Centrifuges in vaccine production processes

GEA Separation technology

THOMAS MÜLLER, 06.08.2020, OELDE, GERMANY

engineering for
a better world

Speaker

Thomas Mueller
Global Product Manager Sales
Pharma Biotechnology

With GEA since 2006
specialized in separation technology in pharma processes

Formerly 15 years with pharma company Baxter, starting as automation specialist, later taking on various positions as pharma specialist

- 50 years old, married, two sons aged 16 and 19
- Main education: automation technician
- My second life is to work around lifesaving (Baywatch)

Contact: Thomas Müller, Tel.: +49 1721615934, thomas.mueller@gea.com

Table of content

- About GEA
- Separation Technology
- Biosaftey
- Separation technology for vaccine processes
- Experience with vaccine productions

In touch with GEA every day - Our applications

engineering for a better world

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

GEA Introduction- “engineering for a better world”

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)

564
million operating EBITDA (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.

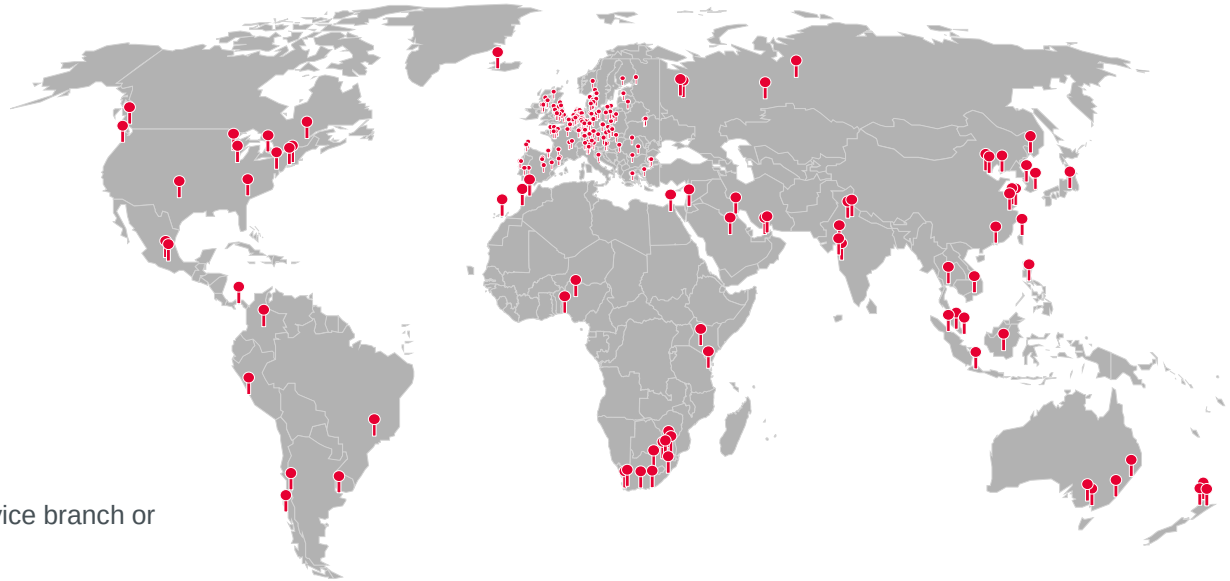
4,605
million revenue (EUR)

1.31
earnings per share (EUR)

12.2
% operating EBITDA margin

Strong local presence around the globe

engineering for a better world



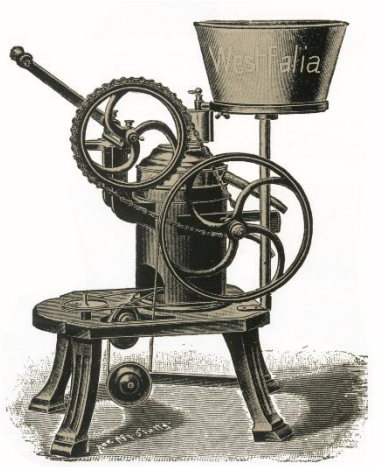
GEA locations
(sales office, service branch or other GEA sites)

GEA centrifuges

The first **centrifuge** was built in Oelde in **1893** - and we've been at the forefront of mechanical separation technology ever since.

