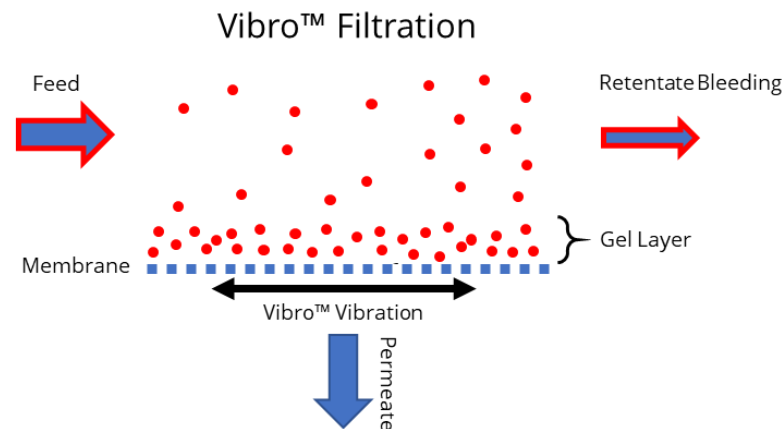
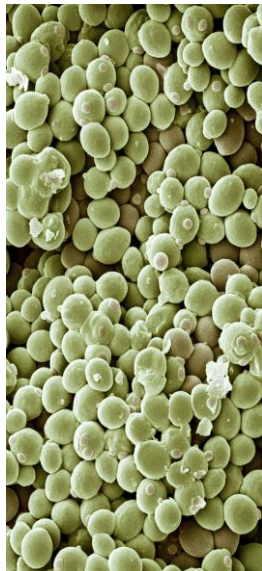


# SANI Membranes

## Vibro™ Technology for Micro- and Ultrafiltration Brewing applications



# Beer clarification & more Beer

Vibro™ technology combines 3 unique separation features that enables multi purpose use in the Brewery.

- Handling high solid loads and viscosities
- High transmission of essential beer components, e.g. aroma compounds and foam proteins, due to unique separation process control
- Low shear process

These three performance characteristics lead to new opportunities for improving separation processes in multiple brewery operations

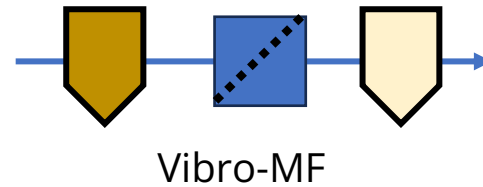
Vibro separation units are in fact just a very smart membrane filter that can replace a lot of other separation technologies

We will support all our present and future customers in the transition to smarter solutions to make the world a better place by higher productivity using less energy and materials, leading to a more efficient and thus greener solution.

In the following, we seek to visualize that, in order to make these opportunities available to all, and to avoid process patents that limits others from benefitting.

# Beer clarification & more Beer

**Vibro Membrane Filtration (VMF)**  
Simple, Fully CIP-able, High Yield,  
Low Shear, Energy efficient



From Brewhouse to packaging

The solutions shown in the following slides can be used in any kind of

- Separation, filtration, concentration, clarification, diafiltration etc. process such as: Wort separation (lautering), Wort recovery (trub filtration), green beer filtration, beer recovery, spent grain filtration, beer clarification, waste-water treatment and beer filtration

For many and any kind of end products such as

- Beer, wine or other fermented beverages.

From many and any feed or fermentation of such as

- Yeast, bacteria or any other cell-based media.

and same solution can be added steps in between presented steps such as

- Cell lysing, chemical extraction, pH change etc.

And for not fermented processes such as proteins processed from grains, the very same solutions can be used with the same benefits.

# Beer clarification & more Beer

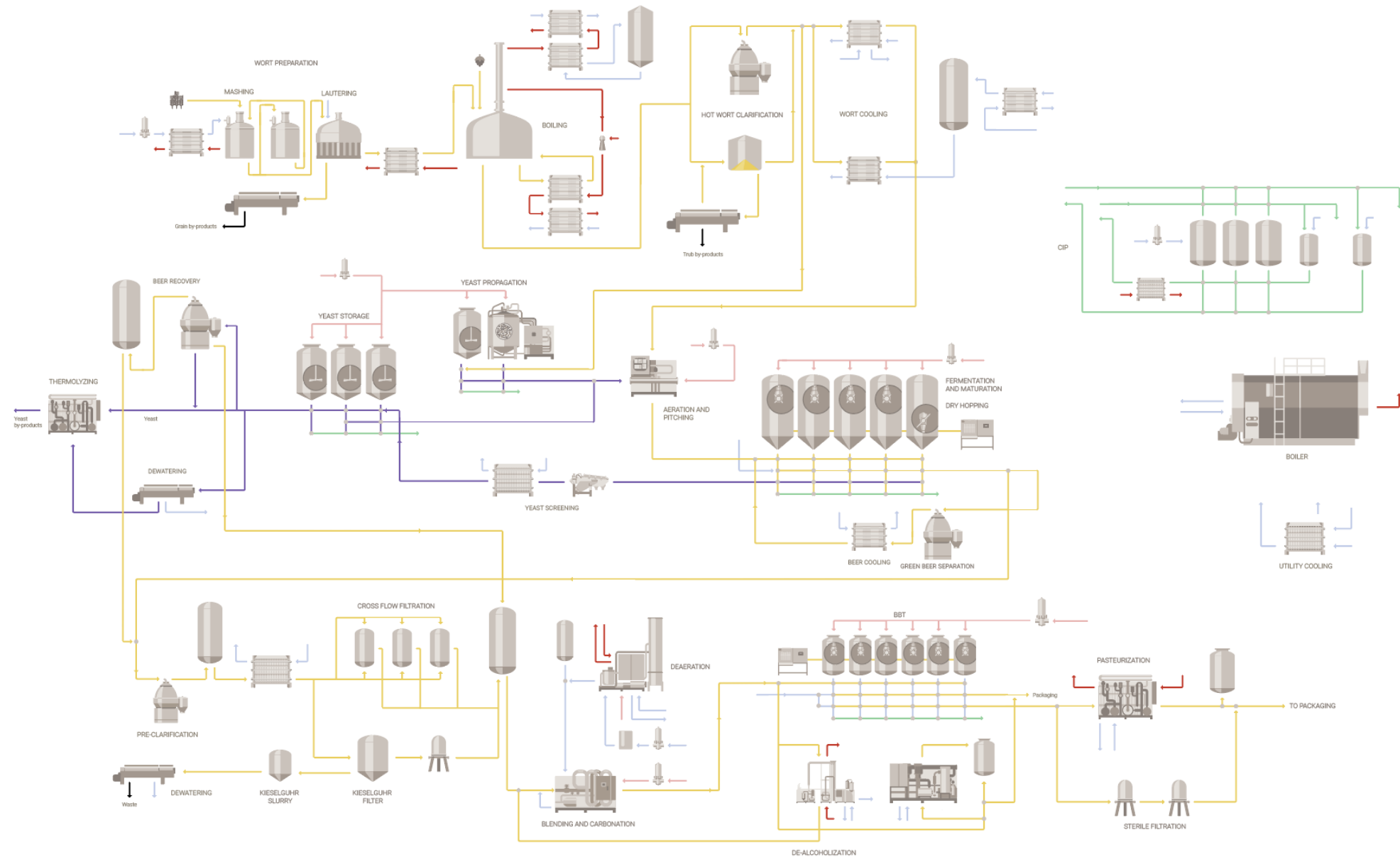
The Vibro™ Technology is applicable both for micro breweries and large-scale industrial size breweries.

