Introduction to HVO pre-treatment

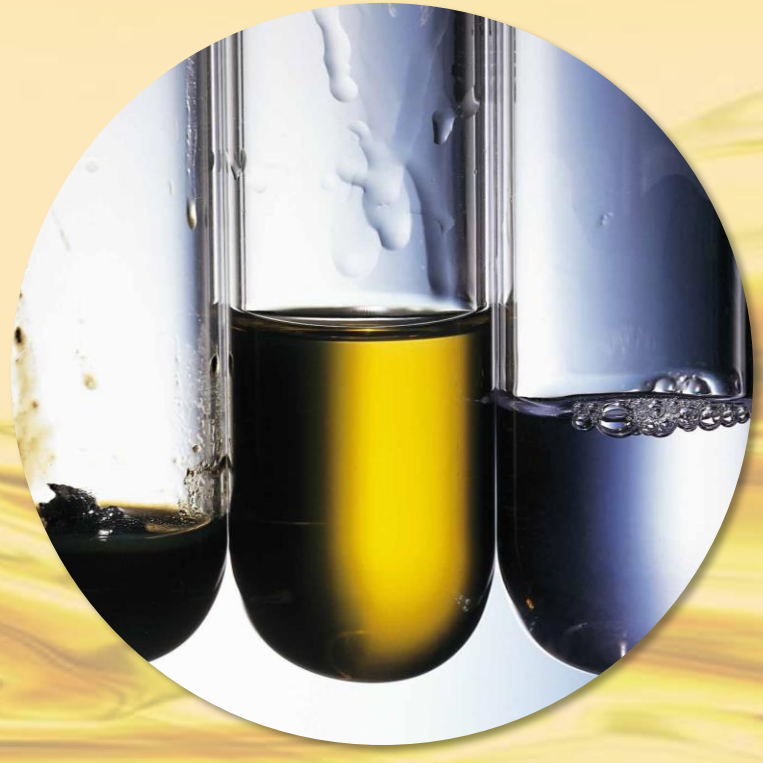
Andrew Logan

- Processing fats and oils as feedstocks

What we'll talk about today

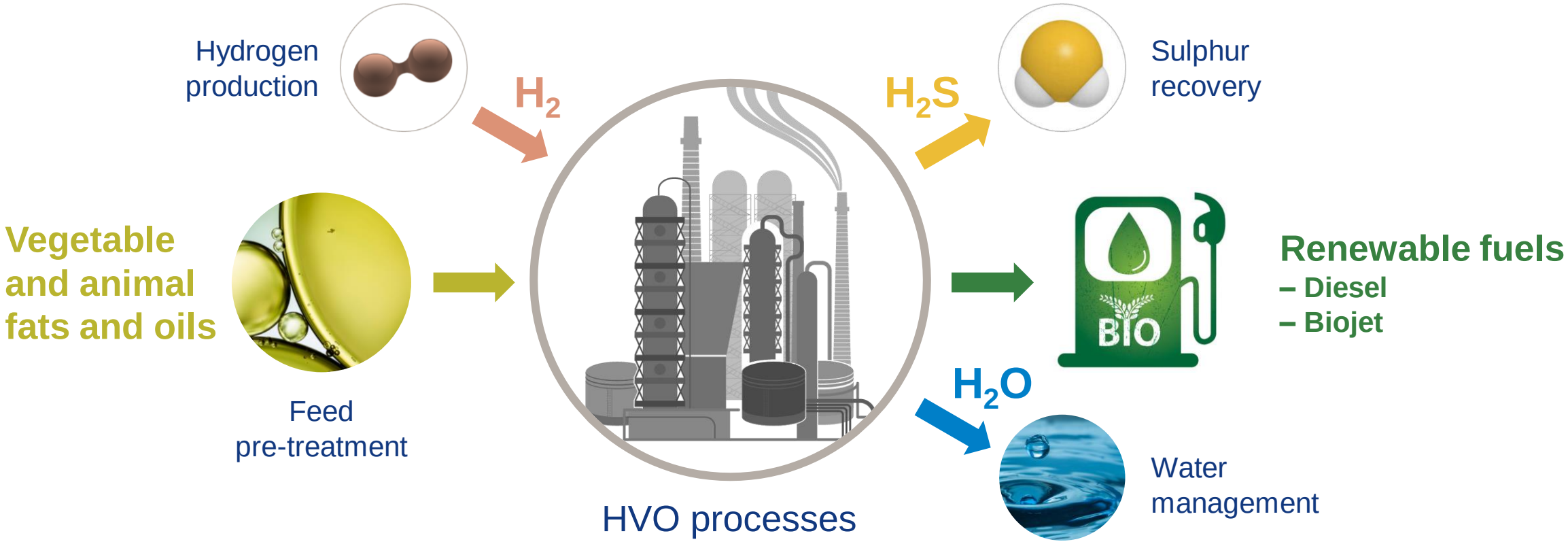
– Agenda

- The pre-treatment process
- Factors affecting pre-treatment process design
- Considerations to bear in mind beyond the pre-treatment process
- Why Alfa Laval



