

Temperature measurements and control in industrial freeze drying of foods – challenges, solutions and wishes

Technological Institute,
Thematic day on temperature measurements

TROELS B. PEDERSEN,
PROCESS TECHNOLOGIST IN FREEZE-DRYING
TROELS.PEDERSEN@GEA.COM

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- Freeze-drying 101
- How do we use temperature measurements in our process equipment
 - Case 1: Recipe development in RAY PP
 - Case 2: Bacteria freezing and freeze-drying
- Why is temperature control important?
- Challenges
- Wishes/interests

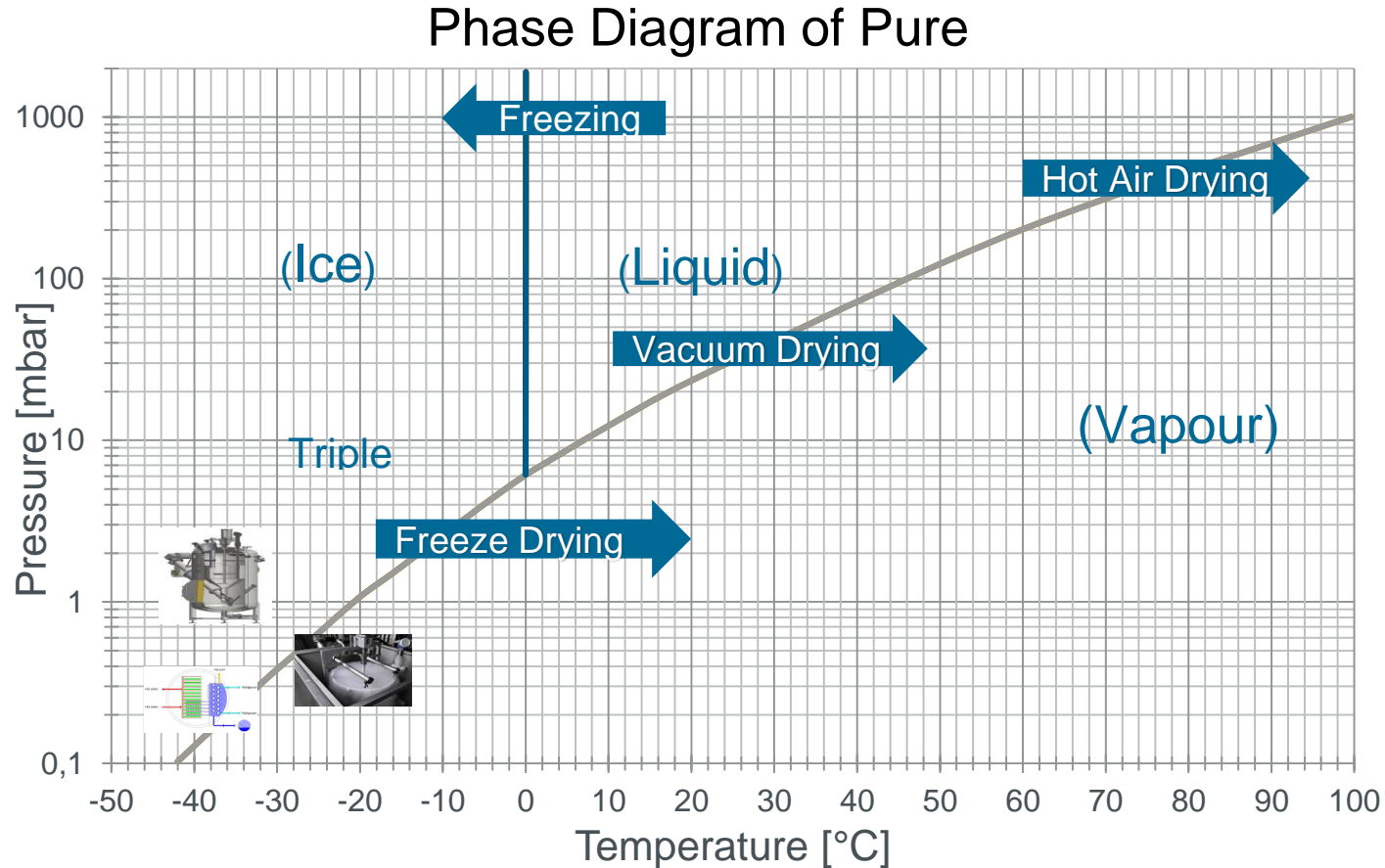
- Briefly about GEA

Briefly about me



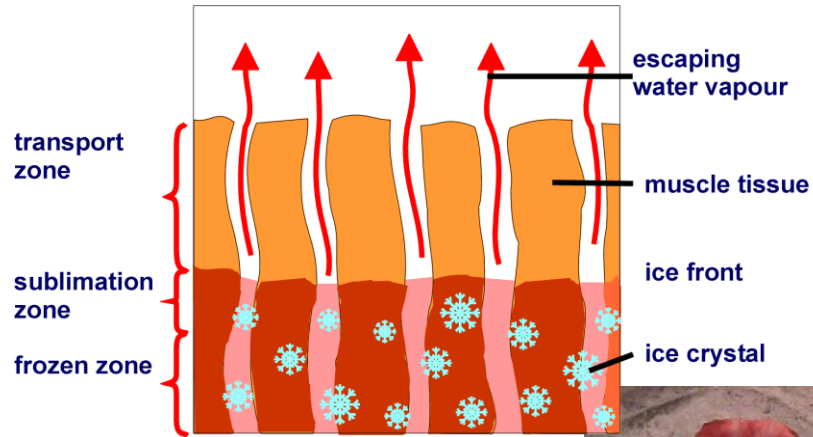
- Troels B. Pedersen
- Trained chef - 2009
- M.Sc. Dairy Science and Technology - 2018
- Started at GEA - 2018
- Process Technologist at GEA - 2019
 - Bacteria cultures
 - Fruits, vegetables meats etc.
 - (Instant coffee)