The **separators, decanters** and **process lines** prove their value worldwide in high-performance companies of all shapes and sizes, sometimes under extreme operational conditions.

GEA SEPARATION 126 YEARS Since 1893



GEA engineering for a better world

Centrifugal separation: approx. 3,500 applications

Chemical/Pharma

Renewable Ressources

Beverage

Dairy

Environmental

Oil & Gas, Energy

Marine

Core products - separators and decanters

Centrifugal Separators

- With bowl diameters of 160 mm to 1,050 mm
- Throughput up to 500,000 l/h
- Particle size from 0.5 µm
- “Liquids oriented”

Decanter Centrifuges

- With bowl diameters of 200 mm to 1,030 mm
- Throughput up to 350,000 l/h
- Particle size from 5 µm
- “Solids oriented”

GEA Skid Units

Pharmaceutical skids perfectly designed for standard and customized requirements

Maximum safety, maximum yield.

GEA Pharma Product -Biotech Applications

engineering for a better world

Fermentation

Technologies

- Fermenters
- Bioreactors

Liquid dosage applications

- Vaccines
- Insulin
- Growth Hormones
- mAbs
- Therapeutical Proteins

Homogenization

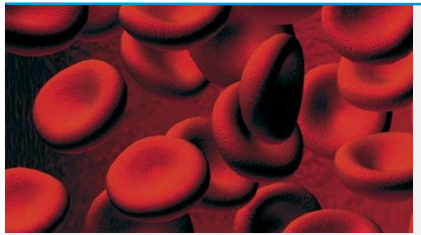
Technologies

- Cell Disruption
- Homogenization

Liquid dosage applications

- Vaccines
- Therapeutics
- Diagnostics
- Enzymatic Preparations

Separation



Technologies

- Mechanical Separation

Liquid dosage applications

- Vaccines
- Hormones
- Human blood proteins
- Mammalian cell culture
- Starter cultures
- Enzymes

Key success factors pharma

engineering for a better world

Safety

Efficiency

Biosafety is of highest priority

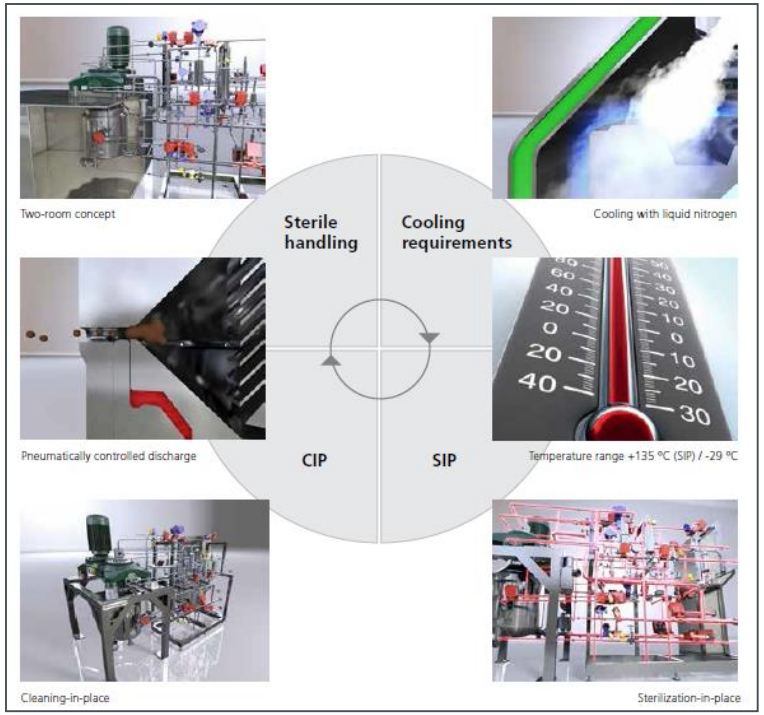
engineering for
a better world

Safety: Strictly aseptic process

Absolutely reliable steam sterilization required for vaccine and sera:

- Compliance with FDA requirements
- Compliance with GMP requirements
- Sterile complete closed system
- Guarantee on the employed sterile separator skids