The HVO complex

– Alfa Laval solutions in all parts of the complex



The HVO complex

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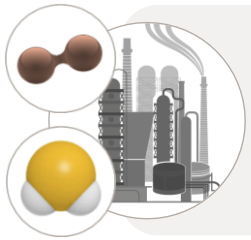
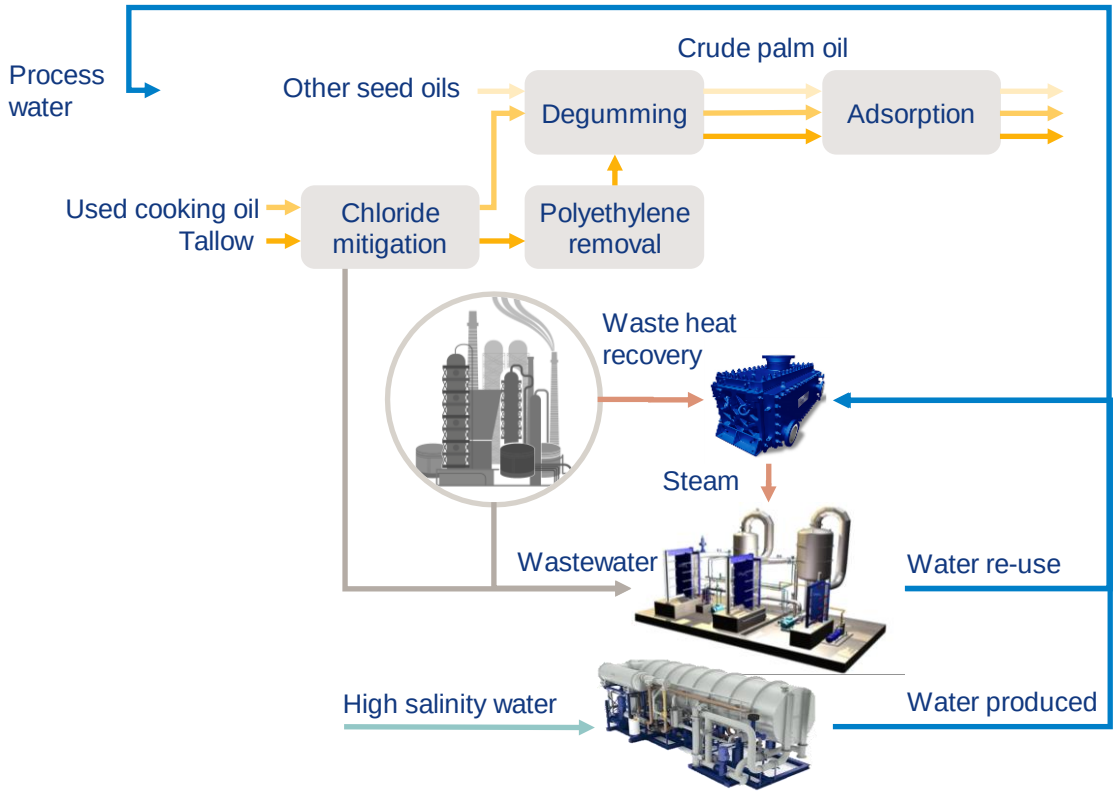
Alfa Laval solutions

Pre-treatment (PTU)
Basic process design and critical equipment supply



HVO processes
Process optimization for maximum efficiency and optimal heat exchanger selection

Water management
Solutions to produce and re-use process water and minimize waste



The HVO complex

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Alfa Laval solutions

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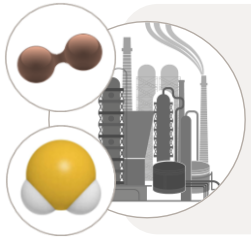
Basic process design and critical equipment supply



HVO processes
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Solutions to produce and re-use process water and minimize waste

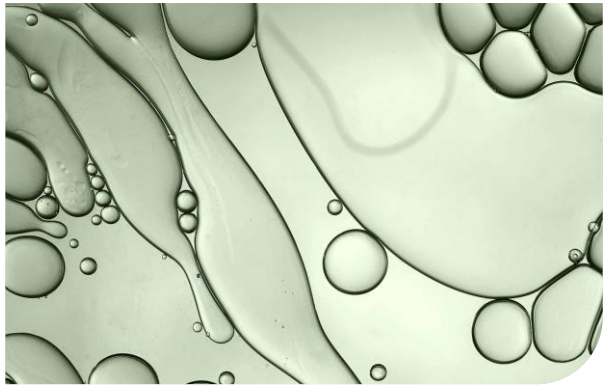
Value for end users

- Maximum feed stock flexibility
- Longest catalyst life cycle
- Maximum product yield
- Maximum energy efficiency
- Minimum CAPEX
- Minimum utility and waste
- Minimum environmental footprint

Why pre-treat?