The following is a non exhaustive list of applications, which are currently commonly being performed by expensive technologies with a very high energy consumption such as e.g. High Speed Separators (HSS), by Diatomaceous Earth/Kieselguhr filtration(DE/KG) which has a high environmental impact and is also carcinogenic and thus disposal is problematic or complex ceramic and polymeric membrane technologies.

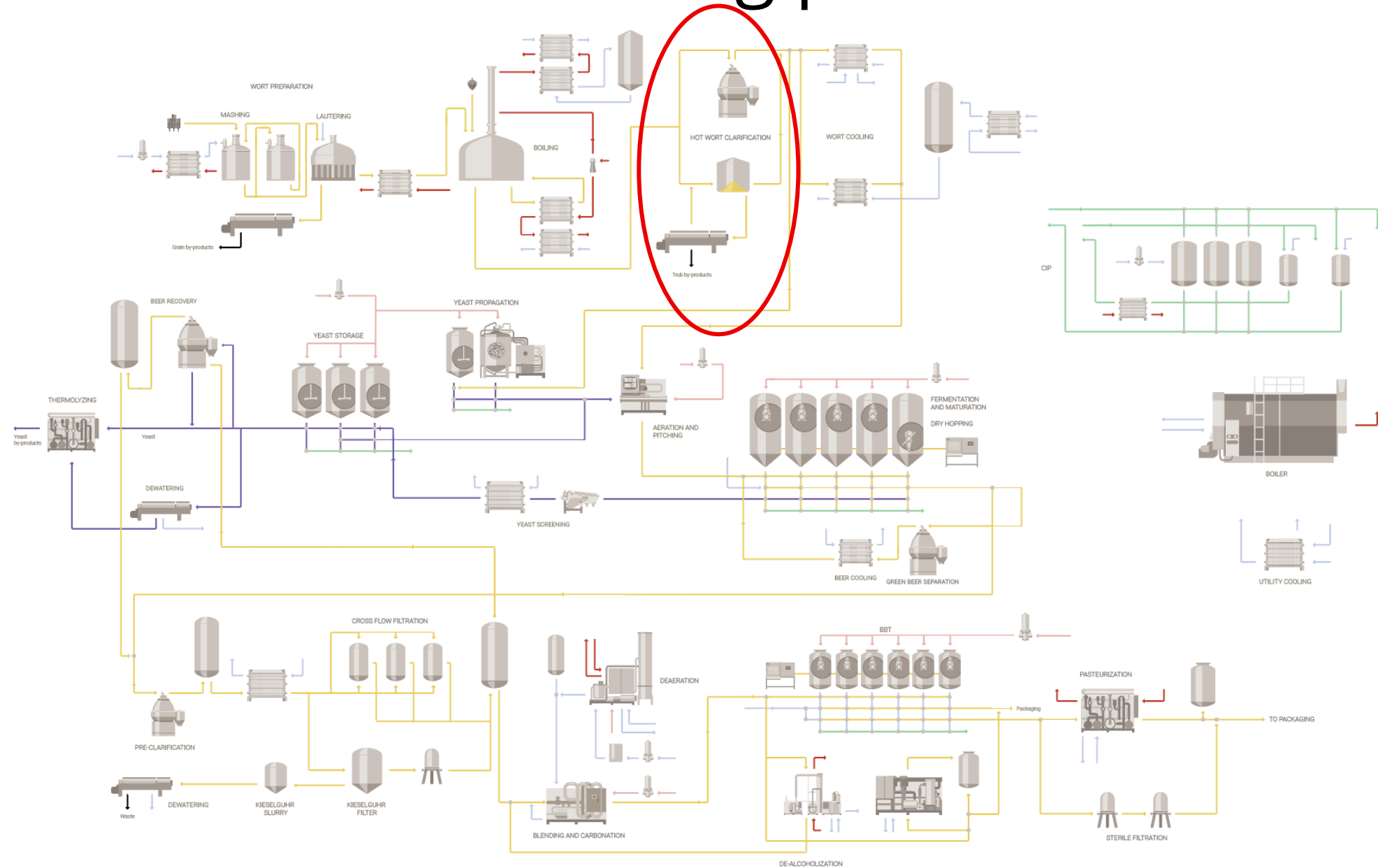
We propose a simple solution using our patented unique technology can replace these operations, with both qualitative and economical benefits:

- Hot Trub separation/Wort recovery
- Cold Trub separation
- Yeast Harvesting and yeast beer recovery
- Tank bottom filtration/Green beer separation
- Beer Clarification
- Filtration of stabilized beer (Separating beer from single use stabilizers such as PVPP, Silica gel or similar)

