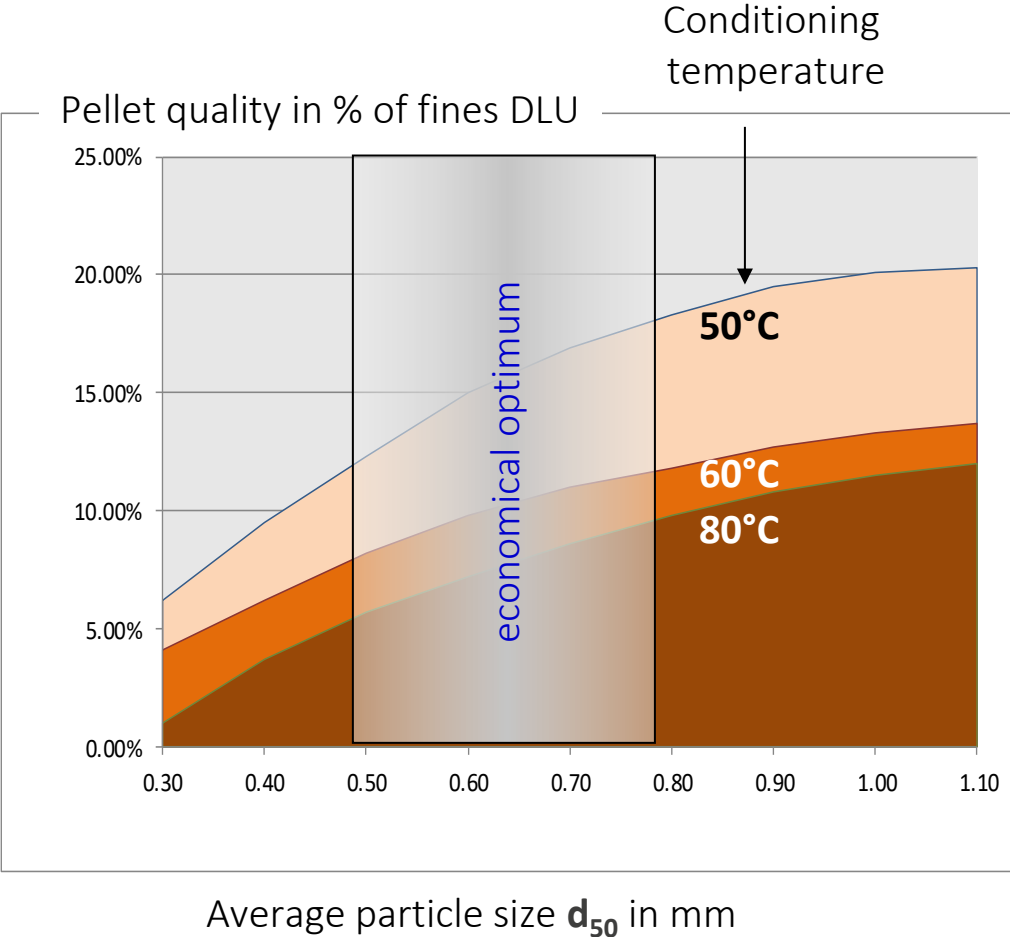


MAIN INFLUENCES ON THE PELLETING PROCESS



Source: Kansas State University

PARTICLE SIZE AND PELLET QUALITY



Maximum and minimum particle size

Overs	1.5 mm	none, max.	5%
Overs	1.0 mm	than	10%
Overs	0.5 mm	than	40%
Overs	0.3 mm	than	25%
Through	0.3 mm	not less than	20%



DEFINITION OF PELLET QUALITY

The most often applied method is the **durability** or **abrasion** test

DLU = **Durability Lab Unit**

expresses fines in %

e.g. 3%

PD = **Pellet Durability**

expresses good pellets in %

e.g. 97%

PDI = **Pellet Durability Index**

expresses good pellets as an index

e.g. 9.7

Other quality parameters:

Pellet hardness

in N or kp

Pellet length / diameter

in mm

Bulk density / specific weight

in kg/dm³

Nutritive value / water activity

chem. analysis, feed units, mold developing, shelf life

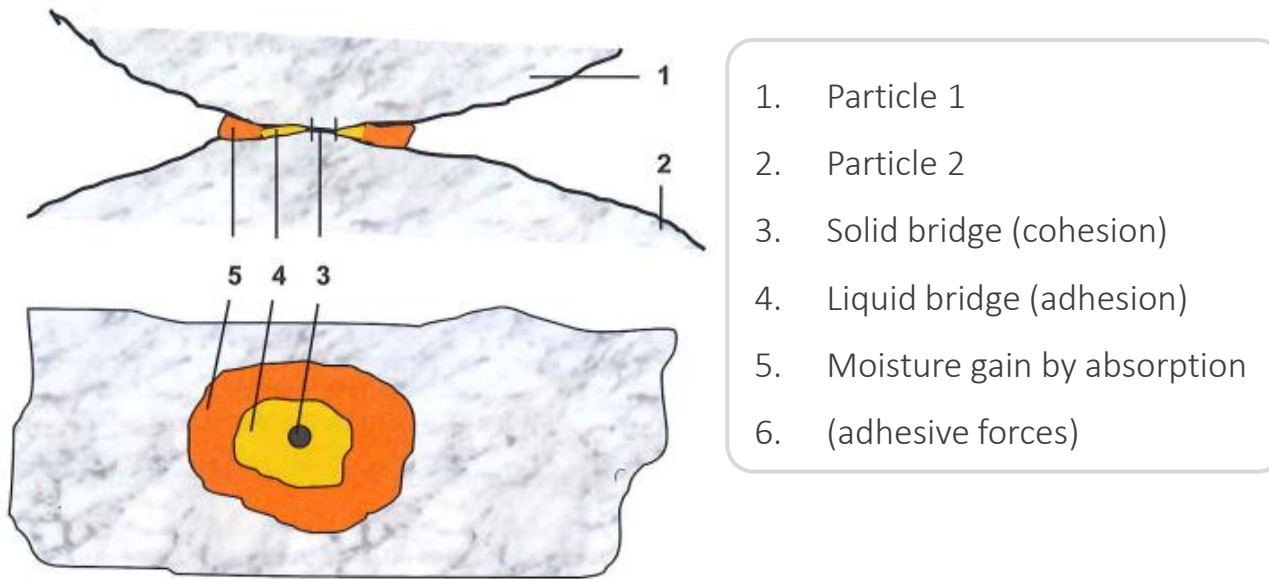
Appearance / taste / stickiness

color, cracks, burnt smell, moisture, molasses addition

Pathogenic germs

thermal treatments, hygienizing of compound feed

MAIN REASONS FOR STEAM CONDITIONING



After cooling, the pellet should show a moisture content of 13–14% H₂O.

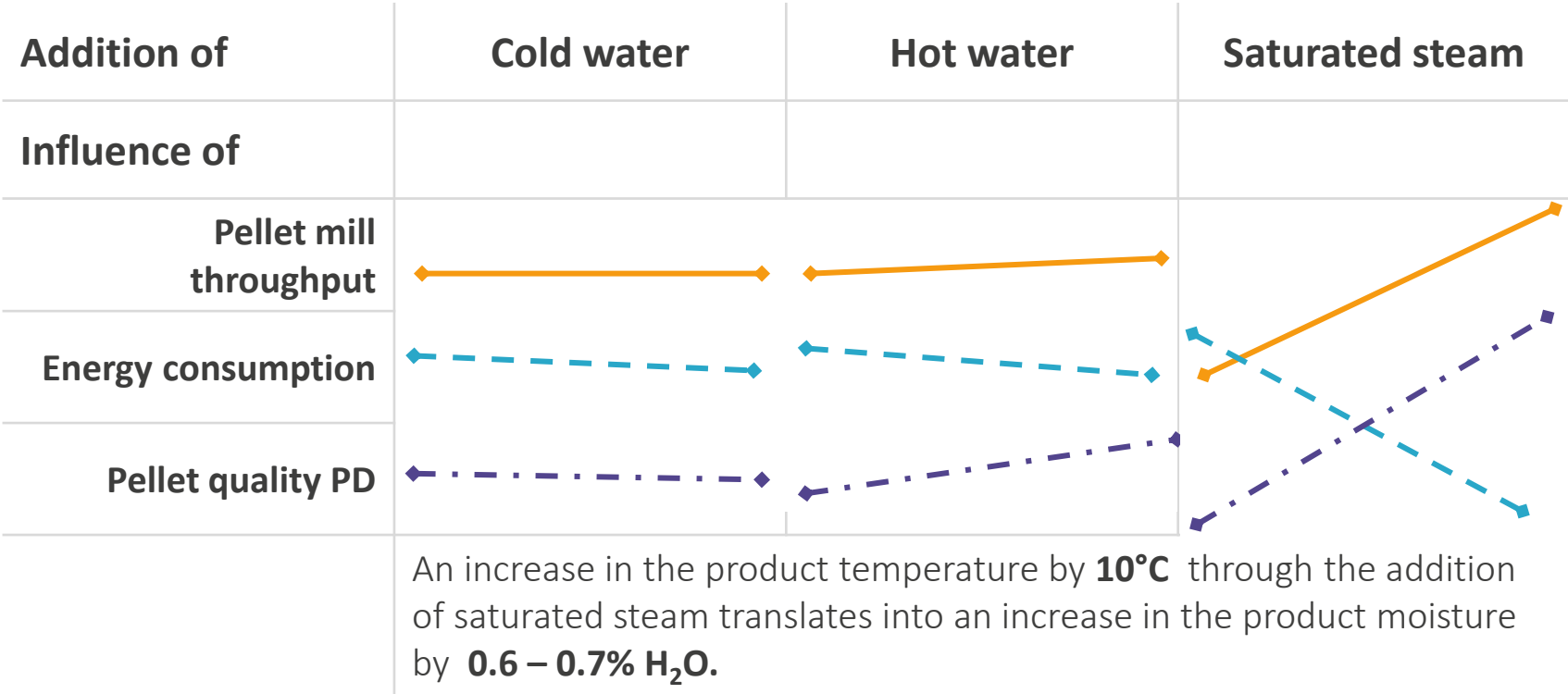
For commercial reasons > higher bulk density possible

For quality considerations > as close as possible to the shelf-life limit

Objectives of steam conditioning

- Plasticizing of the individual solid particles
 - Creation of liquid bridges
 - Higher throughput rates due to lubrication effect
 - Reduction of the energy requirement
 - Longer service life of dies and rolls
 - Partial gelatinization of the starch
 - Improvement of the moisture balance
 - Reduction of production costs
 - Reduction of harmful bacteria
- = thermal treatment / Hygienizing**

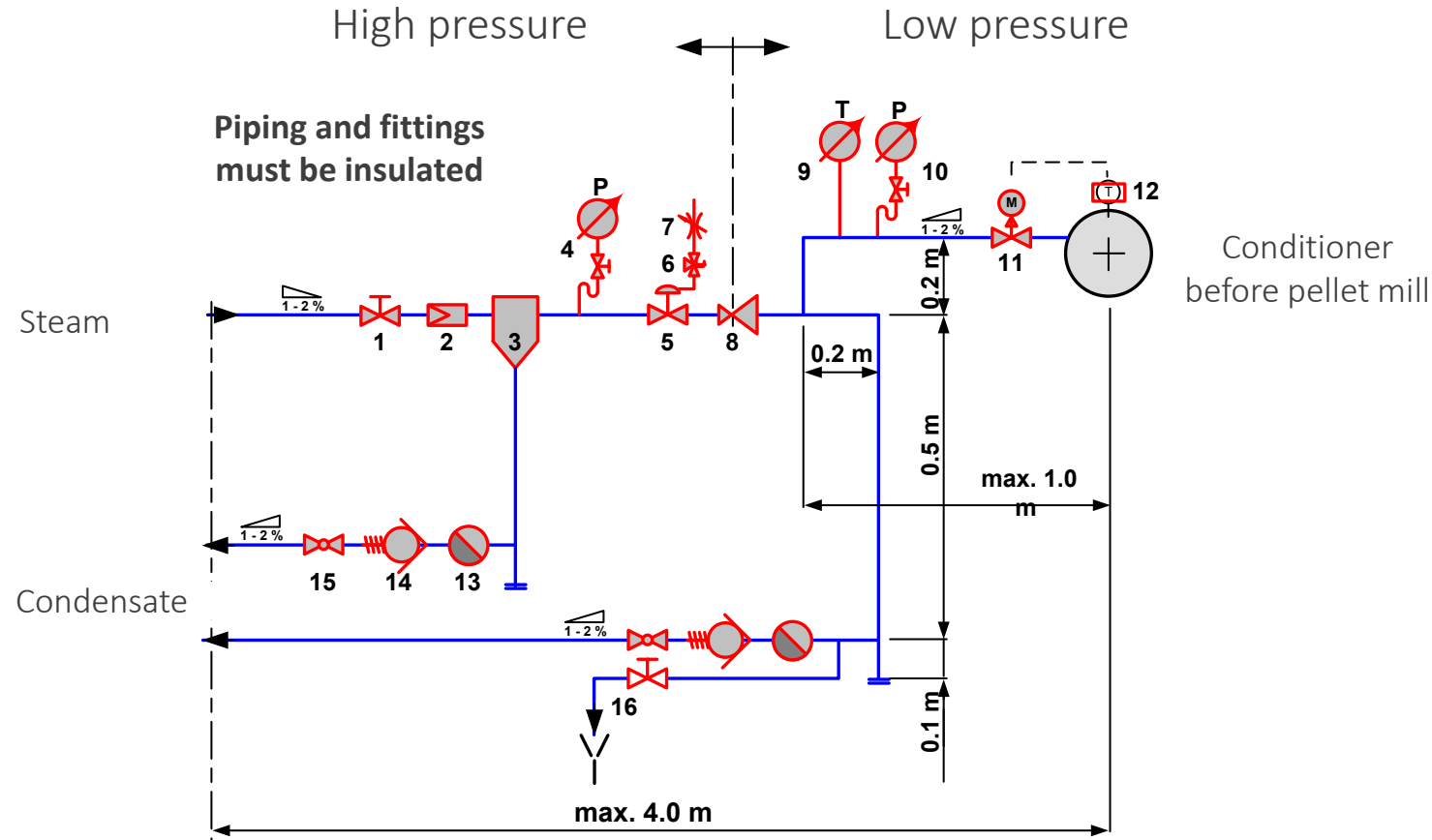
CONDITIONING OF MASH WITH WATER AND SATURATED STEAM



Conditioning is limited by the influence it can have on the nutrients, vitamins and micro-organism contained in the mash and above all on the moisture content.