- To remove contaminants in crude fats and oils feedstocks or to reduce them to acceptable levels
- To protect equipment and maximize catalyst lifetime
- To ensure high yields of renewable diesel downstream

Why pre-treat?



Removal or reduction of contaminants, such as:

- Chlorides
- Insoluble impurities (solids)
- Polyethylene
- Phospholipids and other phosphorus compounds
- Proteins
- Metals
- Moisture
- Others: Free fatty acids and sulphur compounds

Typical PTU feedstock quality parameters

Component	Unit	Vegetable oils	Animal fat (Cat 3)	Used cooking oil
Free fatty acids (FFAs)	%	3	20	7
Moisture and volatile matter	%	0.5	1.5	1
Insoluble impurities	%	0.2	0.5	0.5
Unsaponifiables	%	1	1	1.5
Phosphorus	ppm	250	200	5
Total metals (Mg, B, Na, Fe, Zn, K, Ca, Si)	ppm	150	300	150
Nitrogen	ppm	50	700	60
Sulphur	ppm	10	100	15
Chlorides (total)	ppm	10	200	50
Polyethylene	ppm	nil	200	50

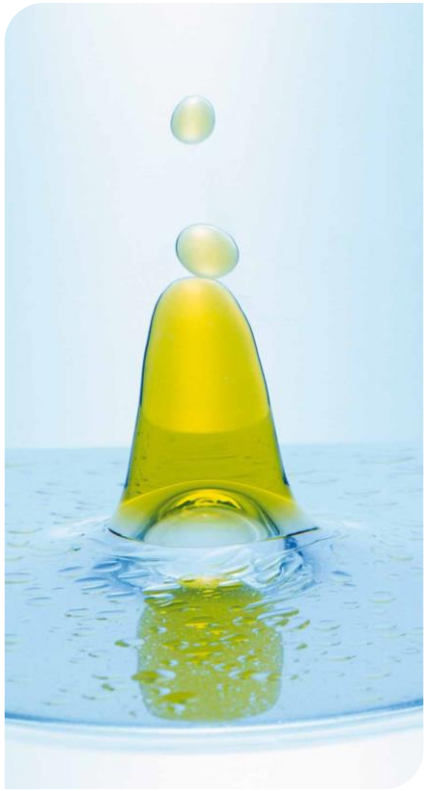
Typical HVO feedstock quality parameters

Component	Unit	Provider A	Provider B	Provider C	Provider D
Free fatty acids (FFAs)	%	15	25	20	20
Moisture and volatile matter	%	0.05	0.05	0.05	0.07
Insoluble impurities	%	0.05	0.01	0.01	0.01
Unsaponifiables	%	1	1	1	1
Phosphorus	ppm	3	3	3	2
Total metals (Mg, B, Na, Fe, Zn, K, Ca, Si)	ppm	5	5	7	5
Nitrogen	ppm	350	n.s.	350	200
Sulphur	ppm	250	n.s.	20	100
Chlorides (total)	ppm	10	10	50	5
Polyethylene	ppm	50	20	50	50

