



2018

# THE ALMOND CONFERENCE

ALMOND PASTEURIZATION: LANDSCAPE OF  
TECHNOLOGIES/EQUIPMENT (PART 2)

ROOM 306-307 | DECEMBER 5, 2018



# AGENDA

- **Tim Birmingham**, Almond Board of California, moderator
- **Ramesh Gunawardena**, JBT
- **Paul Favia**, Laitram Machinery
- **Jim Becker**, Revtech





# JSP-C Hybrid Steam Pasteurization System

## Almond Conference

Ramesh Gunawardena / December 5, 2018



# Overview

- Objective
- Background Modes of Heat & Mass Transfer
- Actionable approach to determine the variables with the greatest influence
- Describe the overall pasteurization model
- Conceptual design
- Principles of operation applied to next generation solution
- Validation considerations
- Processing capacity and cost of ownership
- Design features - an emphasis on functionality, simplicity, performance
- Q & A



# Objective

How we started:

Apply knowledge of cooking principles to surface pasteurization of low moisture foods

Where we are today: A technology update

# 3<sup>3</sup> Factorial Arrangement -Background



Oven Temperature	Percent MV	Fan Speed	Air Velocity (ft./min.)	
375°F	40	50(2250)	75(3375)	100(4500)
	60			
	80			
425°F	40			
	60			
	80			
475°F	40			
	60			
	80			



- Process by which heat energy is delivered to a bulk product for the purpose of .....?
- Path Specific
- Factors involved in heat transfer
  - Temperature
  - Heat Mode
  - Thermal Conductivity

# Variables to Consider

Heat to the product surfaces



Heat to the product surfaces

## Equipment

- Operating temperature
- Humidity
- Velocity
- Heat transfer rate
- Dwell time

## Product

- Surface temperature
- Core temperature
- Thermal conductivity
- Product bed depth
- Specific heat
- Thermal diffusivity





# Heat Transfer Modes -Background

**Heat transfer occurs through three basic modes:**

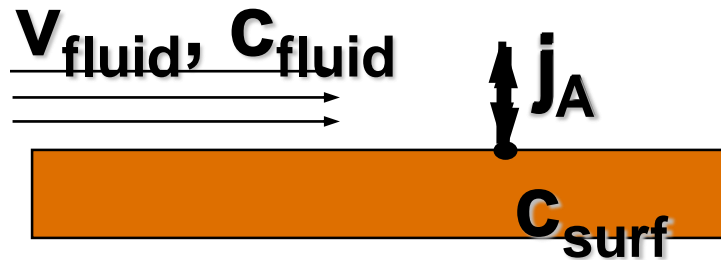
- **Conduction**
- **Convection**
- **Radiation**

**Heat is also exchanged as a result of mass (water) condensation or evaporation.**

# Modes of Mass Transfer -Background



Diffusion  
Convection



*Condensation* when

$$T_{\text{air,dewpoint}} > T_{\text{product, surface}}$$

*Evaporation* when

$$T_{\text{air,dewpoint}} < T_{\text{product, surface}}$$

# Development Objectives Vs. Design Considerations



## Development Objectives

Provide consistent >5 Log reduction of SE PT-30

Maintain natural quality and product characteristics

Design must ensure that all nuts on the conveyor receive identical treatment

## Design Considerations

Rapid and lethal energy transfer

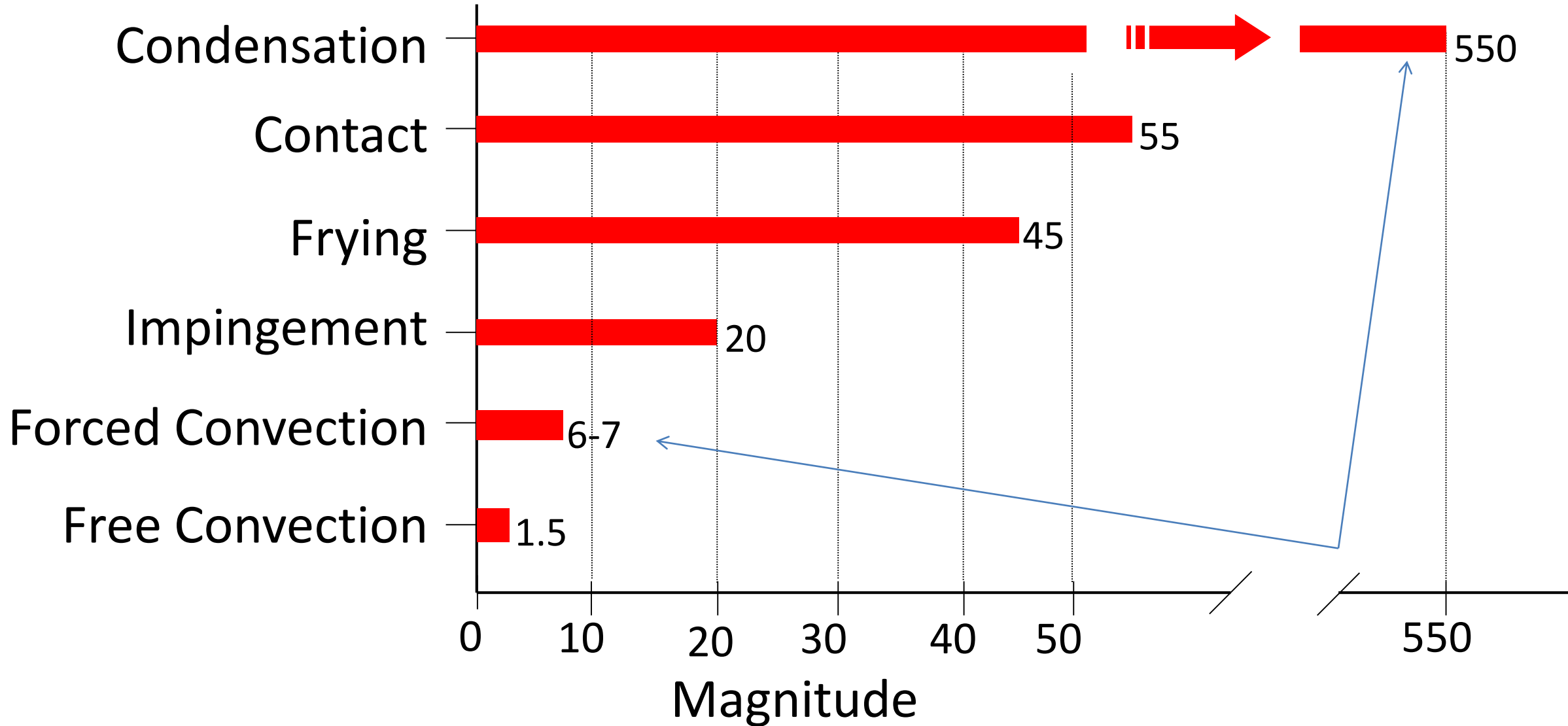
Compress time

Heat transfer mechanisms arranged in the proper sequence

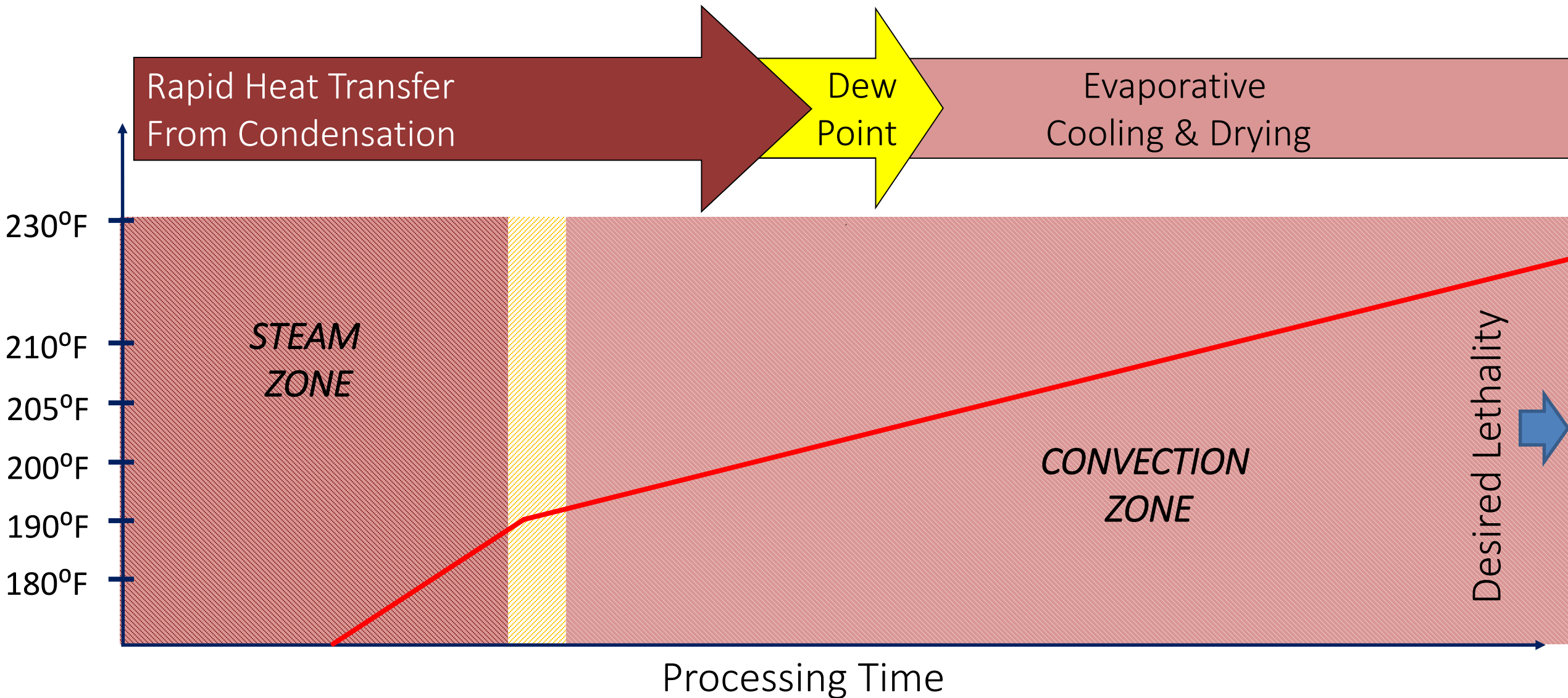
Uniform energy transfer through

- Correct fluid conditioning
- Fluid distribution balance

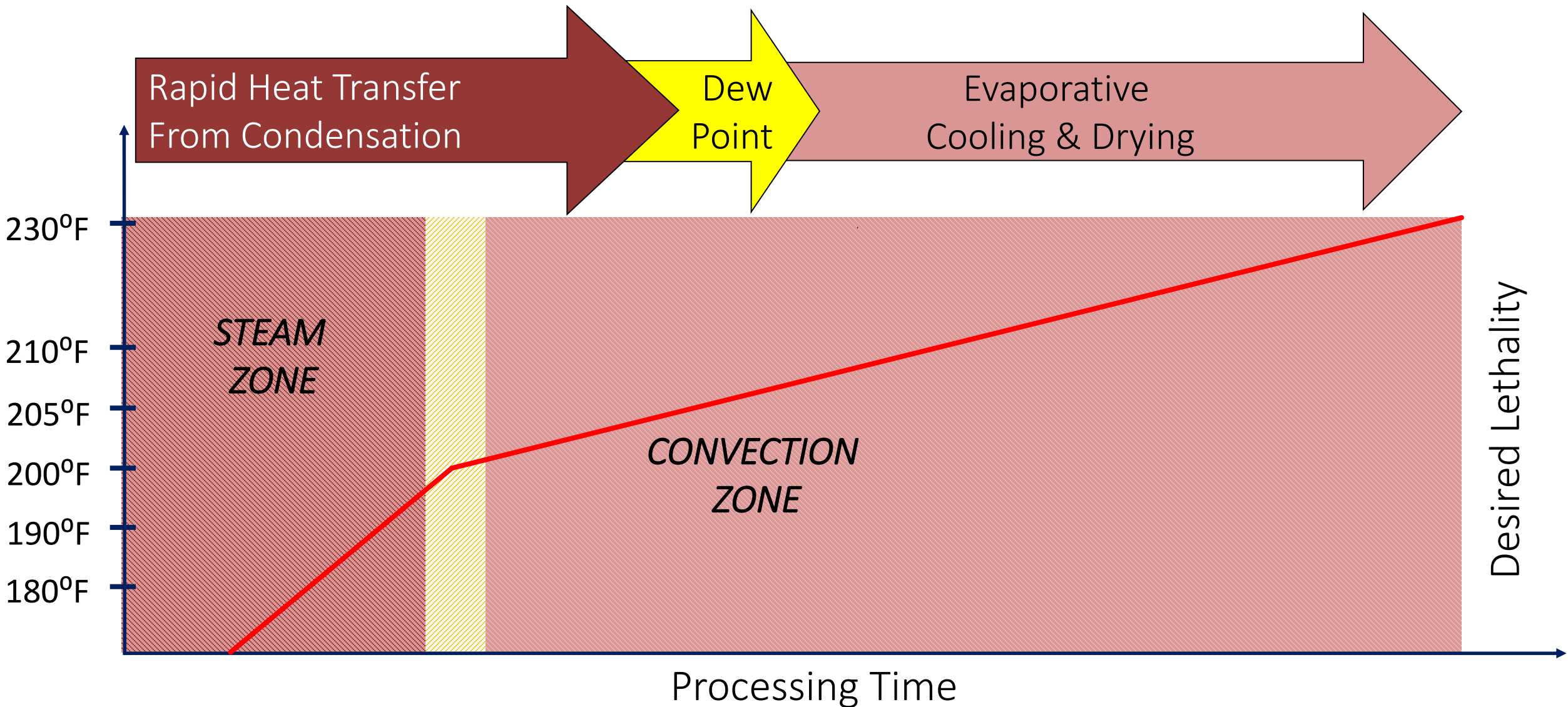
# Effective Heat Transfer Coefficients (Btu/hr-Ft<sup>2</sup>-°F)



