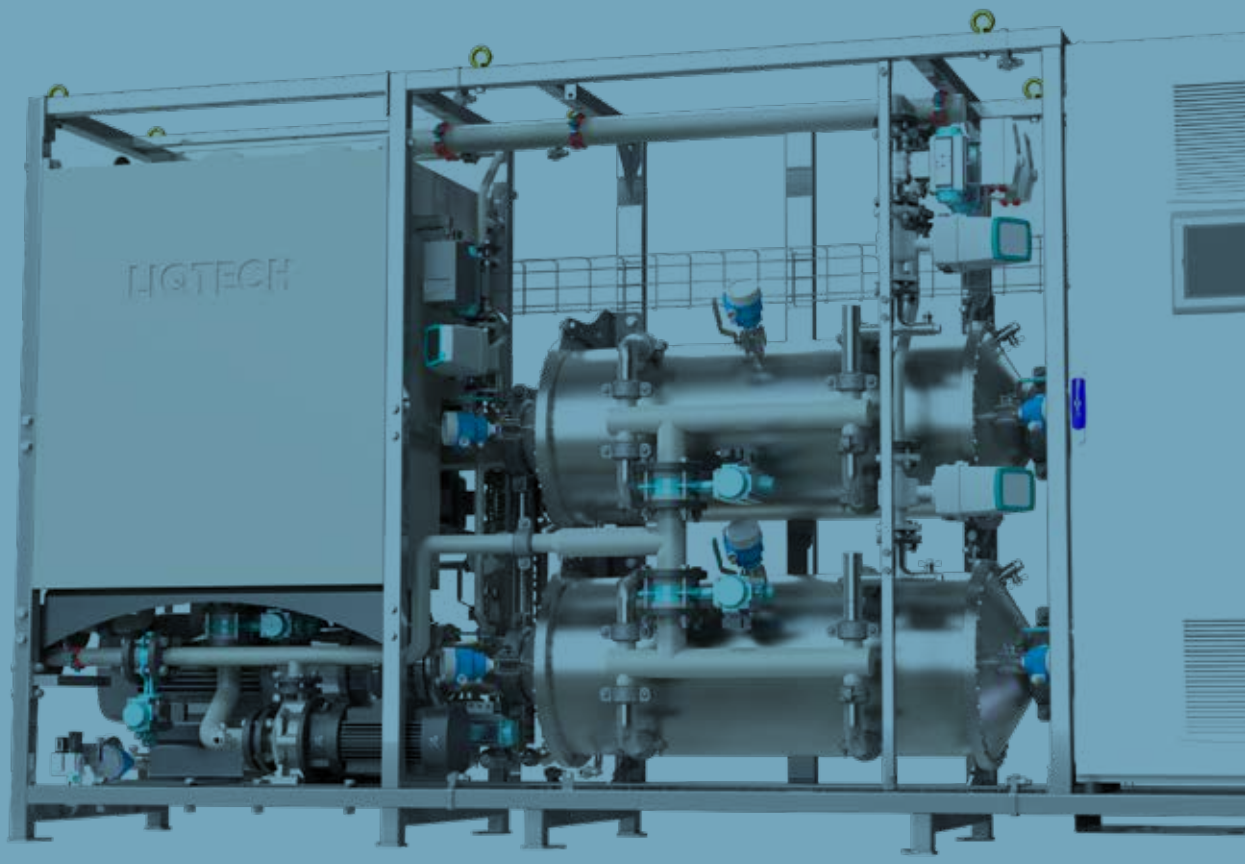
LIQTECH WATER




# MK7
## Process & Modules

LIQTECH
WATER

# IMPROVING OUR FUTURE

The world is running out of clean water resources and it is essential that we treat the resources we have with respect and care. LiqTech has developed a unique ceramic membrane capable of removing oil, pathogens and heavy metals etc. from water, thus providing robust filtration solutions for essential applications.

liqtech.com/water

# A Customized Solution Based on Your Requirements

**Overview**
LiqTech's 7th generation scrubber wastewater treatment system (MK7) is a water treatment unit designed to remove soot and other particles captured by the scrubber process, producing a permeating quality with an NTU/FNU value well below 25. The core technology in this process is LiqTech's patented silicon carbide (SiC) membrane, which is extremely chemically resistant to both strong acids and bases as well as hydrocarbons. The water treatment unit (WTU) is a fully automated system that controls permeate production, sludge production, chemical dosing, backwashing, and periodic chemical cleaning of the membranes.

