



**HAARSLEV™**

Processing Technology

# Overview of Haarslev's Approach to THP

Josh Mah

2017 Biosolids Workshop – Ohio Water Environment Association

*Master Your Process*

# INTRODUCING HAARSLEV INDUSTRIES

- Global market leader in rendering
  - Headquartered in Denmark
  - Founded in 1973
  - ~1200 Employees
  - Revenue just shy of \$300M (in USD) in 2016
  - 25 offices serving 120 countries (US HQ Kansas City, MO)
  - Factories in Denmark, Germany, China, Turkey, Peru, Brazil, US
  - 17 service centers globally
-

# HAARSLEV INDUSTRIES

- Cooking tough industrial materials since 1973
- Atlas-Stord: Batch thermal hydrolysis for ~60 years
- Continuous hydrolysis of feathers and hair: Patented in 1986
- Complete line of animal carcass handling equipment
- Fish factories in Artic/Antarctic ship hulls: 2
- Main products of the Environmental Division
  - Continuous Thermal Hydrolysis System
  - Sludge Belt Dryers and Disc Dryers
  - Waste Food Depacker



## SOME QUESTIONS ABOUT THP?

- How hard is it to operate?
  - How complicated or complex is the THP unit?
  - How big is the THP system?
  - How many moving parts need to be maintained?
  - What do you want to get out of THP?
  - How does continuous THP work?
  - What are the benefits of continuous THP?
-

# HAARSLEV'S CONTINUOUS HYDROLYSIS SYSTEM

- THP = Cooking sludge = Not magic!
  - Target 160C for 30 minutes
  - Potential vendor differentiators:
    - Quality of thermally hydrolyzed sludge
    - Quality of mechanical components
    - Thermal and electrical efficiency
    - Footprint
    - Capital Cost and Operating Cost
    - Simplicity (Operations and Maintenance)
-

# HAARSLEV'S CONTINUOUS HYDROLYSIS SYSTEM

## - "Continuous" System:

- Preheater is fed continuously from pre-dewatering (typically a cake bin)
  - The Pressurizer feeds 1/40<sup>th</sup> of main reactor volume every ~90 seconds
    - Think of this like a piston pump
  - After sludge leaves the pressurizer, remainder of process operates with continuous flow
-