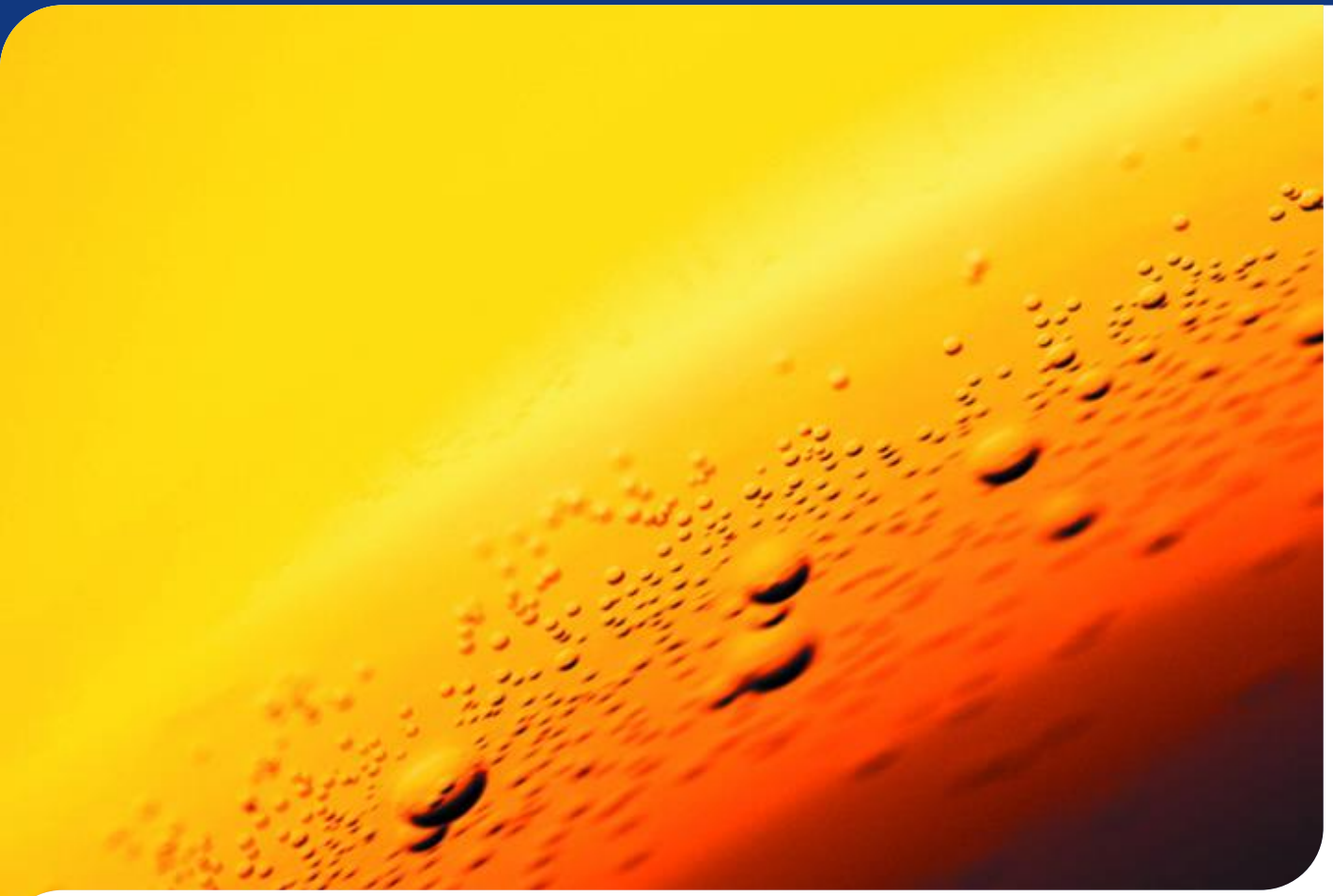
Contaminant removal

– Process setup

Chloride mitigation (optional)	**Polyethylene removal** (optional)	**Special degumming**	**Adsorption**
Contaminants treated	**Contaminants treated**	**Contaminants treated**	**Contaminants treated**
Chlorides	Polyethylene Solids	Chlorides Solids Phosphorus Proteins Metals Sulphur	Solids Phosphorus Proteins Metals Sulphur Moisture
By-products/effluents	**By-products/effluents**	**By-products/effluents**	**By-products/effluents**
Wastewater	Spent adsorbent	Gums Wastewater	Spent adsorbent Wastewater

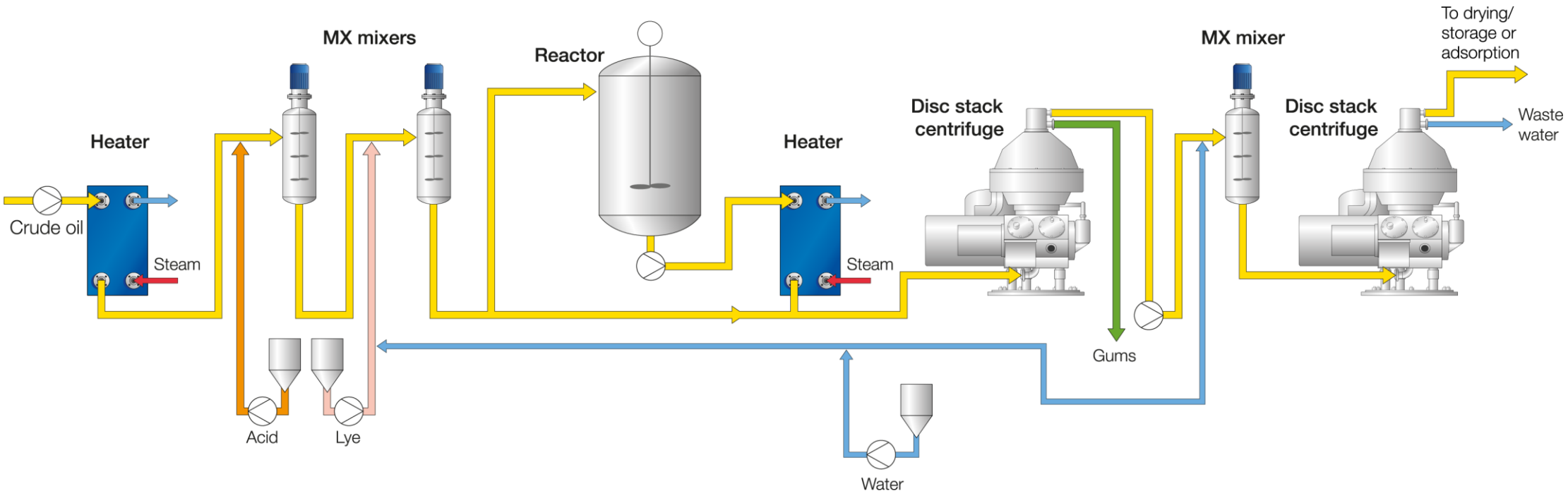


Why degumming?