- 20+ years of experience in the filtration industry
- 300+ water treatment systems installed worldwide
- Selected by Market Leaders
- Water treatment solution customized to your needs

In the MK7 WTU, housings of 99 or 137 tubular ceramic membranes are arranged in a crossflow filtration configuration. Crossflow configuration is usually used in membrane filtration for challenging, high-fouling applications – such as scrubber wastewater.

The permeate produced requires no additional treatment and can be reused or discharged overboard.

The resulting sludge can be handled as a pumpable liquid, or further dewatered to a dry cake for storage and handling.

The MK7 WTU benefits from a pre-treatment step that removes coarse material and coagulates very fine material. LiqTech has developed a pre-treatment solution for this purpose.

To accommodate retrofit scenarios and new shipbuilding alike, the MK7 WTU has been designed as a standardized modular system, so that it can be installed where space is available.

**Process overview**
The pre-treatment consists of a coagulation step and a hydrocyclone separation step. Coagulation is done with injection and mixing with iron chloride and pH-adjusted for optimum reaction characteristics. Separation with hydrocyclones removes the large and heavy particle fraction from the wastewater, allowing the filtration to work efficiently with the remaining smaller particles.

The ultrafiltration step utilizing the LiqTech ceramic membrane produces dischargeable permeate and sludge water. The recovery is typically set to 80-90%, meaning 80-90% of the inlet to the filtration module ends as permeate. With regular intervals, each housing is backwashed briefly, adding to the sludge production. When permeate production cannot be recovered with backwashes, a chemical "cleaning in place" (CIP) is performed to restore capacity.

Post-treatment has the objective to turn sludge water into a dewatered dry cake. Two steps are needed:
- A flocculation step where the sludge water is mixed with a polymer to create particles large enough for the next step, a filter press.
- The filter press dewaters the sludge and the reject water from this process can be returned to the wastewater tank.

In addition to these processes, other ancillary equipment may be required to accommodate installation on different decks/levels.

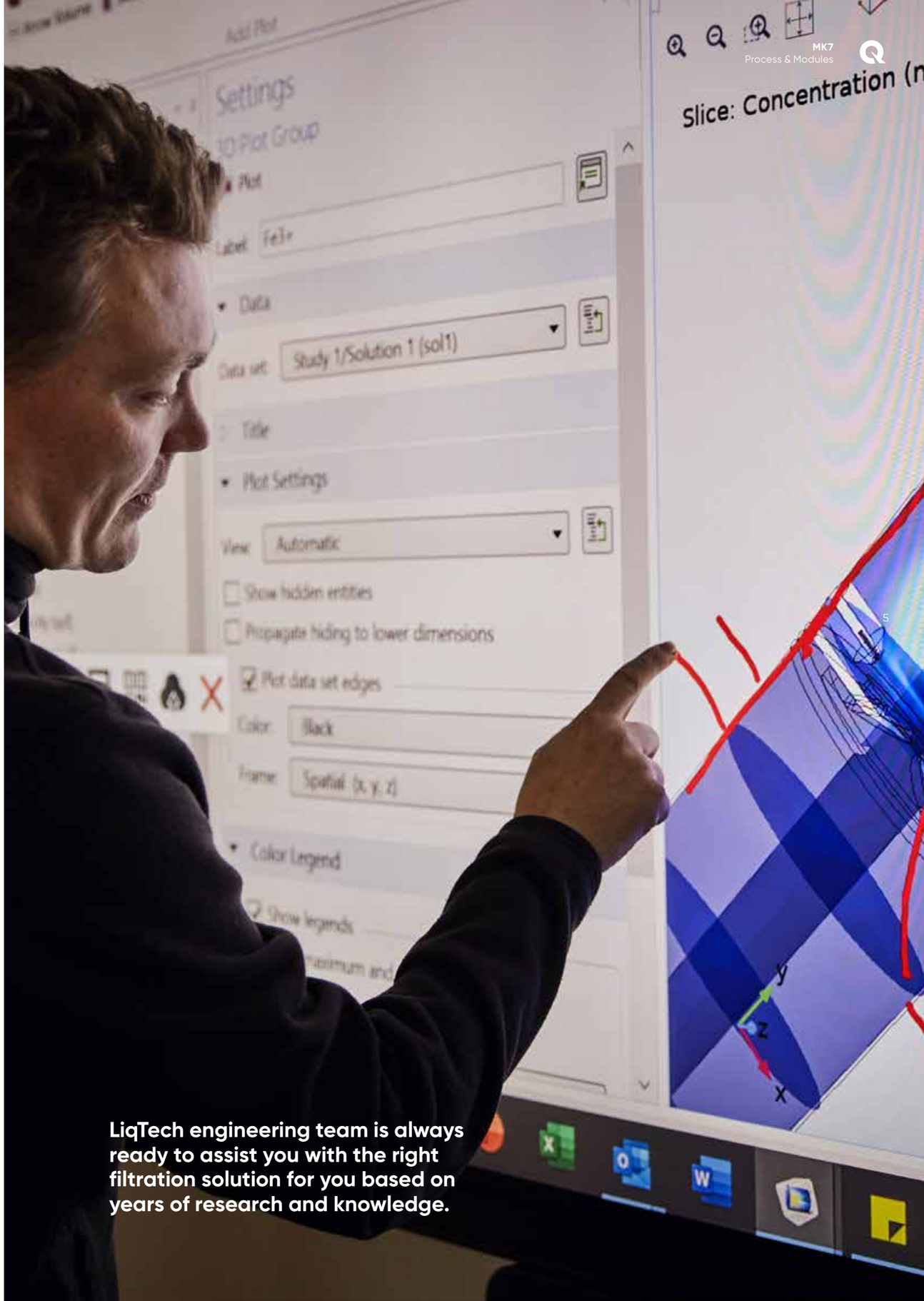
In general, the modules are designed to operate close together, on the same deck/level, apart from the feed module, that is designed to be placed close to the process tank. The water treatment modules can be as far away from the process tank as the feed module pump allows for.