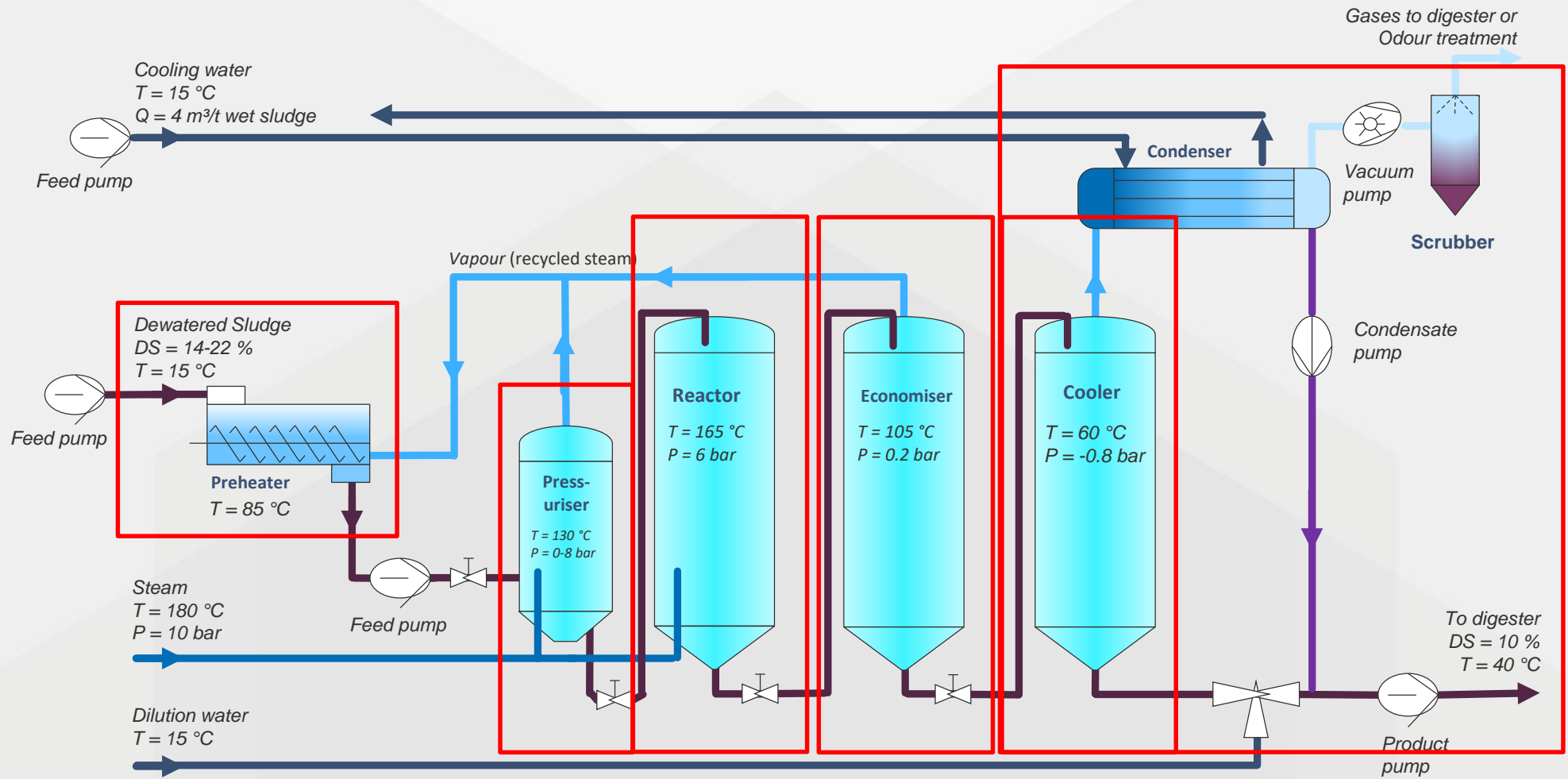
# KEY ASPECTS OF OUR SLUDGE COOKING PROCESS

- Significantly different way of heating the sludge
    - No indirect heat exchangers (i.e. tube-in-tube)
    - Direct steam injection (8 bar required, 10-12 bar supply typically)
    - Steam is injected into small (50 gallon) batches of sludge every 90 seconds
    - Steam is used to push the liquified sludge into the main reactor vessel
    - Very few pumps, motors or moving parts
    - High turndown ratio and relatively smooth steam demand
    - Permits feed TS to at least 22%, which increases throughput and reduces steam consumption on a dry solids basis
-

# KEY ASPECTS OF OUR SLUDGE COOKING PROCESS

- Completely different way of cooling the sludge
  - No indirect heat exchangers (e.g. tube-in-tube)
  - Direct evaporation with an indirect condenser
  - Might sound complicated and confusing, but it is as simple as it gets
  - Basically, “non-contact” cooling
  - Moving parts = some valves, discharge pump, vacuum pump, cooling supply pump
  - Condenser is extremely compact relative to other solutions
  - Permits up to 22% TS cake feed
- Sludge cooler may not be necessary with “WAS-only” THP configurations





# HAARSLEV'S PREHEATER

- Triple purpose
    - Dispose of “used” steam
    - Recover thermal energy from used steam
    - Reduce viscosity of cake fed to pressurizer
  - Mechanically agitated
    - Reduces backpressure on economizer, which improves thermal efficiency
    - Permits up to 22% TS cake feed
    - Not a pressure vessel
    - Operates under very slight vacuum to contain odors
-

# HAARSLEV'S PRESSURIZER

- A feed “pump” to the main reactor using steam as the piston
  - Small 12 bar pressure vessel (~200 liters)
  - 90 second operating cycle
  - Cake fed by PC pump at atmospheric pressure (steam off)
  - Feed valve closed, steam valve opened
  - Heating / pressurizing for ~45 seconds to 8 bar (~90% total steam dose)
  - Valve to main reactor opens, flow to 6 bar by differential pressure
  - Steam and discharge valve close, cycle repeats
  - Well-proven system in rendering
-