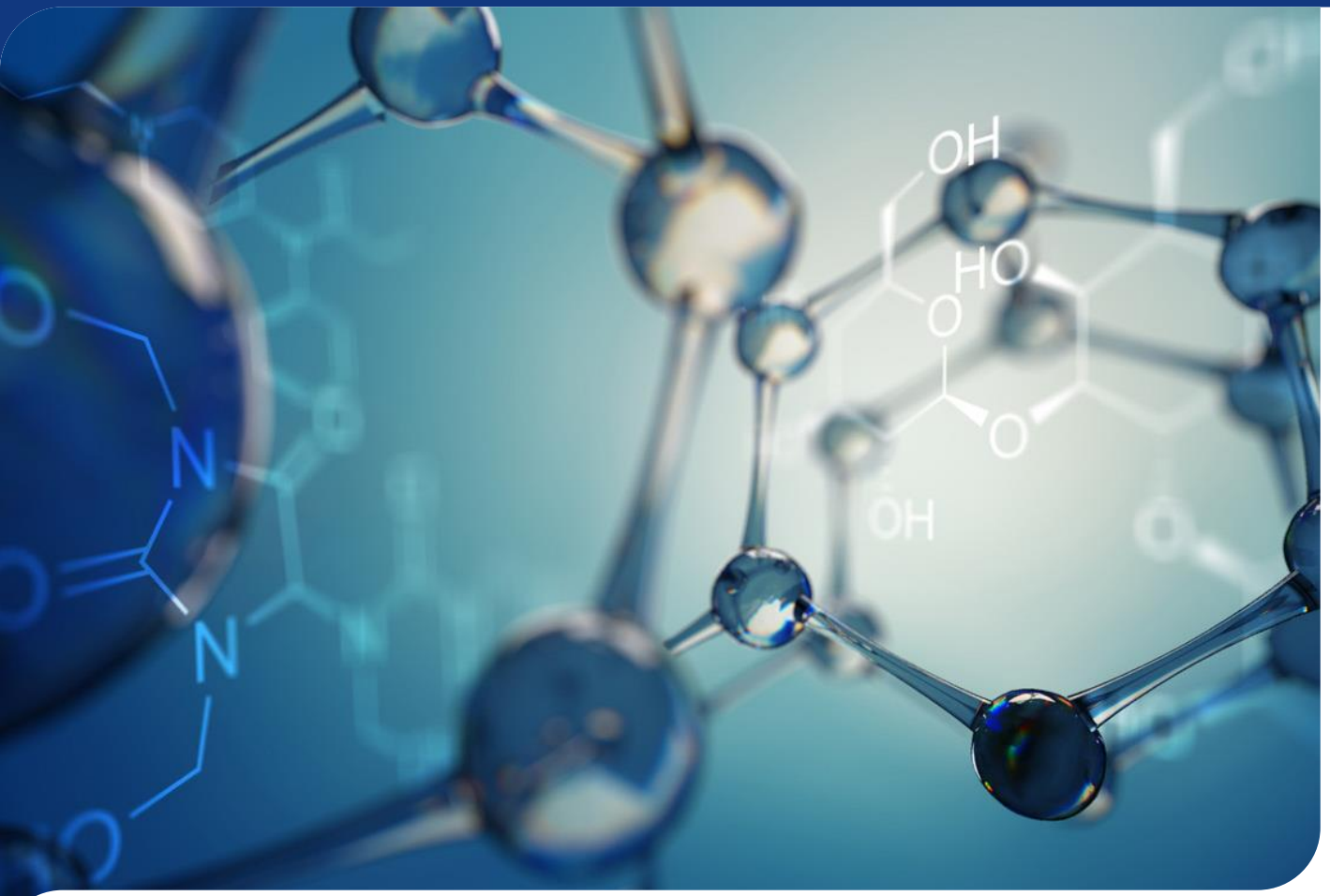


- All fats and oils contain gums, or gum-like material (phosphatides or phospholipids)
- Removal of gums and gum-like material is a ‘must’ before exposing fats and oils to high temperatures to prevent:
  - Fouling of heat exchanger surfaces
  - Catalyst pressure drop
  - Loss of catalyst activity

Special degumming

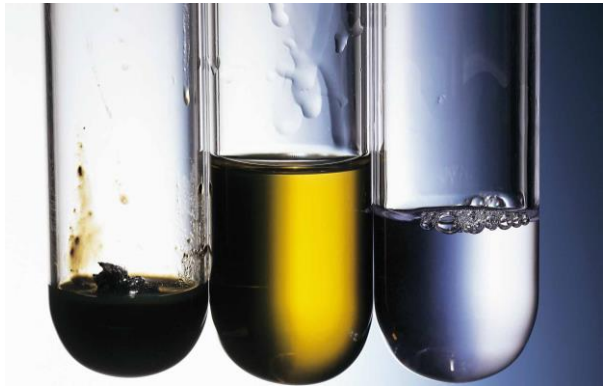


Why adsorption?