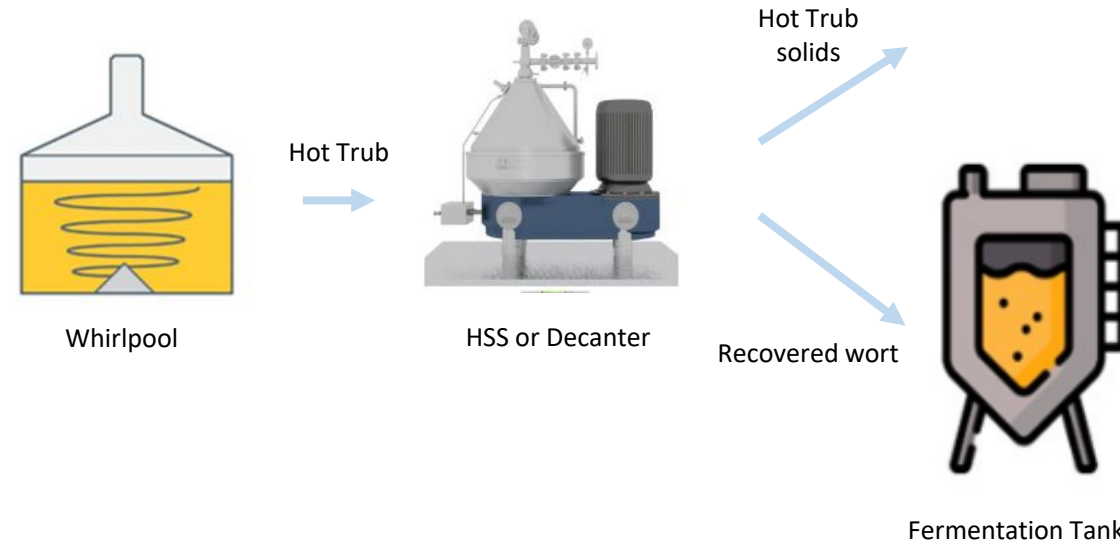
# The brewing process



# The brewing process



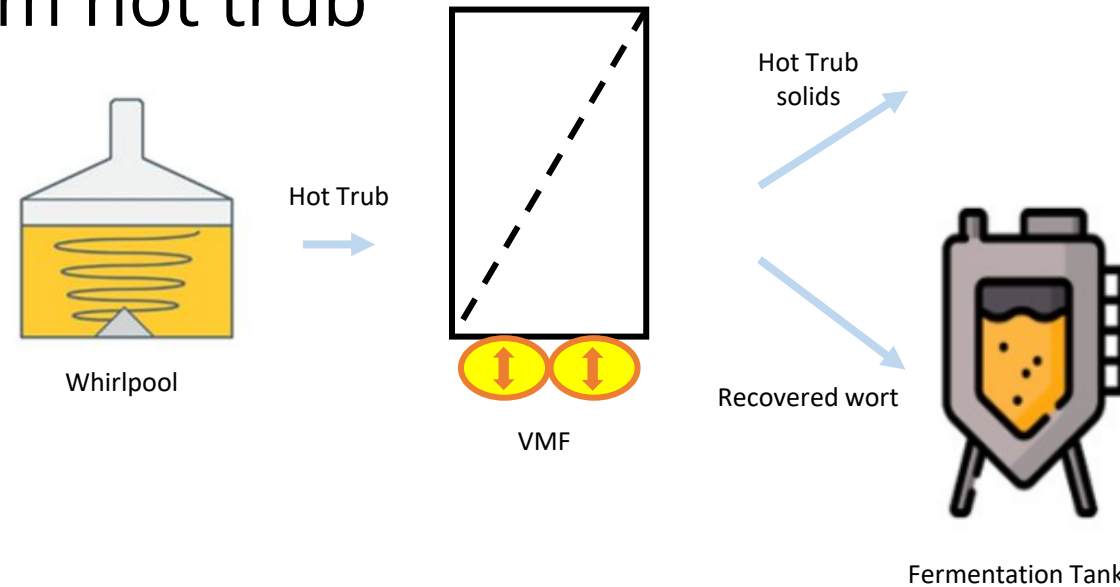
# Wort recovery from hot trub



After whirlpooling, considerable amounts of wort/extract is contained in the so called *hot trub*, which can be recovered, increasing brewhouse yields. This is currently done with decanters, HSS or similar, however with VMF we present an exciting alternative with many benefits:

- Lower CAPEX/OPEX
- Improved Brewhouse yield
- Improved colloidal stability of the recovered Wort, increasing cold break formation and improve filterability of finished beer during a later clarification step

# Wort recovery from hot trub

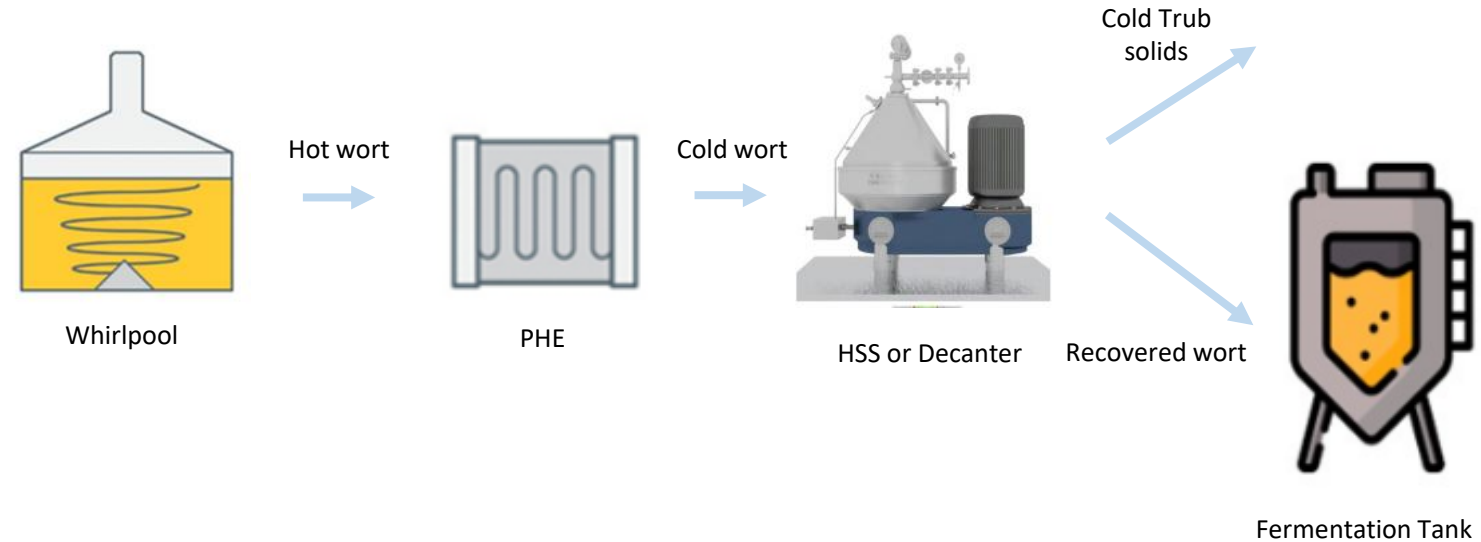


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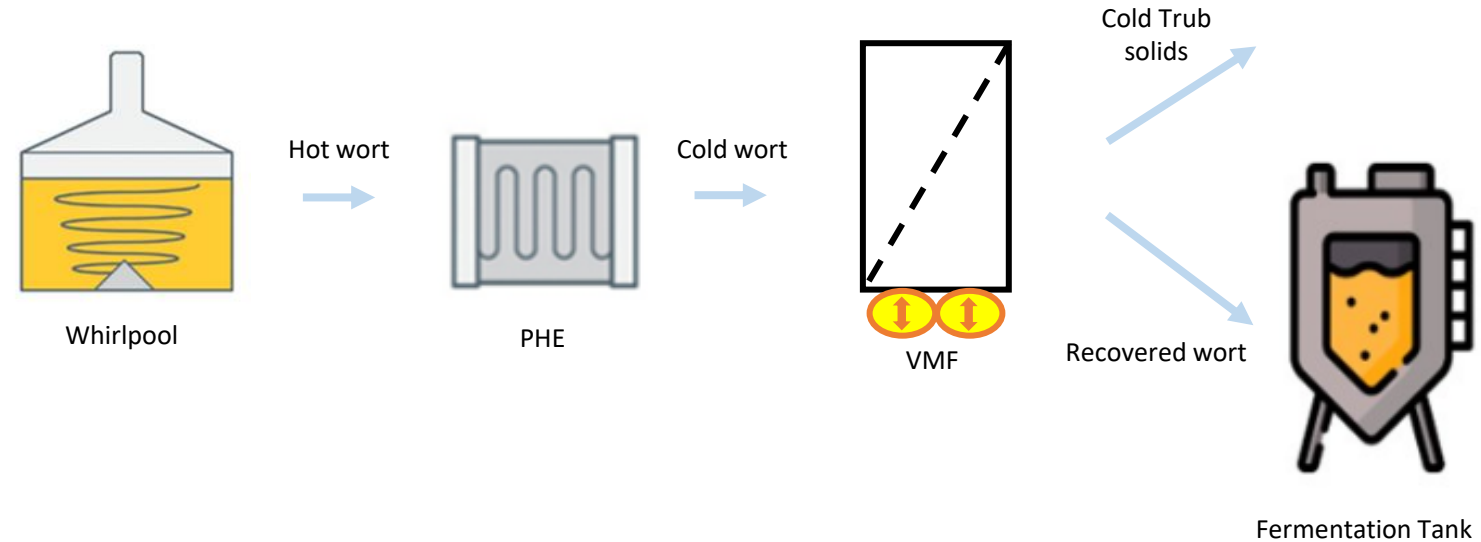
# Wort recovery from cold trub