- CIP/SIP including biocontainment



engineering for a better world

Securely clean with CIP

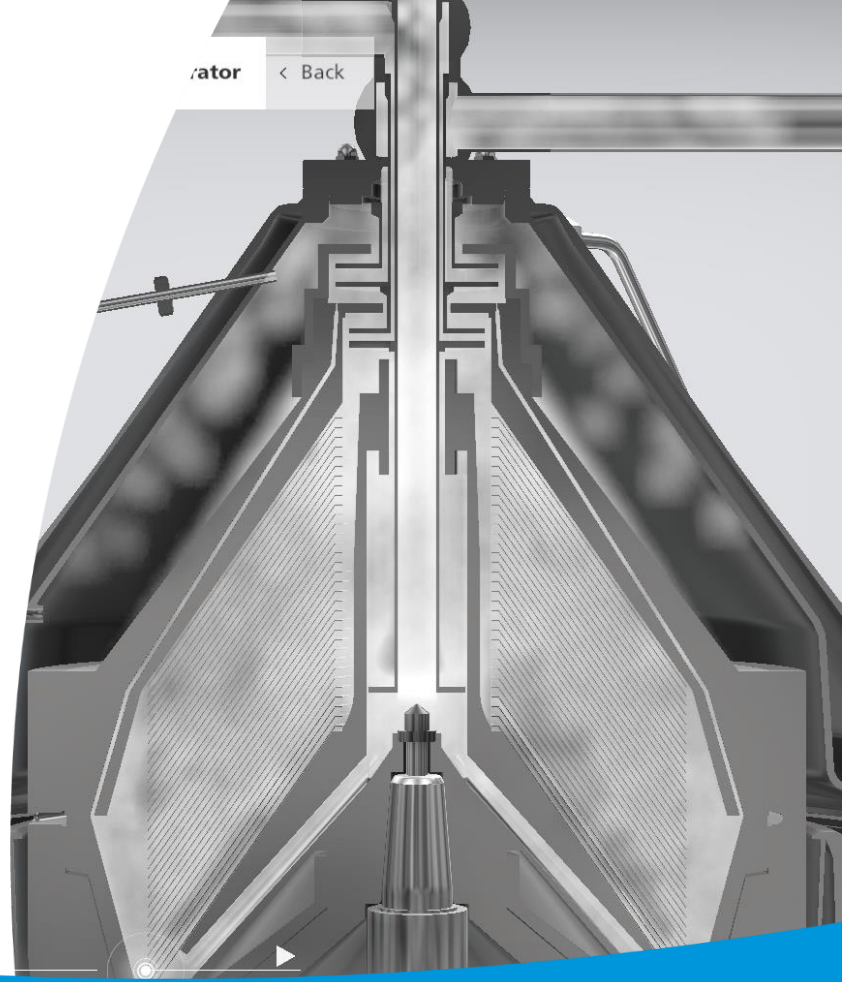
All GEA Pharma Separators

Absolutely clean without dismantling

- **Fully automatic CIP system available**
  The cleaning cycle is controlled by a programmable logic controller. The program sequence for cleaning can be adapted according to local requirements.

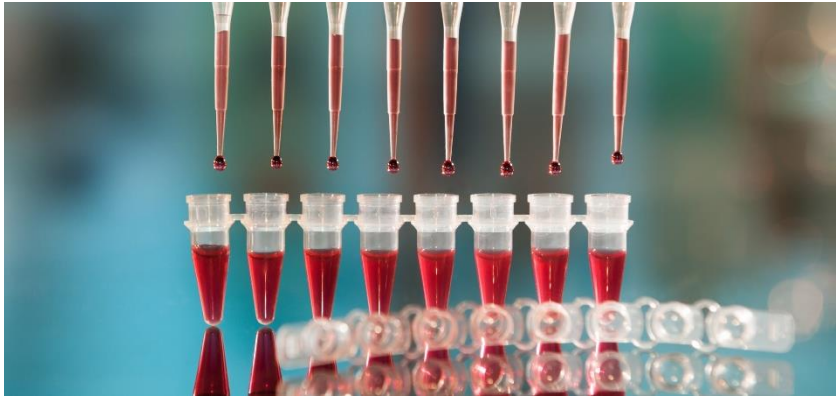
Securely sterile design with steam SIP

- **A sterile, complete closed system ensured**
  according to the FDA specifications
  (Food and Drug Administration)
- **Proven**
  in more than 800 SIP Skid Units installed world-wide