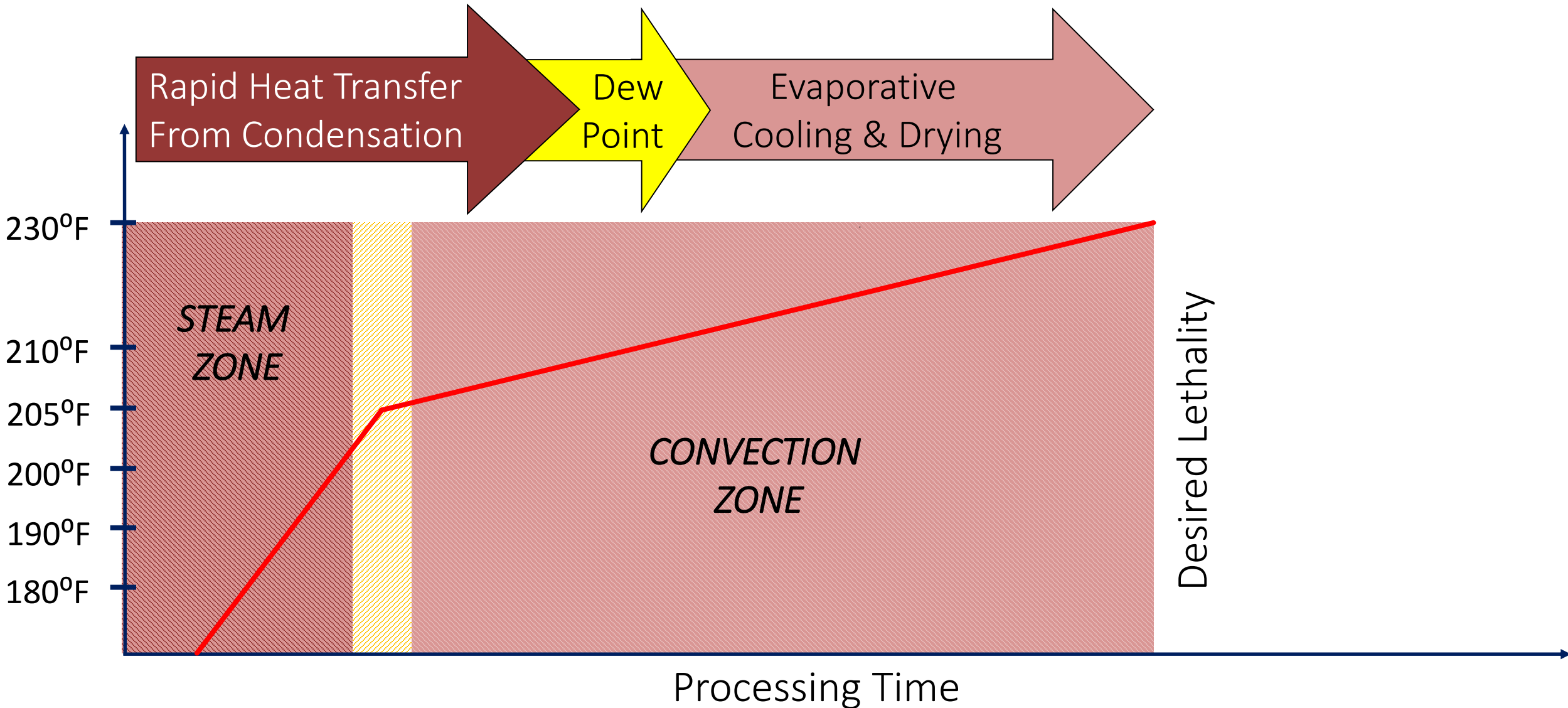
# Pasteurizing with High Humidity



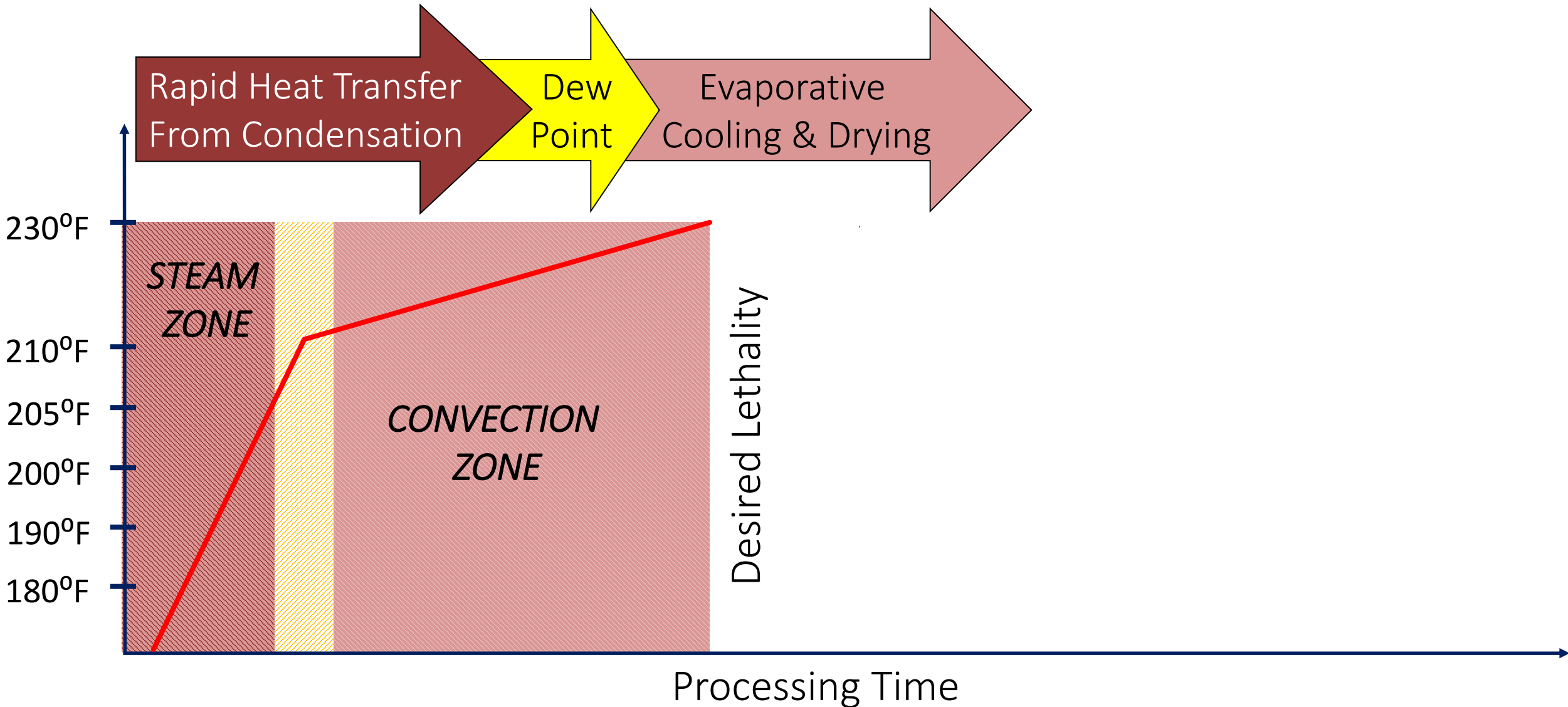
# Pasteurizing with High Humidity



# Pasteurizing with High Humidity



# Pasteurizing with High Humidity





# Modeling the process

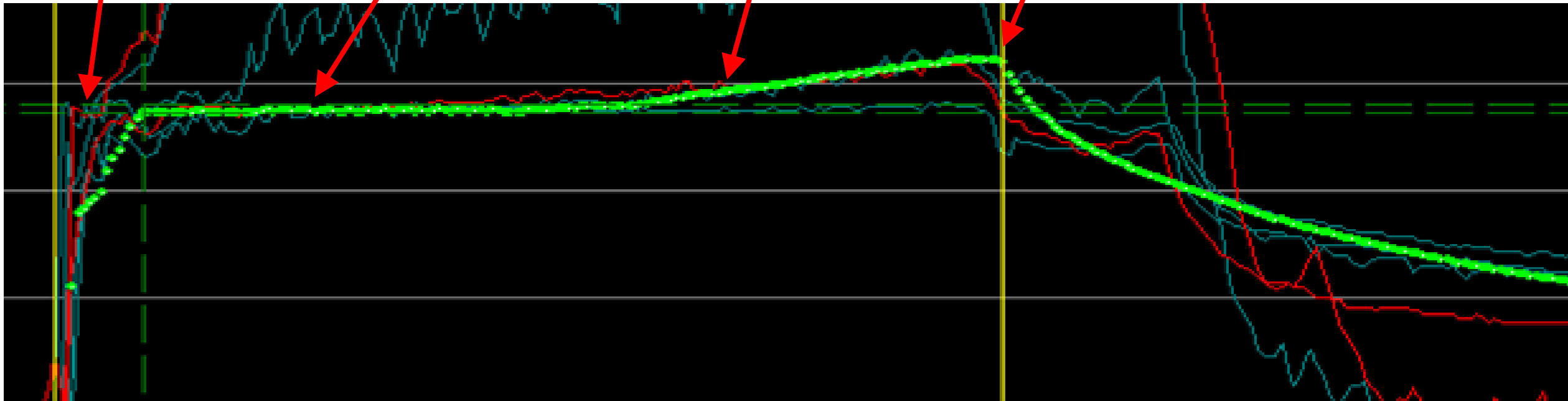


High Condensation

Drying

Exit the Pasteurizer

Condensation & Evap. Cooling



# Jet Steam Pasteurizer Concept



Hybrid System

Zone 1:

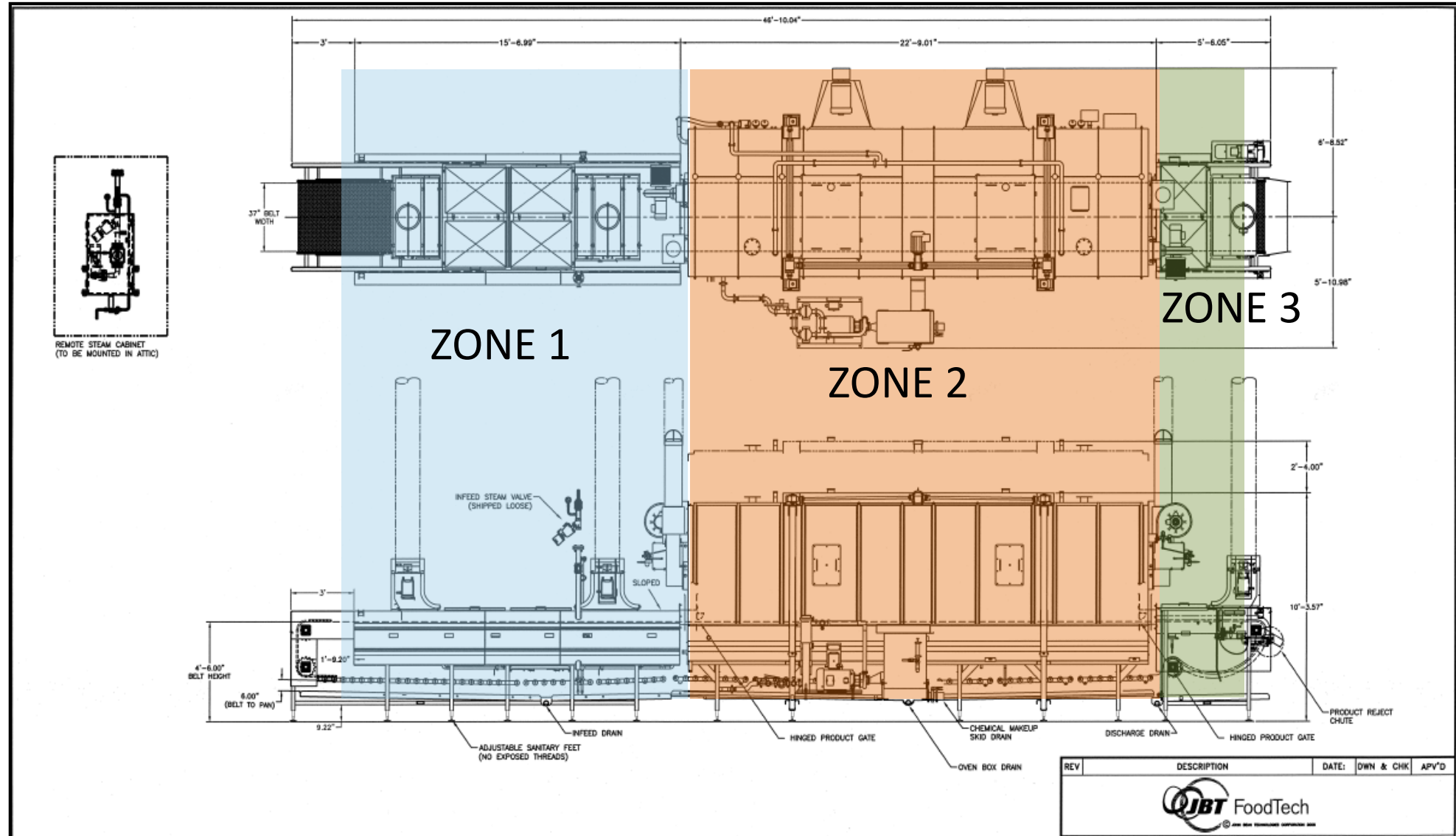
>90% MV

Zone 2:

80-82% MV

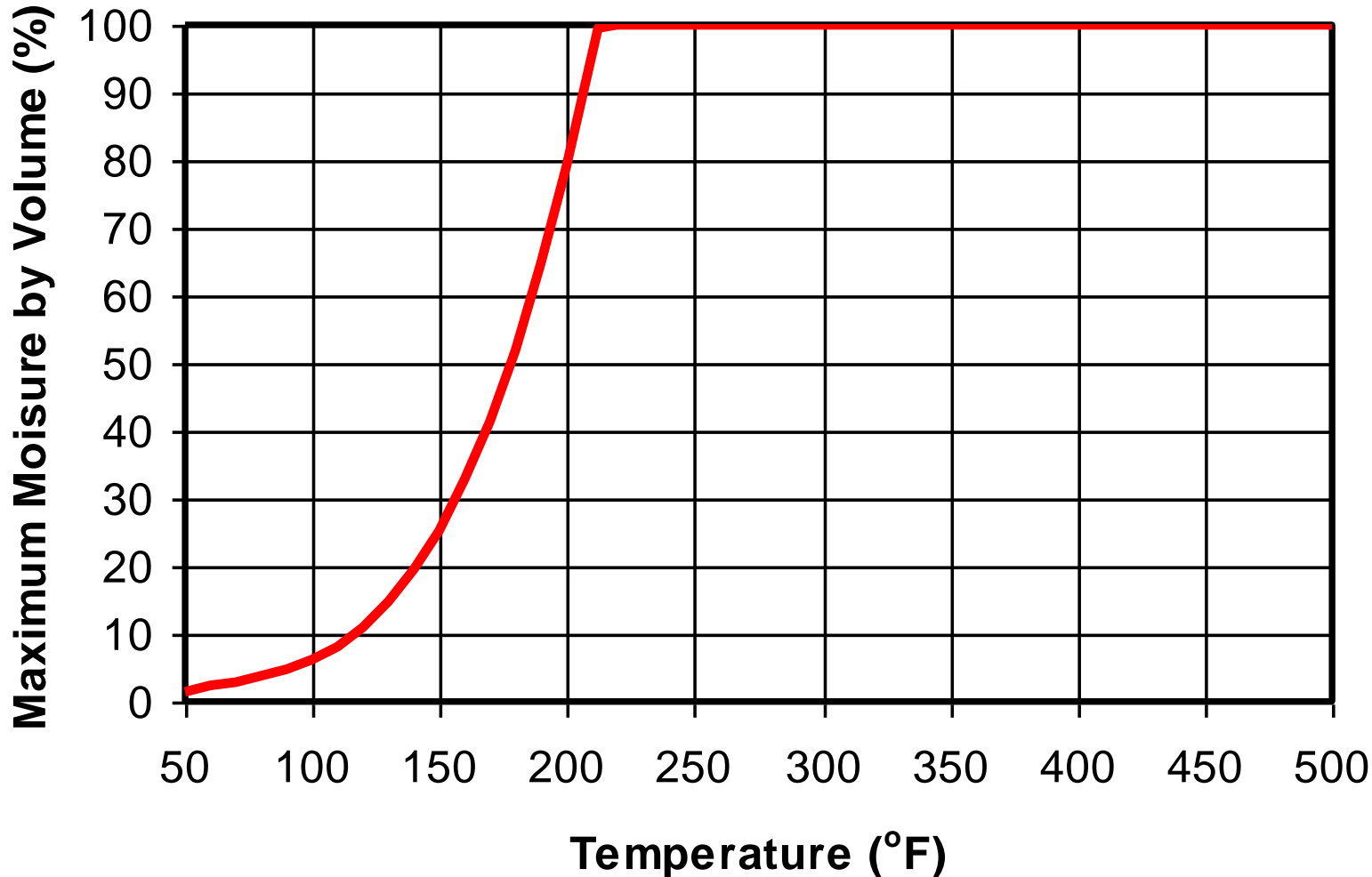
Zone 3:

Discharge



# Moisture by Volume

A better humidity scale for  $T > 212^\circ\text{F}$  ( $100^\circ\text{C}$ )



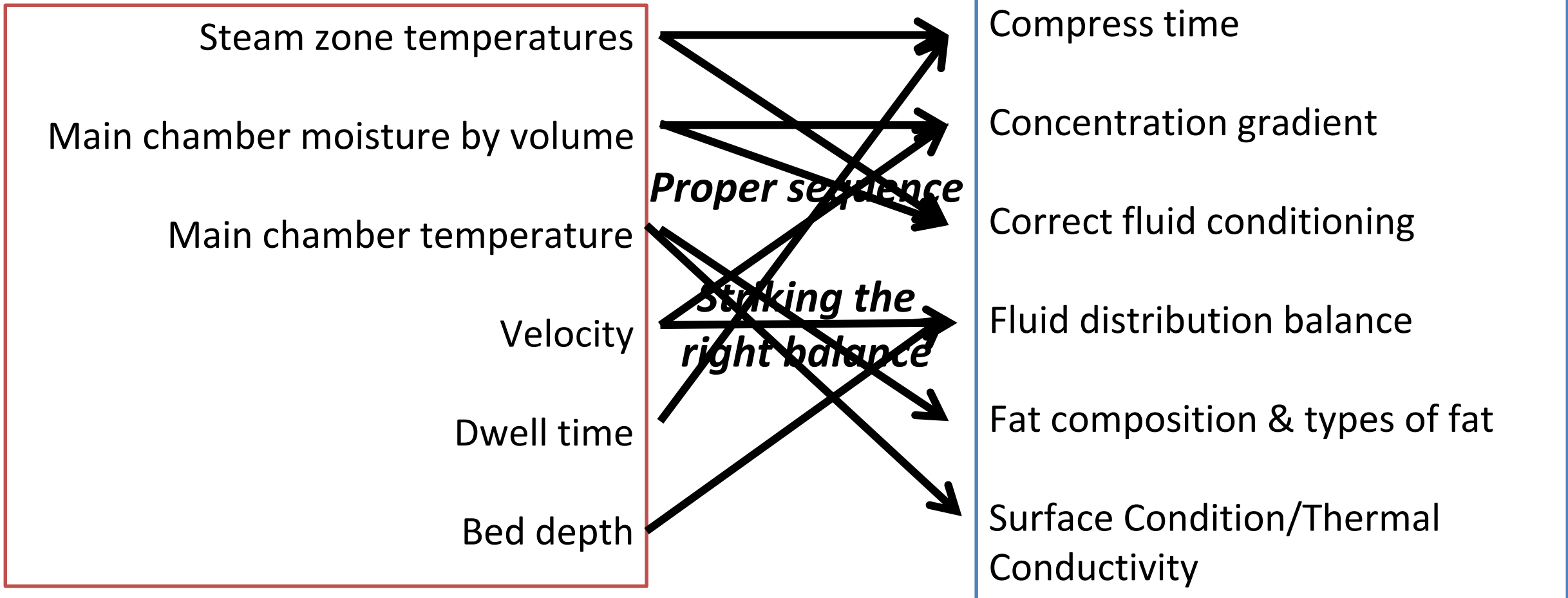
- Humidity
  - relative humidity
  - moisture by volume
  - dew point temperature
- All of the temperature and humidity values are linked by thermodynamics
- $RH = (p_{\text{water}} / p_{\text{saturation}}) \times 100$



# Criteria for Lethality Vs. Product Quality

## Critical Control Parameters for achieving lethality & Purpose

## Essentials for Controlling Product Quality



# Possible causes of surface defects Vs. Corrective actions



## *Loose skins in almonds(example)*

### **Causes of surface defects**



Localized Vapor stagnation

Prolonged exposure in wet steam

Limited pathway for vapor release

### **Corrective actions**

Lower bed depth

Increase zone velocity

Adjust the bed depth

Fluid distribution balance

Raise the operating temperature

Understand where



## Additional Processing Considerations for quality

- Product quality needs to be measured over time
- Degradation over time measured by FFA's & PV
- Oxidative degradation less at lower temperatures
- Review thermal properties
- Employ design of experiments
- Use existing scientific knowledge to reduce the number of trials

# 3<sup>3</sup> Factorial Arrangement - Almonds



Velocity held constant – for providing fluidization

Oven Temperature	Percent MV	Dwell Time 55s	Dwell Time 64s	Dwell Time 74s
370°F	75			
	78			
	81			
380°F	75			
	78			
	81			
390°F	75			
	78			
	81			