Based on more than 20+ years of experience in the filtration industry and 300+ water treatment systems installed worldwide, our team of highly skilled engineers is ready to assist you with the right solution for your requirements.

Please read more about the filtration process and WTU-modules on the following pages. If you have any questions, please do not hesitate to contact us.





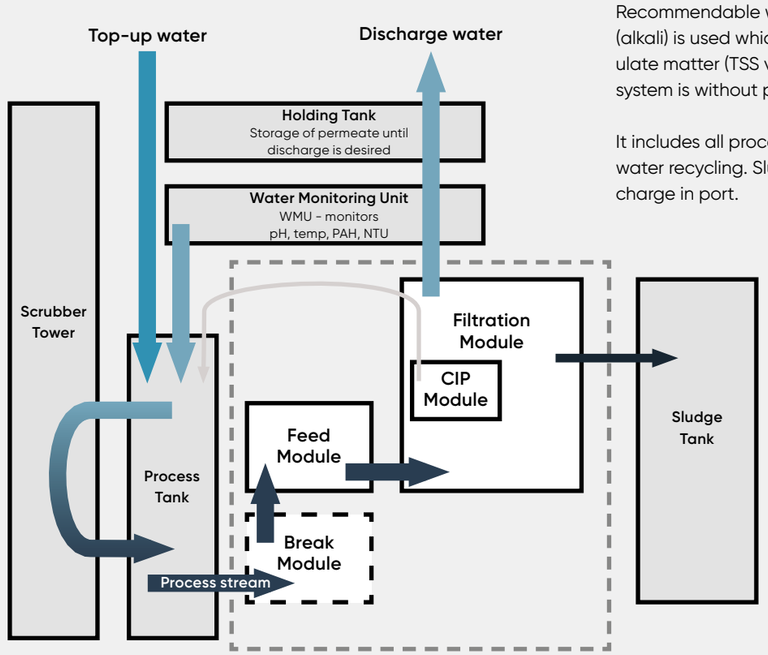



**LiqTech engineering team is always ready to assist you with the right filtration solution for you based on years of research and knowledge.**

# Process One

Recommendable where a sulphur acid-neutralizing agent (alkali) is used which do not add to higher levels of particulate matter (TSS value) in the scrubber process water. The system is without pre- and post-treatment.