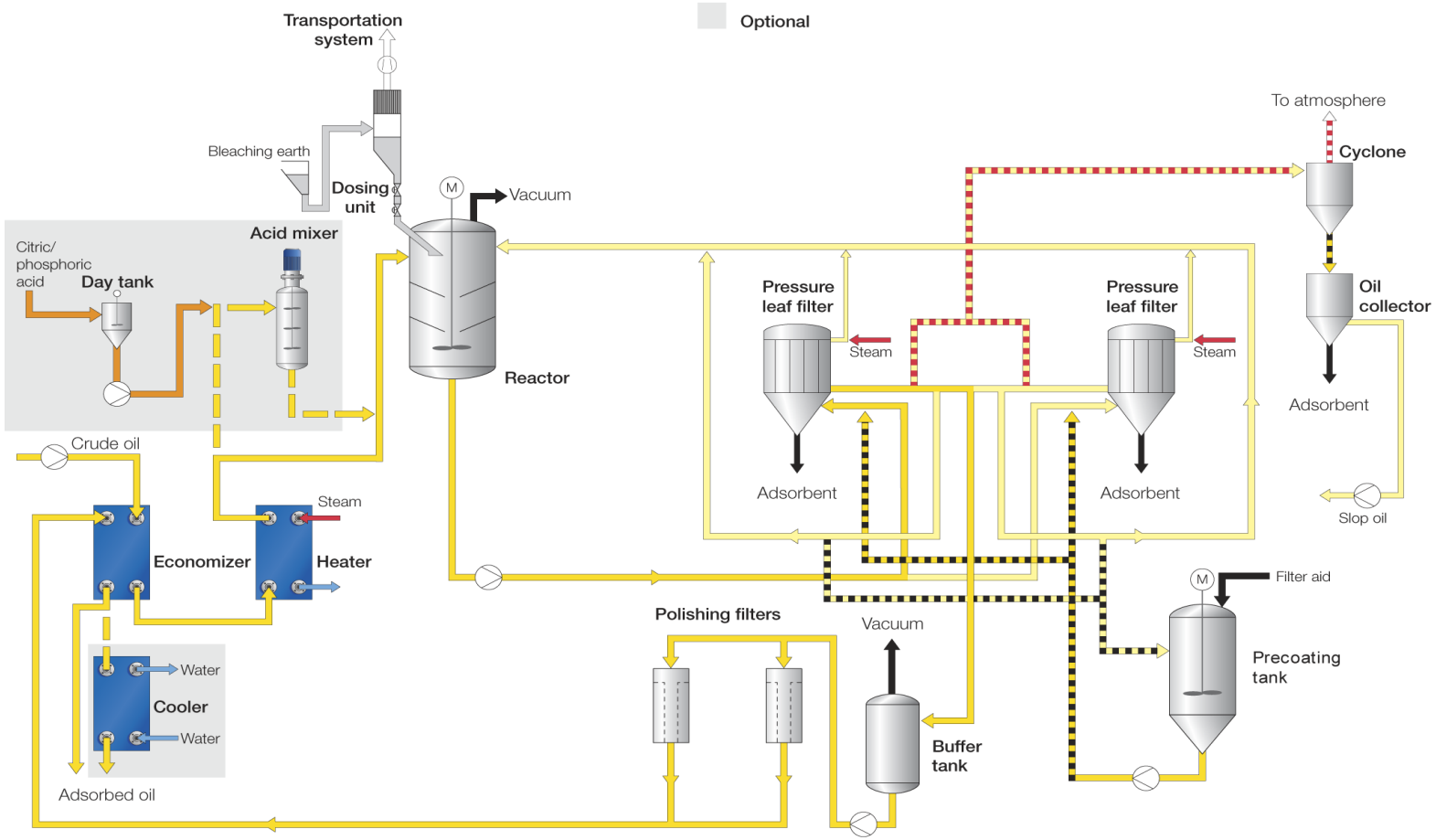
- To remove residual phosphatides after degumming
- To reduce metal content

What is bleaching earth?