STEAM INSTALLATION FOR PELLET MILL CONDITIONERS

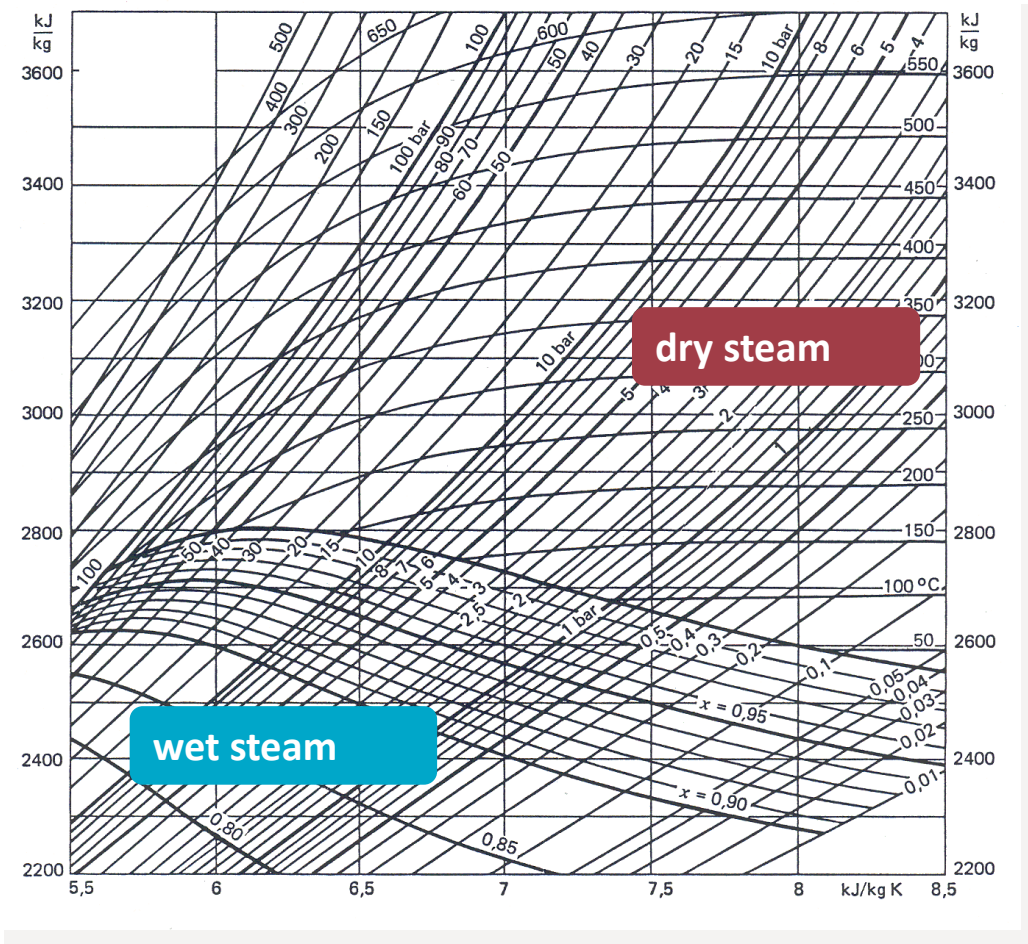
(Direct addition)



1. Shut-off valve
2. Strainer
3. Water separator
4. Pressure gauge 4 ..16 bar
5. Fast-action shut-off valve
6. Solenoid valve
7. Throttling check valve
8. Pressure reducing valve
9. Temperature gauge
10. Pressure gauge 0..10 bar
11. Motorized valve
12. Temperature sensor
13. Condensate trap
14. Non return valve
15. Ball valve
16. Fast-action water drain

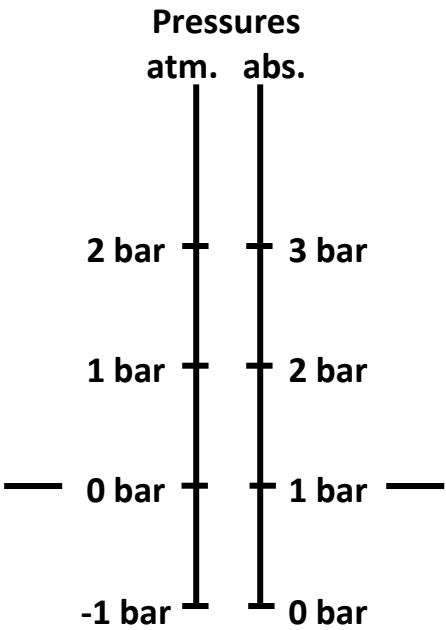
H,X – DIAGRAM FOR STEAM (ACC. TO MOLLIER)

Steam quality requirements



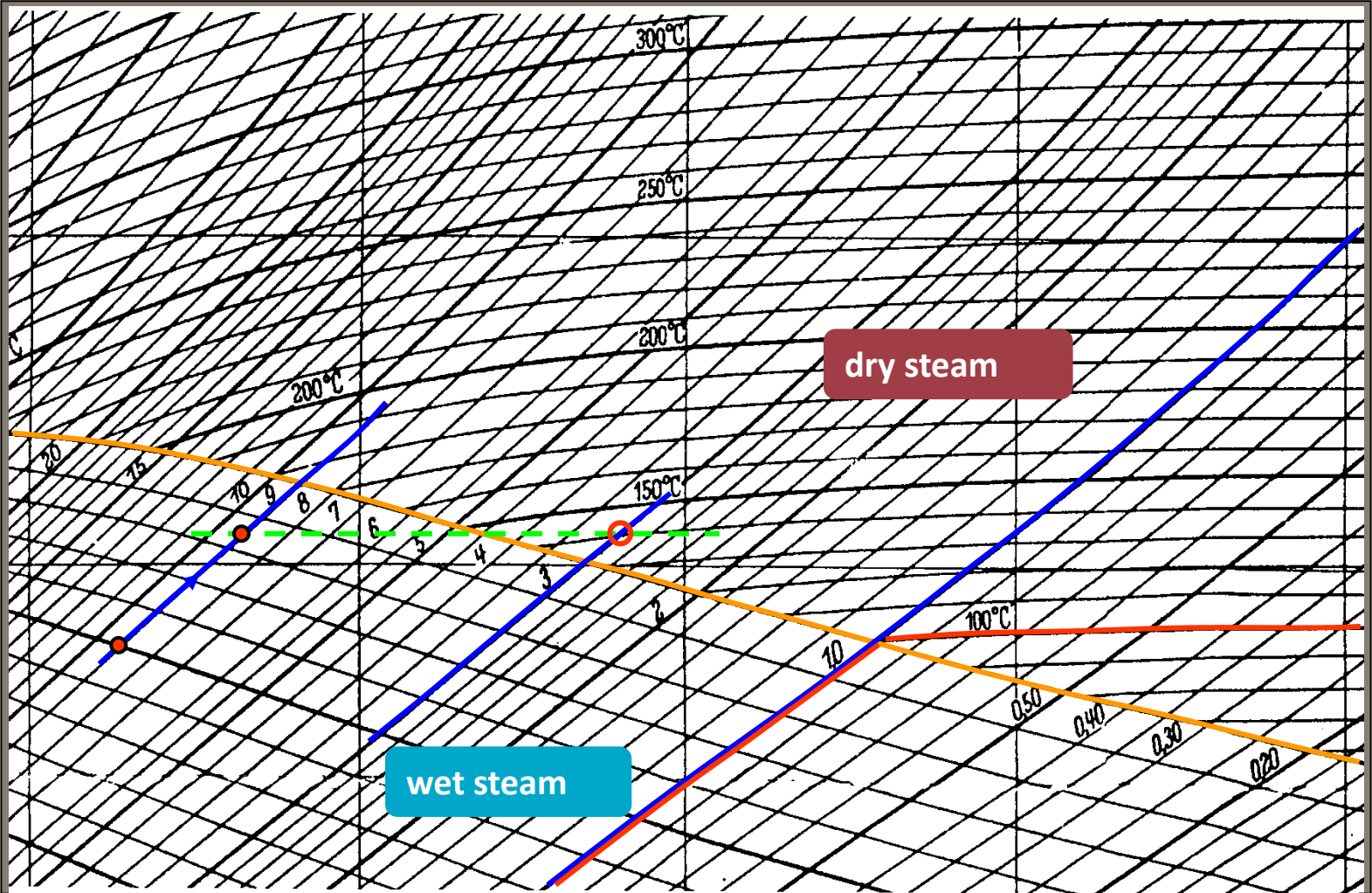
Note:

Pressure indications in steam diagrams are mostly in absolute pressures.

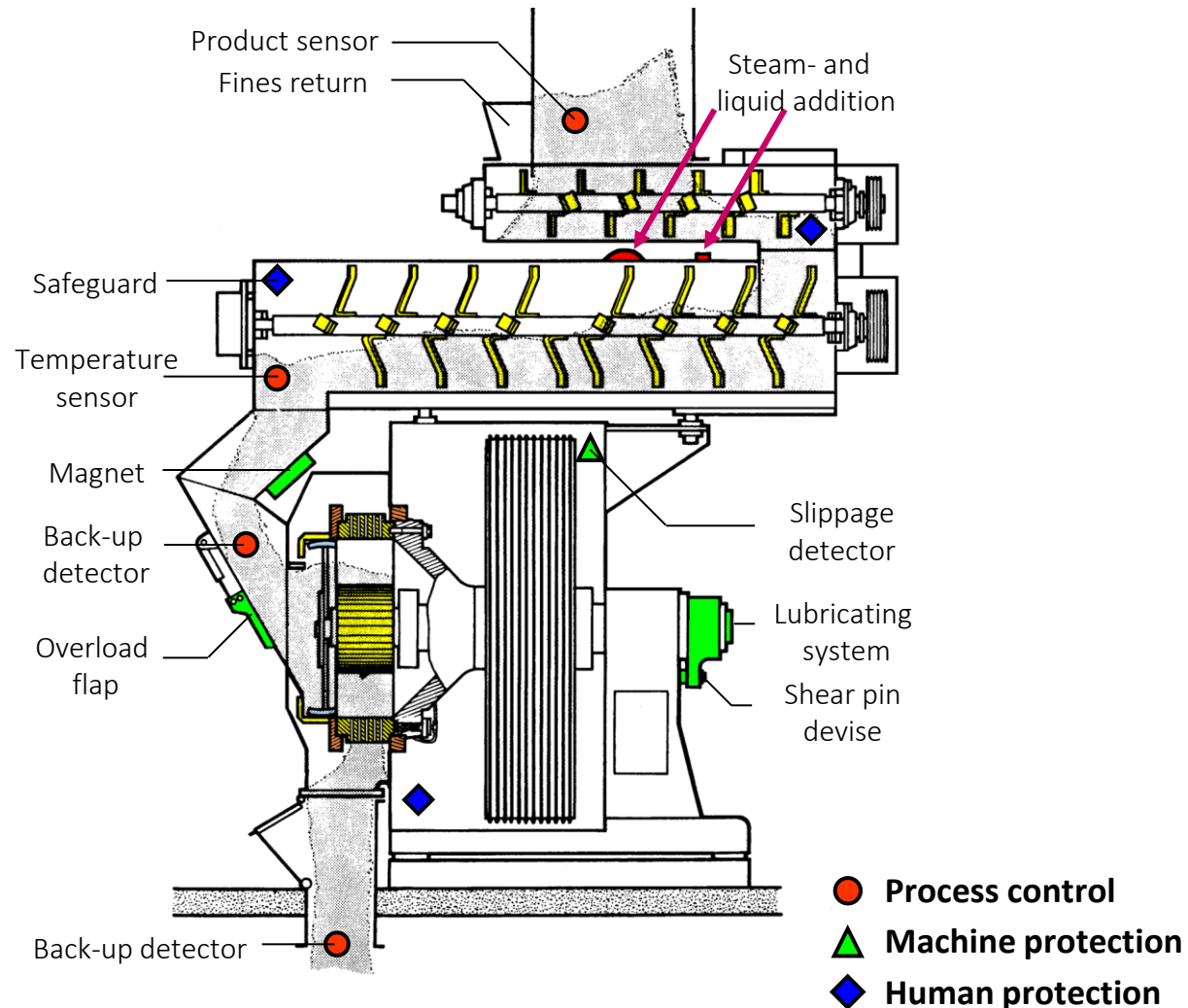


H,X – DIAGRAM FOR STEAM (CUT OUT)

Steam quality requirements



PELLET MILL WITH FEEDER AND CONDITIONER



Feeder, volumetric

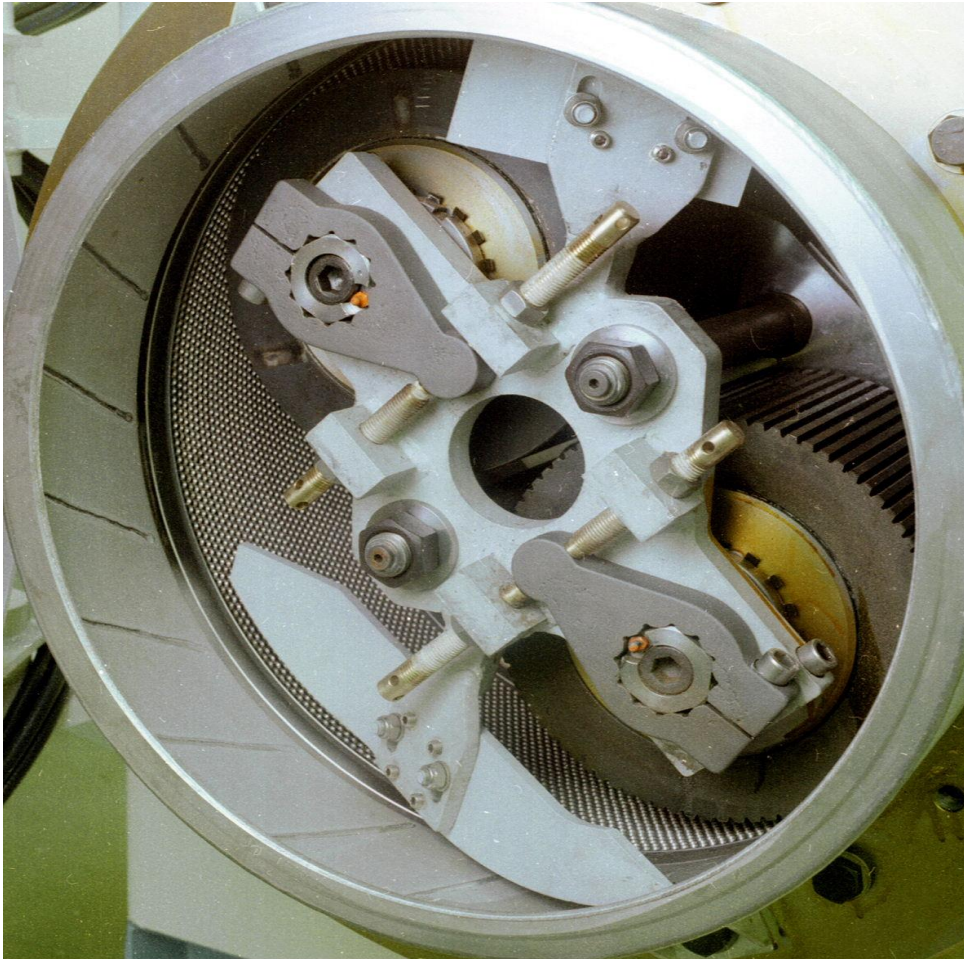
- Load controlled throughput regulation
- Screw- or paddle-rotor, progressive arrangement

Conditioner

- Homogeneous dispersion of added steam and liquids
- Paddle-rotor, setting 10° inclination
- Retention time approx. 8 – 15 s

Pellet mill

- Forming the conditioned mash under high compaction forces into a pellet
- Rotating ring die - circumferential speed approx. 5 – 8 m/s
- Press rolls dimpled or grooved
- Dwell time in die hole approx. 3 – 6 s



Arrangement of press rolls 30°

- Better product distribution
- Uniform wear of rolls and die
- Uniform pellet quality
- Higher throughput rates
- Less breakdowns

**Deflectors are subjected to wear and tear
Need to be readjusted or replaced**

Press rolls

- Diameter as big as possible
- Dimpled roll-shells recommendable
- Adjustment to highest point of die
- Frequent check of wear and tear

POOR CONDITIONING AND PELLETING

Temperature, moisture, and retention time issues

- Insufficient conditioning reduces pellet quality and starch gelatinization
- Excessive heat can damage vitamins, amino acids, enzymes, and probiotics
- Poor pellet durability increases fines

Impact on performance:

Reduced digestibility, lower feed intake, and poorer feed conversion.