# HAARSLEV'S MAIN REACTOR

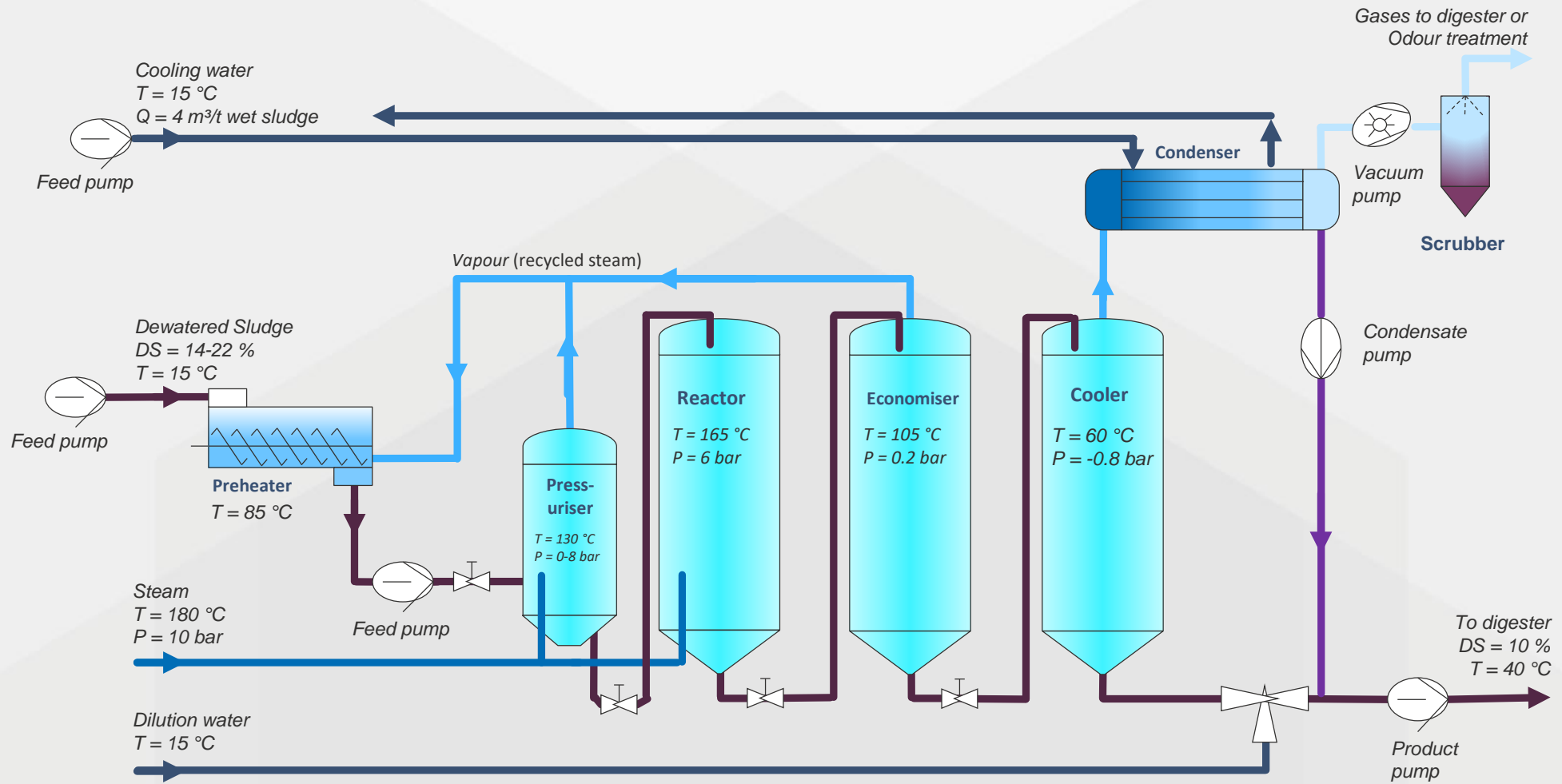
- Feed to top of reactor vessel from pressurizer
  - Sludge is liquified at this point
  - Downward “plug flow”
  - Typical 30 minute retention time (2-12 cubic meters)
  - Additional steam fed into headspace to maintain temperature (~10%)
  - Discharge regulated by nozzle and automated valve
  - No mechanical agitator in the pressure reactor
  - No radioactive level sensors
-