Our separation solutions for vaccine processes

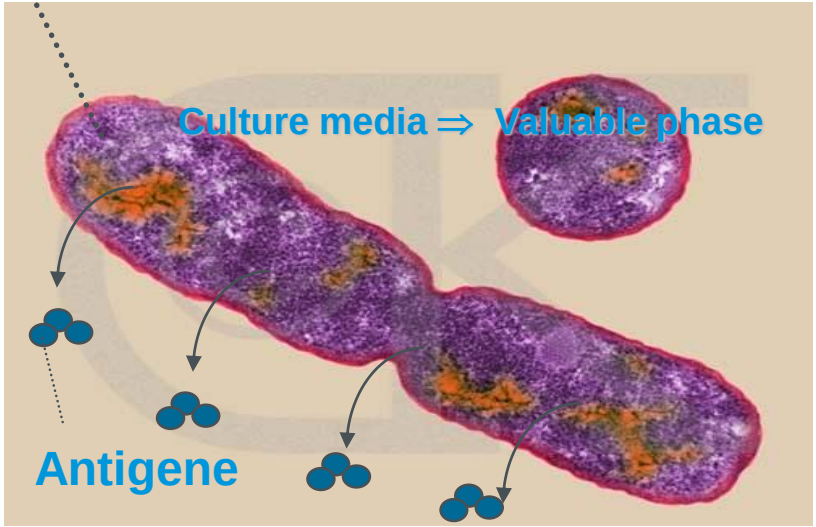
engineering for a better world



Comparison: “Live Vaccine” und “Non-live Vaccine”