Response variables: PV, FFA, Bacterial Count

# Production Feed to the Pasteurizer



Metering Gate

Vibratory Feed Conveyor

Infeed JSP-C



# JSP-C Pasteurizer Designed With Vision Of The Future



# JSP-C Pasteurizer – Hood in Elevated Position



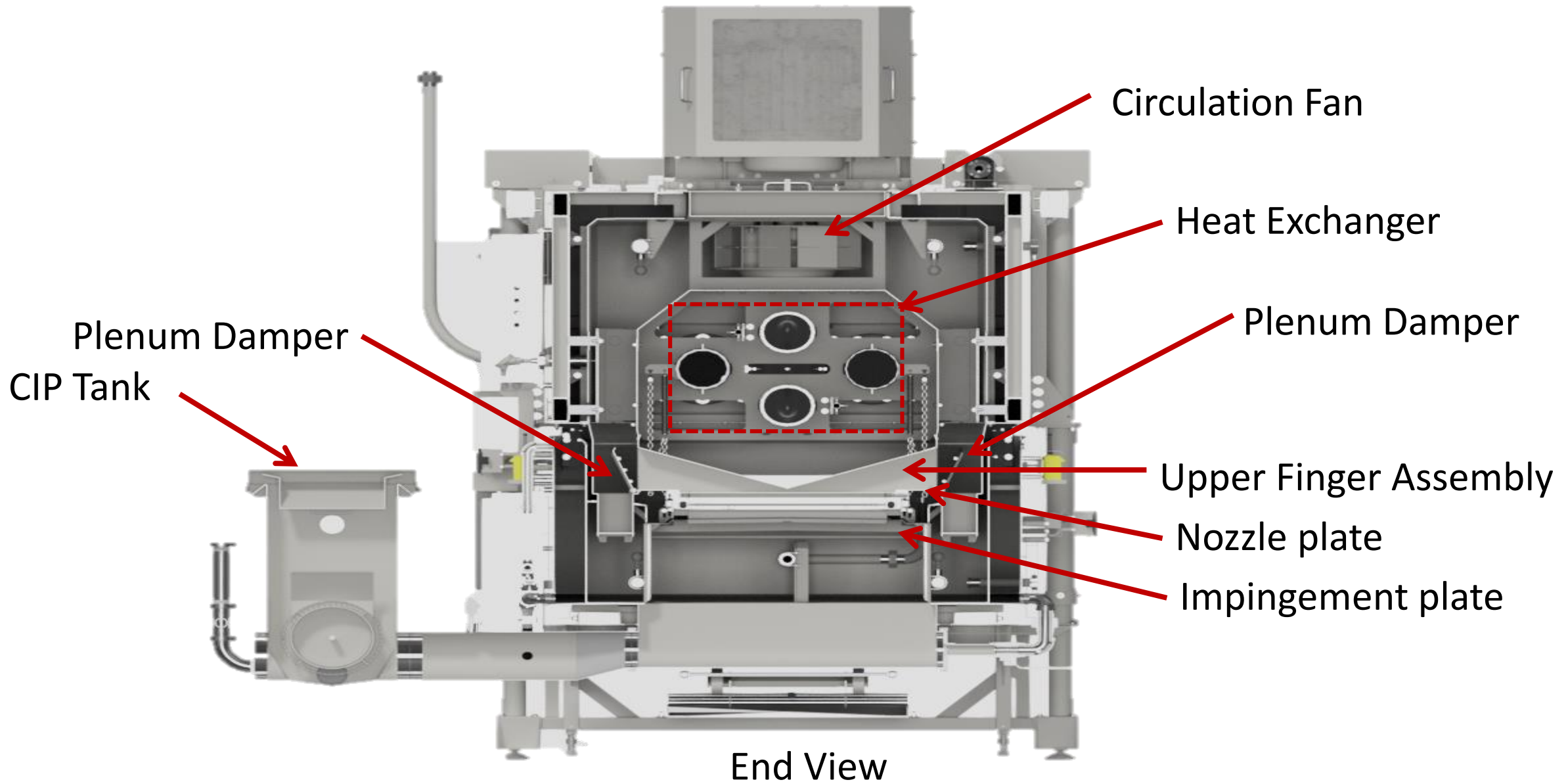
Easy Access After CIP

# JSP-C Pasteurizer – Hood In Operational Position

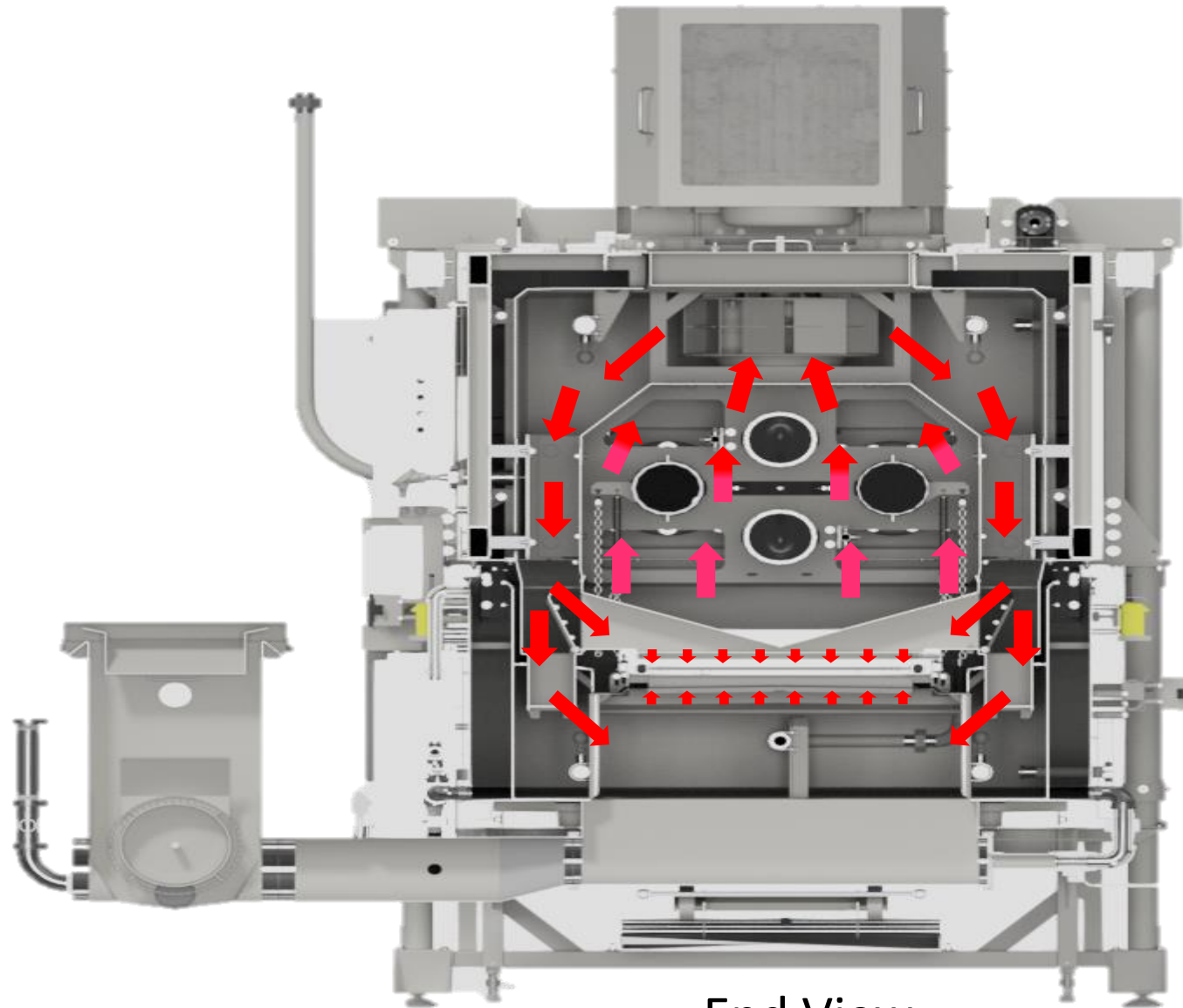


Full Perimeter Seal

# JSP-C Pasteurizer – Key Functional Elements

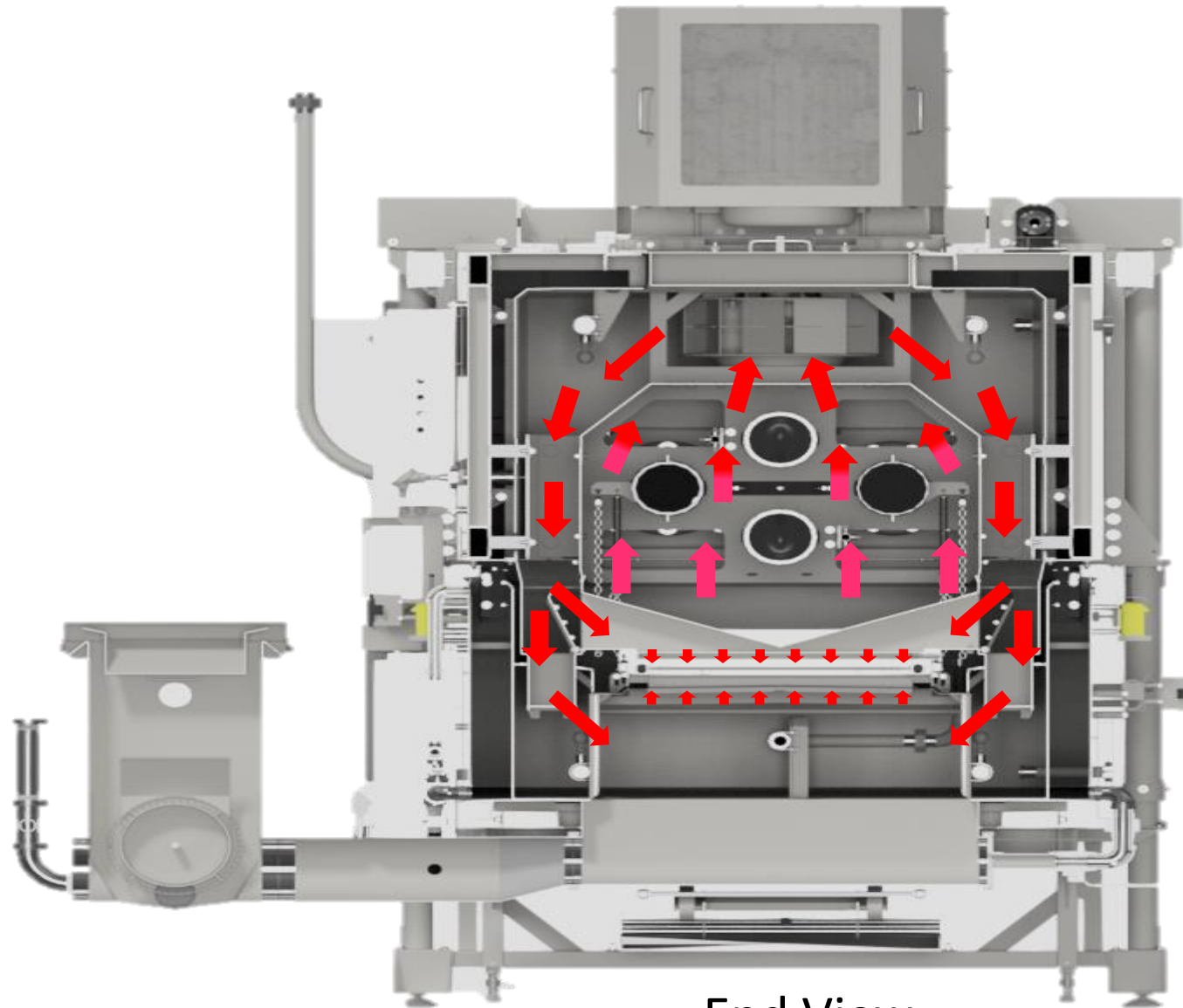


# JSP-C Pasteurizer – Supply & Return Airflow Paths



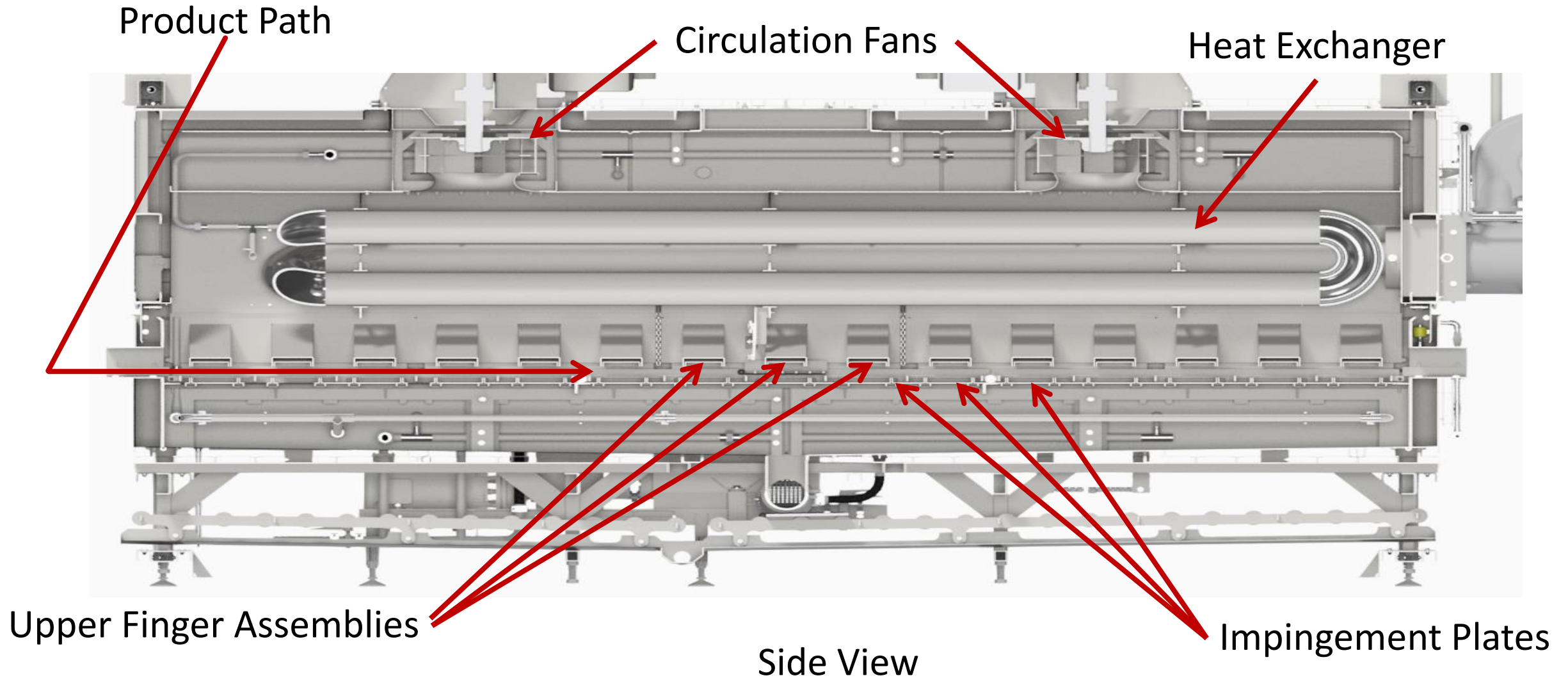
End View

# JSP-C Pasteurizer – Supply & Return Airflow Paths

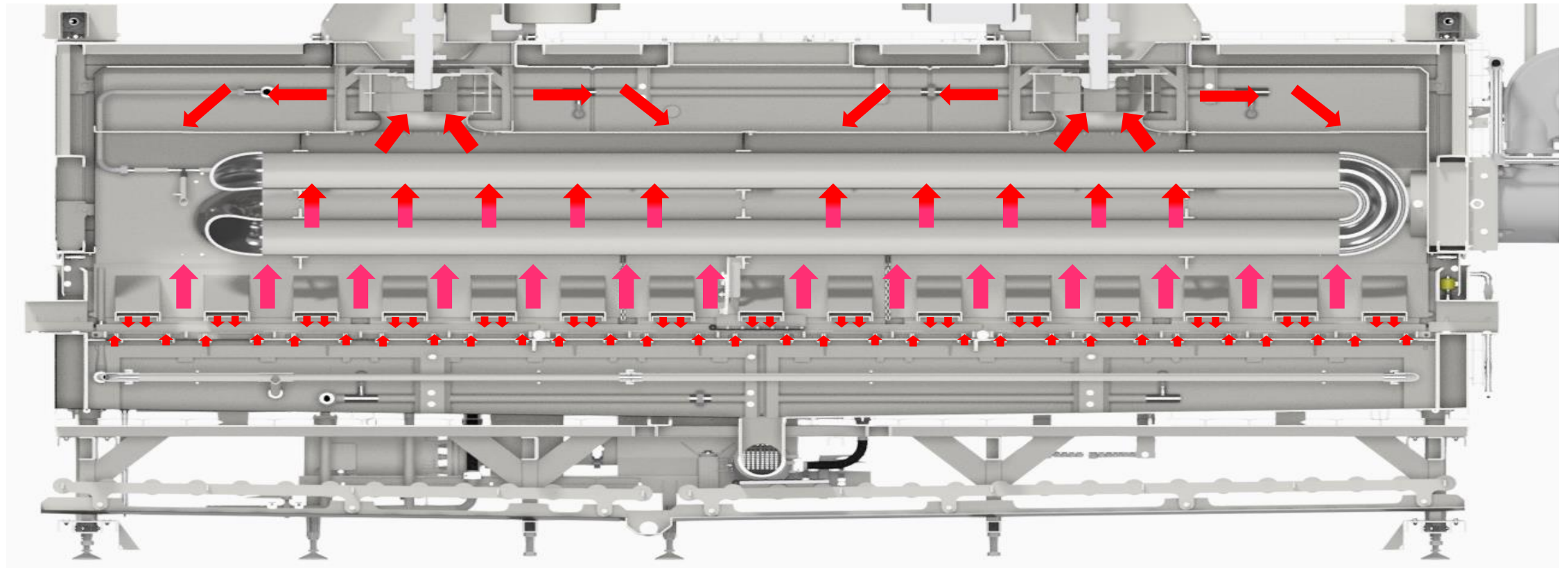


End View

# JSP-C Pasteurizer – Key Functional Elements



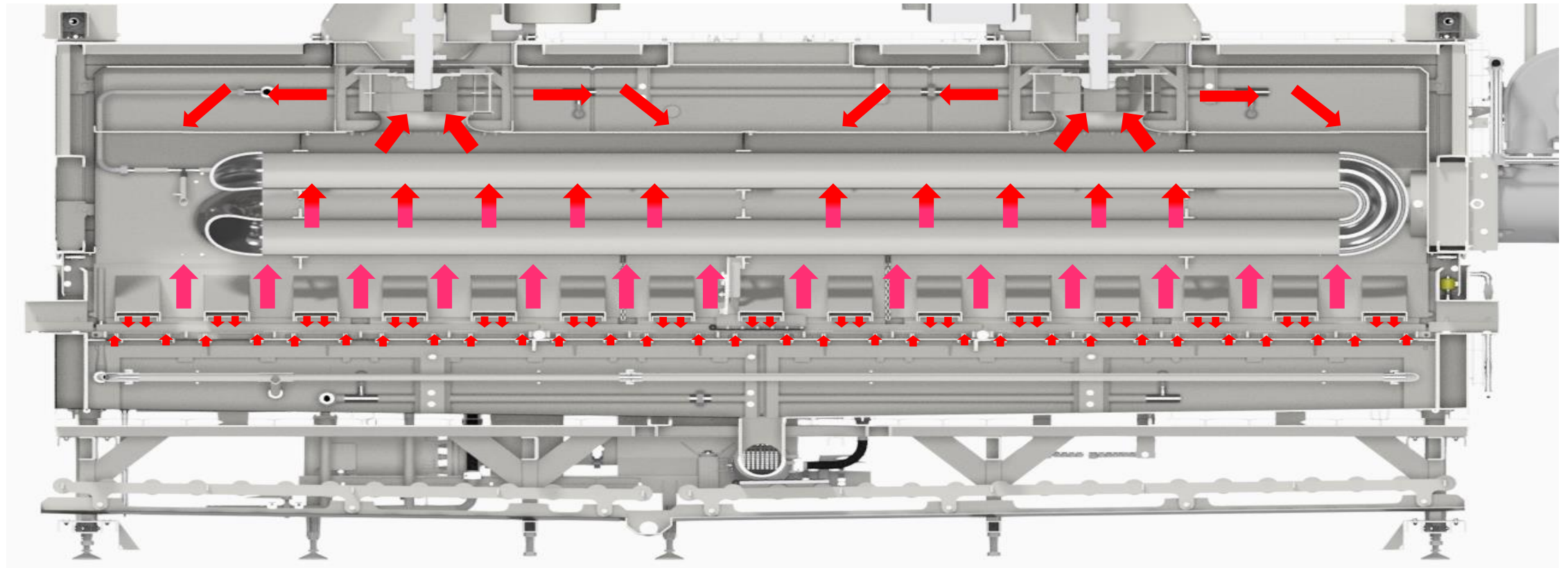
# JSP-C Pasteurizer – Supply & Return Airflow Paths