Upon cooling the wort ( $< 60^{\circ}\text{C}$ ), so called *cold trub* forms from precipitation of polyphenol/tannin and protein complexes. These tiny particles ( $0.5\ \mu\text{m}$ ) adhere to yeast cells, lowering the surface area in contact with the fermenting wort, decreasing fermentation efficiency. This is especially important for yeast which is reused for multiple brews. Furthermore, removal of cold trub will have the following benefits:

- Foam improvement (Precipitation of fatty acids)
- Flavour stability
- More intense fermentation
- Rounder beer flavour (more pleasant bitterness)

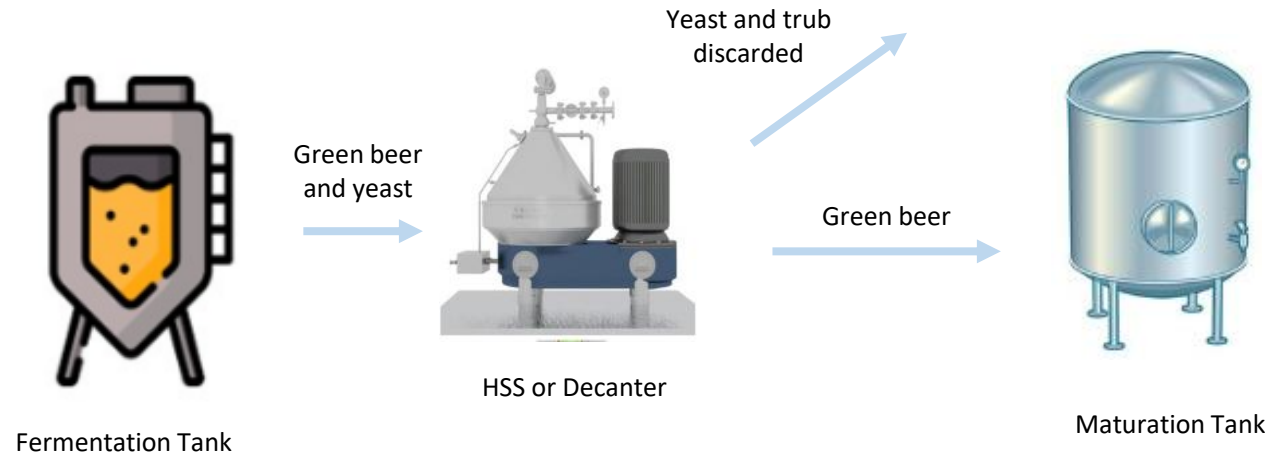
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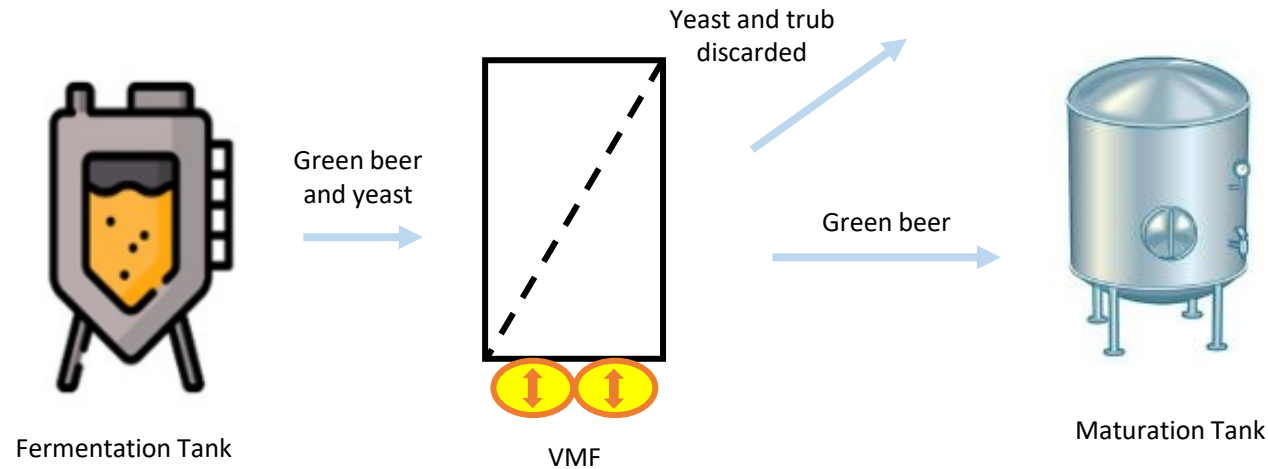
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# Green beer recovery