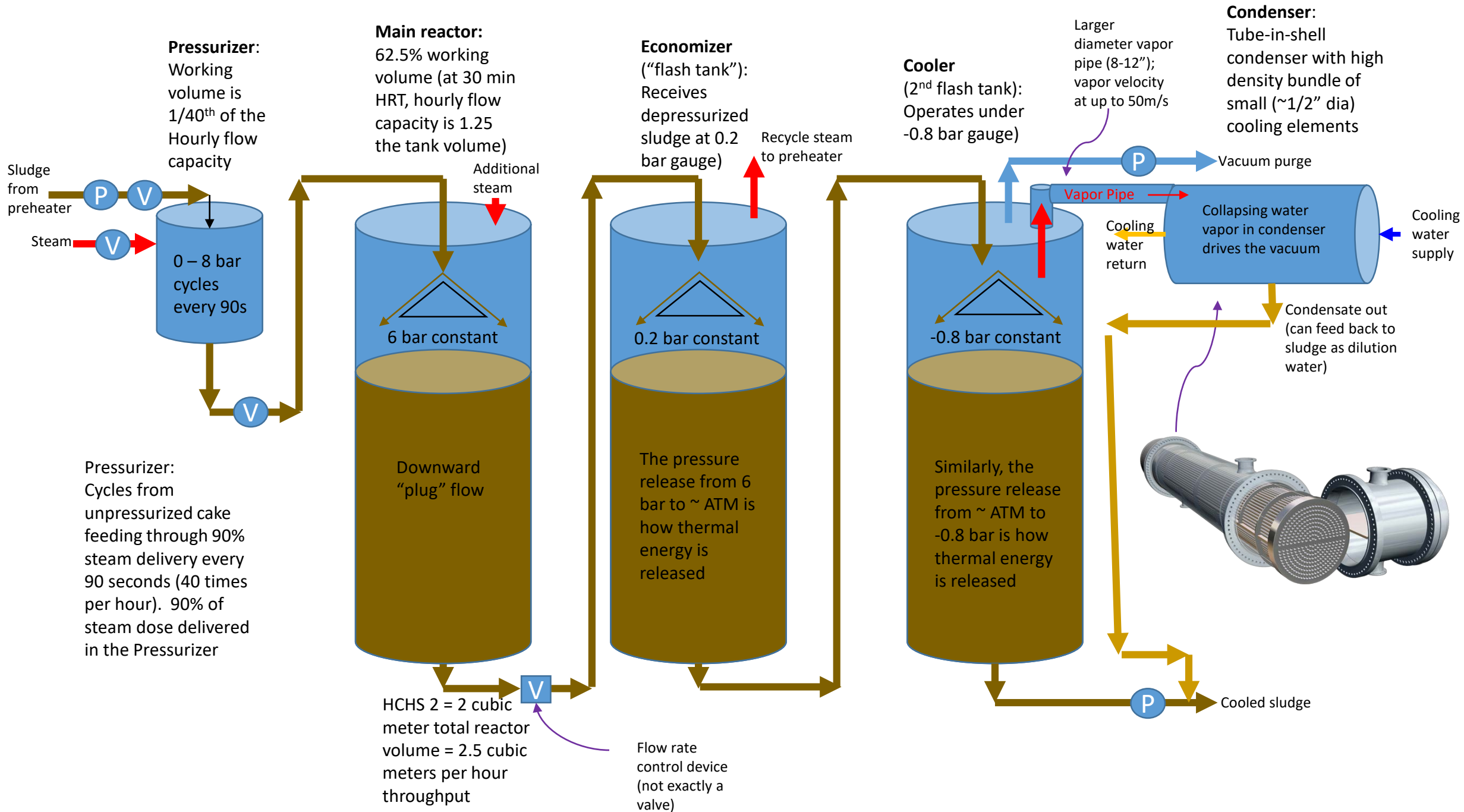
# HAARSLEV'S ECOMOMIZER

- Receives depressurized sludge from main reactor vessel
  - Target pressure of 0.2 bar gauge (~105C)
  - Flashed steam returned to preheater
  - Vessel is typically ½ the volume of main reactor
  - Not necessarily a pressure vessel
-