- Aluminium silicates (bentonite, montmorillonite, attapulgite)
- Acid activated to enlarge inner surface
- Typically 40 m^2 pore surface area per gram
- Adjusted particle size distribution to ensure good filtration
- Quality varies – price and performance is often related

Example of adsorption section

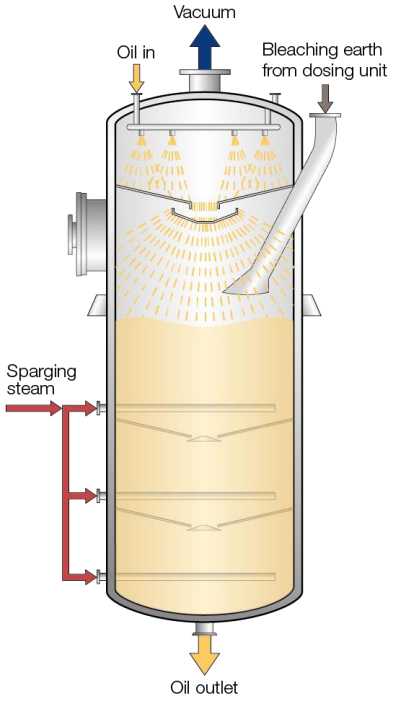


Key equipment

– Mandatory supply

Process line equipment

- Centrifuges
- Pressure leaf filters
- Process vessels and reactors
- Heat exchangers
- Dynamic mixers



PTU design considerations

Considerations

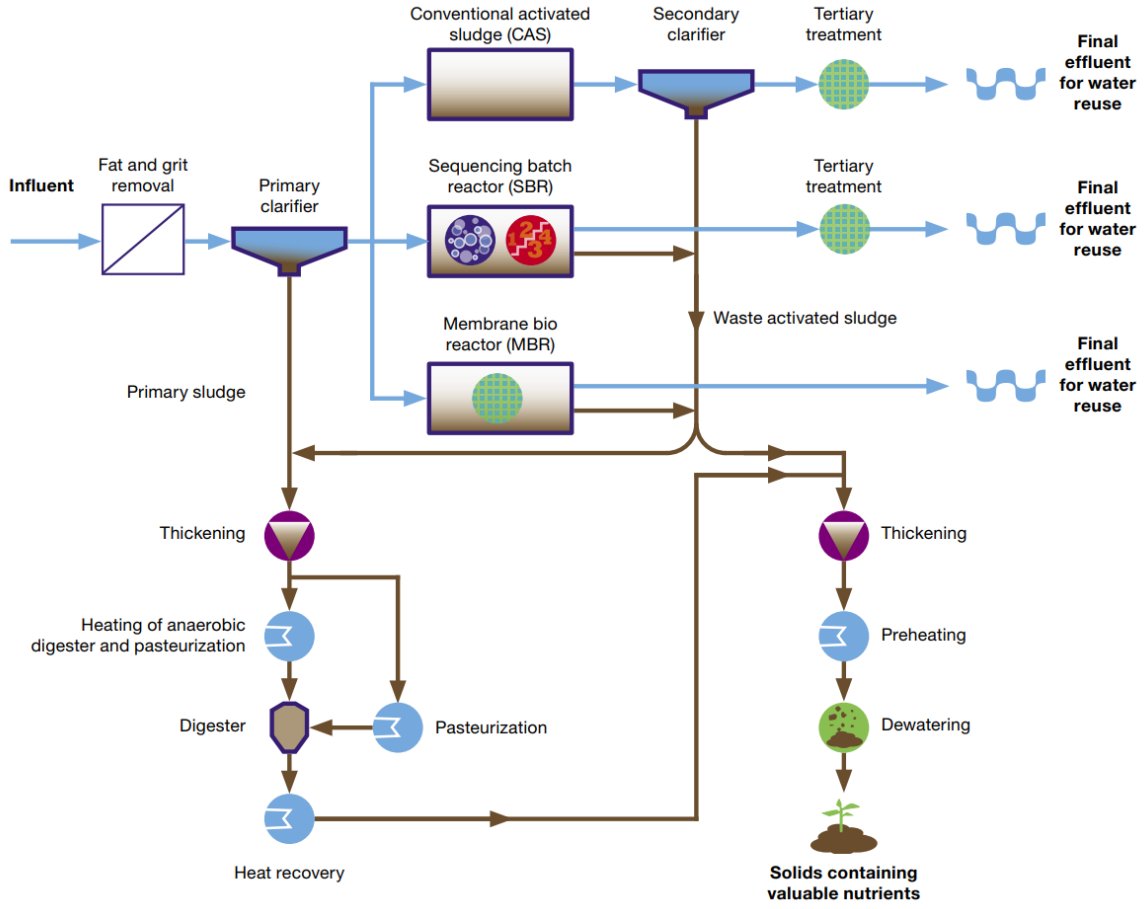
- Feedstock(s)
- By-product disposal
- Location
- Number of lines/trains
- Availability

Wastewater management

– Maximum recovery, recycle, reuse!