INADEQUATE COOLING AND DRYING

Post-processing quality loss

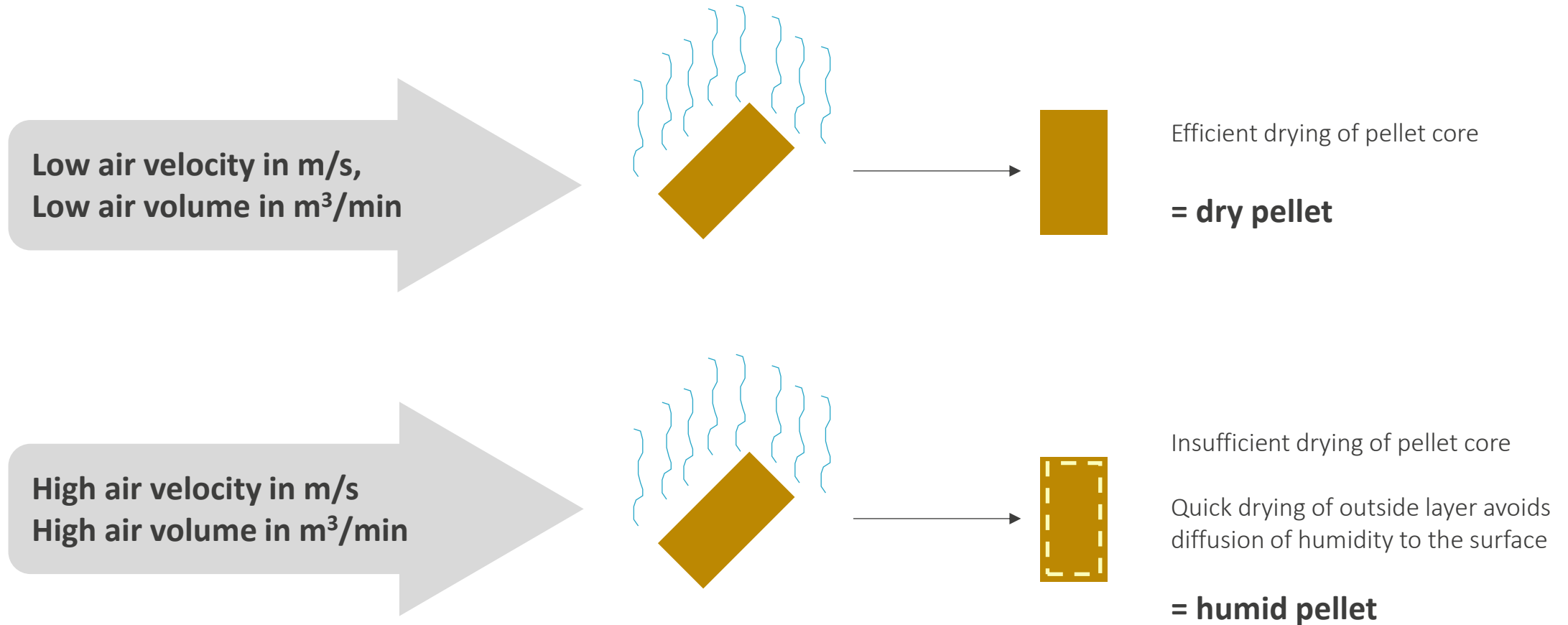
- Pellets stored too hot or too moist increase mold risk
- Overdrying can reduce palatability and pellet durability
- Poor cooling causes condensation during storage

Impact on performance:

Feed spoilage, mycotoxin risk, reduced intake, and animal health challenges.

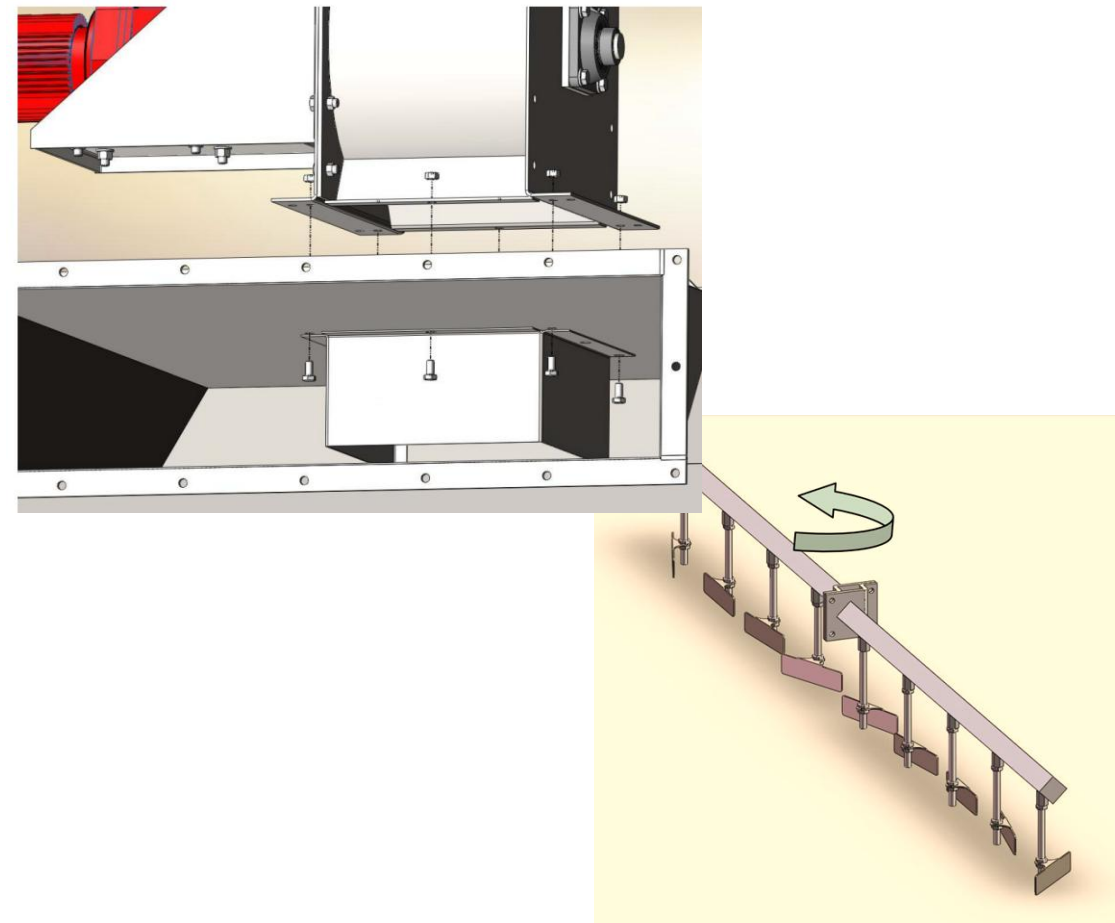
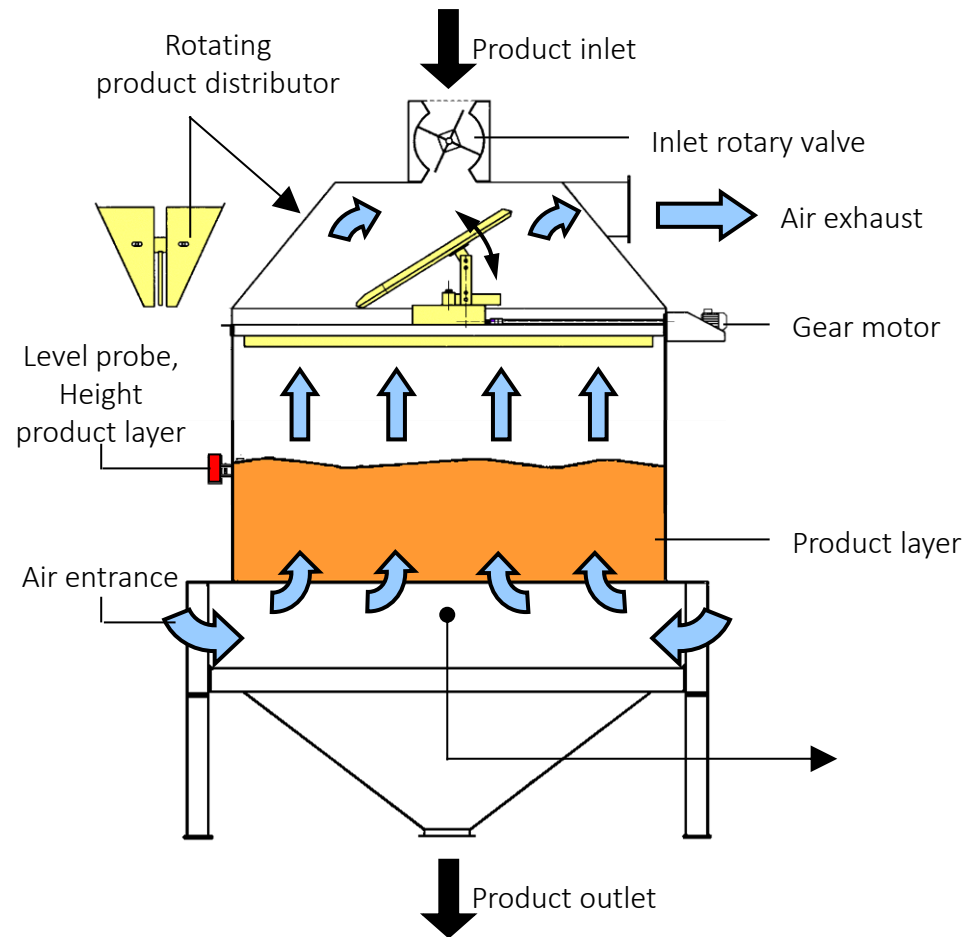


DEHYDRATION OF PELLETS AT DIFFERENT CONDITIONS OF AIR



COUNTER CURRENT COOLER

Type: Geelen Counterflow



06

PRECOMPACTING COMPARISON

Comparison of different pre-compacting processes and their effect on feed manufacturing

	Single Pelleting	Double Pelleting	BOA Compactor	Expander
Mechanic energy input via kneading & shearing effect	+	++	++	++
Expansion by over pressure/ releasing	-	-	+/-	+++
Pasteurizing and Hygienizing	+	++	++	+++
Changing nutritive properties of feed	-/+	+	++	+++
Increasing digestibility of feed	-/+	+	++	+++
Starch gelatinization	-/+	+	+	+++
Higher fat & molasses addition before pelleting	-	+	++	+++
Increasing capacity	-	++	++	+++
Improvement of pellet quality	-	++	++	+++
General effect	Pellets	Pellet quality	Pellet quality	Multi effect

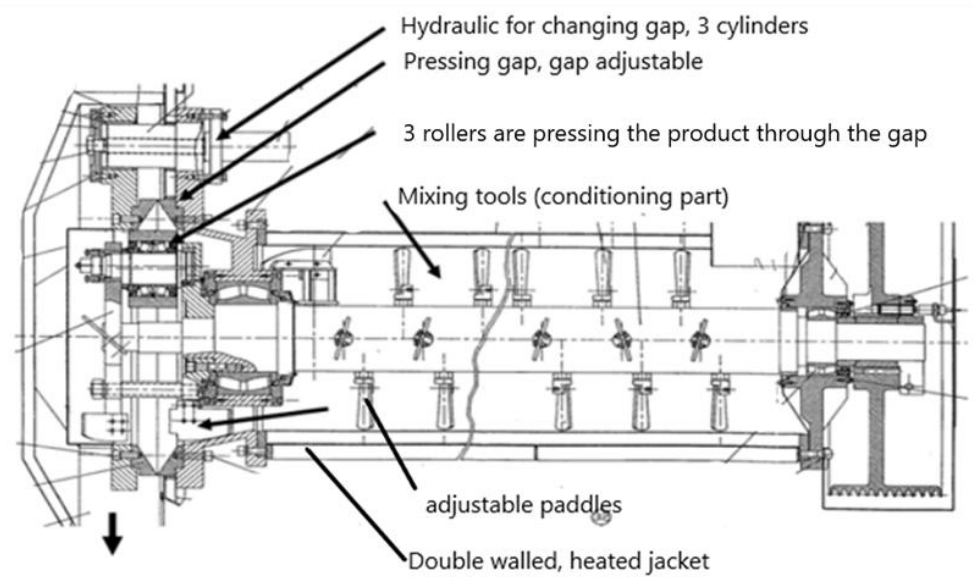
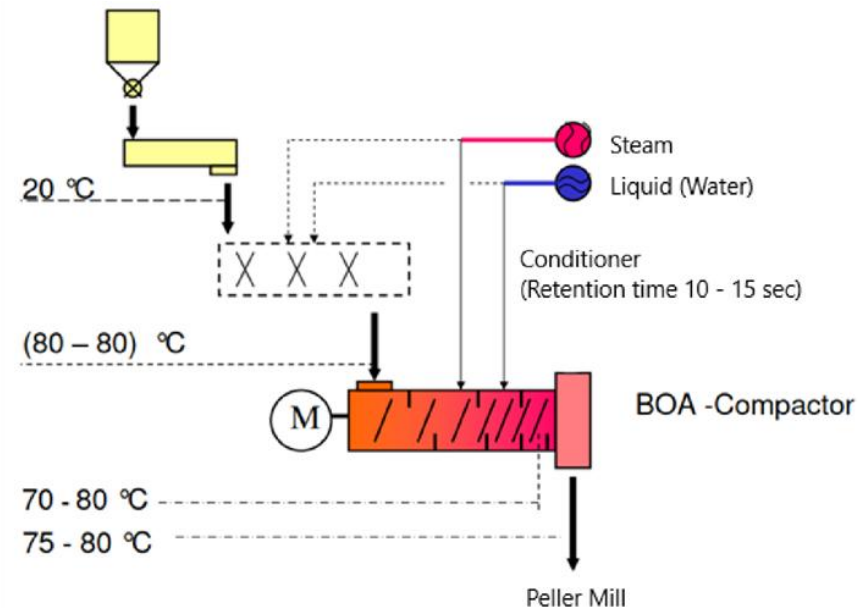
USE OF THE EXPANDER

The expander is used today for the following applications

- Starch digestion for young animal feed, especially piglets.
- Production of granules for soup feeding of pigs.
- Treatment of broiler and layer feeds for Salmonella decontamination.
- Treatment of raw fiber-rich rabbit and horse feeds with practically no dust content in the pellets.
- Production of cattle and cow feeds with high liquid additions.
- Influence on protein digestibility.
- Fish feed production with high fat additions and increased starch digestion.
- Pretreatment of raw materials for starch digestion, protein solubility and reduction of enzyme-inhibiting substances, etc.
- Improved pellet quality and higher press performance.
- Inactivation of contaminants.