# HAARSLEV'S SLUDGE COOLER

- Conceptually: reverse action of a steam boiler
  - Two parts:
    - Cooling vessel - another tank (not a pressure vessel)
    - A tube-in-shell condenser
    - Headspace of cooling vessel connected to condenser by large diameter pipe
  - Steam is condensed on the inside wall of the condenser
  - As volume is collapsed from vapor to liquid, vacuum is created
  - “Steam vapor” in hot sludge is evaporated under vacuum
  - Thermal energy is extracted from the sludge to the condenser
  - Result is non-contact cooling of sludge in one tank by separate condenser
-







## Reference – WWTP Grevesmühlen, Germany



### Application:

Client:	Zweckverband Grevesmühlen
Location:	WWTP Grevesmühlen, Deutschland
Size:	<b>HCHS 2</b>
Product:	Secondary and digested sludge
Steam production:	exhaust heat of CHP
Throughput:	2 t/h (wet) 8 – 10 t <sub>DS</sub> /d
Dry Solids:	Dewatering 1: 15-20% Dewatering 2: 33%
Spec. steam cons.:	190 kg <sub>Steam</sub> /m <sup>3</sup>
Spec. elec. cons.	5 kWh/t <sub>wet sludge</sub>
Operation time:	24 h/d, fully automatic
Commissioning:	2014

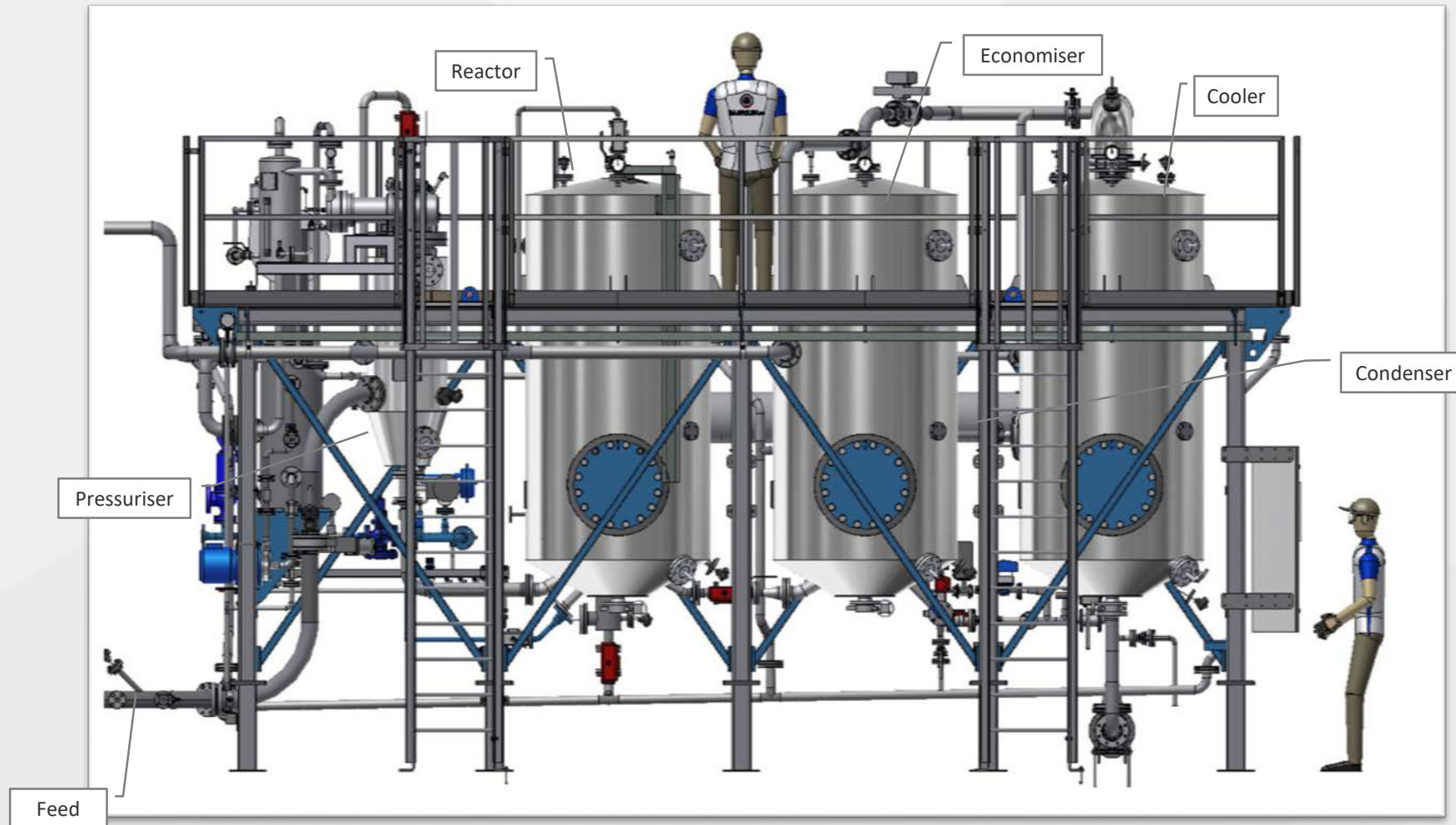
## Reference – WWTP Wola Dalsza, Łancut, Poland