Side View

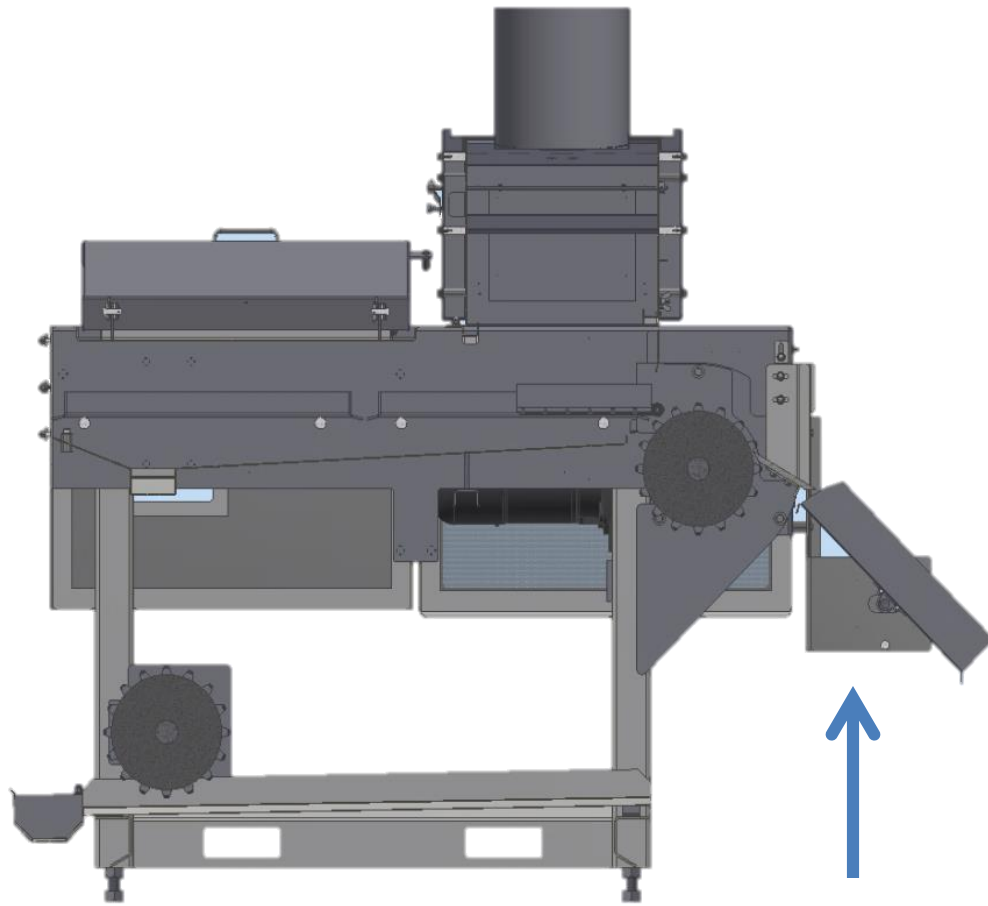


# JSP-C Pasteurizer – Supply & Return Airflow Paths

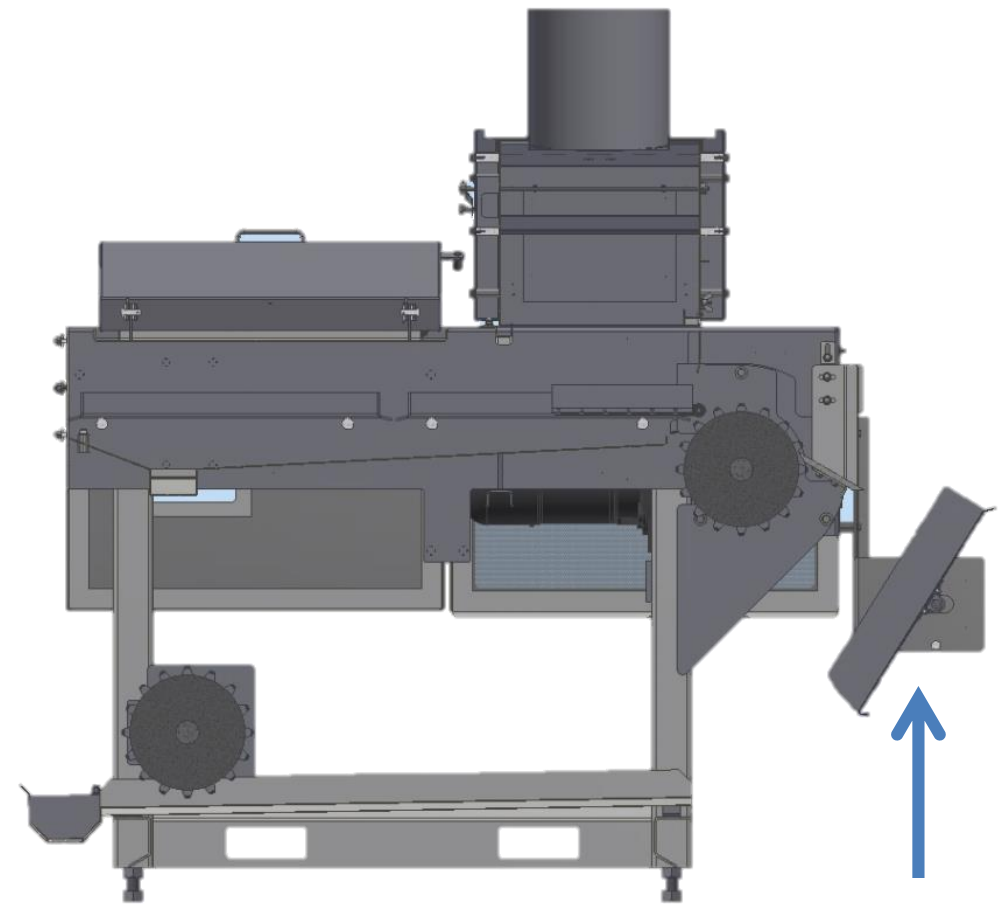


Side View

# JSP-C Pasteurizer – Discharge Diverter Gate



Production Mode



Bypass Mode

# *JSP-C Almond Pasteurization System – Benefits*



- **Continuous process**
- **Cleaner product with greater product appeal**
- **Very short dwell times**
- **Shorter foot print**
- **Drying is part of the process**
- **Low operating cost ~ 0.35 Cents/Lb.**





# Processing Capacity and Cost of Operation\*

- **Pasteurization Capacity up to 4300 lbs./hr.**
- **Effect on yield: Negligible**
- **Operational Cost: \$32.76/hour for Gas, Electricity and Water**
- **\$0.0312/lb. based on 4300 lbs./hr.**

\*Based on JSP-C 2416

# Throughput Rates for the JSP-I-4022 & JSP-C-2416



JBT pioneered their unique hybrid steam pasteurization process for almonds and received Almond Board of California's TERP approval in 2006. Since then JBT has also developed processes with onsite validations completed for Walnuts, Hazel Nuts (in-shell and kernels) and Cashews using the ABC protocols. Throughput rates for pasteurized nuts at a 5 log reduction of Salmonella Enteritidis PT-30 at the equipment discharge are as shown in the table below.

Product	Throughput in JSP-I-4022 Lbs./Hr.	Throughput in JSP-C-2416 Lbs./Hr.	Throughput Basis
Almonds	18,000	7,700	Validated process since Feb. 7, 2006
Walnut -Halves	14,000	6,000	Validated process since July 21, 2017
Walnuts-Pieces	13,000	5,600	Validated process since July 21, 2017
Hazel Nuts	8,500	3,600	Validated process since May 16, 2017
Cashews	14,200	6,100	Validated process since June 15, 2017
Pecans	16,000	6,900	Range finding completed
Macadamias	8,000	3,500	Range finding completed
Peanuts	18,000	7,700	Range finding completed



Your turn to ask  
questions



# STEIN JSP-C



JBT Technical Training Department  
offering training in:

**coating, frying & oven cooking applications,  
line operations, maintenance, sanitation,  
safety, customized training, and more**

at your site or in our  
**Food Processing Technology Center**

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# Almond Pasteurization Landscape of Technologies Almond Conference 2018

COOLSTEAM® PASTEURIZATION

Presented by Paul Favia – Crystal Process Equipment



**Laitram  
Machinery**

[www.laitrammachinery.com](http://www.laitrammachinery.com)



# Pasteurization... Safety and Quality

## Pasteurize (Verb)

1. To expose a food to an elevated temperature for a period of time sufficient to destroy certain organisms, as those that can cause disease or spoilage, without radically altering taste or quality.

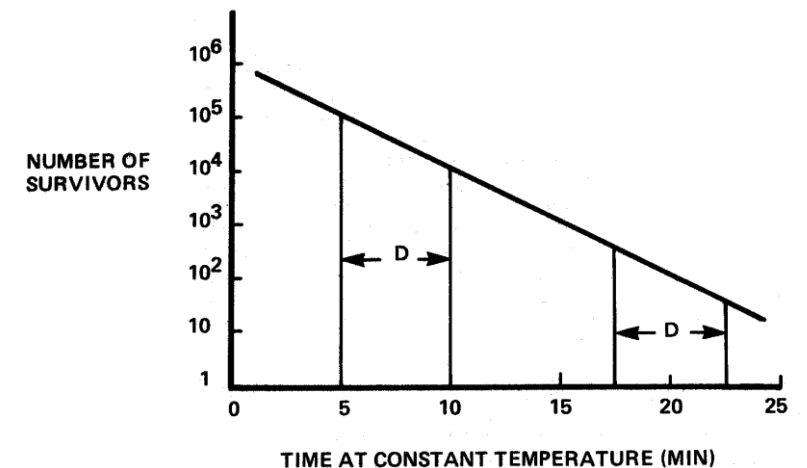
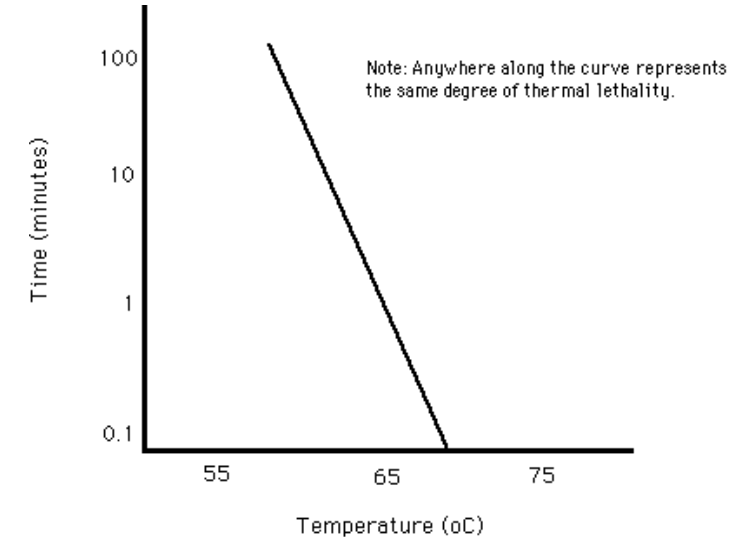
- China 1117 AD – Heating of wine for preservation
- France 1679 – Denis Papin invents the Pressure Cooker
- Italy 1768 - Lazzaro Spallanzani discovers heat will sterilize meat broth
- France 1795 – Nicolas Appert begins modern canning in glass.
- England 1810 – Peter Durand expands Apperts work to tin cans
- France 1864 – Louis Pasteur pioneers low temperature treatment of wine
- USA, 2007 – Pasteurization of almonds is mandated



- ✓ Regulatory Compliance
- ✓ Customer Requirement
- ✓ Liability Mitigation
- ✓ Doing the Right Thing

# Pasteurizing with Steam

- “Expose to... elevated temperature for a period of time” = Heat Units!
- Steam temperature and method of application directly impacts product characteristics.
- Two key relationships
  - Time and Temperature = Heat Units
  - Heat Units and Lethality = Desired Log Reduction



# Challenges with Nut Pasteurization

- Nuts are a delicate product requiring gentle processing to minimize quality impact:
  - Texture
  - Flavor
  - Moisture
  - Shelf Life
  - Skin Lift
  - Color
- Laitram CoolSteam technology has evolved specifically for other delicate products.





# THE COOLSTEAM® PASTEURIZATION SYSTEM

# Breakthrough technology for Delicate Products



## Crab and Lobster



## Vegetable Blanching

Laitram re-enters the vegetable market with low temp steam blanching



## Nut Industry: Pistachios & Almonds

Laitram is contacted by a Pistachio processor to test. CoolSteam nut pasteurization is launched



## TERP approval for Almonds



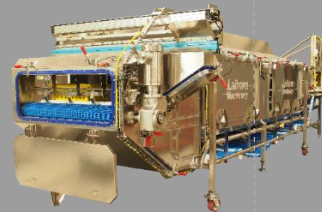
## 16 y.o. J. M. Lapeyre Invented First Steam Cookers in 1943

To cook prior to peel in Cold Water Shrimp



## CoolSteam® Breakthrough Technology Revolutionized Shrimp cooking

Patented technology delivers significant benefits over traditional water high temp cooking systems: Yield, Energy savings, Quality and Food Safety



# Laitram CoolSteam – The Sweet Spot

- “It’s a “Steam Pasteurizer” - All steam is not created equal!