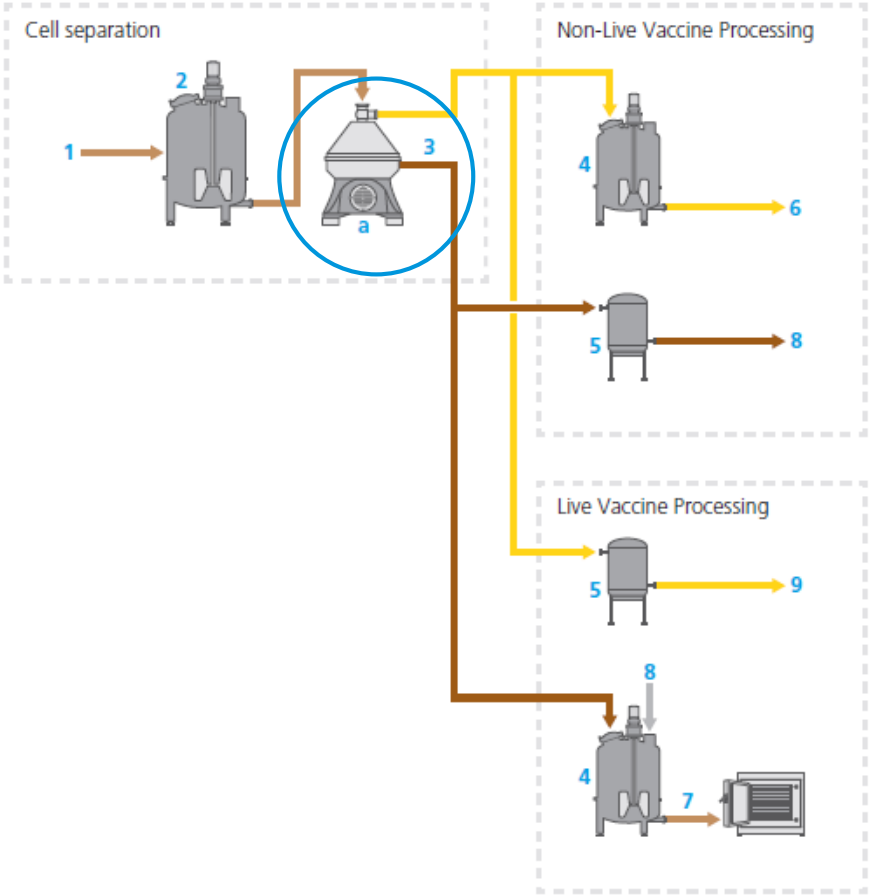
Cell

Live Vaccine



Non-live Vaccine

Vaccine Process – Human vaccines



Human vaccines

Cell separation
1 Microorganism / Substrate / Aeration
2 Fermentation
3 Biomass

Non-Live Vaccine Processing
4 Harvest tank
5 Kill tank
6 Further processing

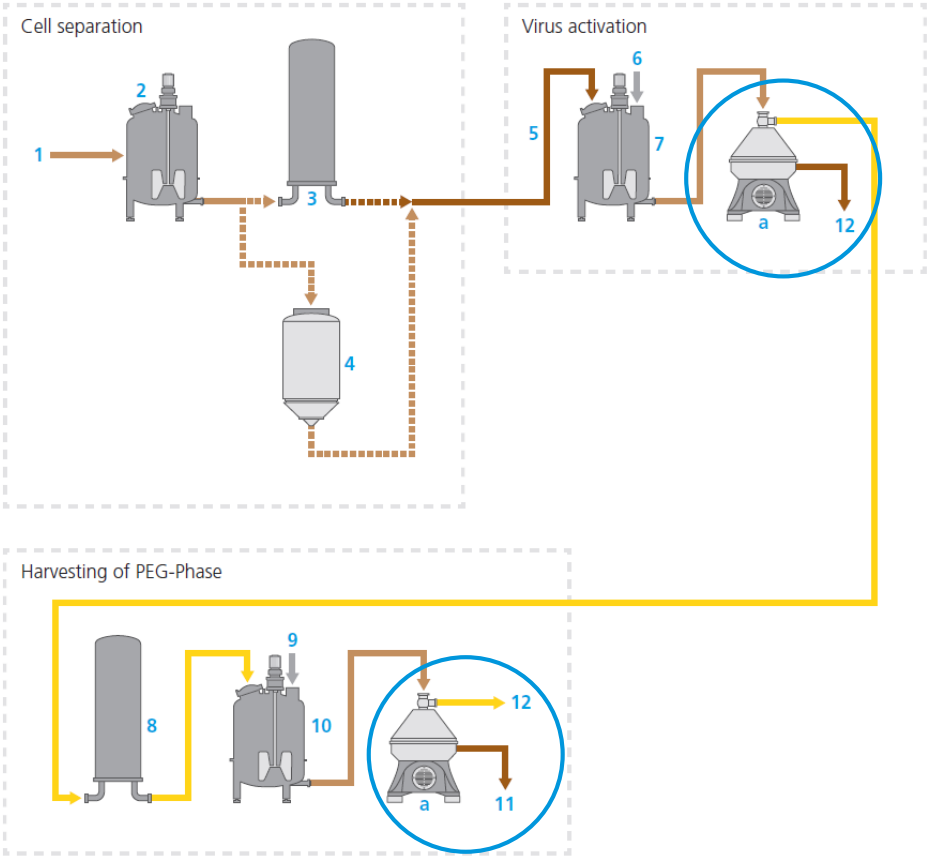
Live Vaccine Processing
7 Live vaccine to freeze dryer
8 Additives

a Self-ejecting or nozzle separatc

9 Waste

supernatant
solids

Vaccine Process – Veterinary Vaccines (FMD)



Veternary Vaccines (Example FMD Vaccine)

Cell separation
1 Cell Culture / Substrate / Aeration
2 Fermentation
3 Micro filtration
4 Settling tank