### Application:

Client:	WWTP Wola Dalsza
Location:	Łancut, Poland
Size:	<b>HCHS 2</b>
Product:	Primary and secondary sludge
Steam production:	burning of biogas
Throughput:	1.1 t/h (wet) 4.2 – 5.3 t <sub>DS</sub> /d
Dry Solids:	Dewatering 1: 16 - 20% Dewatering 2: 31%
Spec. steam cons.:	170 kg <sub>Steam</sub> /m <sup>3</sup>
Spec. elec. cons.	4 kWh/t <sub>wet sludge</sub>
Operation time:	24 h/d, fully automatic
Commissioning:	2014

## Reference – WWTP Wola Dalsza, Łancut, Poland



# VALUE OF A CONTINUOUS PROCESS

- Continuous process flow results in optimized vessel sizes and energy recovery
    - Lower peak flowrates -> smaller vessel sizes
      - Lower capital cost
      - Reduced footprint
    - Continuous steam consumption at all capacities
    - Indirect evaporative cooler is a substantially smaller heat exchanger
-

# VALUE OF HIGHER DRY SOLIDS CONTENT

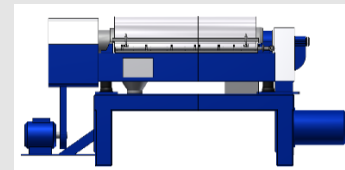
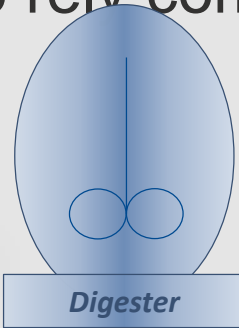
- Higher %TS feed results in higher dry solids throughput
  - Flexible in dry solid content with a range of 14 - 22% DS
  - Operation at higher solid content → improved steam economy
- Effect of increasing DS from 16.5% to 22 %
  - 33 % increased capacity of the same installation
  - 28 % reduced steam consumption

	16.5 % DS	22 % DS
Flow to HCHS (t/h)	9,9	6,9
Steam consumption (t/h)	1,6	1,1
Steam consumption kg/t DS	978	705



# COMBINING THP WITH THERMAL DRYING

- Reduced anaerobic digester volume from THP
- Reduced water evaporation load from better dewatering = smaller dryer
- Use of primary sludge for cooling and dilution of hot hydrolysed secondary sludge can eliminate the cooling requirement
- Alleviates the need to rely completely on the AD for Class A