Wastewater produced in PTU plant

- Degumming section
  - 5–10% of oil flow
  - Phosphorous compounds
- Chloride mitigation section
  - 5–10% of oil flow
  - Chlorides



Wastewater management

– Case study of 2,800 m^3/day new PTU complex

Waste heat recovery from fractionation section

~ 10 t/h, 4.2 bar steam generated from hot rundown streams

~ 15 MW recovered into district heating hot water loop (400 t/h @ 95°C)

Desalination

− Usage of waste heat from HVO process to generate process water for the PTU

- Using waste heat recovered from the HVO processes as energy to produce water below 2 ppm of total dissolved solids (TDS) from sea, river or groundwater source
- No fresh steam required to run these plants because maximum amount of energy is recovered from low grade sources using high-efficient heat exchangers
- Lowest OPEX compared to other desalination technologies

Alfa Laval MEP fresh water generator

Edible oil process line portfolio

− Comprehensive solutions

Crush and extract

Crude palm oil
Olive oil
Avocado oil

Clarify and water degum

Seed oil clarification
Water degumming (lecithin drying)

Degum/ neutralize/ dewax

Neutralization
Degumming (acid/enzymatic)
Dewaxing
Soapstock splitting

Bleach

Bleaching (absorption) to remove impurities

Deodorize

Deodorization (continuous or semi-continuous) to remove volatile components and thermally stabilize/bleach the oil

Modify

Modify by fractionation, interesterification or hydrogenation to produce liquid oils and fats with specific melting behaviours

Biodiesel/HVO feedstock

Cooking oils

Margarine and shortening

Specialty fats end product

References

Fats and oils

- More than 500 complete refineries (with neutralization/degumming, bleaching, deodorization)
- Thousands of individual process sections

Pre-treatment

- More than 20 engineering projects
- More than 5 plants under construction or in operation

Why Alfa Laval?

− Comprehensive Alfa Laval pre-treatment systems for HVO production

Boost HVO quality and yield

- Flexible, automated pre-treatment systems for continuous handling high volumes of multiple feedstocks
- Vast experience in energy-efficient and robust processing for the edible oil and the petroleum refining industries
- Leading technologies for wastewater treatment and water recycling
- Global service network with local presence

Why Alfa Laval?

– Continuing support

- 24/7 hotline for process/plant support available in selected countries
- Remote connectivity
- Service Level Agreements

  First 1–2 years (longer term possible)
  - Four to six recommended visits

  Year 3 onwards
  - Two to four recommended visits
- Process development and testing
  - Process optimization
  - New feedstock validation
  - Troubleshooting

Q&A

Any further questions

Please feel free to contact:

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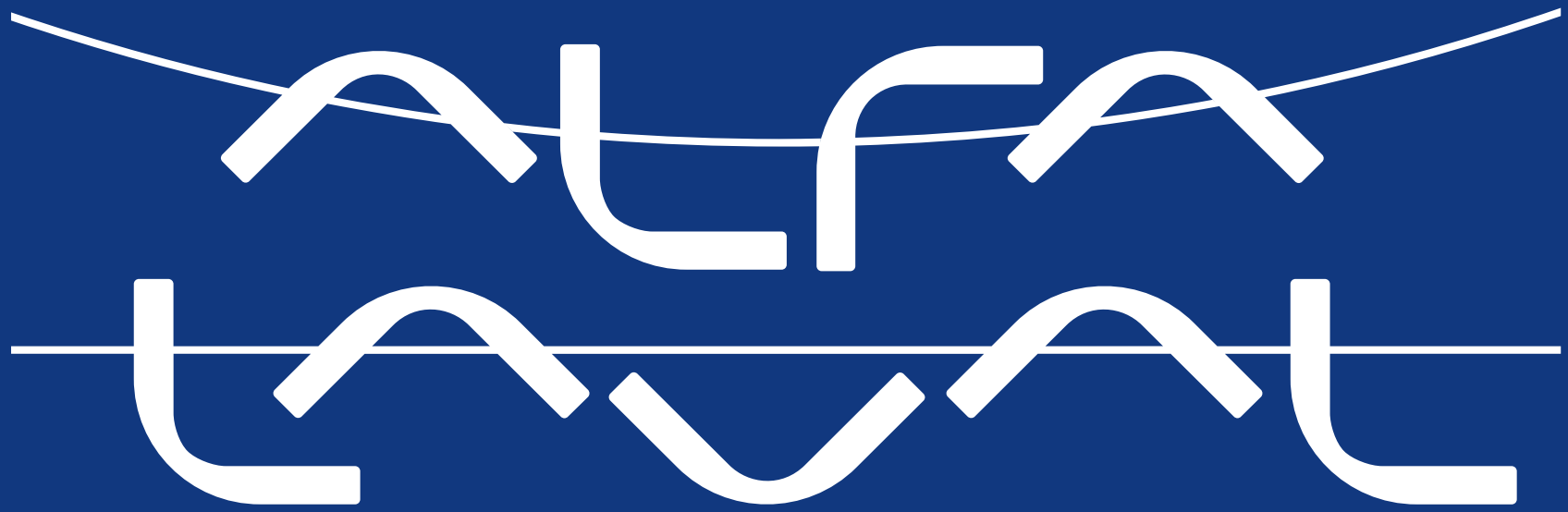
Visit our web page on HVO pre-treatment systems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