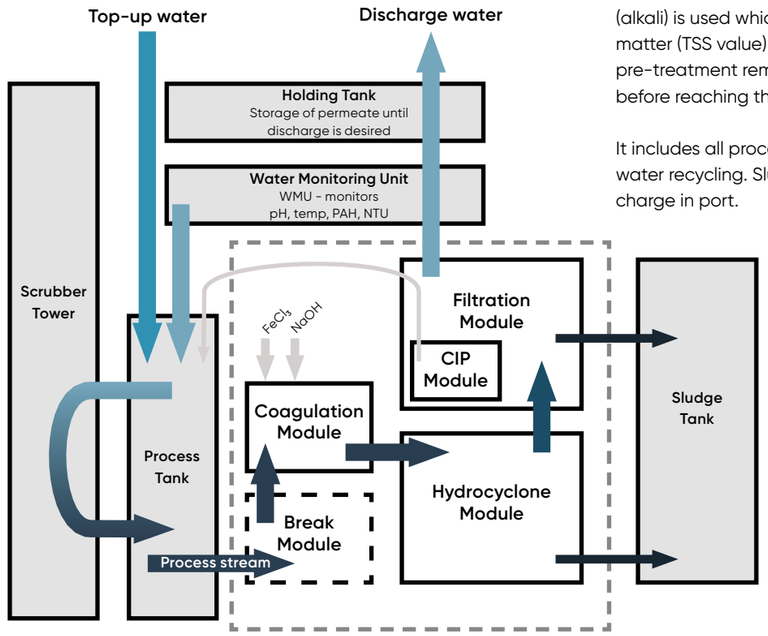
It includes all processes for safe system operation, offering water recycling. Sludge is stored in liquid form for discharge in port.




# Process Two

Recommendable where a sulphur acid-neutralizing agent (alkali) is used which adds to higher levels of particulate matter (TSS value) in the scrubber process water. The pre-treatment removes a significant percentage of solids before reaching the filtration unit.

It includes all processes for safe system operation, offering water recycling. Sludge is stored in liquid form for discharge in port.



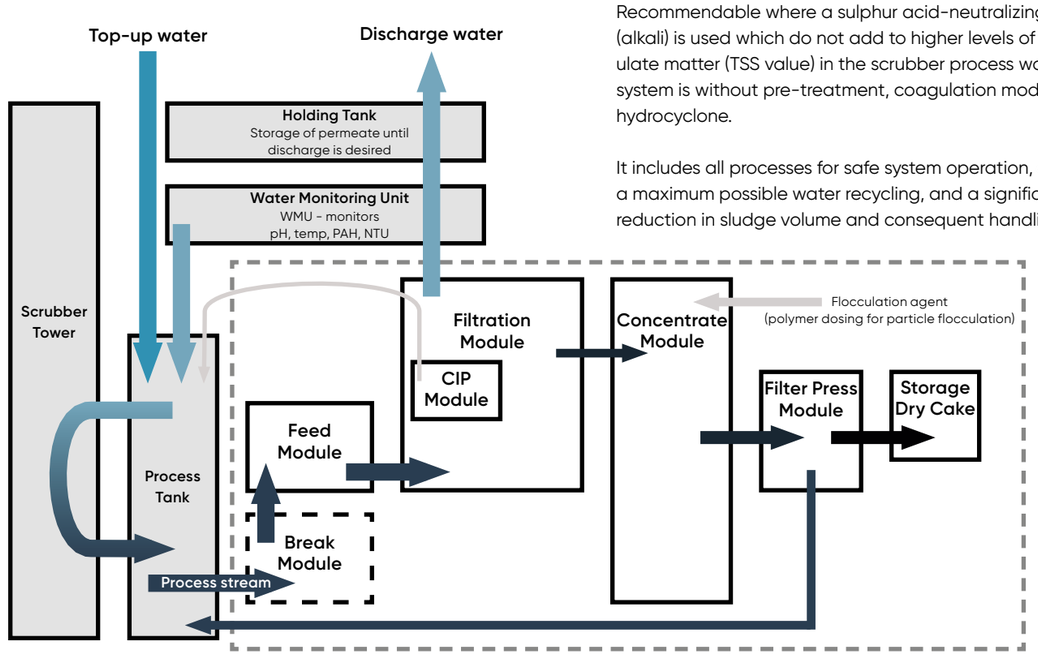





# Process Three

Recommendable where a sulphur acid-neutralizing agent (alkali) is used which do not add to higher levels of particulate matter (TSS value) in the scrubber process water. The system is without pre-treatment, coagulation module, and hydrocyclone.