Virus activation
5 Biomass
6 Virus solution
7 Activation tank

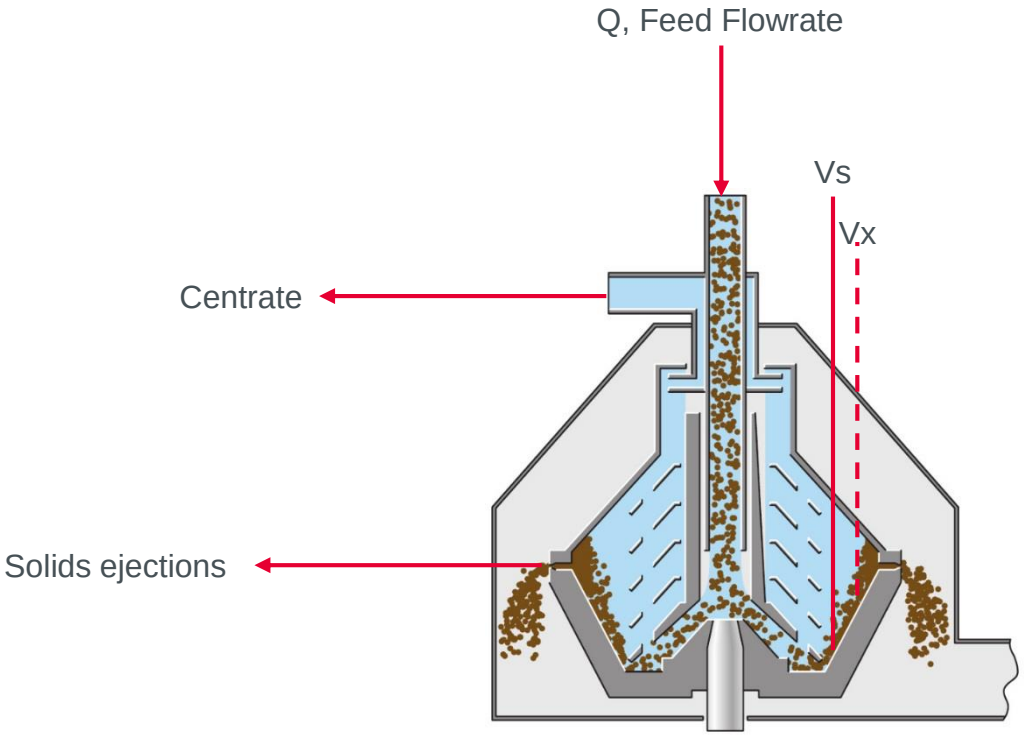
Harvesting of PEG-Phase
8 Macro filtration
9 Poly ethylene glycol (PEG)
10 Inactivation tank
11 Harvest of product (PEG-phase)

a Self-ejecting or nozzle separator

12 Waste

supernatant
solids

Selfdesludging centrifuge



Requirements – GEA features – Your benefits

engineering for a better world

Separator

Main features	Your main benefits
▪ Patented hydrohermetic product feed inlet	▪ Gentle product treatment tested on shear sensitive mammalian cell cultures for best product quality
▪ Unique patented gap-free welded disc spacers	▪ Highest hygienic standard
▪ Variable ejection volume	▪ Adaption to different product properties
▪ Discharge of separated solids with the patented GEA hydrostop system	▪ Precise, reproducible and step less adjustable ejection volumes

Automation

Main features	Your main benefits
▪ Newest generation for HMI and PLC series by SIEMENS	▪ Long availability of spare parts
▪ Combined compact control cabinet for MCC and PLC mounted on the skid	▪ Pre-cabled and pre-tested
▪ GAMP 5*	▪ Guideline for programming of control system for pharmaceutical industry including the relevant documentation

Requirements – GEA features – Your benefits

engineering for a better world

Package unit

Main features	Your main benefits
▪ Complete skid including piping and control cabinet	▪ Plug-and-play
▪ Customized footprint and package assembly	▪ Adaptation to customers' needs
▪ Pretesting of the complete skid on our pharmaceutical test bay with purified water and clean steam	▪ Reduces time for testing during commissioning

Qualification

Main features	Your main benefits
▪ Qualification documents of complete scope of supply done by GEA	▪ Prequalified system, easy to implement in customers' qualification files
▪ GEA verification plan including IQ/OQ documents filled out and tested	▪ Minimized qualification work on customers' side

Special requirements for documentation

- Legal requirements for the pharmaceutical industry

- Comprehensive requirements of the pharmaceutical customers
  - Machines, equipment, spare bowls and spare parts