COMPACTER

Application	Mainly ruminant feed Used for retrofit due to little space requirements
Reasons	- Increasing pellet quality & capacity - Using cheaper raw materials - Increasing liquid addition
Capacity [t/h]	- Possible to increase for products with high crude fiber content by 10-30% - Not possible for grain-based recipes due to high process fluctuations and overload
SME [kWh/t]	Increasing SME in total by up 10 kWh/t



How to Improve Feed Processing

- Define target particle size by species and age
- Validate mixer performance regularly
- Control conditioning temperature, moisture, and retention time
- Monitor pellet durability and fines
- Check moisture and cooling efficiency
- Protect heat-sensitive additives
- Use routine quality control and documentation



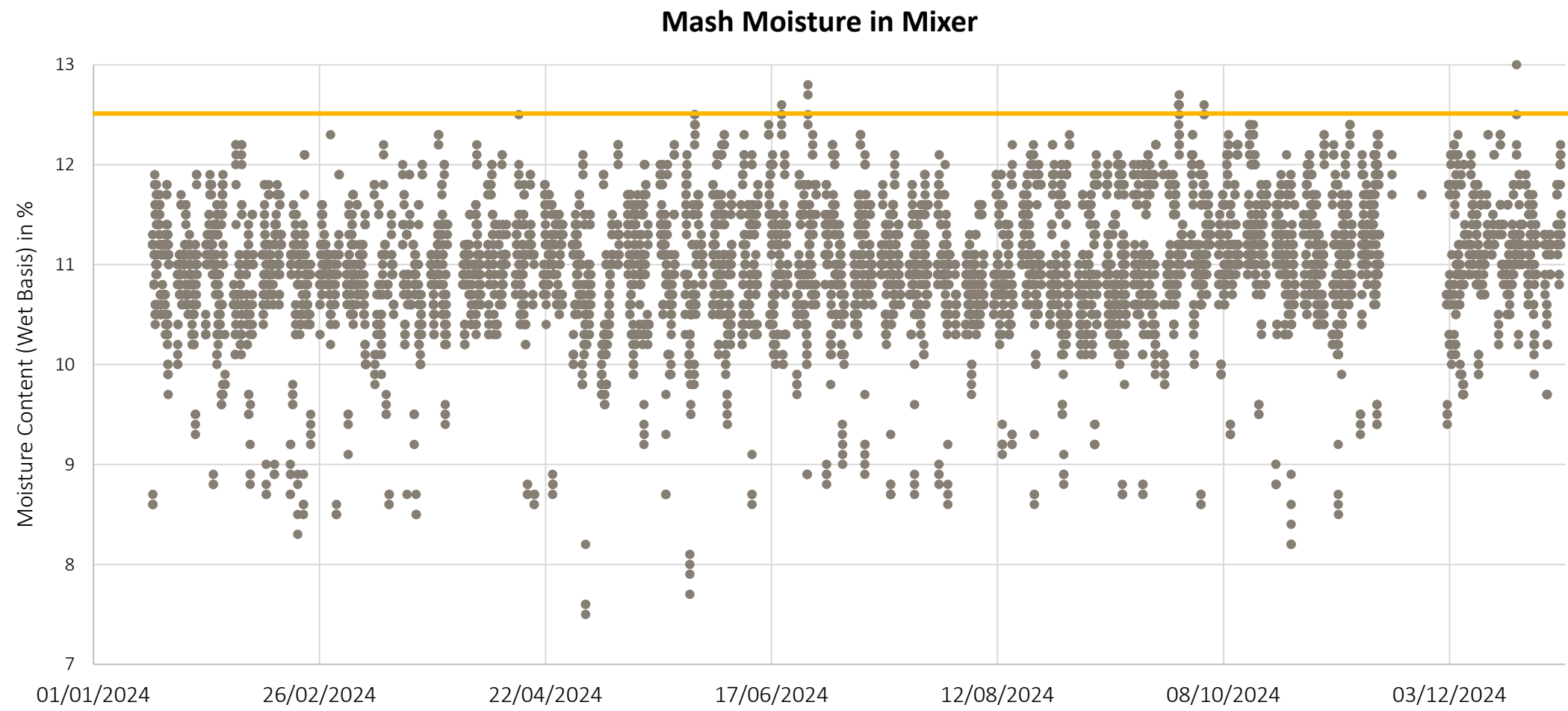
07

SUMMARY



ACTUAL MOISTURE VARIATIONS WITHIN ONE YEAR

Average values for jobs with same target value of 12.5 %



LATEST PELLETING TECHNOLOGY TO IMPROVE EFFICIENCY

Moisture management – Process optimization by online moisture control

Solution:

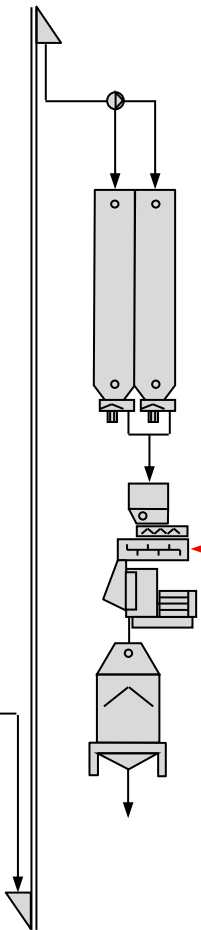
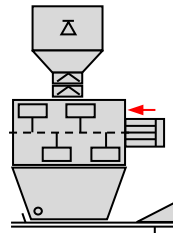
moisture by steam **3.25 % H₂O**
moisture to mixer **1.75 % H₂O**

Example:

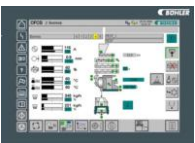
temperature: **30°C**
moisture **11 %**



Inline NIR-system



Example:
set cond. temp. **80°C**
desired moisture **16 % H₂O**



Procedure & requirements for online moisture control

- Inline NIR-system measures the moisture & temperature of the mash during the mixing time.
- System needs to know the conditioning temperature set value & the desired moisture content of the mash in front of the pellet mill.
- System subtracts the moisture added by steam from the calculated total moisture difference and adds the missing quantity into the same batch in the mixer.

ROI IN LESS THAN ONE YEAR

With moisture regulation alone

Lean cost formulations

Reduced „safety margin“ of moisture content in formulation due to constant measurement ($\pm 0.3\%$)

Constant product quality leads to approx. 5% more-line availability

Continuous product quality, even in case of moisture fluctuations of raw materials. Increased line availability due to reduction of fines.

Energy savings in pelleting process

Reduction of Pellet-Mill SME by up to 10% due to optimized moisture content.



Line capacity:	100'000 tons/year
Moisture increase:	0.5 %
Sales price feed:	300 €/ton
Annual savings:	150'000 €
ROI:	< 1 year



MEET OUR SPEAKER



Dr. Jean-Michel Nebout

MICROBIOLOGIST · FEED & FOOD MANUFACTURING

Critical Production Points in the Feed Mill

With more than 38 years of experience, Jean-Michel specialises in sanitation, contamination control and feed manufacturing best practices.

GOOD MANUFACTURING PRACTICES PROCESS CONTROL & MICROBIAL RISKS

Madrid

12/10/2026

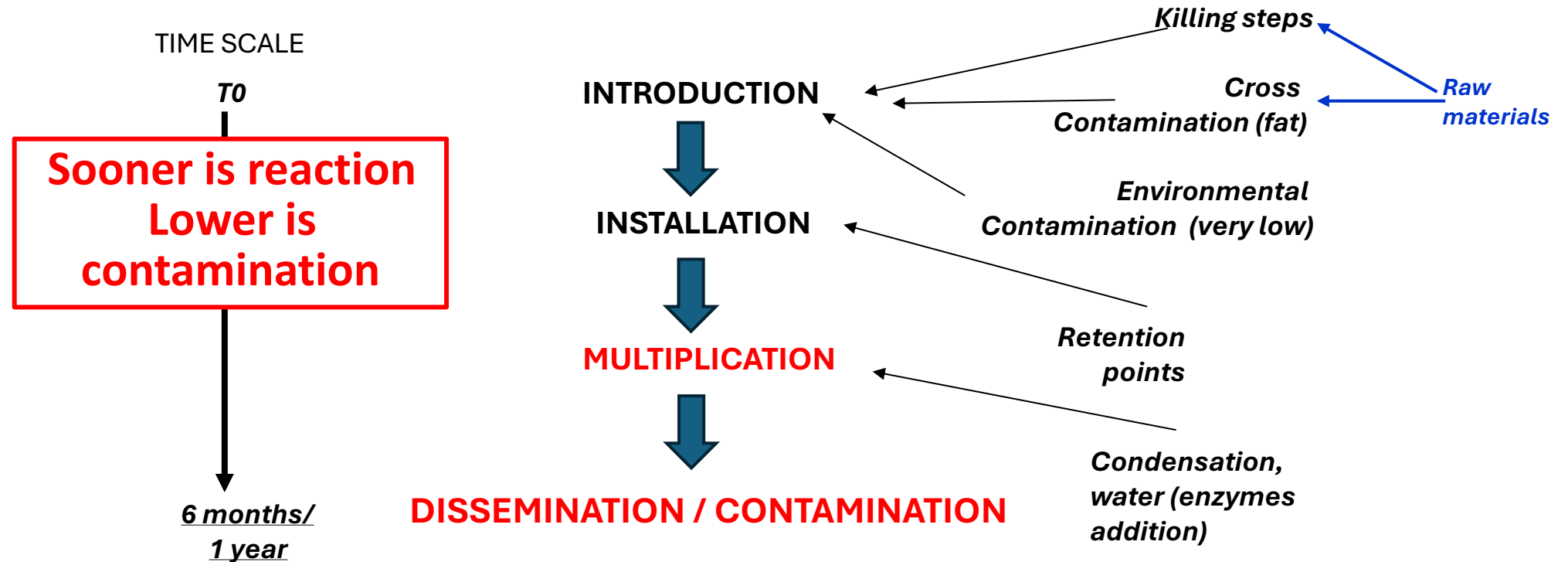
AGENDA

- Definition of risks and assessment
- Ways of contamination
- Dissemination
- Introduction (raw materials, killing step)
- Multiplication because of water
- Installation
- Next steps
- Conclusions

WAYS OF CONTAMINATION

HOW BACTERIA CONTAMINATE PRODUCTION LINE?

Bacterial contamination ALWAYS follows 4 steps :



**When contamination of finished products is revealed
number of bacteria within the line is already HUGE**

**2 STEPS CAN BE
“EASILY”
CONTROLLED**

INTRODUCTION

MULTIPLICATION

**1 STEP CAN BE
MEASURED**

DISSEMINATION

DISSEMINATION

Measurement with SAMPLING PLAN

HOW MANY SAMPLES TO TAKE?

P_u , probability of no positive results
in n , number of samples:

$$P_u (\%) = 100(1 - \sqrt[n]{\alpha})$$

Table 4 Percentage defective sample units and maximum contamination levels assuming random distribution of target organism and assuming 100% test effectiveness (i.e. any target organism in the sample would be detected) (modified from Jarvis 1989)

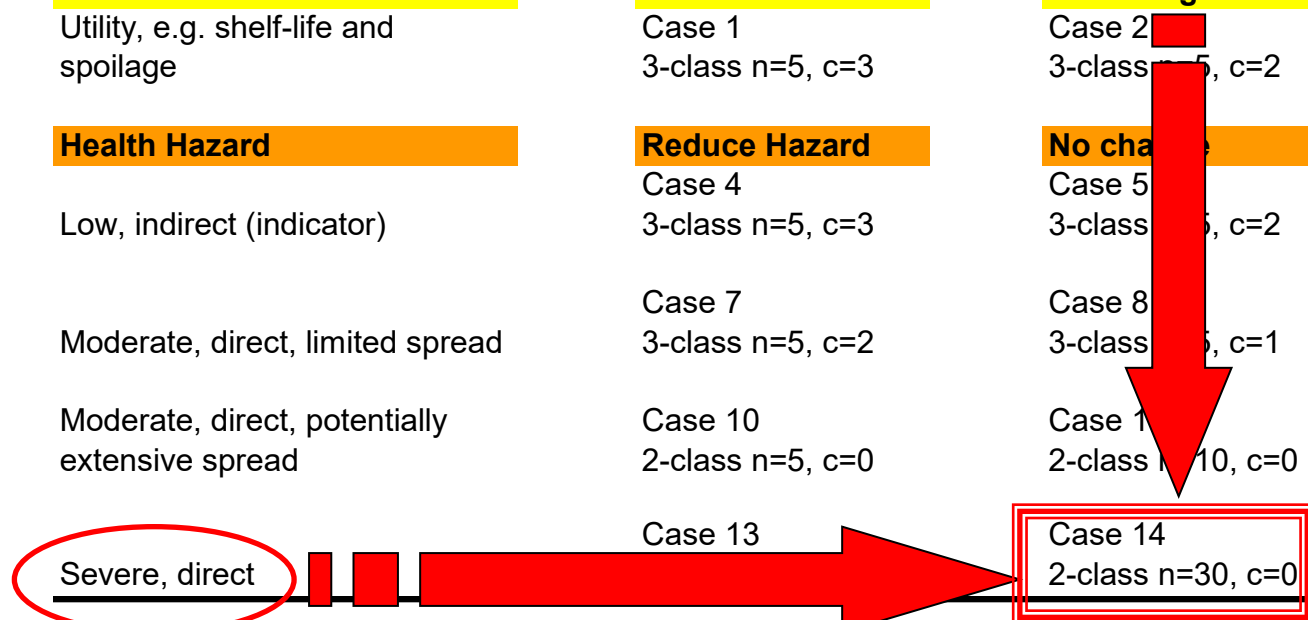
No. of sample units tested (n)	% Defectives ($\tau\%$)* at		No. of organisms per kg*† at	
	$P_u = 0.95$	$P_u = 0.99$	$P_u = 0.95$	$P_u = 0.99$
1	95.0	99.0	120	184
2	77.6	90.0	60	92
3	63.2	78.5	40	61
4	52.7	68.4	30	46
5	45.1	60.2	24	37
10	25.9	36.9	12	18
20	13.9	20.6	6	9
30	9.5	14.2	4	6
50	5.8	8.8	2	4
100	3.0	4.5	1	2

*Assuming no positives detected, the true incidence will not be more than the values shown with indicated confidence.