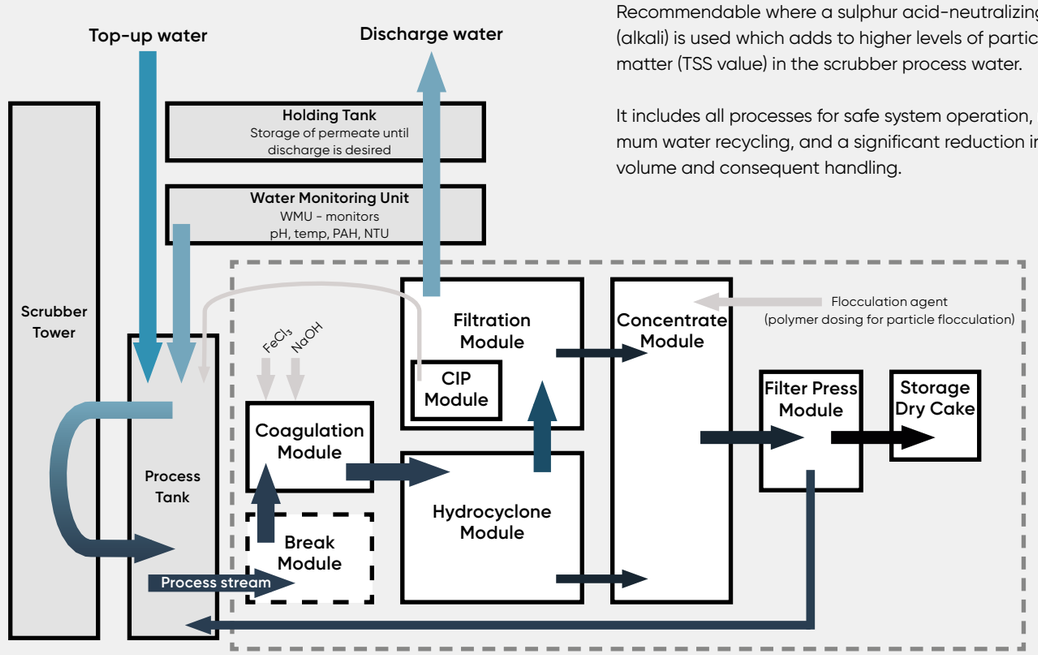
It includes all processes for safe system operation, offering a maximum possible water recycling, and a significant reduction in sludge volume and consequent handling.




# Process Four

Recommendable where a sulphur acid-neutralizing agent (alkali) is used which adds to higher levels of particulate matter (TSS value) in the scrubber process water.

It includes all processes for safe system operation, maximum water recycling, and a significant reduction in sludge volume and consequent handling.



# Filtration Module

The heart of the WTU (Water Treatment Unit) is the filtration module with LiqTech's ceramic filter elements in a crossflow configuration, providing ultrafiltration capabilities on water with high levels of fouling. The filtration module is available with different capacities.

The filtration module is available as a master unit alone, or in a master and a slave configuration.

**Master**
The master unit holds either 1 or 2 filter housings, backwash pump, permeate tank, crossflow pump, sensors, external fluid- and pneumatic connections, CIP system with chemical dosing, backwash system, HMI, and main electrical cabinet. The main electrical cabinet can optionally be placed "off-skid".

**Slave**
The slave unit functions as an optional addition to the master unit for system capacity expansion, utilizing the same permeate tank and backwash system. The slave unit is always configured with 2 filter housings. All fluid and pneumatic connections, except for the two CIP inlets, on the slave unit interfaces with the master unit.

The slave unit must be bolted together with the master unit and cannot be placed in a different location.

- Ultrafiltration providing NTU value well below IMO regulations
- Integrated Clean-In-Place
- Integrated backwash
- Modular system design for flexible installation
- Fully automated system







**Filtration module with crossflow configuration, providing ultrafiltration capabilities on water with high levels of fouling.**

# Break Module

A break module is an optional buffer tank that is required if the feed pressure from the process tank exceeds 0,5 bar(g) at the filtration module through a non-operating feed module or 0,1bar(g) at a coagulation module. The size of the tank is determined by the filtration capacity and the level regulating possibilities.

- Optional buffer tank

# Feed Module

The primary function of the feed module is to supply the filtration module with a consistent feed pressure for the regulation mechanisms to function as designed.

The feed module requires an inlet pressure between -0,5 and 0,5 bar(g) and must be placed on the same level as the filtration module(s) or below. If the pressure is outside this range, a break module is required.