Long Process



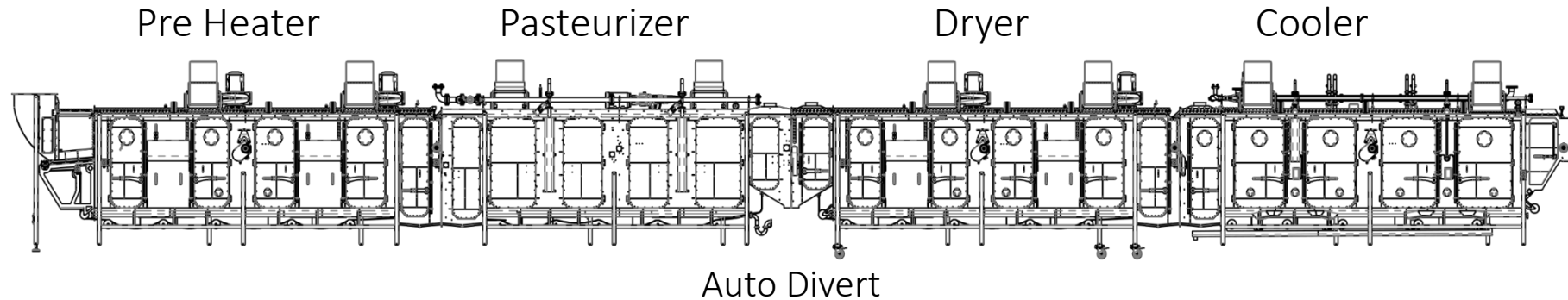
Short Process



- Homogeneous Steam – Air Mixture
- Rapid lethality is achieved.
- Moisture uptake is controlled
- Laitram CoolSteam process never exceeds 212 F.



# Pasteurization Process – 4 Steps



- **Pre Heater – Gentle, dry heat increases surface temperature of product to control (reduce) condensation.**
- **CoolSteam Pasteurizer – Homogenous Steam / Air mixture for gentle heat transfer.**
- **Dryer – Dry heat removes all residual moisture**
- **Cooler – Decreases product temperature to ambient or below, direct to storage or final package.**

**COOLSTEAM<sup>®</sup> means product never over 212 F**





# Excellent Product Quality



- **Product Looks and Tastes Raw**  
No Skin Damage, Flaking, or Color Change
- **Natural Crunch**
- **Moisture Neutral**
- **Excellent PV** (Peroxide Value) **and FFA** (Free Fatty Acid)  
**Values for Walnuts**

# Product Applications

Proven to produce high quality:

Pistachios



Almonds



Walnuts



Cashews



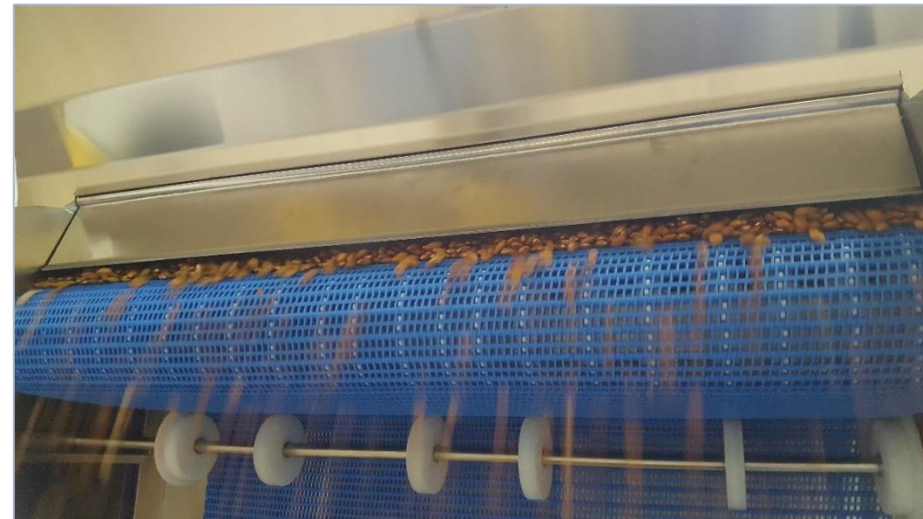
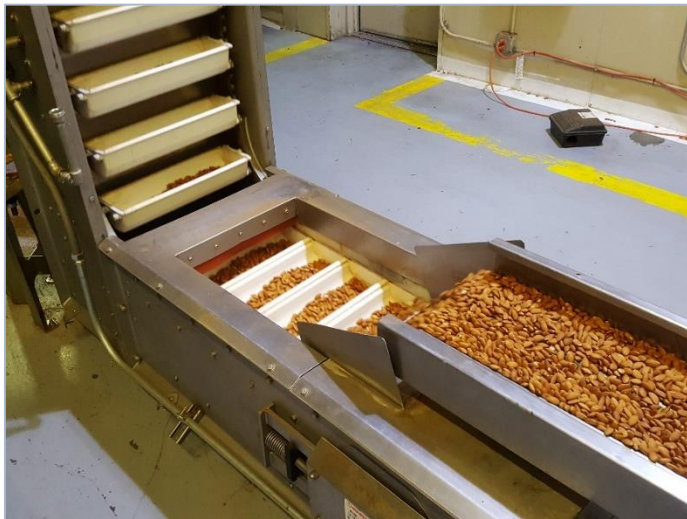
Hazelnuts



Pecans



Macadamia



# Food Safety



The CoolSteam® System complies with rigorous food safety standards. Our technology has been tested and approved by renowned universities, third party labs and our most demanding customers.

- **Selectable 4 or 5 Log Reduction**  
Recipes allow for optimal balance of lethality and quality  
Proven on Almonds, Pistachios, Cashews and Walnuts
- **TERP Approved**  
Validated per Almond Board of California TERP protocol
- **Precise Temperature Control**  
Temperature control within +/-0.5°F
- **Cleanable design**  
Emphasis on sanitary design principles  
Self cleaning belt

# THANK YOU!

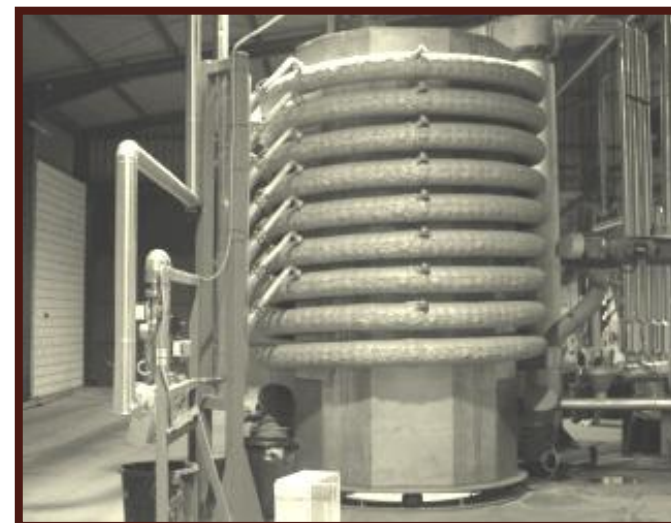
Time for Discussion & Questions





## Almond Pasteurization:

Landscape of Technologies/Equipment



# Pasteurization & Roasting technology for almonds



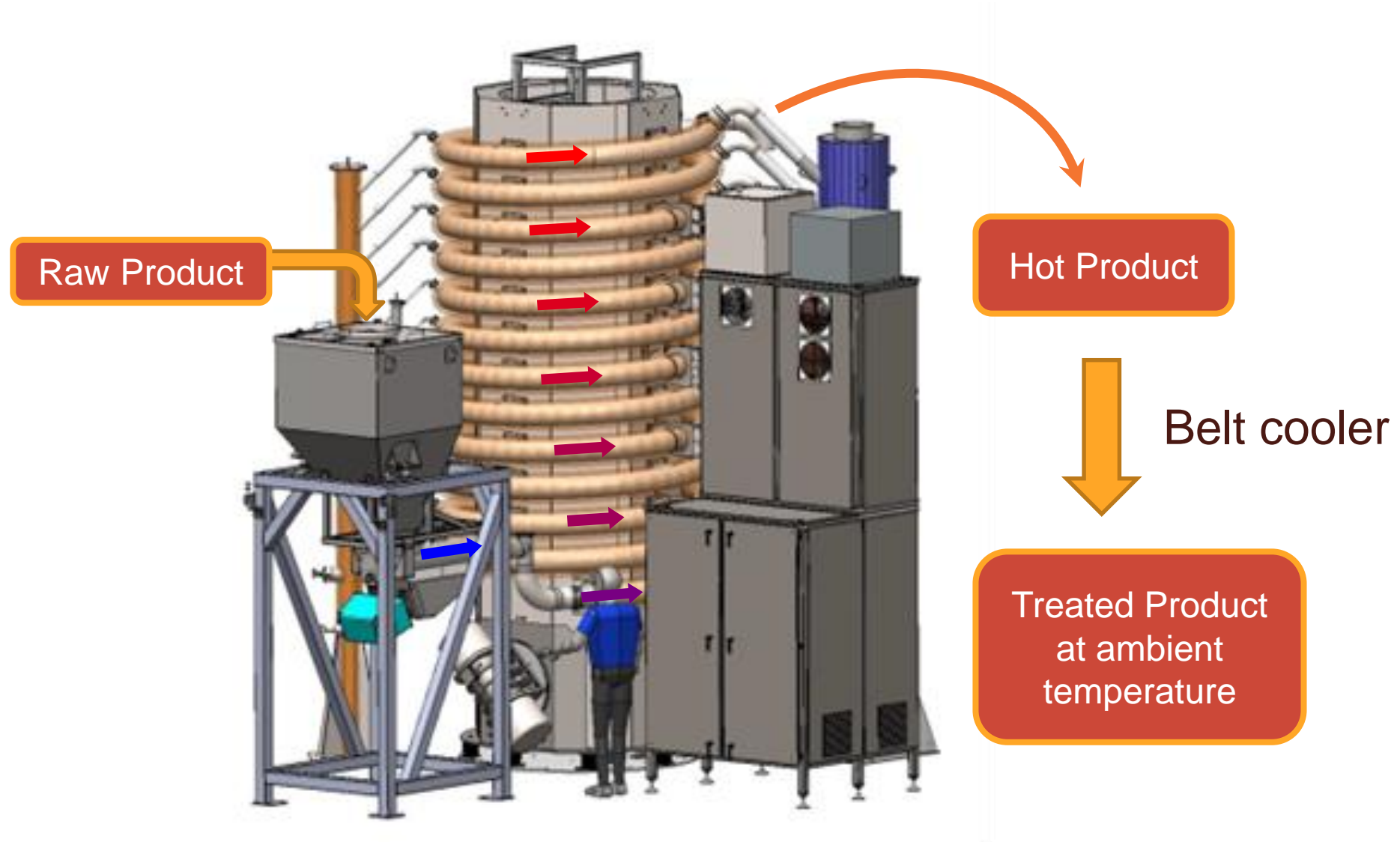
## Who is Revtech?

- Created in **1997**, based in **France**
- Technology: **Vibrating Electrical Heated Tube.**
- **Continuous heat treatment system** for bulk solids in food, pharmaceutical and chemical industries.
- Design, Installation and Commissioning of complete customized industrial units in the customers plant:

**Tailor – made & turn – key projects.**



# Principle of operation





## How does it work?

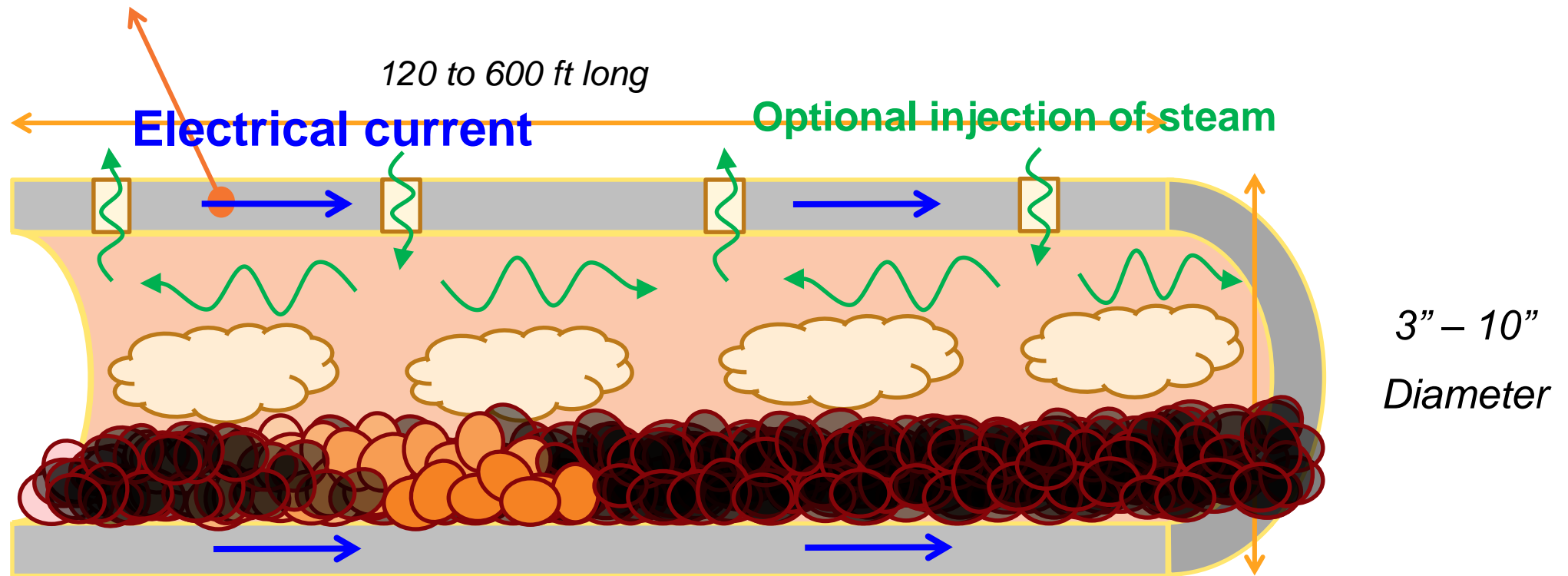
Continuous process based on a combination of 3 simple principles:

- Transportation / Mixing by **vibrations**
- Heating by direct **contact with a hot surface**
- Treatment in a **confined space to control the atmosphere**

# Principle of operation

In terms of process:  
(from the product point of view)