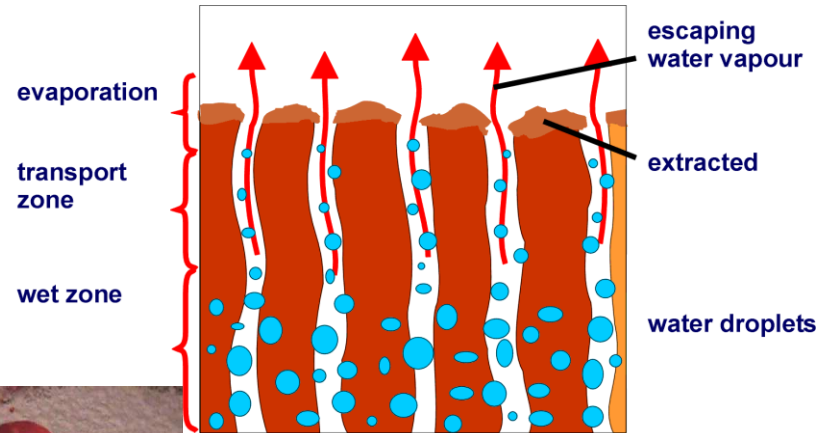
Product Structure

Freeze drying



**Freeze-drying
solid structure**

Conventional drying

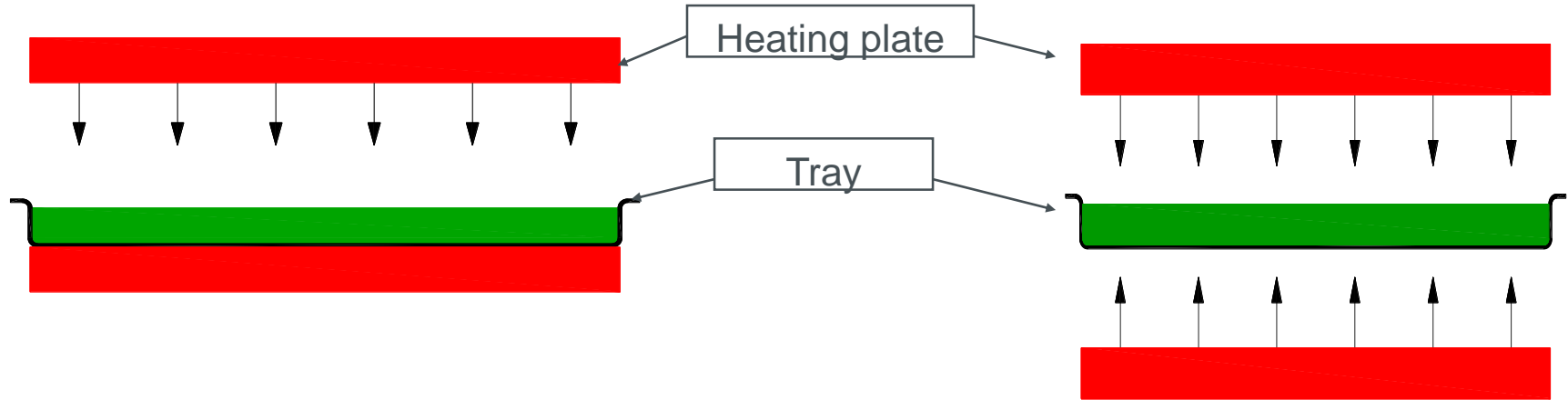