†Rounded to the nearest whole number and assuming sample size = 25 g.

FINISHED PRODUCTS: SUGGESTED SAMPLING PLAN

Feed industry: finished products, fat

Degree of concern Relative to Utility and Health Hazard	Conditions in which Food is expected to be handled and Consumed After sampling in the Usual Course of events		
	Conditions Reduce Degree of Concern	Conditions Cause No Change in Concern	Conditions may increase Concern
No Direct Health Hazard Utility, e.g. shelf-life and spoilage	Increase shelf-life Case 1 3-class n=5, c=3	No Change Case 2 3-class n=5, c=2	Reduce shelf-life Case 3 3-class n=5, c=1
Health Hazard Low, indirect (indicator)	Reduce Hazard Case 4 3-class n=5, c=3	No change Case 5 3-class n=5, c=2	Increase hazard Case 6 3-class n=5, c=1
Moderate, direct, limited spread	Case 7 3-class n=5, c=2	Case 8 3-class n=5, c=1	Case 9 3-class n=10, c=1
Moderate, direct, potentially extensive spread	Case 10 2-class n=5, c=0	Case 11 2-class n=10, c=0	Case 12 2-class n=20, c=0
Severe, direct 	Case 13	Case 14 2-class n=30, c=0	Case 15 2-class n=60, c=0

ICMFS, 1974

SAMPLING PLAN - CONCLUSIONS

- As seen, signification of FINISHED PRODUCTS sampling plan is very low
- NEVER establish and follow ACTIONS PLAN from sampling plan
- Use alternative solutions

SAMPLING PLAN – ALTERNATIVE SOLUTIONS

- For finished products:
 - Possibility to use other samples, i.e. dust/residues of sifters: very representative of large production proportions
 - Example: sifter
 - Rejection of 1 to 2% of dust, from EXTERNAL part of pellets
 - Detection of ***Salmonella*** in 25 grams of sifter dust = analysis in 2,5 kg of finished product
- Environmental sampling plan:
 - Swabs on floor around machines (leaks): pelleting machine, cooler, etc.

RAW MATERIALS

RAW MATERIALS	EXAMPLES	BIOLOGICAL RISK	CHEMICAL RISK
Raw materials from animal origin submitted to HEAT during production	Blood plasma Whey and dairy products Animal fats	Salmonella Enterobacteriaceae C. Perfringens STEC/ETEC Listeria	Biogenic amines
Raw materials from vegetal origin submitted to HEAT during production	Soya Sunflower meal Rapeseed meal Corn gluten	Salmonella Enterobacteriaceae C. Perfringens	Mycotoxins
Raw materials from vegetal origin without HEAT during production	Cereals (corn, wheat, barley) Rice, broken rice Wheat bran, Rice bran	NA Salmonella Salmonella, Enterobacteriaceae	Mycotoxins
Mineral raw materials	Clay	Clostridium spp	
Other raw materials (synthetic, fermentation, etc.)	Yeast FOS, MOS	Salmonella Enterobacteriaceae C. Perfringens NA	Biogenic amines NA

PROCESSED RAW MATERIALS

RAW MATERIALS IN POST-PELLETING

- For post-pelleting, raw materials MUST BE very microbiologically CLEAN:
 - Poultry and pig fats
 - ?
- **AT RISK: Fat**
 - **Importance of sampling plan**
 - **Importance of suppliers visits**



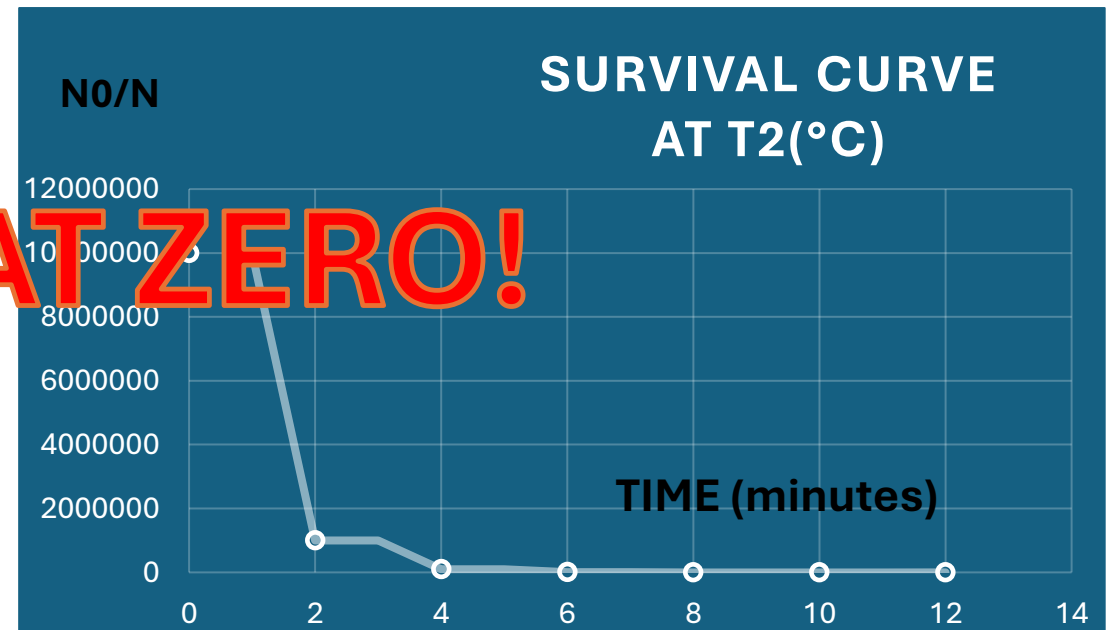
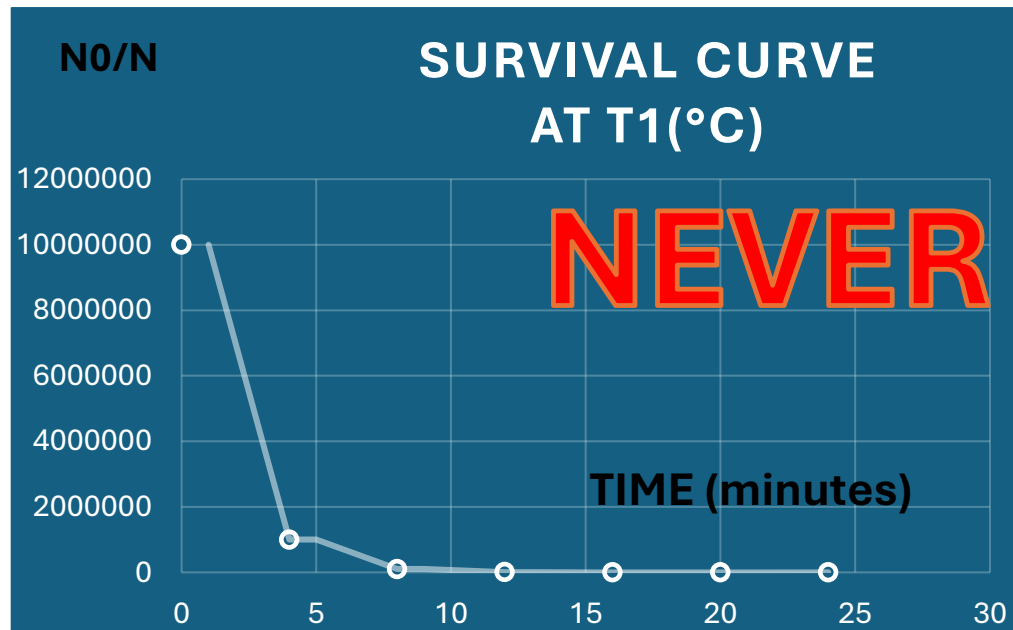
DECANTATION : 15-20 minutes

Sampling at BOTTOM of the truck, NEVER at top

**KILLING STEP:
PRINCIPLES OF
THERMOBACTERIOLOGY**

PRINCIPLES OF THERMOBACTERIOLOGY (1)

- Destruction of microorganisms (wet heat, dry heat, Gamma rays, UV, sanitizers, etc.) ALWAYS follows the same asymptotic curve:
- If $T_1 \ll T_2$:



NEVER AT ZERO!

PRINCIPLES OF THERMOBACTERIOLOGY (5)

Serotype	type of food	Aw	D-value (minutes)																			z-value
			50°C	53°C	56°C	57°C	58°C	60°C	63°C	65°C	68°C	70°C	71°C	80°C	85°C	90°C	105°C	115°C	125°C	135°C	145°C	z (°C)
Typhimurium	ground beef	0,99	30,2			2,1-2,7			0,36													6,5
	minced cook-chill roast beef	0,98						0,9		0,25		0,095										10,3
	Chocolate	<0,5										816	396	222		75						>19
	Wheat (dry heat)	0,57															132,5	55,7	16,6	3,5	1,4	19,4
	Sesame seeds (dry heat)	0,58															102,5	37	12,1	3,5	1,2	20,5
	Walnuts (dry heat)	0,49															174,6	75,5	10,9	2	1,3	17,1
	Pecans nuts (dry heat)	0,66															170,9	62,9	10,3	2,7	2,1	19,3
	Pumpkin seeds (dry heat)	0,65															235,3	92,7	29,3	9,9	3	21
	Brazil nuts (dry heat)	0,61															242,1	100,2	21,3	5,2		17,6
Senftenberg	Oysters	0,99			35							0,3										
	ground beef	0,98		53			15,2		2,08		0,22											6,24
	Crushed dog biscuit (dry heat)	0,7													220							43,3

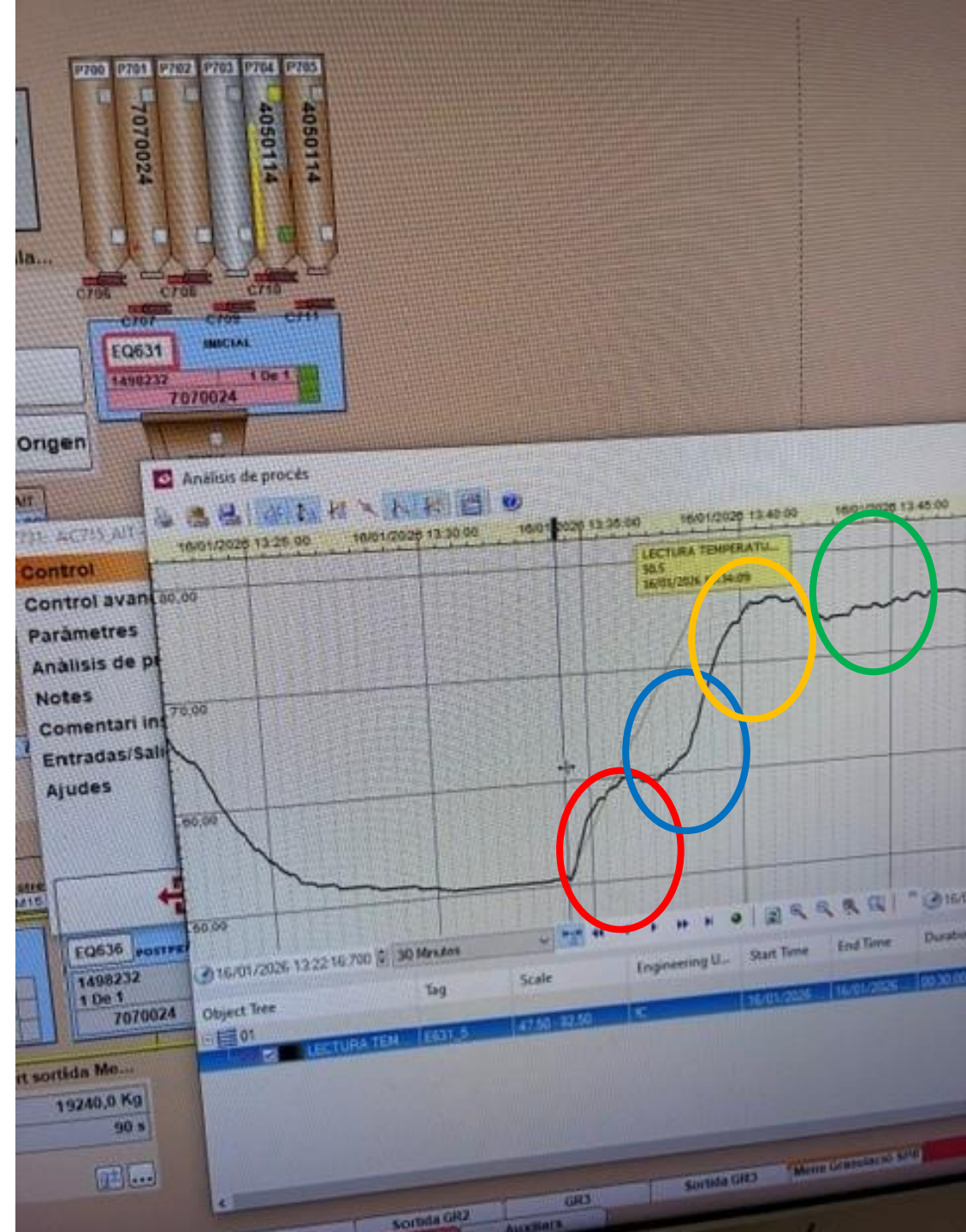
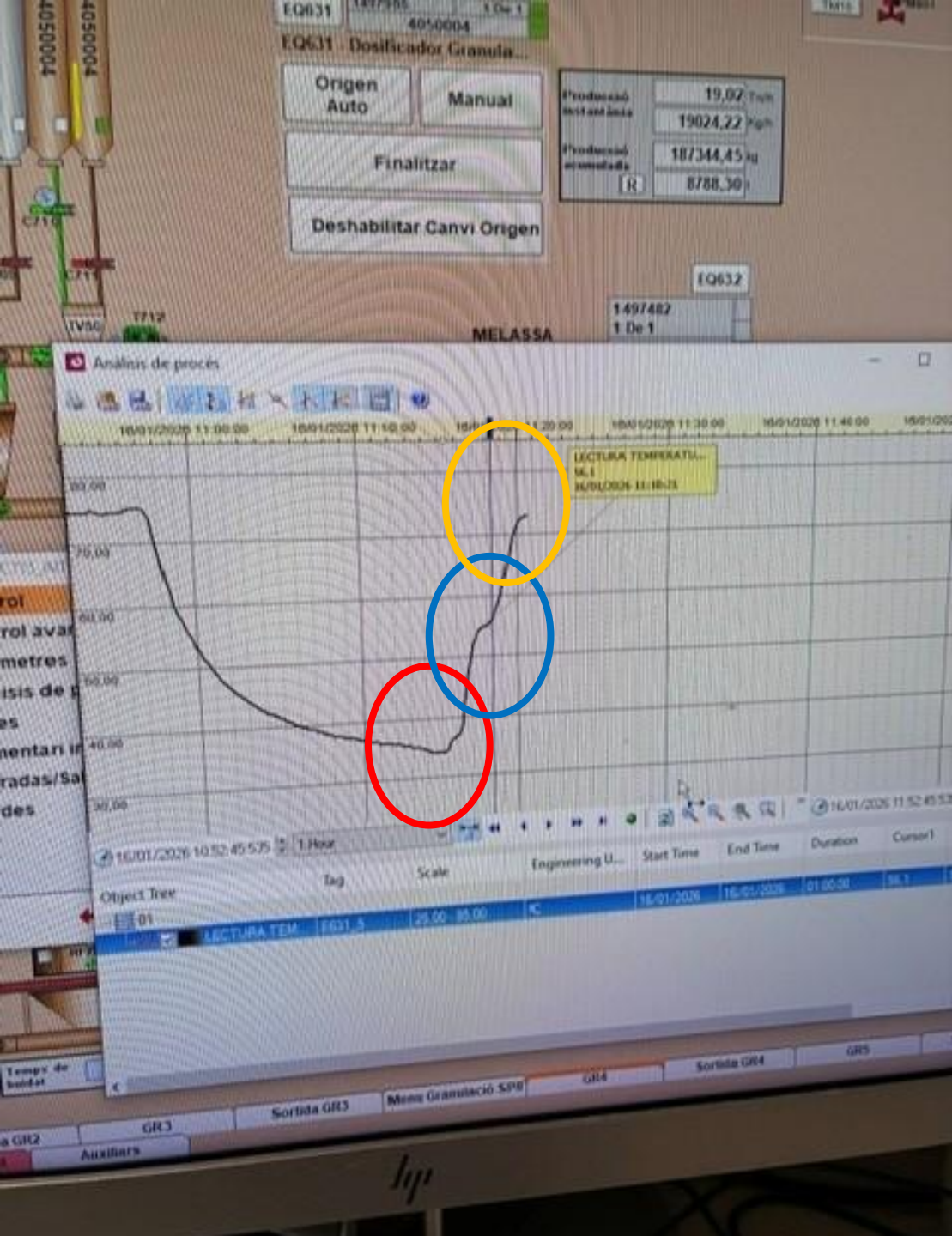
- 2 examples of D-values and z-values in different types of foods for different temperatures
- These 2 values may vary in huge proportions because of humidity and level of fat in the product
- Boyle and al, 2000 – Camden 2014