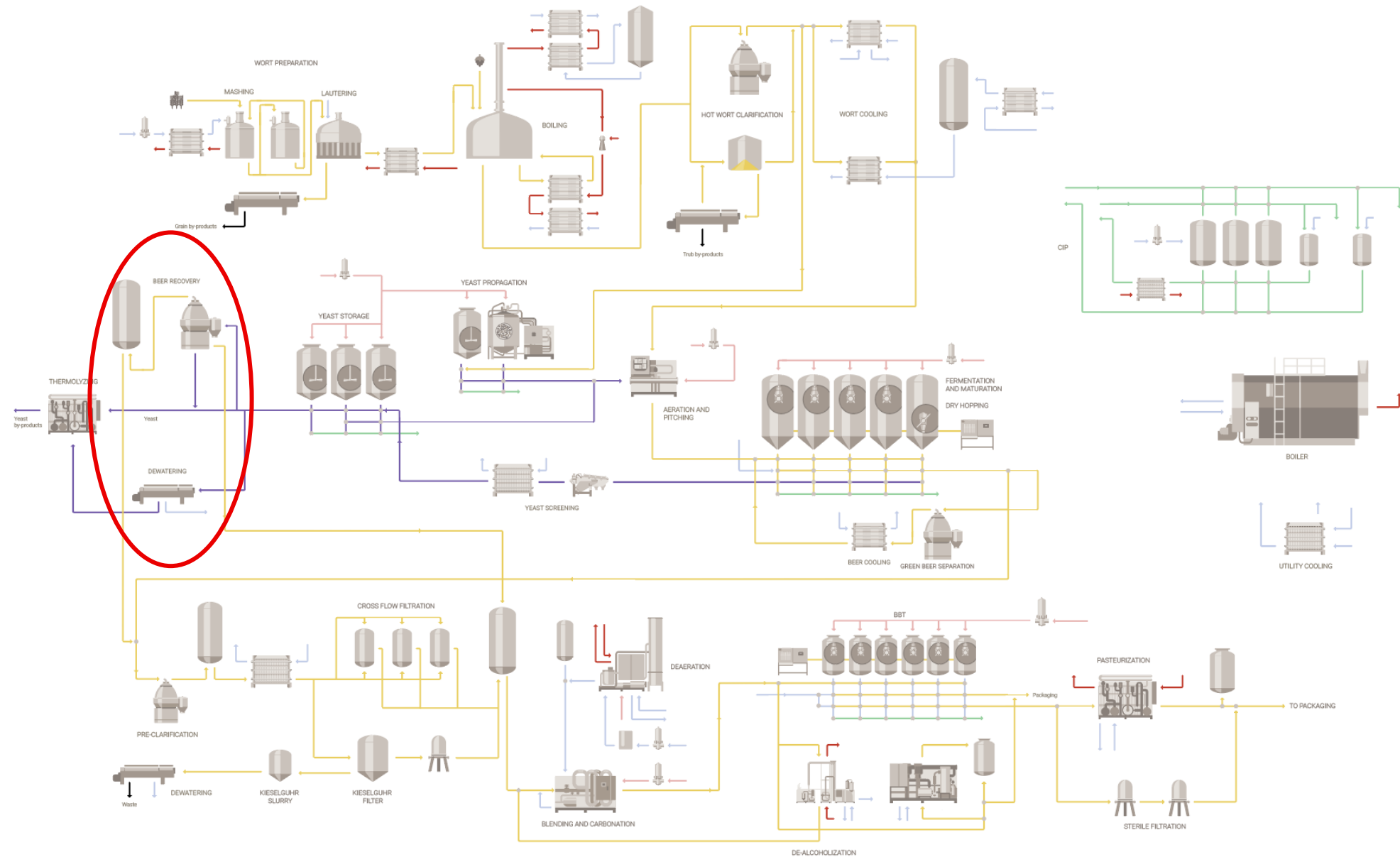
Once beer has finished primary fermentation, a period of maturation is required, which can be done in either the fermentation vessel (Unitank process) or a Maturation tank (2 tank process). This is done for multiple reasons, one being to settle the yeast still in suspension to clarify the beer before final filtration. This requires extensive cooling ( $< 0^{\circ}\text{C}$ ) and is time consuming, especially with large fermentation tanks. To facilitate this process, HSS, decanters or similar is currently used. However, these are expensive and has high energy requirements. With VMF we propose a more energy efficient solution, while being cost competitive.

# Green beer recovery



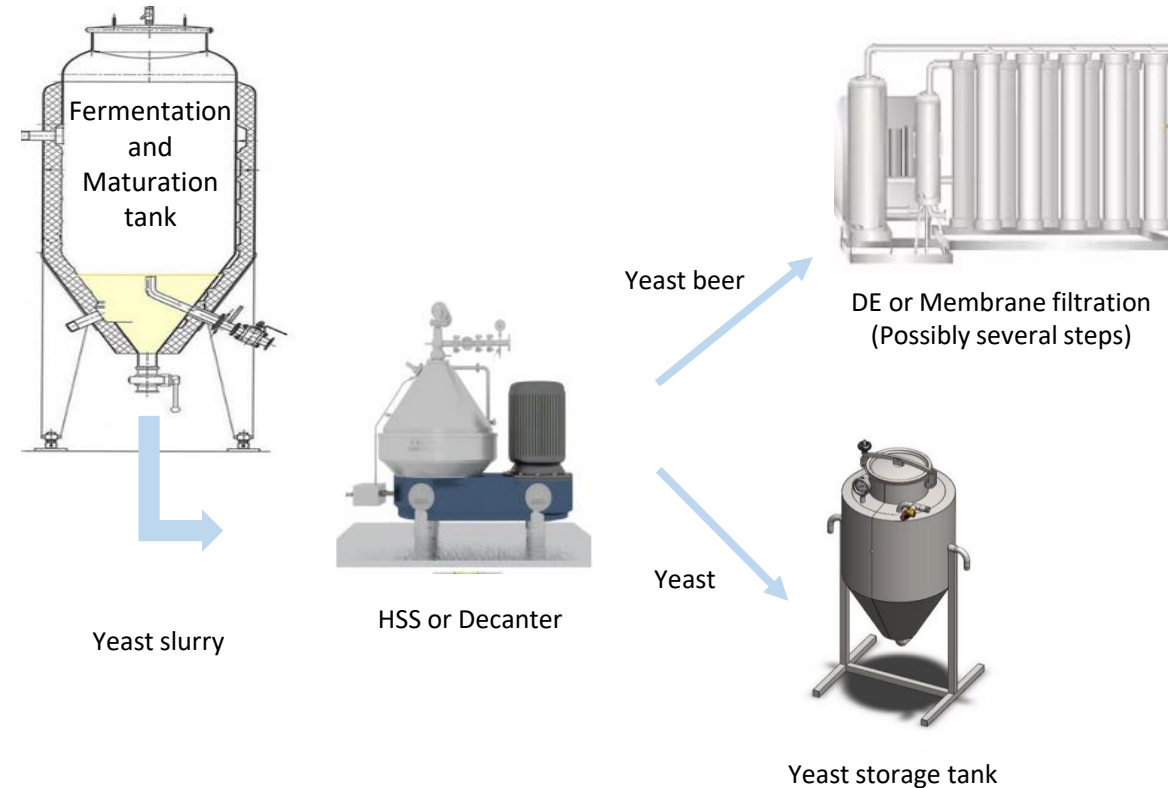
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# The brewing process