FAT - SAT

Product recipes

ASME BPE

21 CFR part 11

X-Ray

Filter integrity test

GAMP 5 - HDS – SDS - FDS

DQ - IQ - OQ

HAZOP Meeting

Monthly meetings / telcons

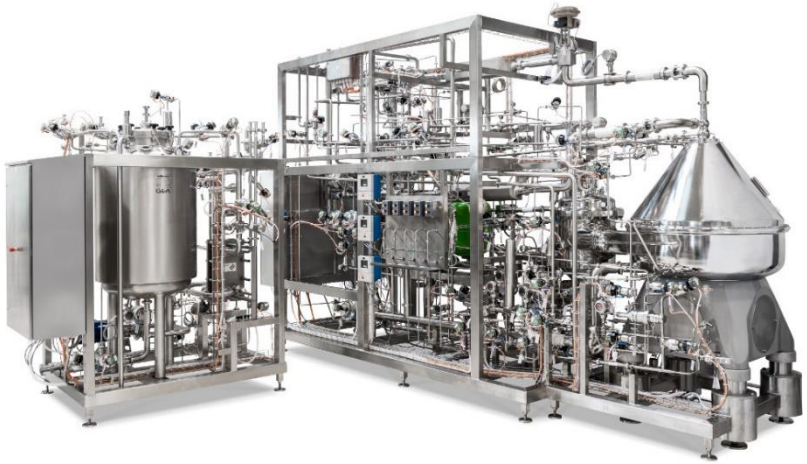
Riboflavin test acc. GEA standard

Centrifuge Product Range

engineering for a better world

Self cleaning separators in steam sterilisable design GEA Pharma separator aseptic

Machine type	Product capacity depending on product and process, in l/h
CSC 6	100 - 200
CSC 15	250 - 500
CSC 20	500 - 1.000
aseptic 30*	500 – 2.500
aseptic 100*	1.800 - 3.700
aseptic 170*	3.000 - 6.000
aseptic 300*	6.000 - 12.000



* ASME BPE design and Integrated direct drive (IDD)

Efficiency: Skid installation for short ROI

- Skid units ready for plug and play
- Pilot skids to set up new processes (option of easy up scaling)
- Large variety of applications
- Large variety of product variants
- Sophisticated service along the life cycle
- Interdisciplinary team of experts supporting GEA project manager