**conventional drying
wet structure**

Ice front



Radiation versus Conduction



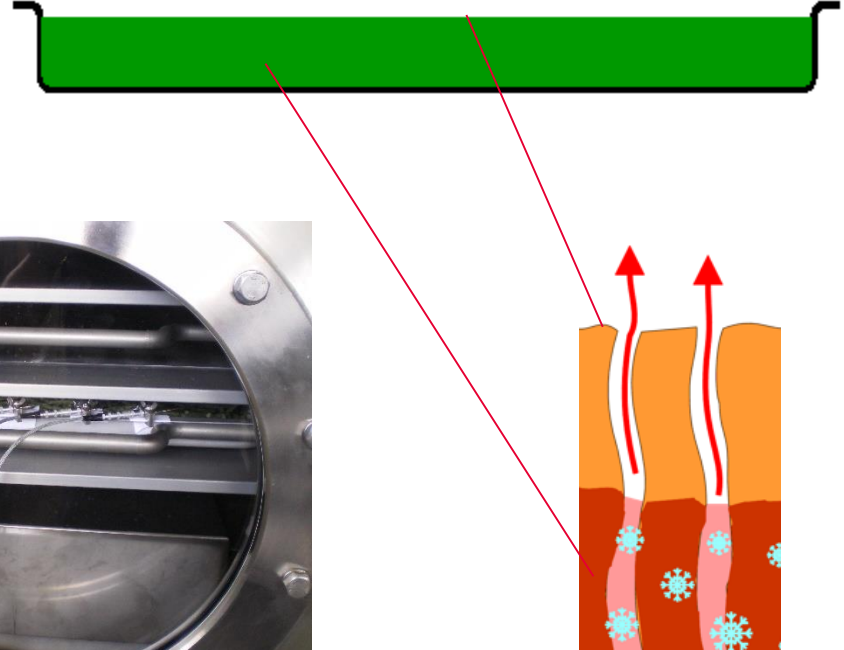
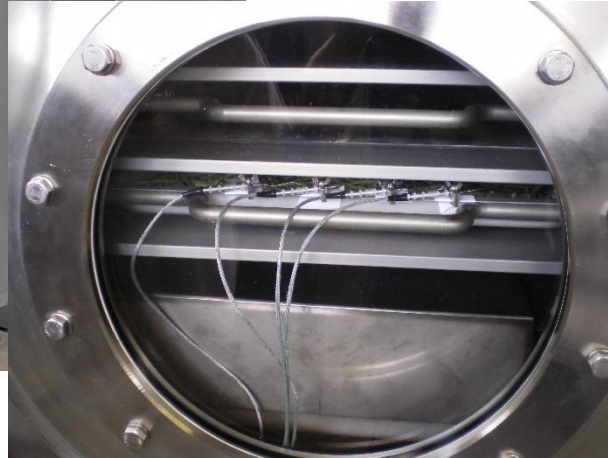
Contact and Radiation