$T$  from  $120^{\circ}\text{F}$  to  $800^{\circ}\text{F}$

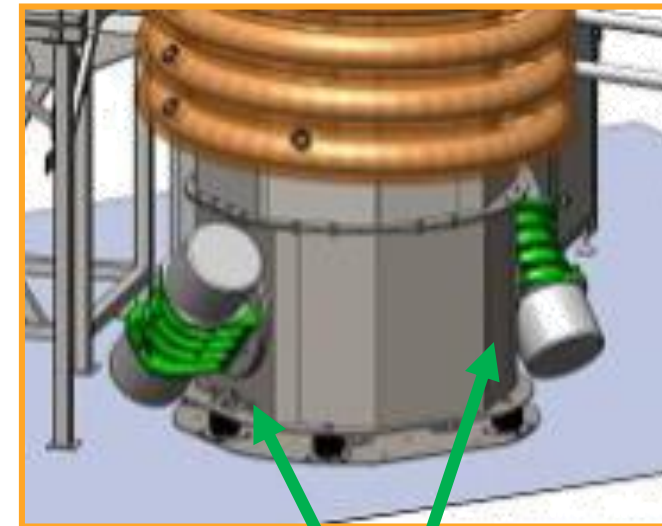
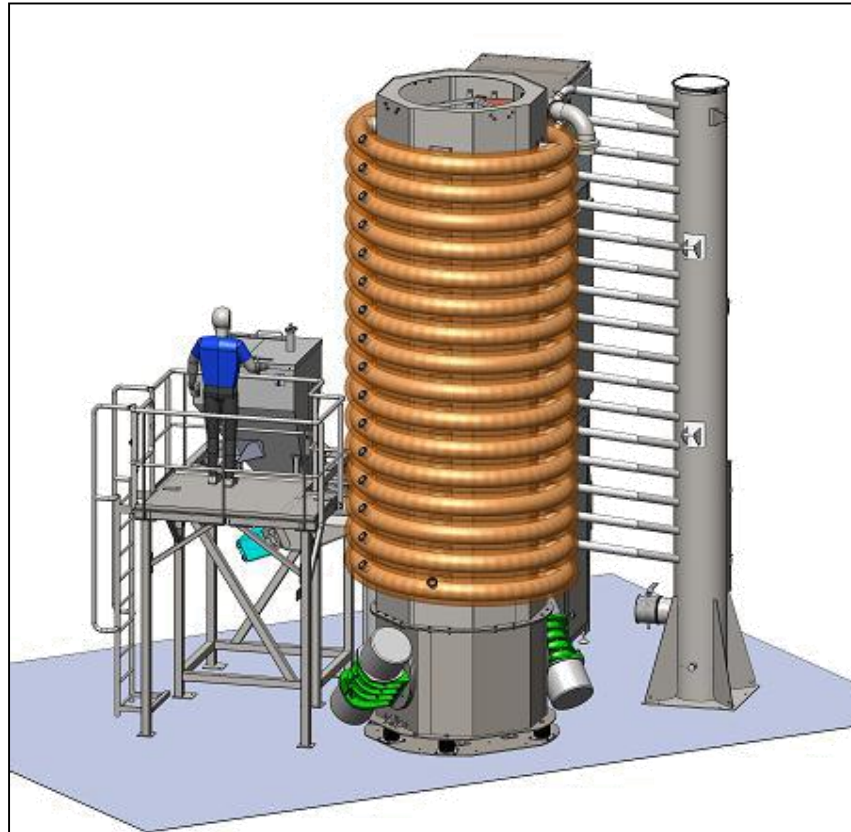


## Main parameters

- Flowrate: 200 lb/h to 5 ton/h
- Temperature: 120 to 800°F
- Residence time: 1 to 40 minutes
- Atmosphere: air, steam, nitrogen...

# Principle of operation

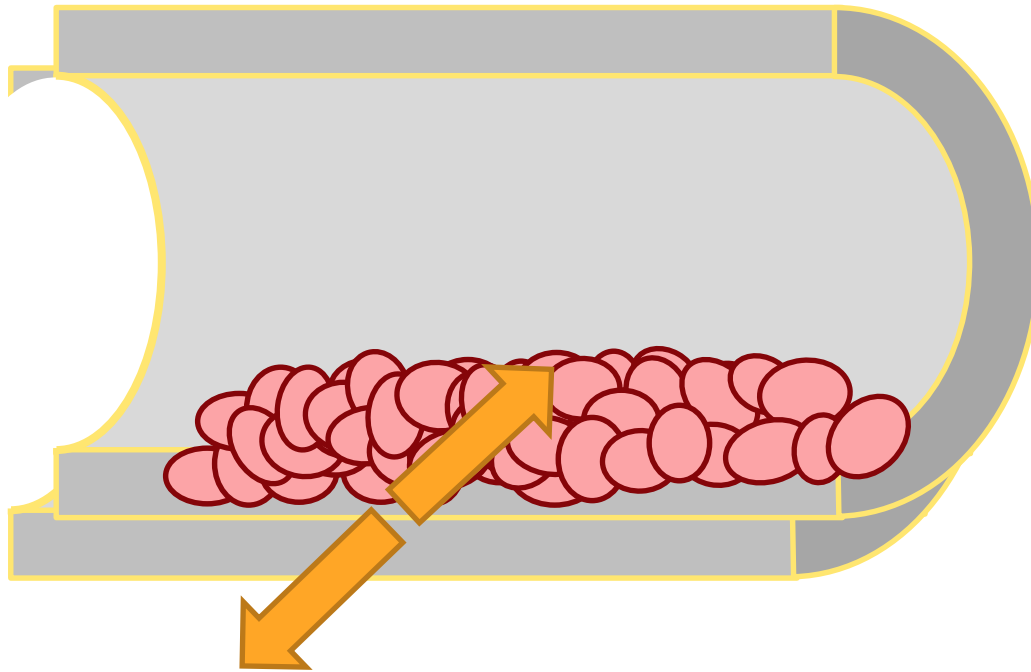
1. **Transport / Mixing:** in ss tube vibrated by off balanced motors



Off balanced  
motors

# Principle of operation

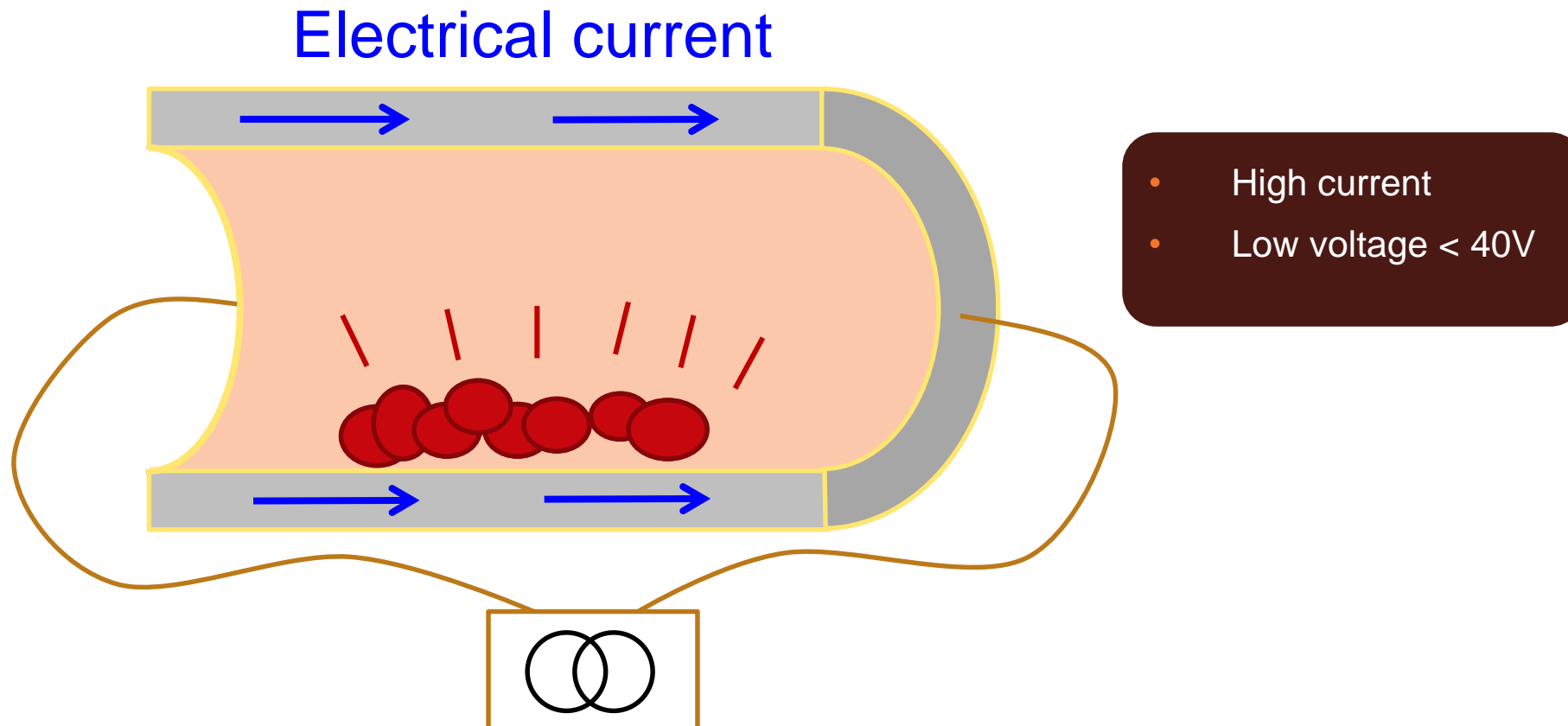
1. **Transport / Mixing:** in ss tube vibrated by off balanced motors



- Frequency: ~ 10-12 Hz
- Amplitude: ~ 1/8 in
- Acceleration: ~ 4 g

# Principle of operation

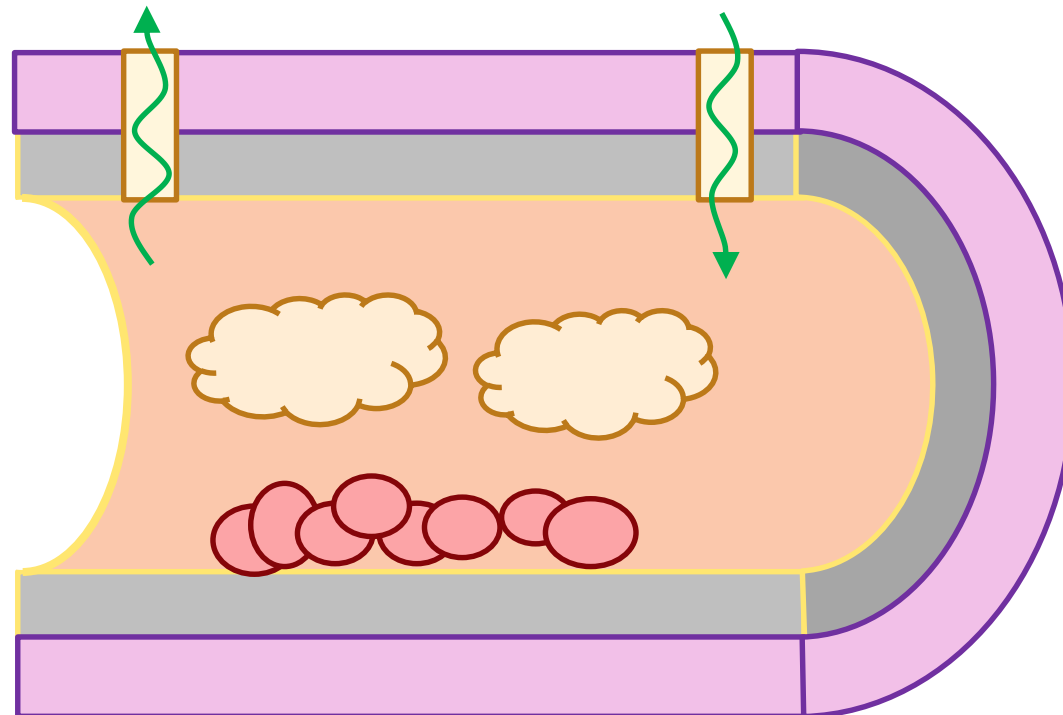
2. **Heating of the product:** by direct contact with hot ss pipe which is heated by electricity using Joule effect (High impedance tube)



# Principle of operation

## 3. Operation in controlled atmosphere:

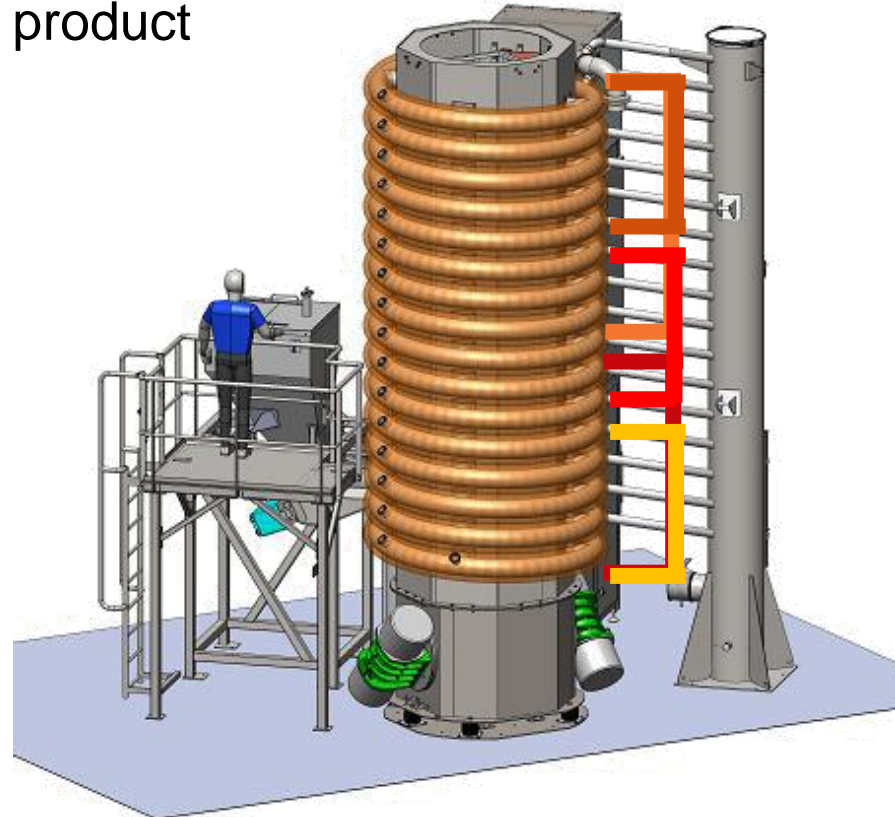
- Product is heated in a confined atmosphere
- Gas or steam can be injected through the process
- Gas inertion is possible as well