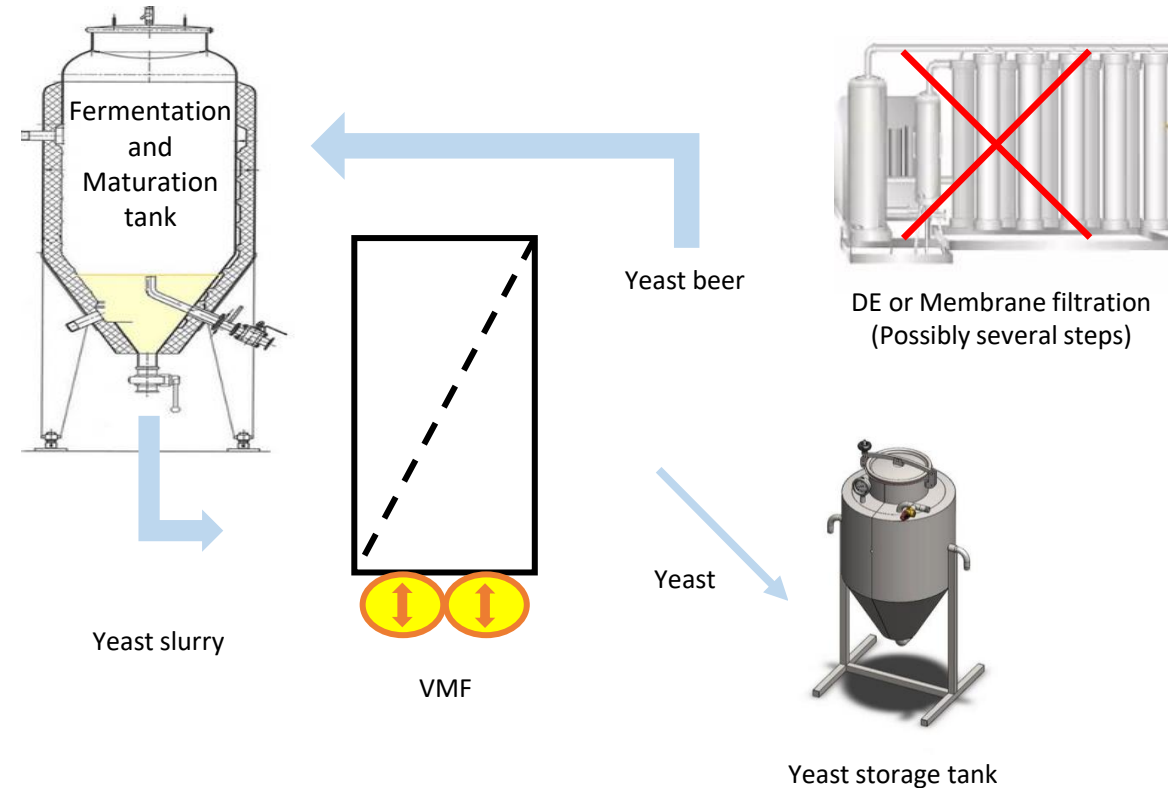
# Yeast harvesting and yeast beer recovery

- Surplus yeast is harvested for later use at the end of primary fermentation. It is then transferred to either a storage vessel, dried and sold as feed or simply discarded.
- When reusing yeast, it is crucial that the yeast is in good condition, meaning yeast with a high viability and high vitality. This is done by minimizing the shear forces applied to the cells, to keep it alive and healthy.
- The harvested yeast slurry contains so called yeast-beer, which is often of lower quality than the actual beer, depending on i.e. harvest time, yeast viability, %ABV of beer etc.
- Yeast beer can account for as much as 5% of the total beer output, and therefore the overall yield can be vastly increased if this beer is recovered and blended with sales beer or fermenting wort. If yeast beer of very high quality is obtained, it can have as much value per hl as actual sales beer, which is why brewers can benefit economically from the recovery of this by-product
- Traditionally yeast beer is recovered using centrifuges or ceramic membranes, but since these are expensive in CAPEX/OPEX and that the yeast beer often requires additional clarification/filtering before use, this operation is inefficient



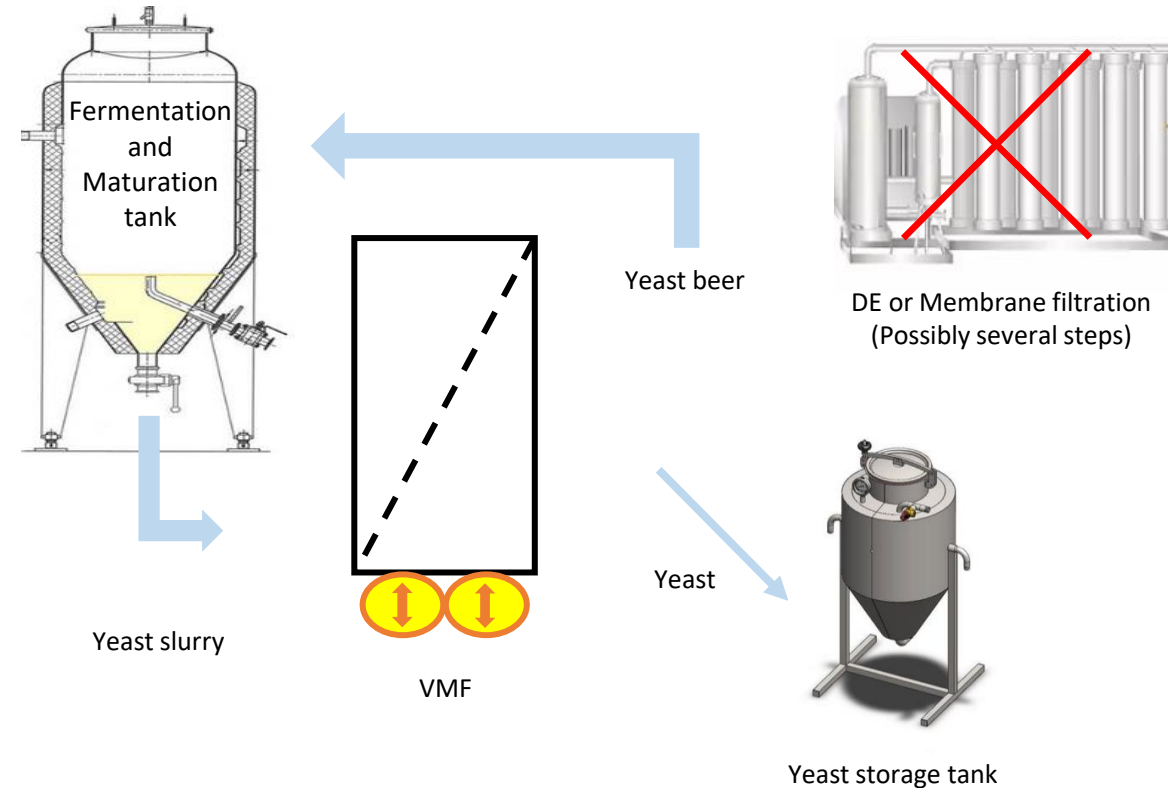
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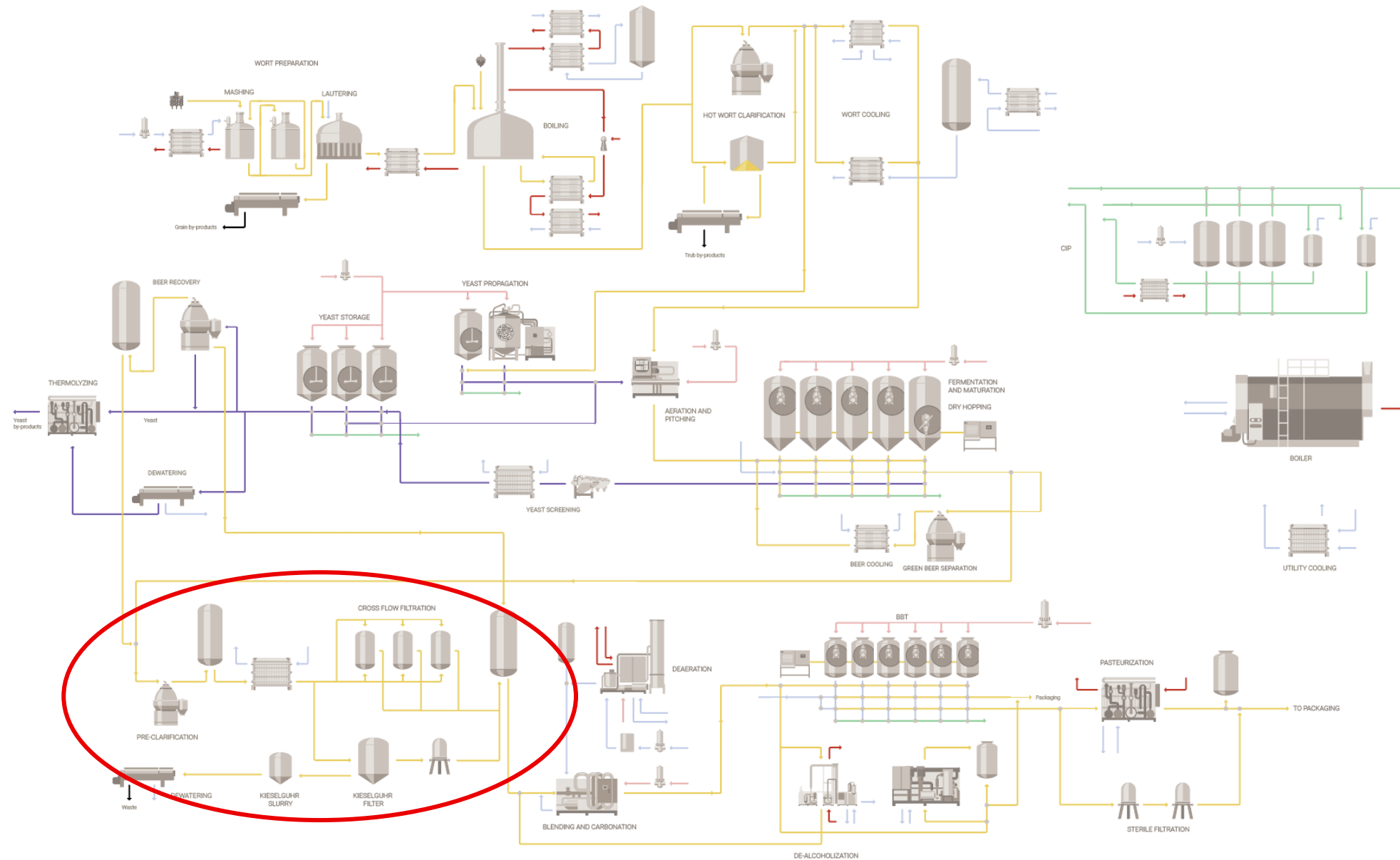
# Yeast harvesting and yeast beer recovery