EVALUATION OF HEATING TREATMENT

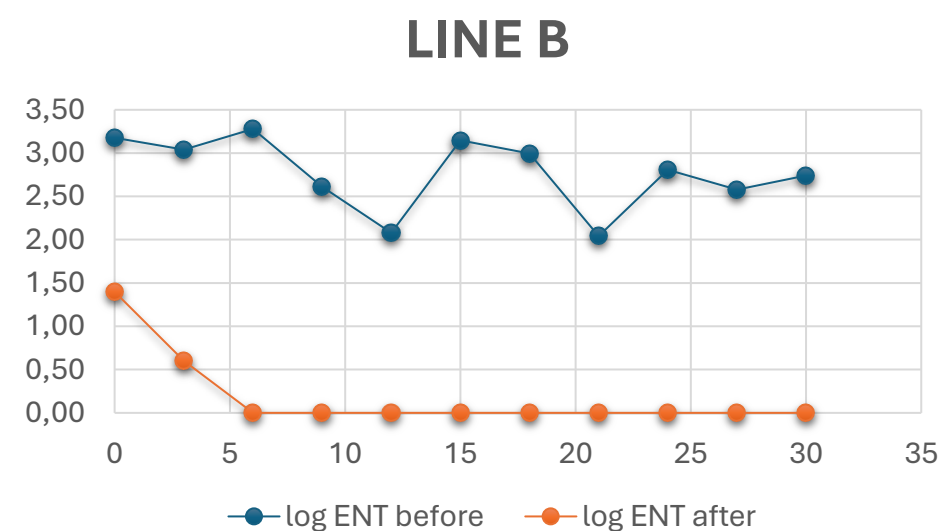
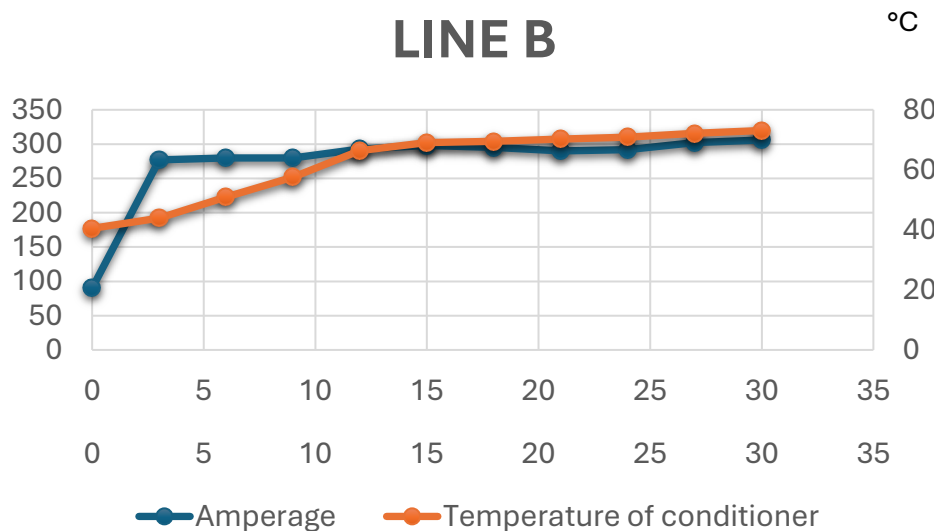
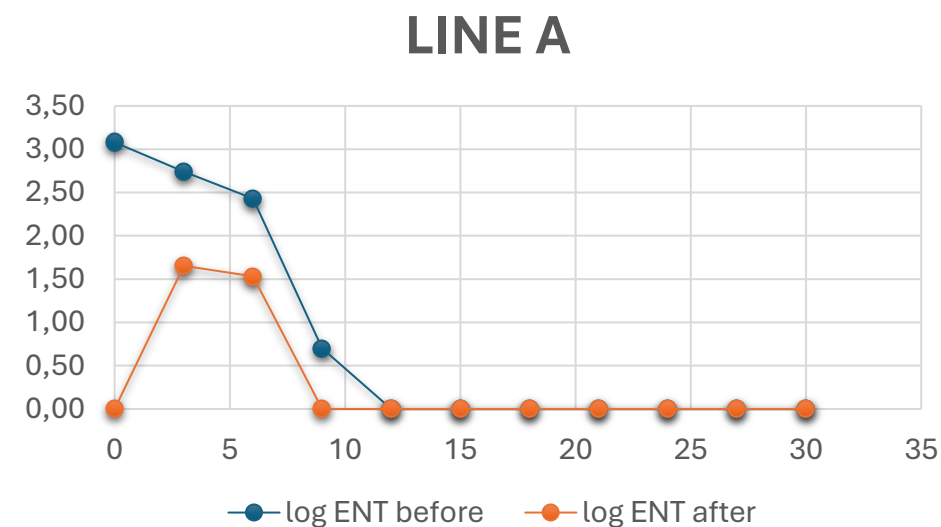
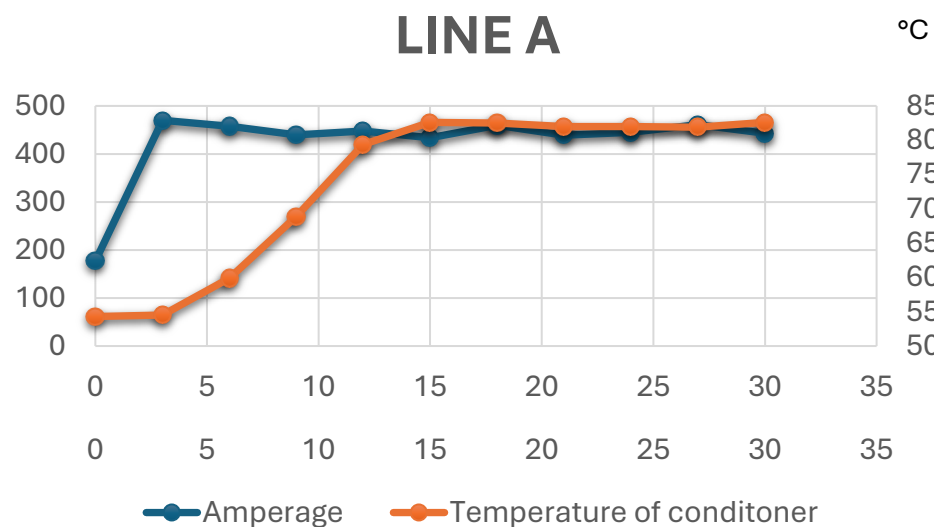
HOW TO EVALUATE HEATING TREATMENT?

2 sampling points:





2 DIFFERENT PRESS PROFILES....



DIFFERENT PRESS PROFILES....

Key learnings:

- Number and position of steam injections within conditioner
- Time with still contaminated pellets
- Potential cross contamination with mash
- Not efficient on spore-forming bacteria (*Clostridium perfringens*, *C. novyi*)
- Efficient on non-spore-forming bacteria, i.e. *Salmonella*, *Listeria*, *E. coli*, etc.
-

CROSS CONTAMINATION

When amperage is too high, sudden discharge of
“uncooked” mash inside finished products side
On new pelleting machine, dedicated discharge pipe



VALIDATION OF PELLETING MACHINE

WHY PELLETING MACHINE VALIDATION: AN EXAMPLE?

- Example: 10 T/h – 15% of proteins – Average level of contamination by ***Salmonella***: around 10 Cells/kg. How many ***Salmonella*** must be killed by pelleting machine?
- Level of contamination of mash entering the conditioner:
 - 15% proteins à 10 CFU/kg = 1 500 Cells/Ton
 - 10 T/h soit 15 000 Cells/hour
 - 3 hours batch: 45 000 Cells/3 hours.
- Another example: 55 T/h
 - 15% proteins à 10 CFU/kg = 1 500 Cells/Ton
 - 55 T/h soit 82 500 Cells/hour
 - 3 hours batch: 247 500 Cells/3 hours.

CONCLUSIONS

- It is essential to evaluate killing capacity of pelleting machine+conditioner DURING INDUSTRIAL CONDITIONS of feed producer, and reduction of entering contamination
 - Contaminated mash with a surrogate (***Enterococcus faecium***) in dry way
 - Contaminated mash with surrogate (***Enterococcus faecium***) in wet way – Inside conditioner at the end of it
 - Contaminated particles with ***Enterococcus faecium***



MULTIPLICATION = WATER

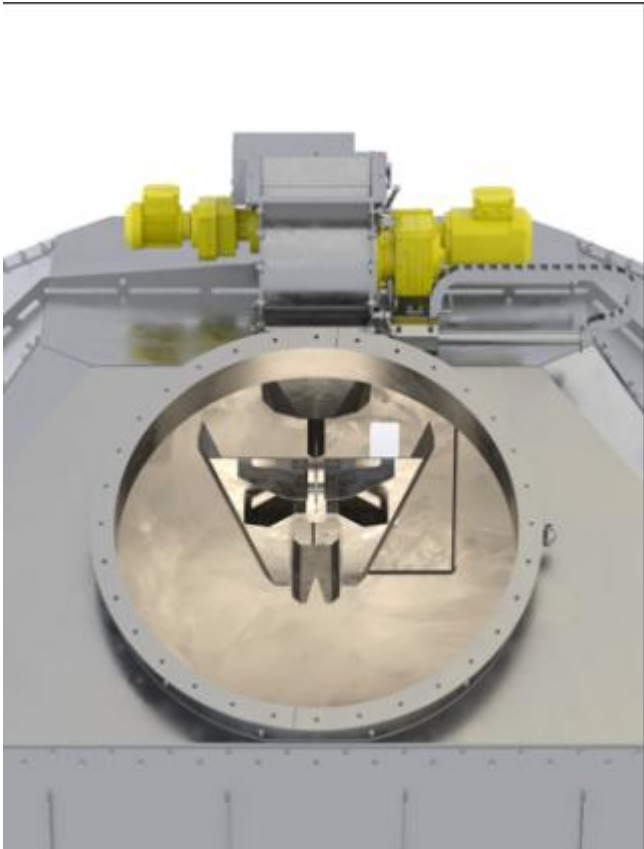
Water from condensation

Water from enzymes addition

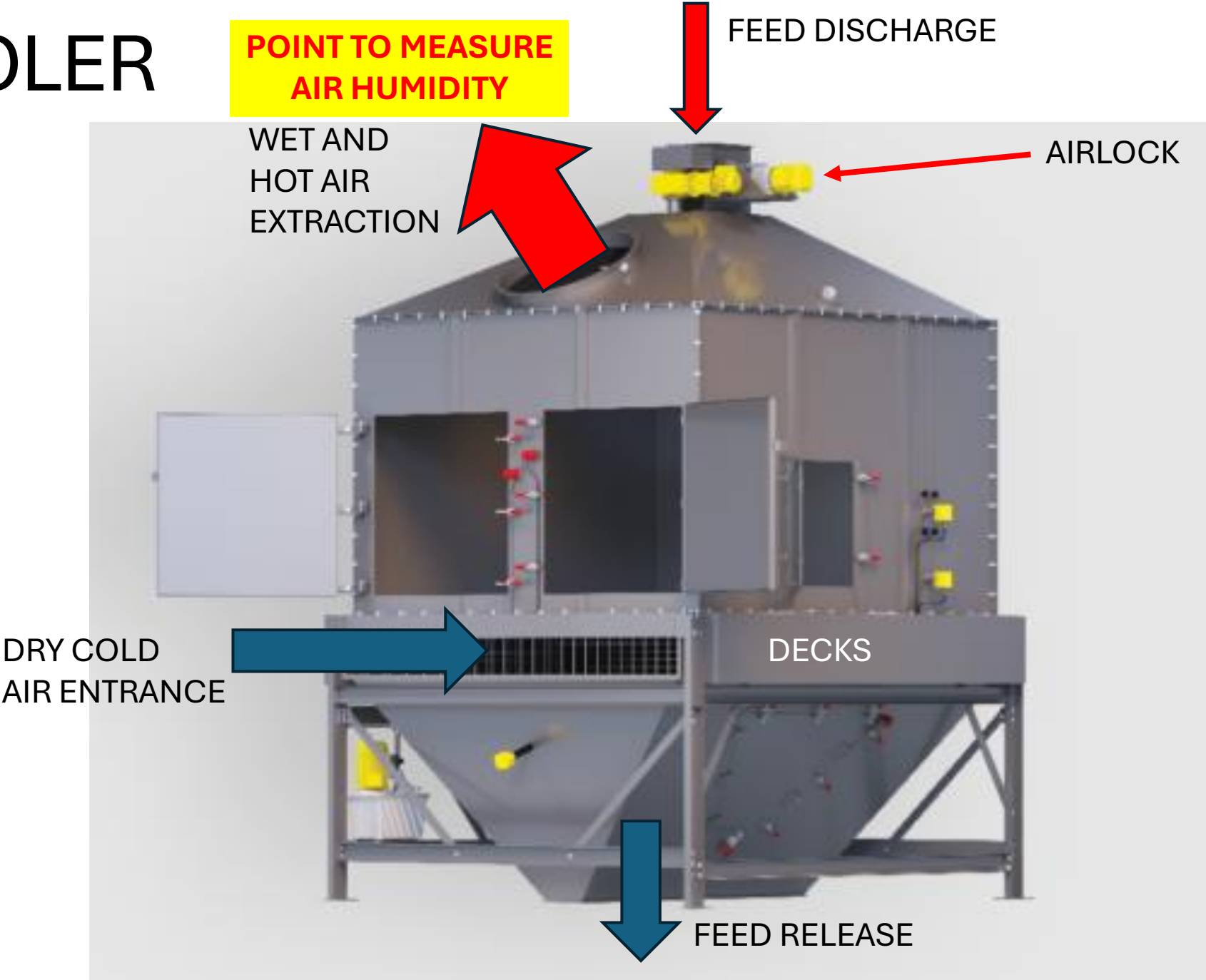
Water from fat

Water from rain ingress

VERTICAL COOLER



Document GEELEN



WATER PROPERLY REMOVED FROM PELLETS: COOLER (15-16% to 12 %)