# Principle of operation

The main operating parameters are then:

- temperature (+/- 1°F) with 2 or 3 independent heating zones
- residence time
- atmosphere inside the tube
- flowrate of product



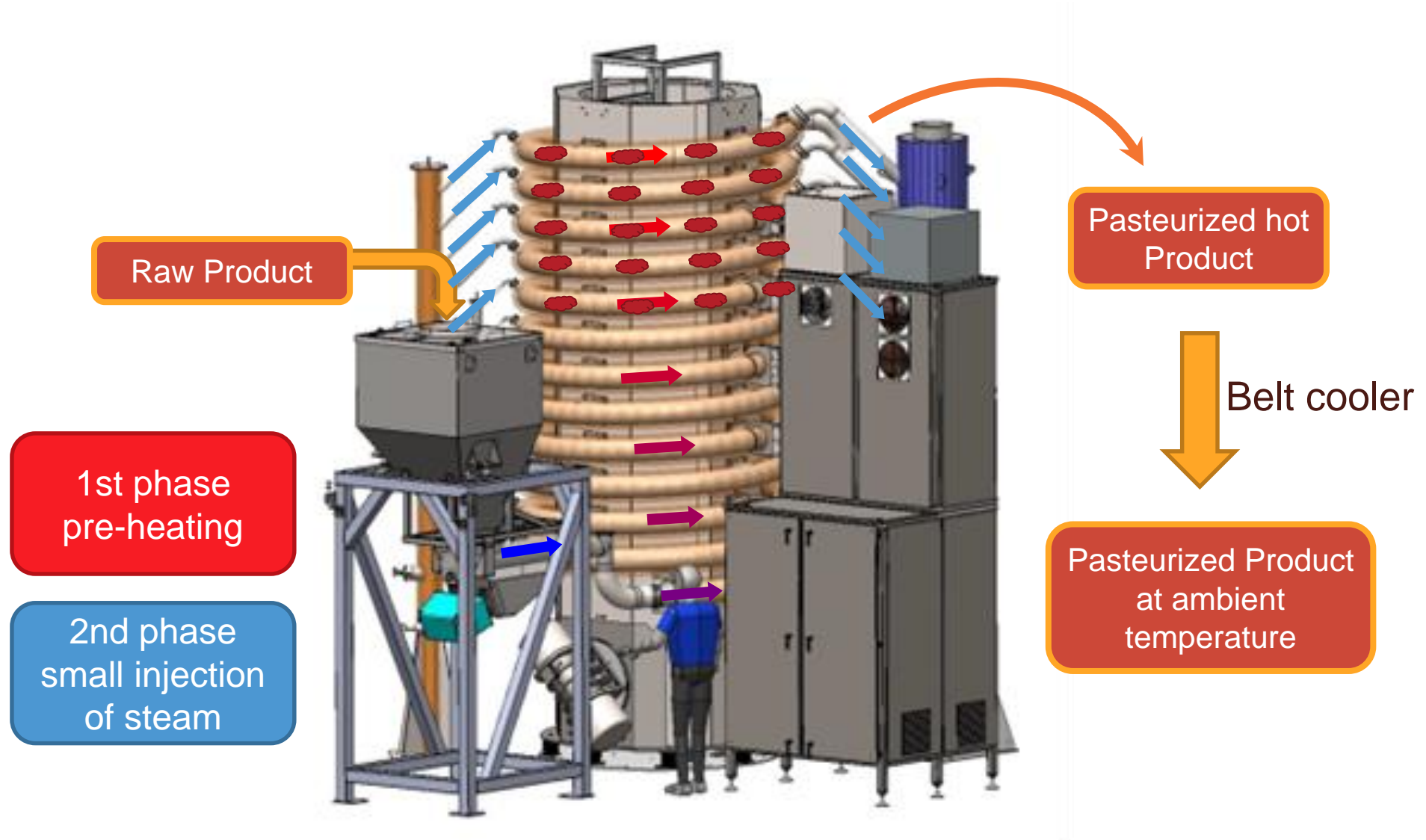
# Revtch for Pasteurization:

## Benefits of Revtch for Pasteurization:

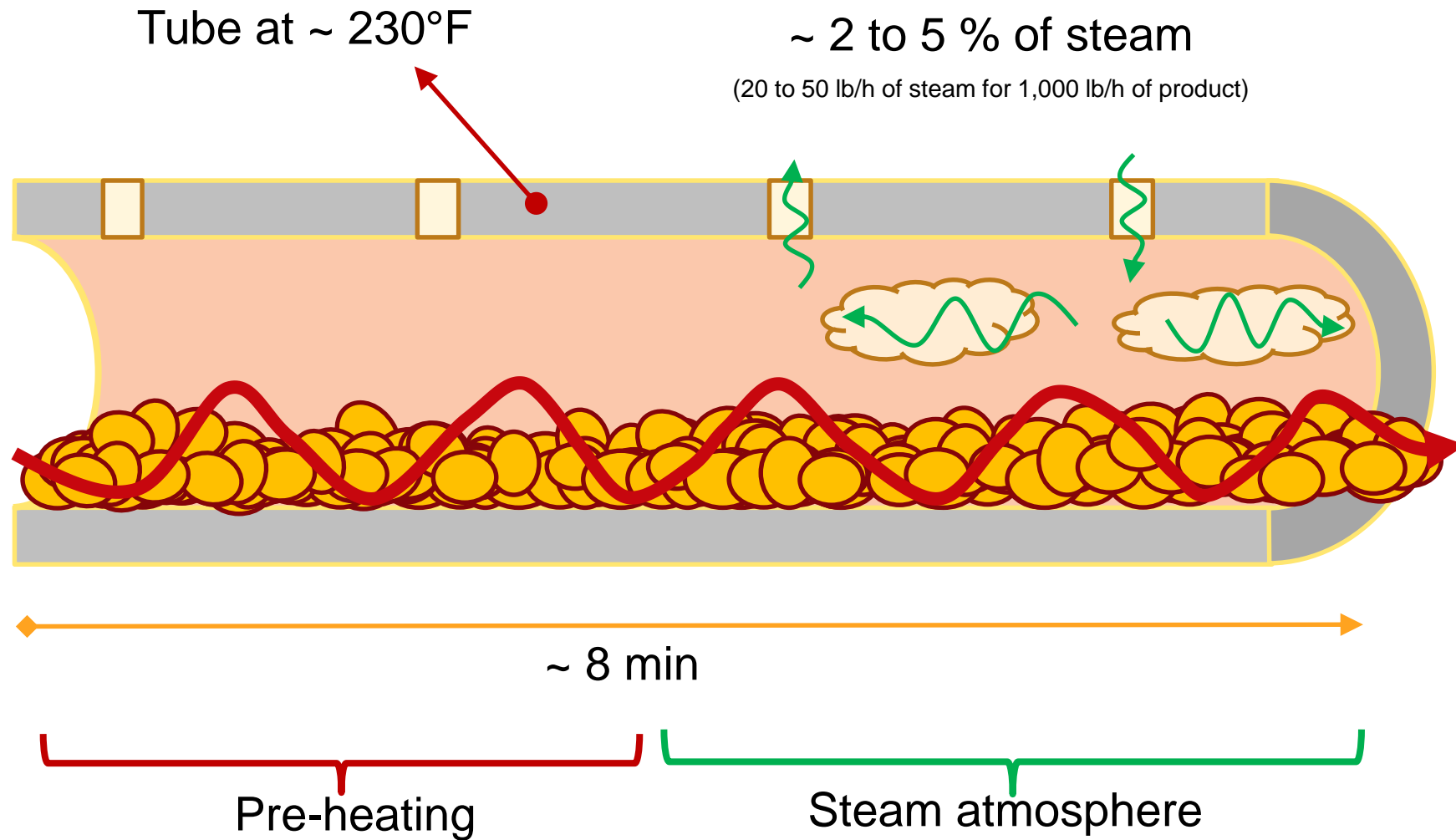
- Able to achieve significant reduction of pathogenic bacteria – Salmonella, E. Coli, enterobacteria, yeasts & molds...
- Minimal change on product properties
- System requires only electrical connection at 3 phase, 60hz, 460Volt
- Highly efficient transfer of energy to product



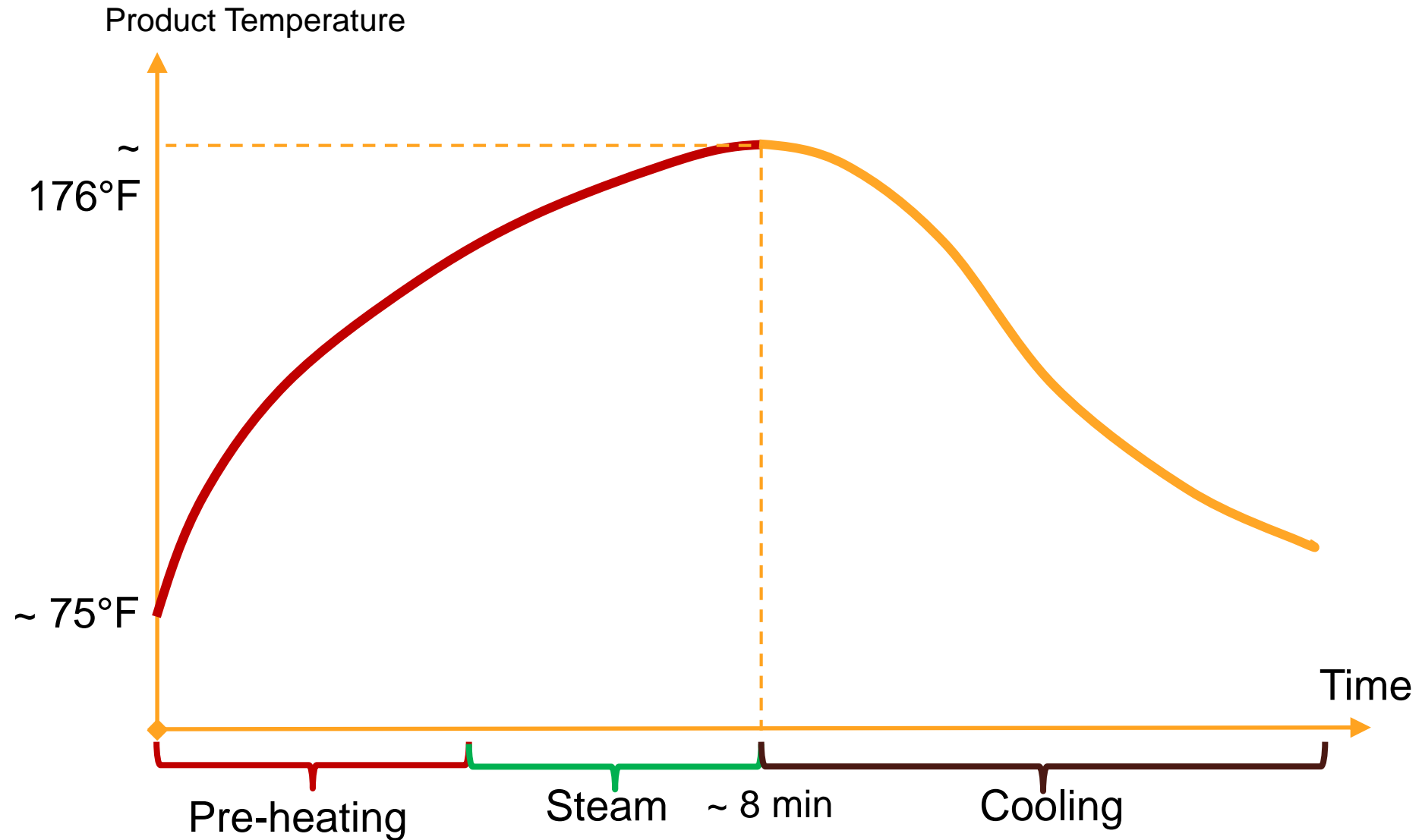
# Pasteurization – How does it work?



# Pasteurization in a Revtech



# Pasteurization in a Revtech



# Pasteurization – Challenge tests on almonds

On **almonds**, the primary risk is a Salmonella contamination & the goals are:

- Guarantee a **5 log reduction on Salmonella**
- Receive approval from reference organizations: **FDA / Almond Board of California**
- Maintain the product quality: skins, color, crunchiness...



# Main Advantages

- **Continuous process:**
  - Low labor cost
  - No recontamination
  - Adapted to modern factories
- **Works for almonds as well as for other products**
- **Low energy consumption**
  - Pasteurization about 100 kW.h/ ton – around **\$12 / ton**
  - Roasting: about 150 kW.h/ton – around **\$20 / ton**
- **Minimal maintenance & easy cleaning**
  - Spiral internals cleaned using pigging technology
  - Basic maintenance every 6 months
- **One operator** to run the unit  
(PLC controller to define recipes & record operating data)



# References

More than **120 projects** installed all around the **world**



# Conclusion

The **key factors** of REVTECH Pasteurization technology:

- **Greater homogeneity** is ensured by vibration:

*Every particle is treated, no particle is over treated*

- **Only gentle vibrations** (no auger, belt, mixer...): perfect preservation of the product
- Every machine can be **validated for pasteurization**  
(5 or more Log reduction on Pathogens / Salmonella – FDA validated)

**Validated for almond pasteurization on three continents!**



Thank you for your time.

Revtech Booth #1209





# What's Next

**Wednesday, December 5 at 12:00 p.m.**

- Luncheon Presentation – Hall C  
Speaker: David Deak

*Luncheon is ticketed and is sponsored by Moss Adams*



MOSSADAMS



## **Silent Auction**

Start your holiday shopping at our Silent Auction in Hall A+B - all proceeds go towards CA FFA scholarships!

Wednesday & Thursday until 3:00 p.m.

## Buy Your Golden Ticket at the FFA Booth

100 GOLDEN TICKETS WILL BE SOLD

★ ★ ★ ★ **GOLDEN TICKET** ★ ★ ★ ★

Throughout the conference 100 golden tickets will be sold. One lucky person will win and get their choice of one item from the live auction.

**MUST BE PRESENT AT THE GALA DINNER TO WIN.**

**Visit the FFA silent auction booth to purchase  
a golden ticket and learn more!**

The golden ticket winner will be drawn prior to the live auction.