- With the Vibro™ technology, the yeast can be harvested and reduced to a desired concentration with a desired DM%, depending on if it is to be reused for beer production or dried and sold as feed.
- Yeast with a high viability due to the low shear forces applied by the Vibro™ units is harvested and this will improve its performance in future fermentations, leading to healthy beer fermentations and thus great quality beer without off-flavours
- Compared to yeast beer recovered by separators, the VMF permeate will have excellent clarity eliminating the need for additional processing steps before blending the yeast beer with sales/fermenting beer

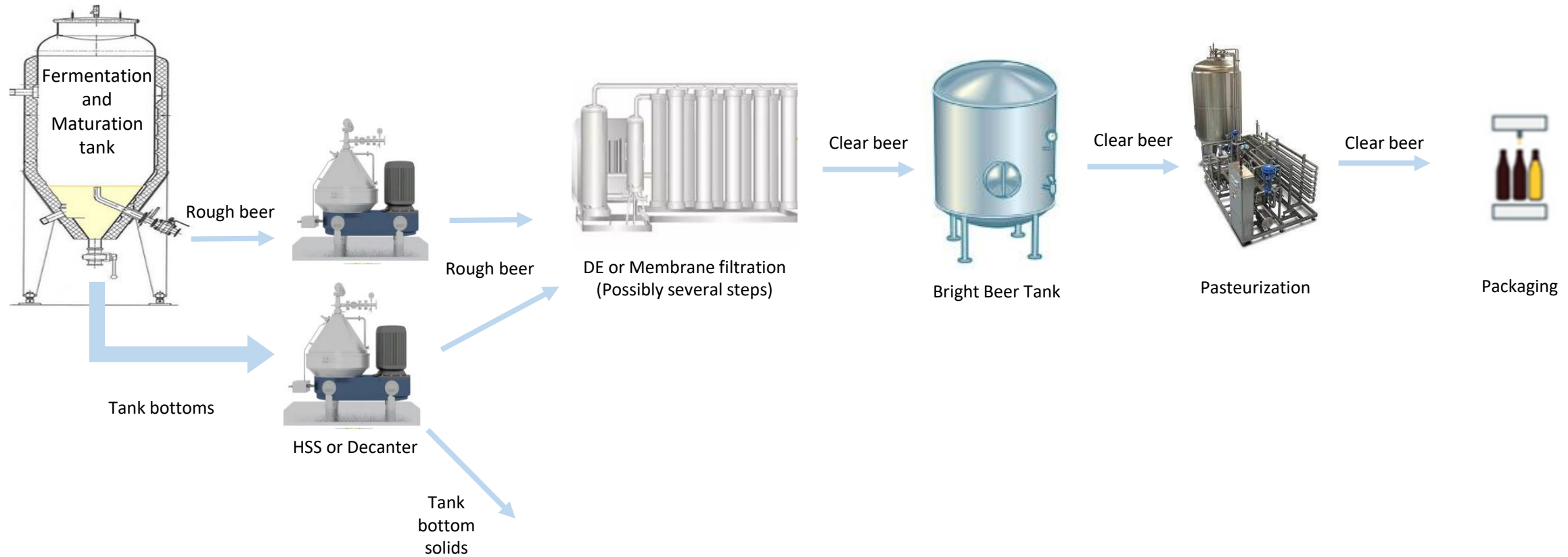




# The brewing process

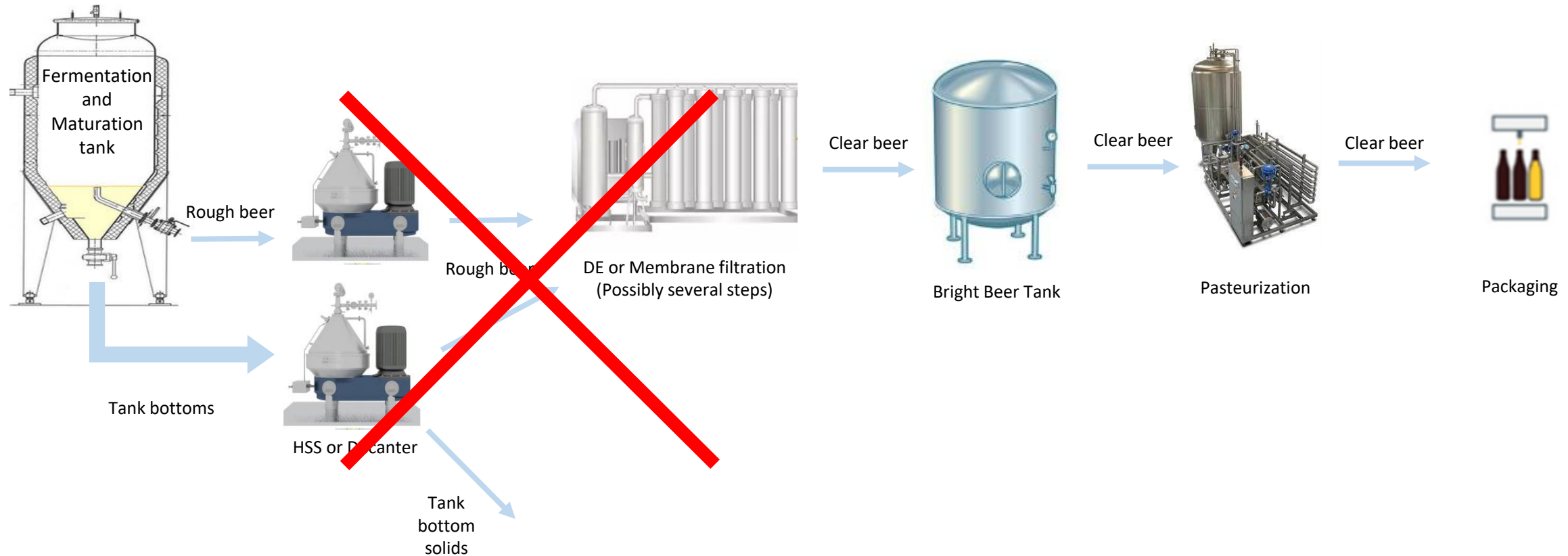


# Clarification and tank bottom recovery



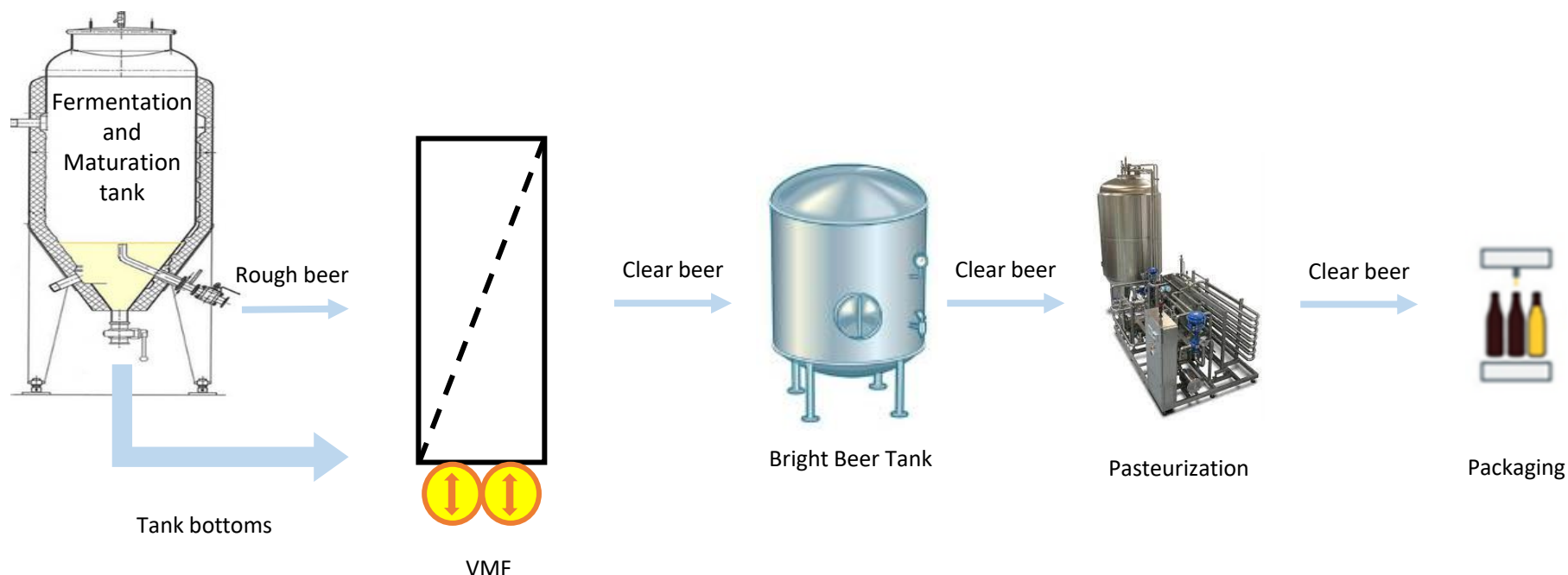
- By the end of maturation, beer needs to be clarified and the tank bottoms needs to be removed, from where additional beer can be recovered
- This is traditionally performed using a HSS or Decanter followed by either DE or Crossflow Membrane filtration, however VMF is a promising alternative with lower energy consumption, replacing both these operations
- This process is presented in a simplified manner, with many underlying sub-processes that are costly and time consuming