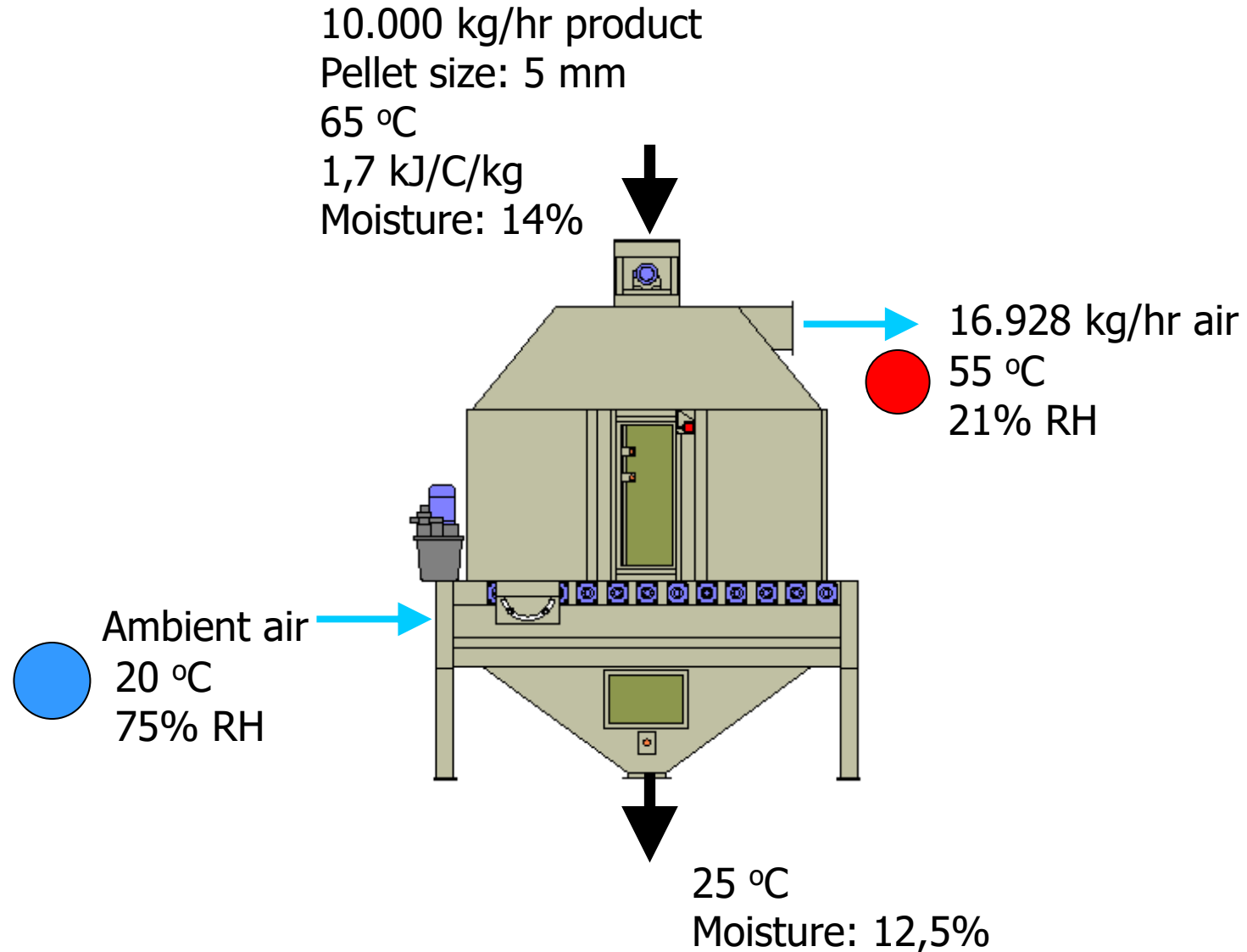
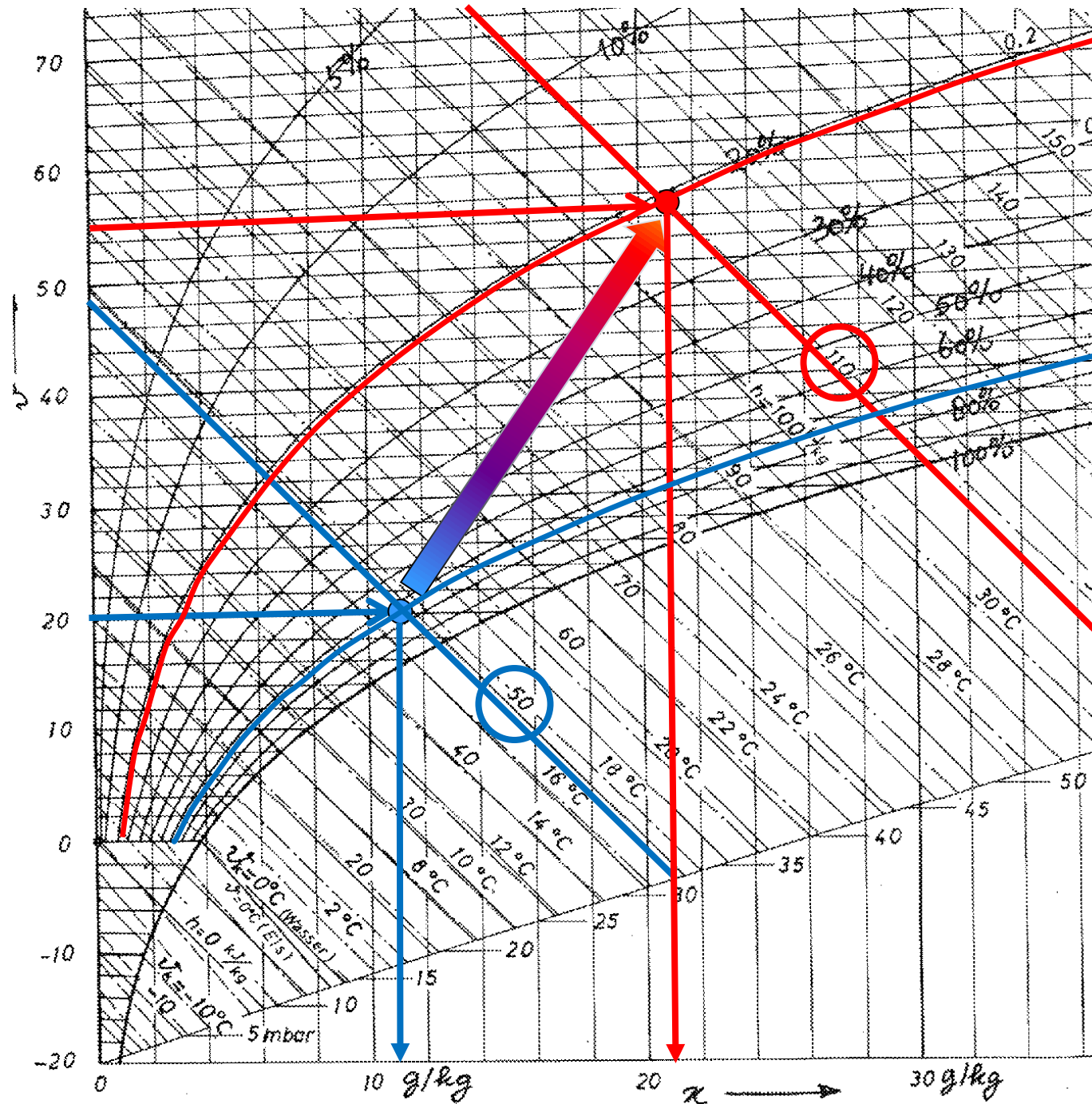


DIAGRAM OF CARLIER

Example: Air Cooler



● 55 °C
21% RH
X=21 g/kg
H=110 kJ/kg

● 20 °C
75% RH
X=11 g/kg
H=48 kJ/kg

EFFICIENCY OF COOLING SYSTEM

QUANTITY OF WATER TO BE REMOVED	QUANTITY OF WATER POTENTIALLY REMOVED BY COOLER
10 Ton/hour of pellets at 14% entering cooler	Ambient air: 11 g of water/kg of air
Almost 10 Tons/hour of pellets exiting cooler at 12,5%	Exhaust air: 21 g of water /kg of air
Quantity of water removed by cooling: around 150 kg	Quantity of water potentially removed by 17 tons of air: 170 kg of water



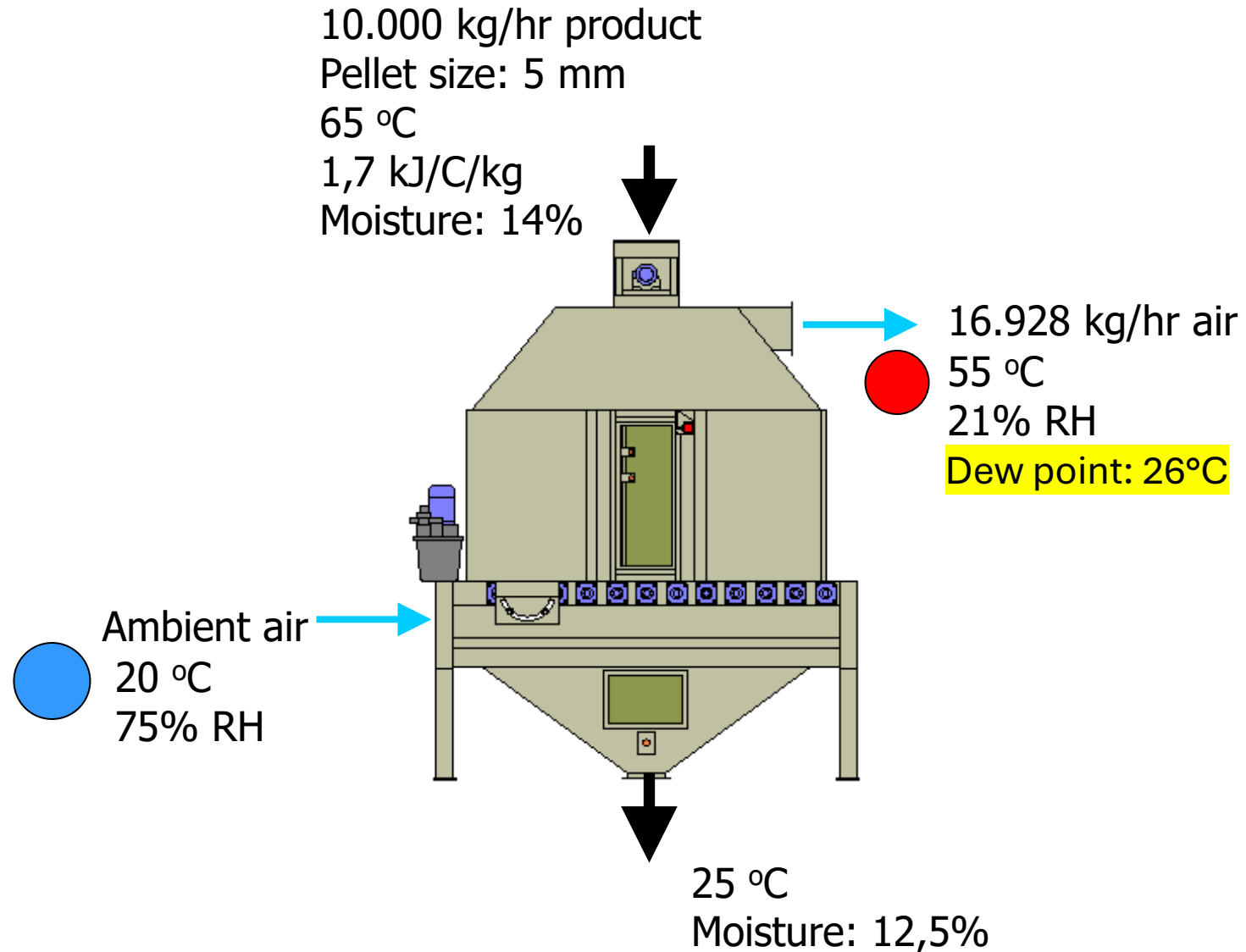
Cooling system efficient

HOW TO MEASURE CONDENSATION?