- Low capacity
- High temperature at contact point
- Mostly for Pharmaceuticals

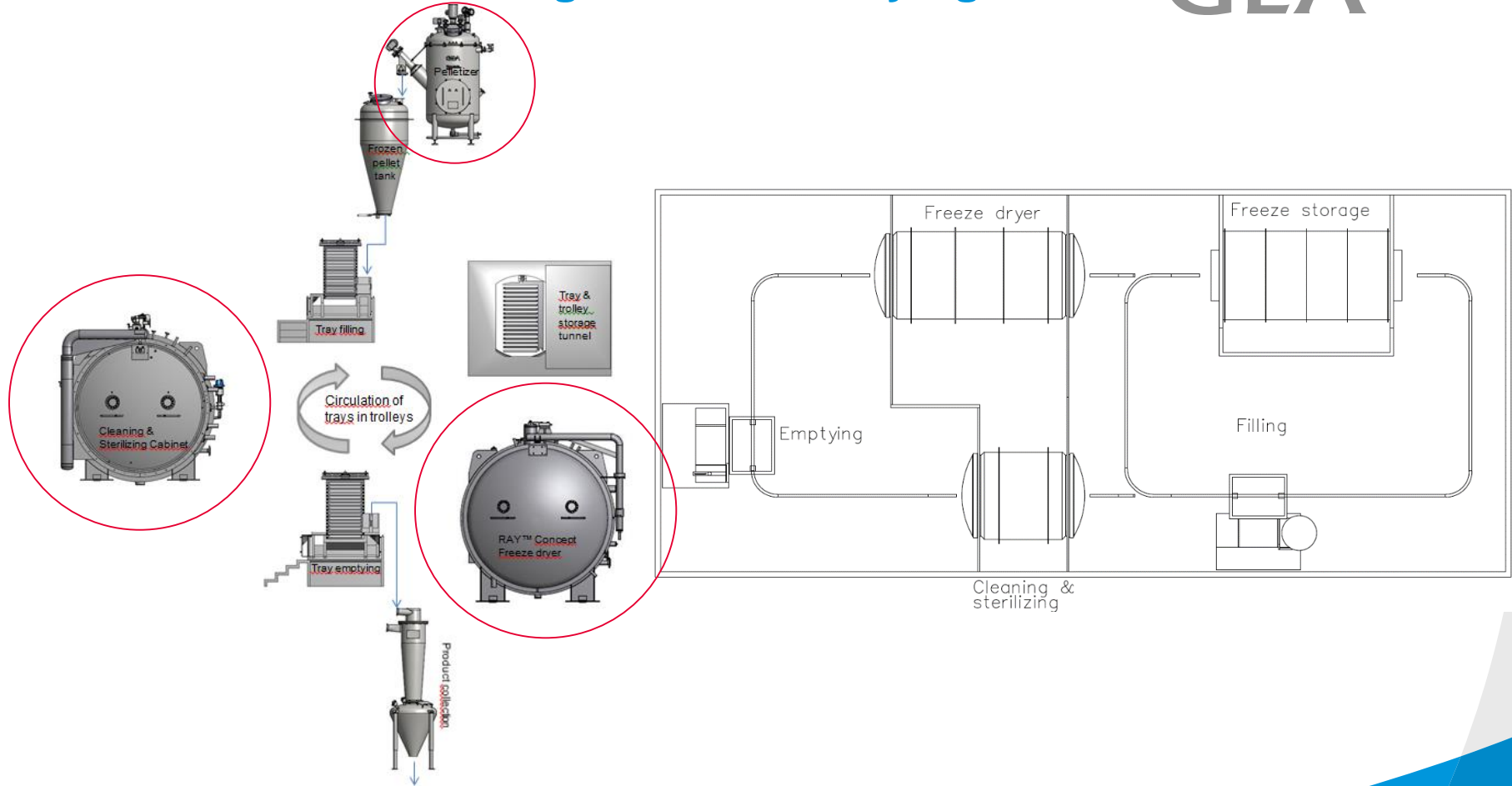
Radiation

- More even heat distribution
- High capacity

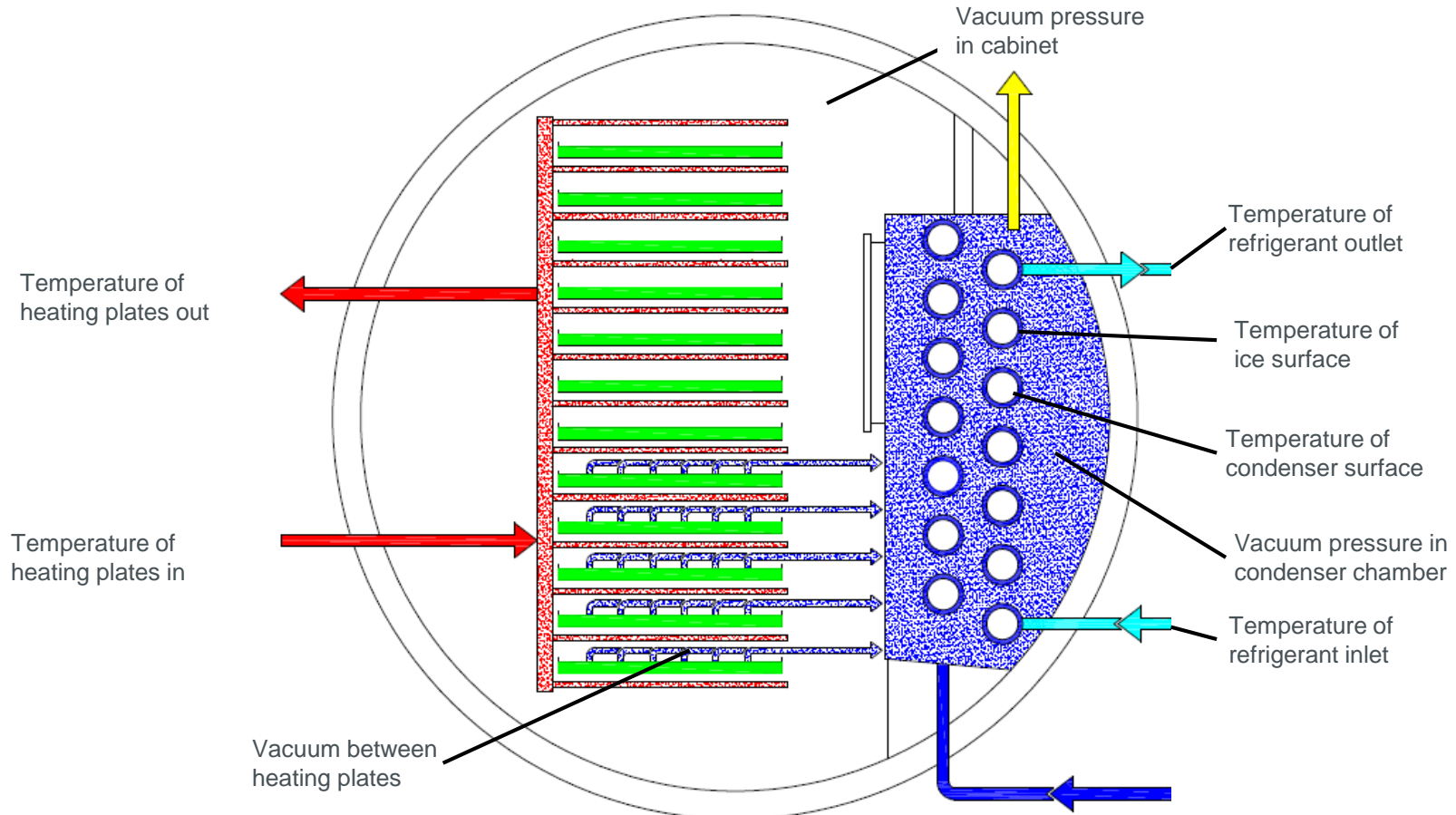
Case 1: Recipe development in RAY PP/1



Case 2: Bacteria freezing and freeze-drying



Case 2: Bacteria freezing and freeze-drying



- Discolouration of product
 - Browning reactions/ Maillard reactions
- Deterioration of heat sensitive products
 - Thermal inactivation of live bacteria
 - Denaturation
- Maintaining product structure
 - This is the temperature of the frozen product which is effectively controlled by the pressure
 - If frozen product temperature is above T_g the product can collapse



- Need for robust sensors
 - Vacuum
 - Cold environment
 - Wide temperature ranges
- "validation" in large dryers
 - Only a few sensor in the first column of trays
- Product variation causing variation in drying process
 - Product quality and size
 - Uniformity of tray filling

- Optical temperature measurement solutions suitable for conditions and layout of an industrial freeze-dryer