Feed module is only required if the water treatment unit (WTU) does not have a hydrocyclone module.

- Supply the filtration module with consistent feed
- Only required if the WTU has no hydrocyclone module





# Coagulation Module

The coagulation module coagulates the particles from the process water to facilitate more efficient removal in the hydrocyclone module.

The coagulation module uses $FeCl_3$ for the coagulation process. The coagulation module has a storage capacity of 800 liters.

- Removal of dissolved heavy metals
- Increased effect of filter module by increasing particle sizes
- pH control for optimal particle coagulation

# Hydrocyclone Module

The hydrocyclone module holds 2 or 3 pumps, 4 cyclones, 2 tanks, and instrumentation. The purpose of the module is to separate heavier and larger particles from the process water and feed the resulting water to the filtration module.

- Increased effect of the filter module by removing a significant percentage of TSS
- Advantageous in synergy with coagulation module

# CIP Module

The chemicals used in the CIP (Clean-In-Place) sequence are supplied from two CIP tanks each containing alkaline and an acidic cleaning solution. The CIP sequence is performed to provide the optimal operation and performance of the filtration module.

The CIP modules exist separately from the filtration module to allow for larger chemical storage capacity and to remove potential damaging vapors/spillage from sensitive instrumentation. The CIP module consists of a tank with capacity for multiple CIPs, a dosing pump, and level switches.

The CIP module has a chemical storage capacity of 100 liters.

- Used for Clean-In-Place
- For optimal performance of filter module

# Concentrate Module

The purpose of the concentrate module is to flocculate the particles received from the filtration module to facilitate further dewatering in the filter press. This is done by adding polymers to the concentrate and mixing for an appropriate amount of time, creating sludge to be dewatered.

The concentrate module consists of a polyethylene tank, an agitator, polymer dosing system, and a membrane pump.

- Flocculates dispersed matter
- High-pressure pump for filter press





# Filter Press Module

Filter press module with integrated reject handling. The filter press takes sludge from the concentrate tank and dewaters to a filter cake with up to 70% dry matter.

The reject water gets transferred back to the process

- Delivers a compact, dry, cake for easy storage and handling
- Returns reject stream to process tank

# End to End Service

At LiqTech, we have everything in-house that is key to our customers because they want to work with filtration experts, and they want to work with a company that knows their technology and equipment in detail.

**Technical Sales Support**
Our Technical Sales Team are highly experienced and competent engineers with years of marine experience enabling us to discuss and advise on the best system configuration for any vessel type and size.

**Process Engineering Consulting & Chemistry**
Through 20 years of manufacturing water filtration systems and filters, LiqTech Process and Chemical Engineers are expert advisors in choosing the best filtration solution, chemicals, and dosage suited for the application for both fresh and saltwater scrubbers. We provide the most reliable scrubber wastewater treatment systems available on the market.

**System Design**
The LiqTech system is modular, enabling various treatment capacities to match the needed requirements in scrubbing. Our flexible systems meet your needs for different water purity, engine sizes, waste treatment and handling, and preferred choice of chemicals (Alkali).

The LiqTech system components may include:

- Prefiltration: Coagulation and hydrocyclone system

- Post-treatment: Facilitates improved system performance, wash-water quality, waste volume limitations, and handling of solids or liquids.

An OEM Scrubber manufacturer may have a unique filtration requirement in order to better match the scrubber and process, including water polishing. The LiqTech design team is happy to partner with you and optimize the complete closed-loop / hybrid-scrubber system to match your needs.

**Project Management**
The LiqTech Project Management team has successfully delivered on schedule 250+ high-quality marine systems to our customers. The individual project managers are given ownership of separate projects, ensuring dedicated focus on client contacts and their systems. Leading up to factory acceptance test (FAT) and system delivery, or whenever a status update in the building process is needed, that appointed person will always be available and ready to report to the client representative.

**Service & Commissioning**
LiqTech will support our systems and your ship for as long as it sails. We support you by:

- Providing technical support to shipyards, shipowners, scrubber manufacturers, and installers, who will enjoy in-depth, expert assistance from our highly qualified team of marine service engineers during the entire process, from sales to operations and repair.

- Providing live demonstrations and in-house training

- Performing pre-shipment FAT on every system, ensuring every delivered system works according to specifications.