Physically: dew point

Microbiologically: ***Enterobacteriaceae*** counts

WATER PROPERLY REMOVED FROM PELLETS: COOLER



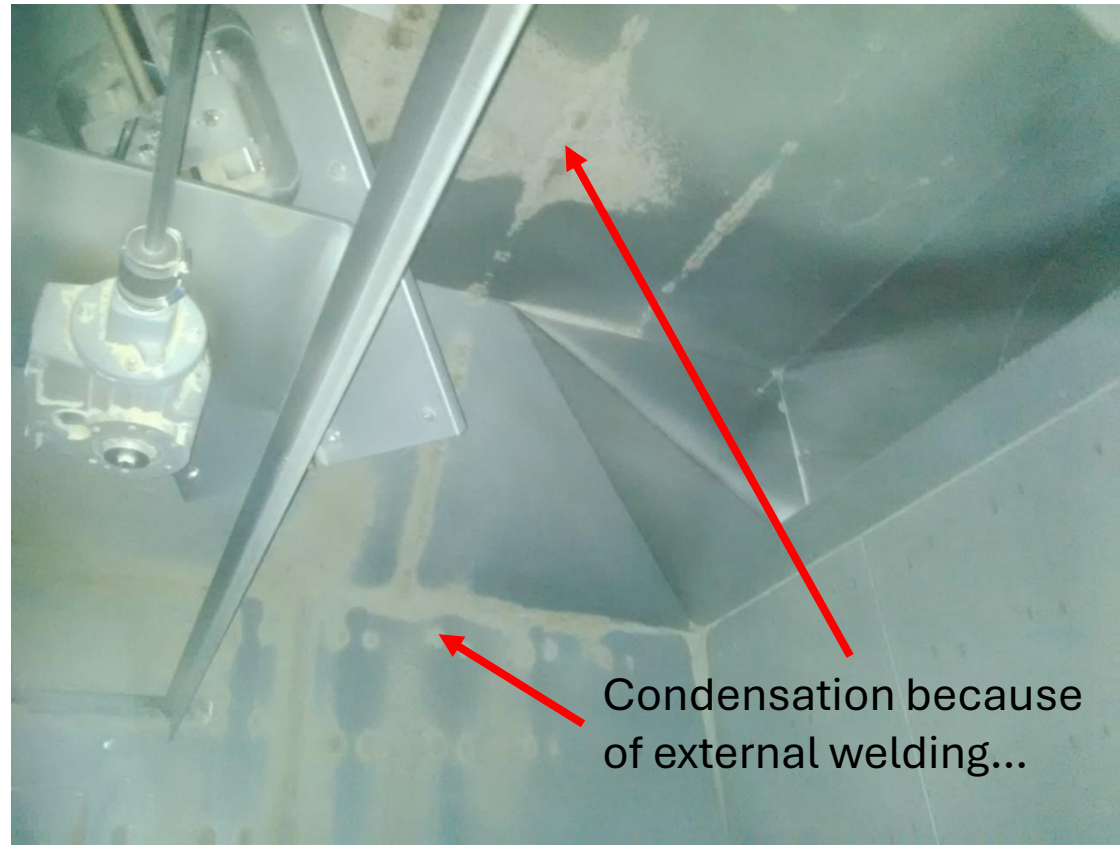
DEW POINT MANAGEMENT

The image displays two screenshots of the MICHELL Instruments software interface. The left window, titled 'Home', features the MICHELL Instruments logo and an 'About' button. It has a 'HIGH HUMIDITY' section with buttons for 'RELATIVE HUMIDITY', 'ABSOLUTE HUMIDITY', and 'MIXING RATIO'. Below this is a 'LOW HUMIDITY' section with buttons for 'MOISTURE IN GASES' and 'MOISTURE IN LIQUIDS'. The right window, titled 'Relative Humidity', also features the MICHELL Instruments logo and a 'Home' button. It has a 'RELATIVE HUMIDITY' section with input fields for 'Temperature' (55 °C), 'Dew-Point Temperature' (25,79 °C, circled in red), and 'Relative Humidity' (21 %RH). At the bottom are 'Reset' and 'Calculate' buttons.

Surface temperature > Dew point: No condensation
Surface temperature < Dew point: CONDENSATION



VISUALIZATION OF CONDENSATION



OTHER POINTS OF CONDENSATION



OTHER LOCATIONS WITH POTENTIAL CONDENSATION

- Cooler cyclone: reuse of fines in conditioner rather than in finished products
- Bottom of elevator/screw: elevator is working as a huge ventilation, pushing condensation towards bottom of elevator (down side)
- Sifter
- Postpelleting: addition of enzymes is addition of water – care with spray nozzles orientation
- Finished products storage silos (condensation underneath ceiling)

CONDENSATION

- Condensation can happen in case of walls temperatures below dew point.
- Solution:
 - insulation and warming of walls
 - Reduction of air entrance humidity (see example on next slide)
 - Increase speed of air ($> 2\text{m/s}$)



**OTHER CRITICAL ORIGIN OF
CONDENSATION: PELLETS**

TRANSFER TO SILOS STORAGE

- At that step, the only predictable microbiological risk is UNPROPER COOLING: feed is still hot.
- Feed will release steam in silos!
- How to measure feed temperature?



AMAZON

VERSUS?





- Feel flask with feed
- Put thermometer probe through the cap into feed pellets or mash
- Wait for 4-5 minutes

CONDENSATION AFTER COOLING

- If temperature of feed is 5-6°C above storage room temperature (be careful with silos AT North and East of factory walls)
- **MAJOR RISK of MOLDS and potentially of *Salmonella***

INSTALLATION

INSTALLATION

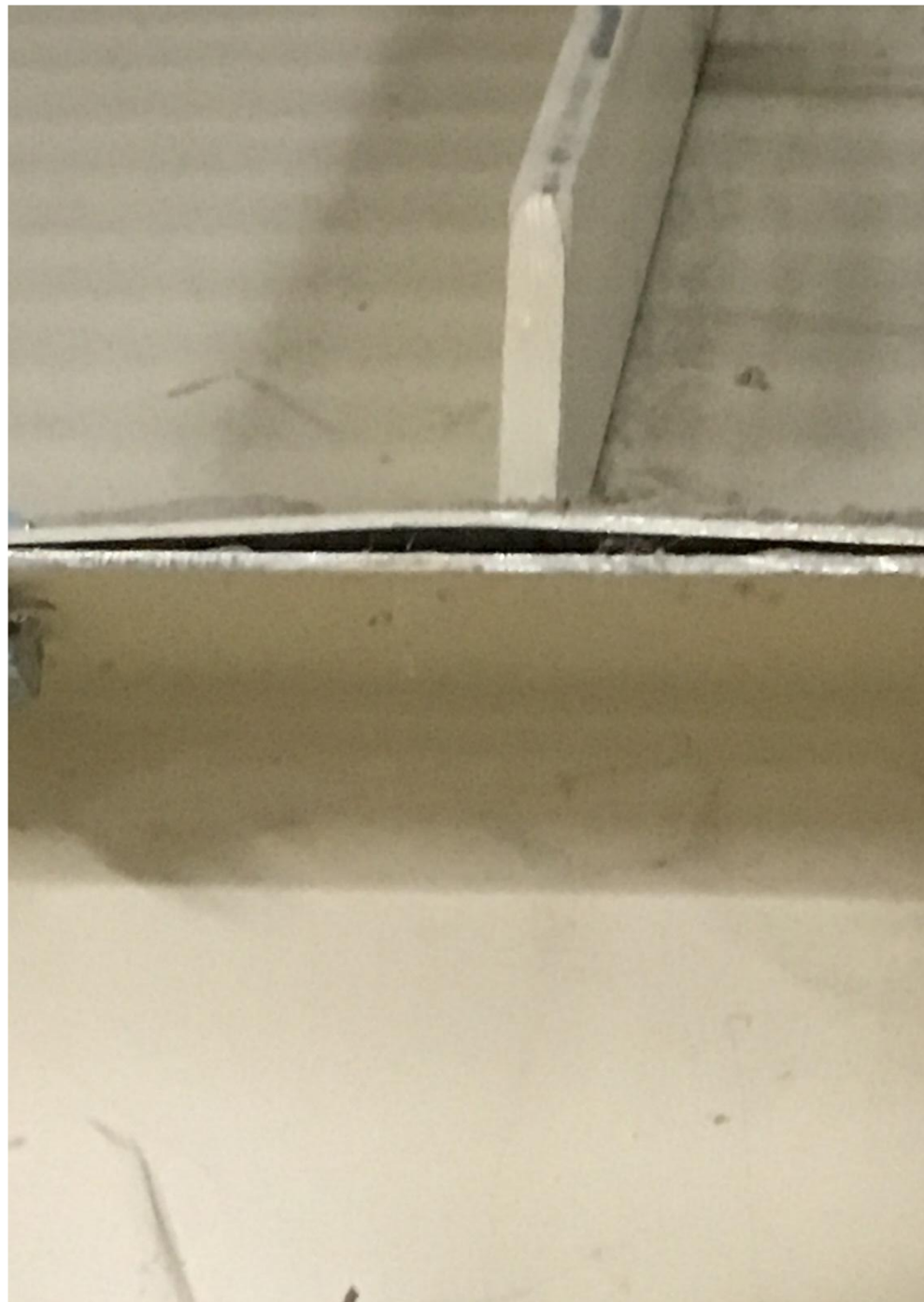
- Retention is starting in part with small holes/not-smooth structure
- When the structure is smooth, retention cannot install



GAPS...

- Example of gap currently found in petfood, feed industry...

-



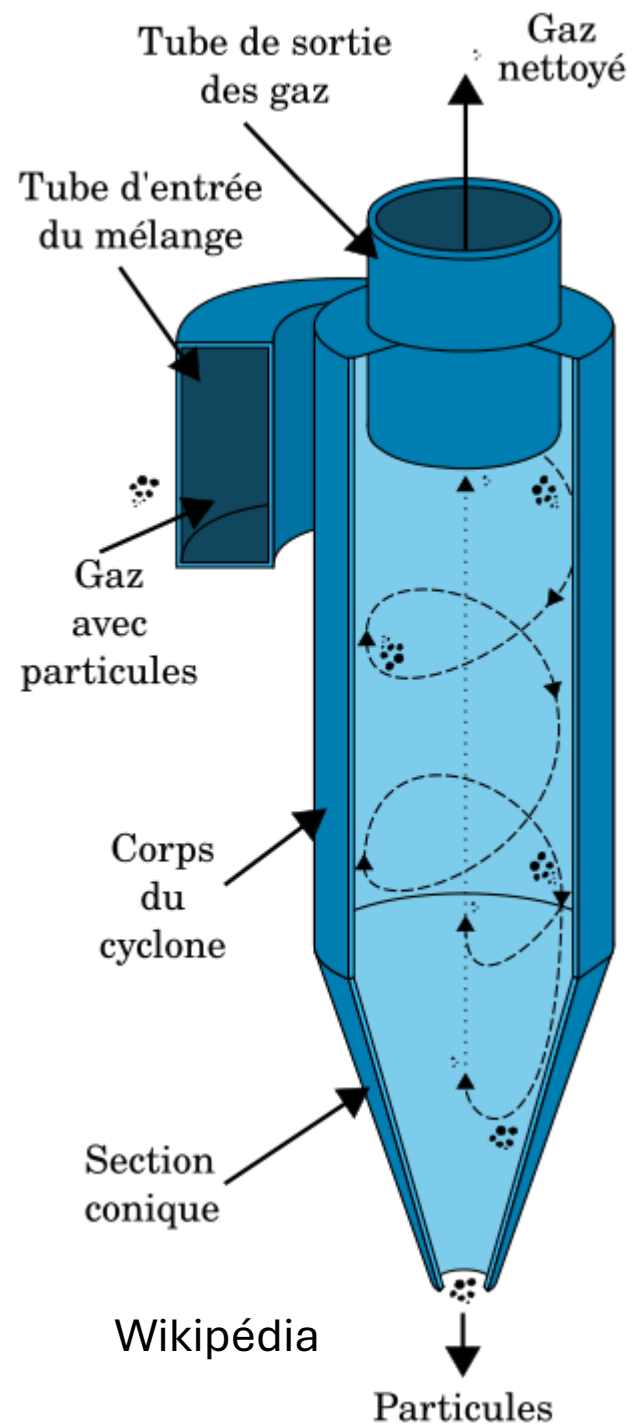


**Gaps opening during production
And closed when line is stopped**



INTERNAL WELDING





CYCLON

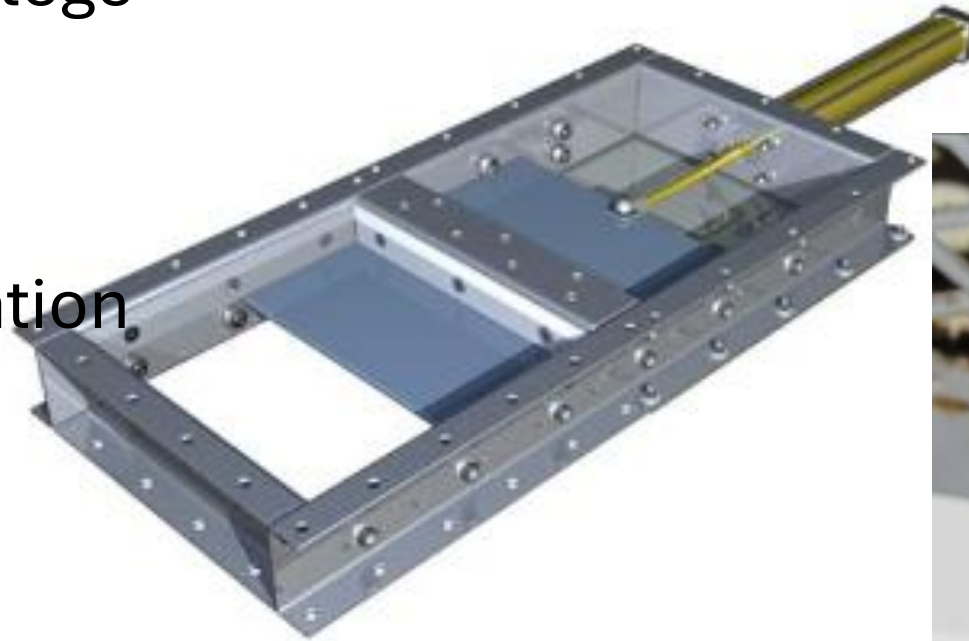
- Design of cyclon
- No access for cleaning



WENGER-Mac

LA TREMIE AVANT ENROBAGE

- Toutes les vannes guillottes sont carénées pour protéger les opérateurs
- Mais dans la boîte qui protège la lame, les produits s'accumulent, rentrent et sortent des équipements entraînant une contamination récurrente (présence d'insectes fréquente)



CONCLUSIONS

Contamination of Final finished product In feed mill is the consequence of a parameters:

- Introduction with raw materials and decontamination by conditioner/expander/pelleting machine
- Installation because of retention points
- Multiplication because of condensation/poor cooling of pellets/water ingress during rain
- Dissemination can be measured ONLY

CONCLUSIONS

Facing a Quality of Food Safety issue during feed production process may help developing a clear strategy:

- NEVER trust on FINISHED products sampling plan. Look at environmental sampling plan or FINES
- Killing step ... is NOT a perfect killing step... only decontamination. Check pelleting machines, mainly at restarting, and avoid cross-contamination
- EVERYWHERE in your line, check for condensation. WATER is your ENNEMY!!!
- Design of equipment is part of supplier, part of factory maintenance
- Finally, make synthesis of all these data to define parameters for safe productions, batches.
- All together, you will be able to get rid of this situation

Thank you for your participation!