- Wireless solutions

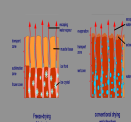


engineering for
a better world

GEA is one of the largest suppliers of process technology to the food industry and to a wide range of other industries.



17,863
employees (FTEs)



4,605
million revenue (EUR)

The company is listed on the German MDAX stock index (G1A, WKN 660 200) and included in the STOXX® Europe 600 Index.

In addition, the company is listed in selected MSCI Global Sustainability Indexes.



4,751
million order intake (EUR)

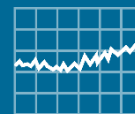
The international technology group focuses on process technology, components and sustainable energy solutions for sophisticated production processes in diverse end-user markets.



564
million operating
EBITDA (EUR)



12.2
% operating
EBITDA margin



1.31
earnings per share (EUR)

Strong local presence around the globe

North America

👤 1,763
€ 846 million
% 18

Latin America

👤 471
€ 317 million
% 7

North and Central Europe

👤 2,927
€ 583 million
% 13

DACH & Eastern Europe

👤 6,398
€ 944 million
% 21

Asia Pacific

👤 2,904
€ 1,027 million
% 22

Western Europe, Middle East & Africa

👤 3,401
€ 889 million
% 19

📍 GEA locations
(sales office, service branch or
other GEA sites)

👤 Employees in 2017 (FTEs)

€ Revenue in 2017

% Regional revenue split in 2017 (only continued operations)

Our applications – in touch with GEA every day

Dairy Farming and Processing



Approx. one quarter of processed milk comes from GEA production systems

Food



Every third chicken nugget is produced using GEA technology



Approx. every third process line for instant coffee was installed by GEA

Beverages



Approx. every second liter of beer is brewed with the aid of systems and process solutions from GEA

Pharma



Every fourth liter of human blood for making plasma-derived products is processed using GEA equipment

Chemical



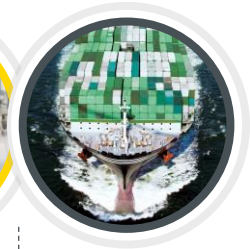
More than one third of all polymer producers are using GEA drying technology

Utilities



Each industry we serve utilizes industrial refrigeration technology from GEA

Marine



Every second container ship in the world sails with GEA marine equipment on board