- Providing on-ship system commissioning for every system

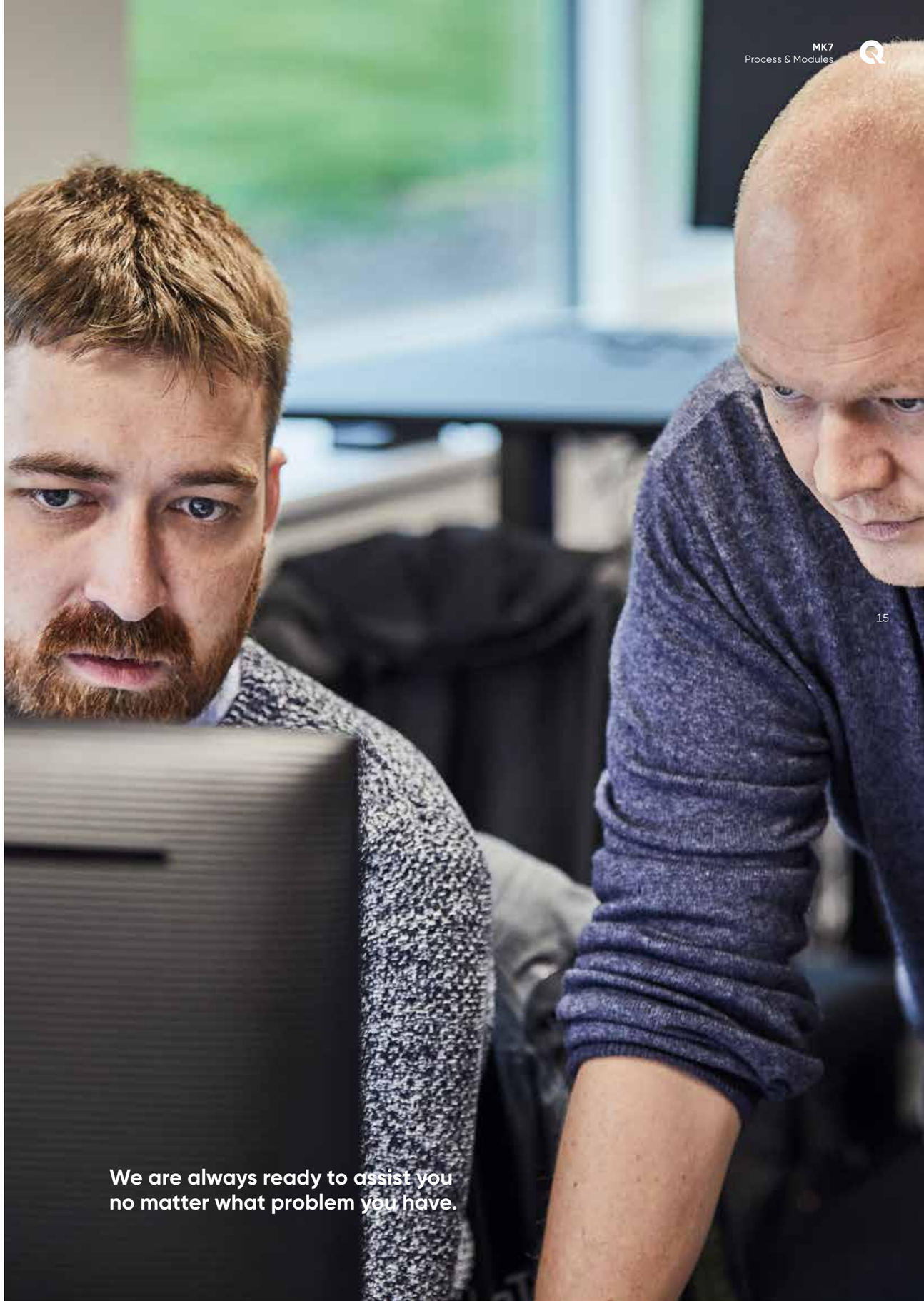
- Continuously upgrading our control module operating system and provide our customers with these upgrades, ensuring the best possible operating performance.

- Providing 24-7 support, so you can have complete confidence in your LiqTech system. The team is always ready to assist through remote service and support on system installation, commissioning, system status, and preventative maintenance.

With our extensive experience collaborating with shipowners, scrubber manufacturers, shipyards, and installers, your closed-loop or hybrid scrubber system will be fully supported by experts, meet your specific vessel needs, and meet or exceed compliance requirements.







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