Experience with vaccine productions

engineering for
a better world

Reference Customers Human Vaccines

Sold 160 package units

Until 2019

50 customers

CSC 6 Package Unit with Automatic SIP

CSC 15 Package Unit with automatic SIP for the Recovery of Vaccines

engineering for a better world

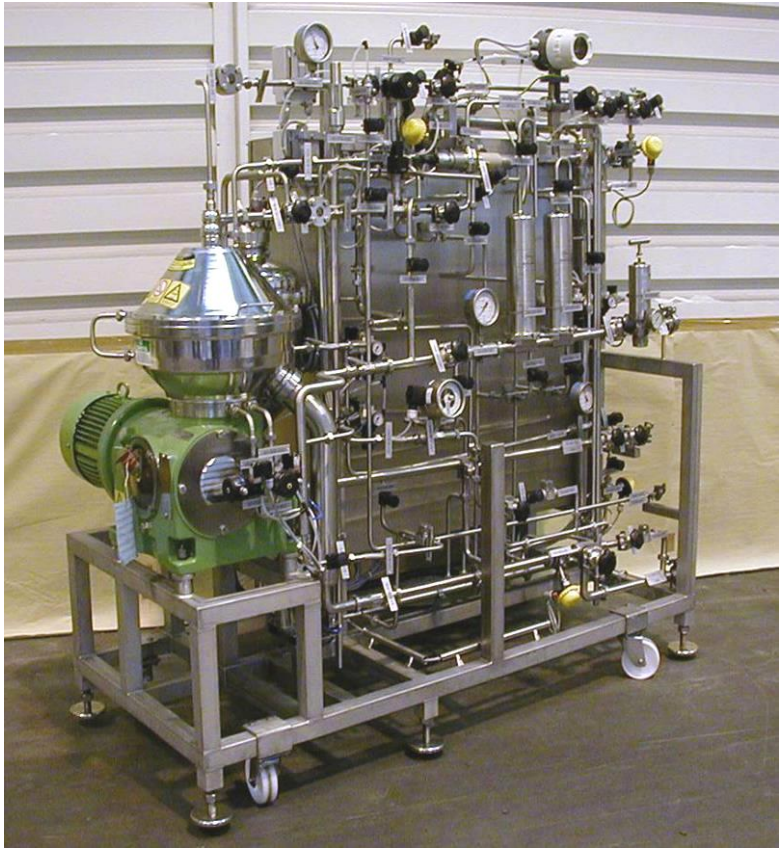
Reference Customers Veterinary Vaccines

Sold 116 package units

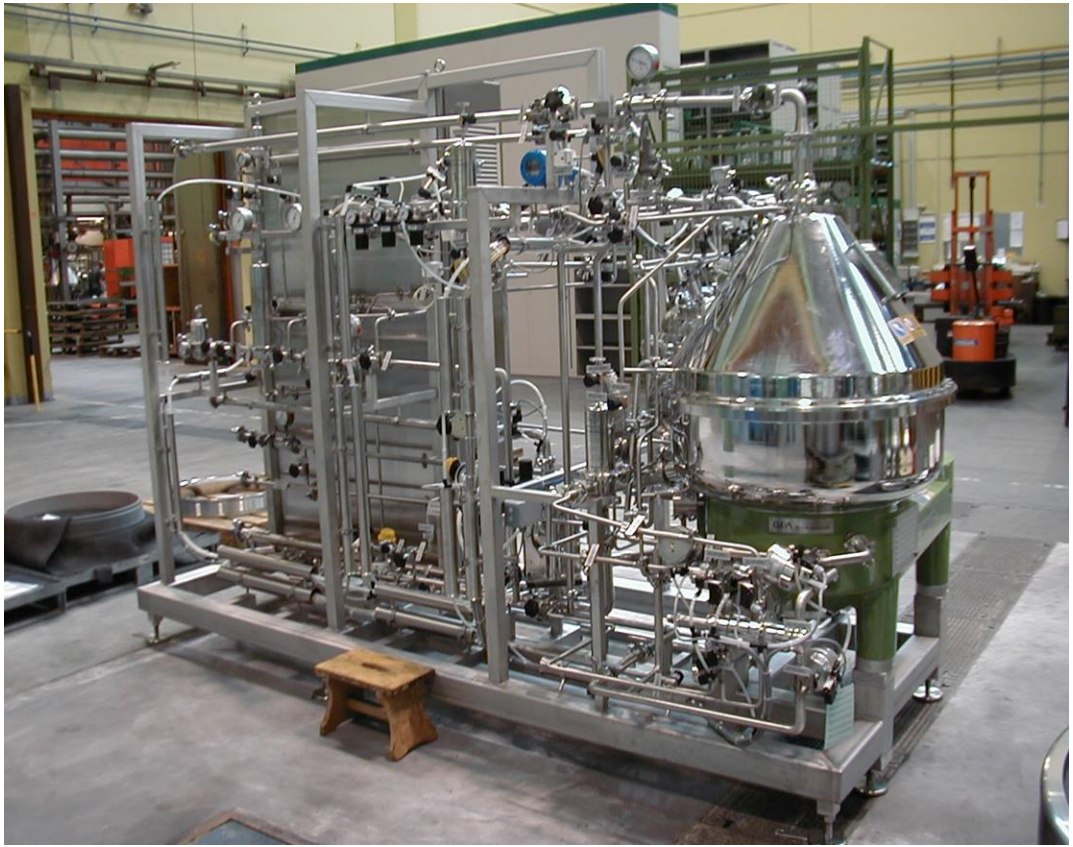
Until
2019

38 customers

CSC 6 Package Unit for the Recovery of Veterinary Vaccines



CSE 80 Package Unit for the Recovery of Vaccines (typical for FMD)



Summary

- Global technology leader
- Specialist for pharma applications
- Experts on safety issues
- Experts on efficiency

engineering for
a better world

gea.com