# Clarification and tank bottom recovery



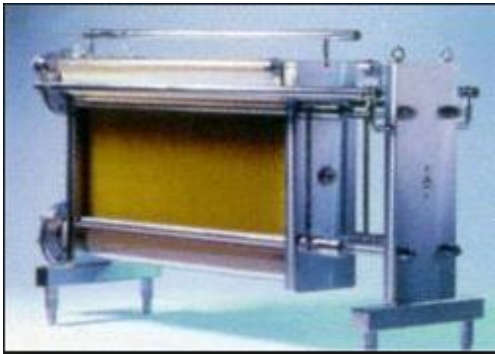
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# Clarification and tank bottom recovery



- Since the Vibro technology can handle high solid loads, the need for a multiple step separation process is eliminated
- With the low uniform TMP achievable, Crystal clear beer can be obtained, while retaining key beer components such as flavour molecules and foam proteins
- In the case of DE filtration, several steps such as precoating, and continuous DE dosing steps are required, and furthermore the DE used is carcinogenic and has a high impact on the environment
- Conventional Crossflow Membrane filtration system requires a prior step of mechanical separation by means of a e.g. HSS
- VMF enables a simpler, greener and more efficient beer clarification process, while being cost competitive, and produces beer of excellent clarity and quality

# Yesterdays Separation Technology!



Vibro™ technology is vastly  
improving performance  
while being cost competitive



# Free Flow Plate™ and Vibro™ technology

The Future of MF and UF

Best separation  
Least energy  
Simplest process

Thank You!

Q&A



**SANI**   
Membranes  
MORE FILTRATION, LESS ENERGY