Hydrolysis

Anaerobic Digestion

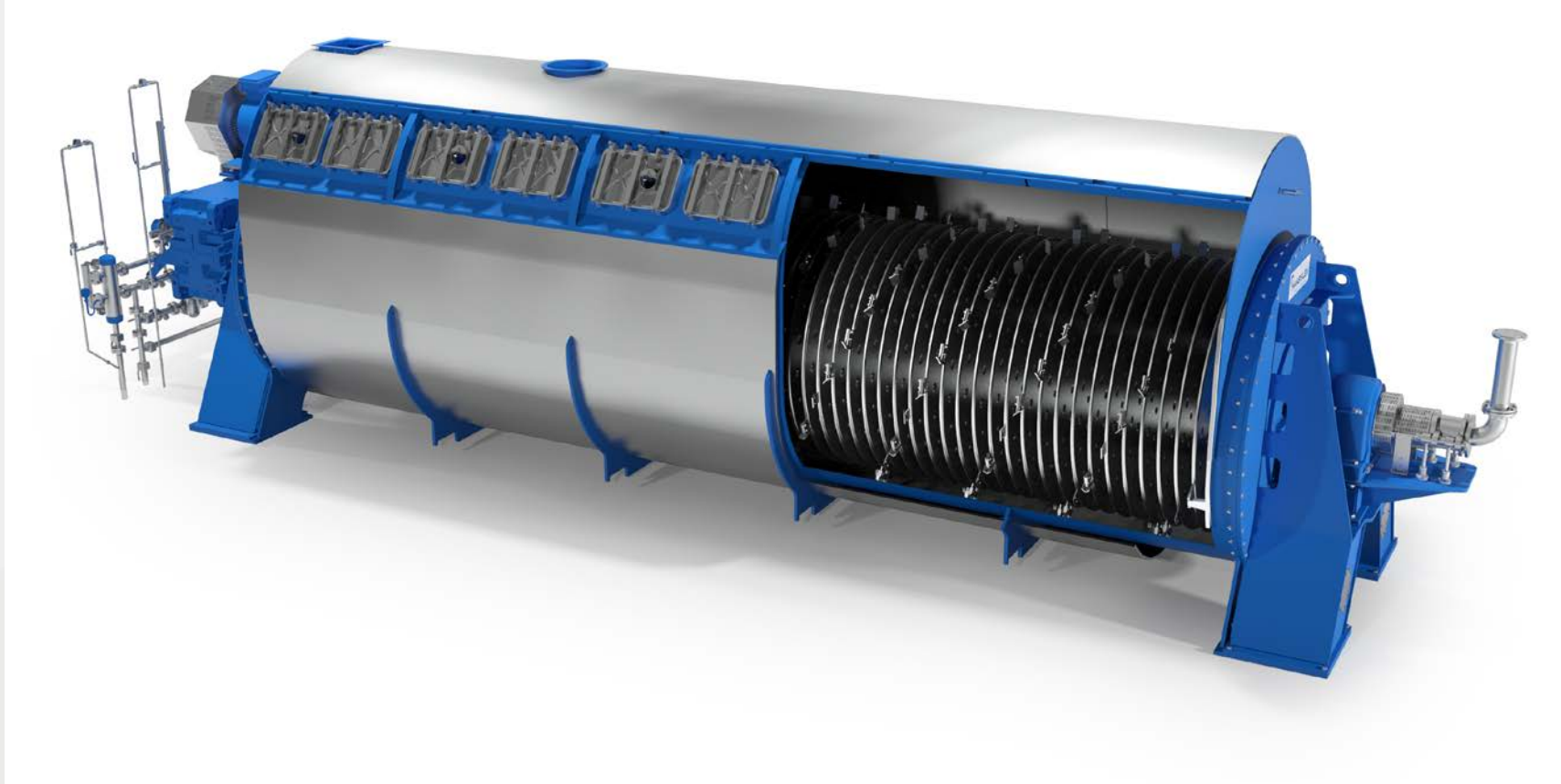
De-watering

Low temperature  
Belt-Drying

# HAARSLEV'S LOW TEMPERATURE BELT DF



# HAARSLEV'S DISC DRYER





# THANK YOU FOR YOUR ATTENTION!

- Josh Mah  
Process Engineer / Technical Sales  
[Joshua.Mah@Haarslev.com](mailto:Joshua.Mah@Haarslev.com)
  - Keith Hamilton  
Director of Sales and Marketing, Environmental Division  
[Keith.Hamilton@Haarslev.com](mailto:Keith.Hamilton@Haarslev.com)
  - Haarslev, Inc. (USA)  
9700 NW Conant Av  
Kansas City, MO  
64153
  - Haarslev.com
-

