Thermolicer

Speak-up

Tore Laastad

Thermolicer/Marketing

2018 –	ScaleAQ Marketing Thermolicer
2015 – 2017	Steinsvik AS Marketing/Thermolicer
20012 – 2015	Ocea AS Marketing/Thermolicer
20011 – 2012	Ocea AS Sales

- Queensland University of Technology – Master of business, Marketing
- BI Bergen– Bachelor in Marketing

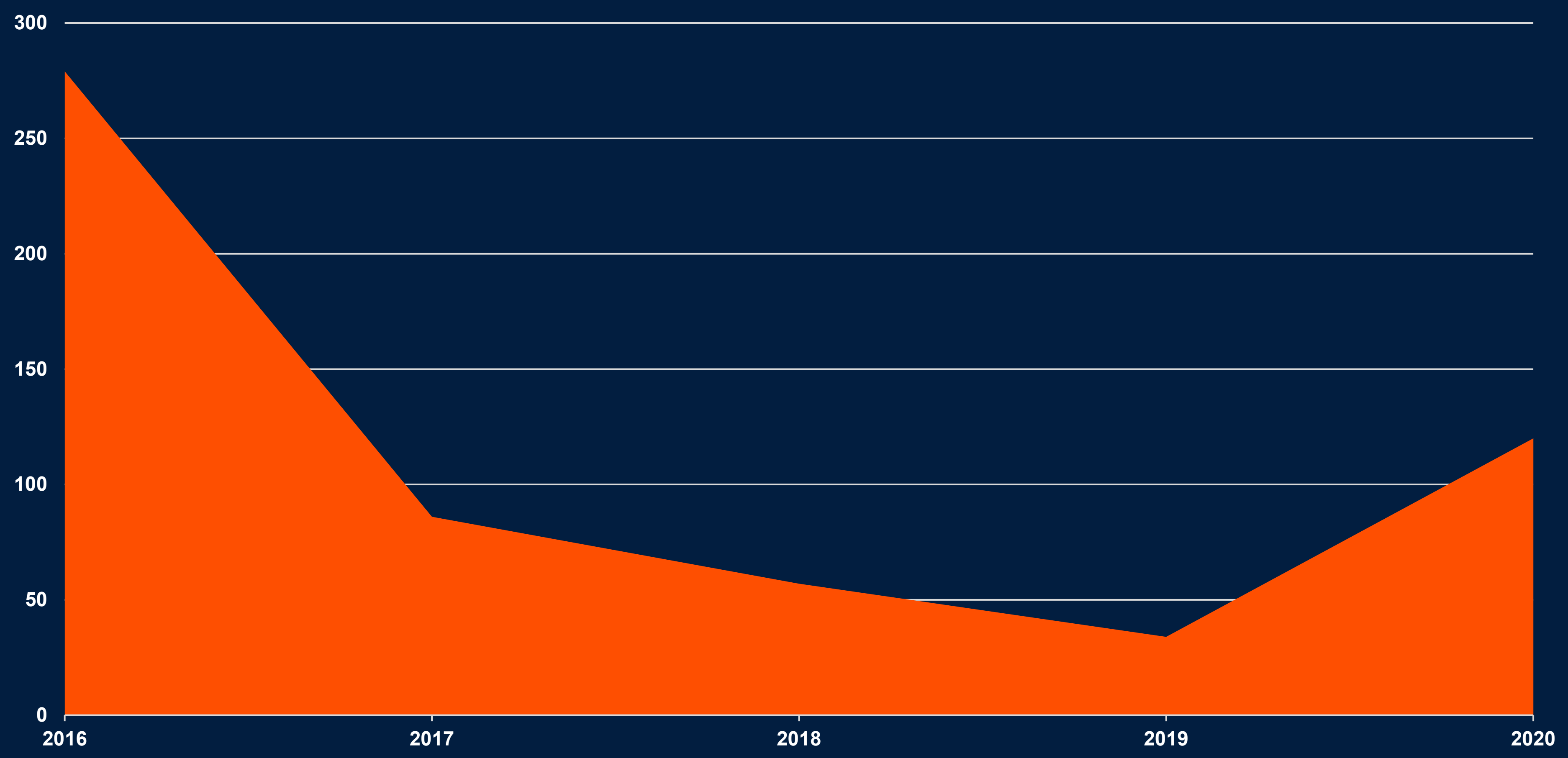
Sealice

Lepeophtheirus salmonis
Caligus pacificus

Cost: (3 quarter 2020)

60 million euro

Thermolicer revenue



Capacity

90 tons per hour

54 units

4860 t/h

Thermal delicing is the prefered option

Active substance	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Azametifos	409	691	480	749	619	257	58	38	82	119
Pyretroider	456	1155	1123	1043	662	276	80	55	73	51
Emamektin benzonat	288	164	162	481	523	608	348	274	451	415
Flubenzuroner	23	129	170	195	201	173	79	27	61	51
Hydrogenperoksid	172	110	250	1009	1279	629	214	90	82	47
Total	**1348**	**2249**	**2185**	**3477**	**3284**	**1943**	**779**	**484**	**749**	**683**

Category	2012	2013	2014	2015	2016	2017	2018	2019	2020
Thermal	**0**	**0**	**3**	**36**	**683**	**1244**	**1370**	**1451**	**1736**
Mechanical	4	2	38	34	331	279	469	734	816
Fresh water	0	1	1	28	88	95	102	172	238
Thermal + mecanic	0	0	0	0	12	42	38	58	57
Term/Mec + fresh water	0	0	0	0	23	22	25	34	43
Other	132	108	136	103	77	55	76	89	93
Total sum weeks	136	111	178	201	1179	1673	2017	2446	2983

The principle

Reference:

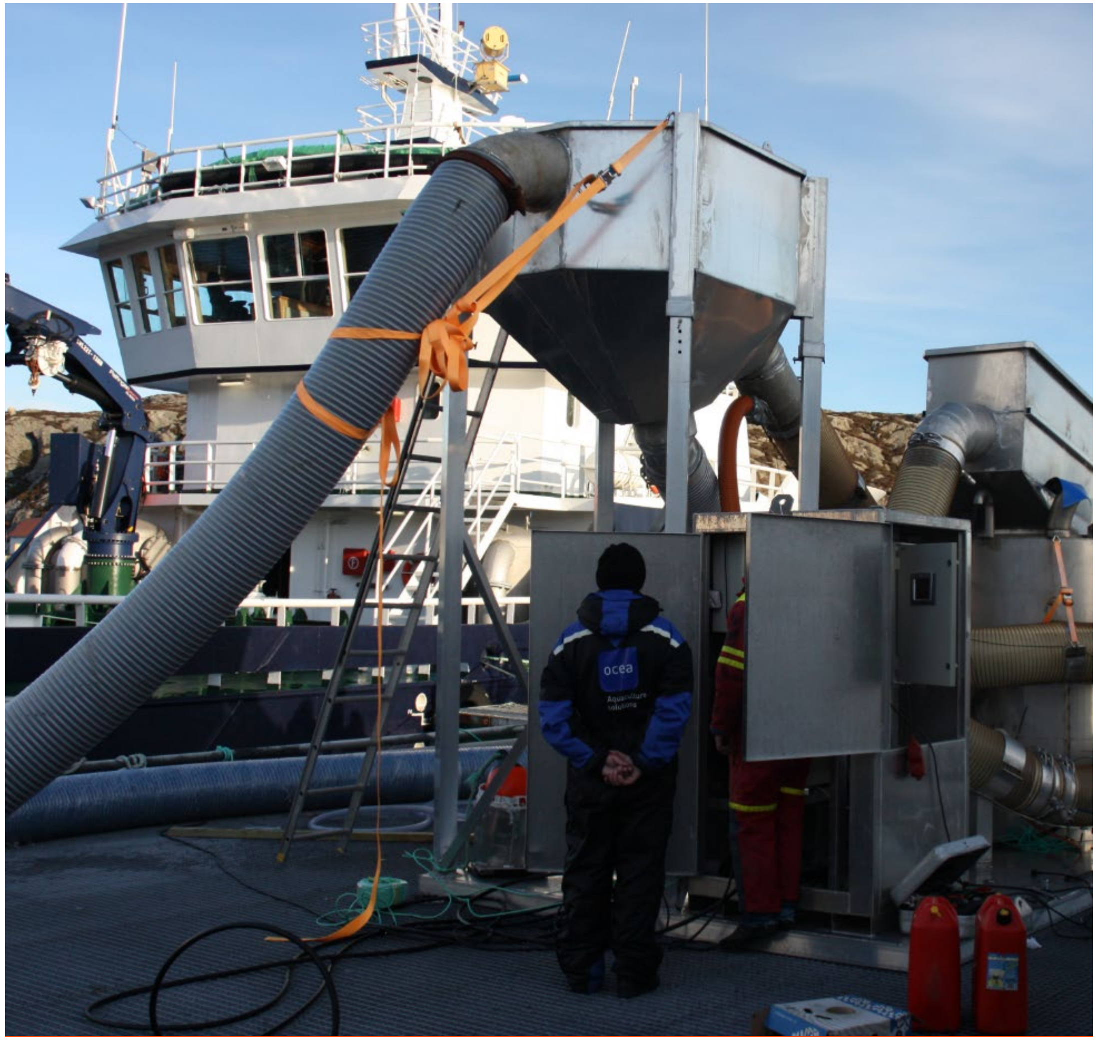
Brunsvik. Per S., 1996. Miljømessig Avlusing av Laks. Gildeskål Forsøksstasjon AS.

Elliot, J. M., 1981. Some aspects of thermal stress on freshwater teleosts. In: Stress and Fish (Ed A. D. Pickering). Academic press, London, 209-245.

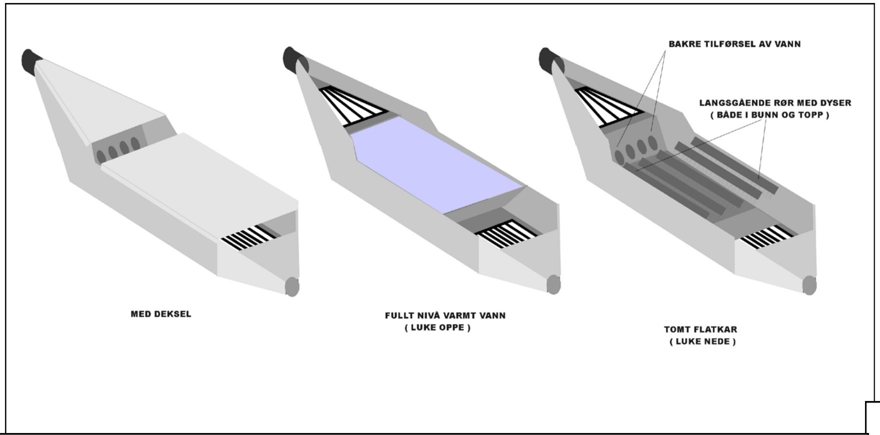
Elliot et. al (1981) shows us that salmoniods can withstand temperatures of 30-34 °C for a short time. (30 min for trout *S. trutta*). The same levels are not established for sea lice but their tolerance will naturally be lower due to their comparable small size. This is supported by ScaleAQ's own finds and Brunsvik (1996)

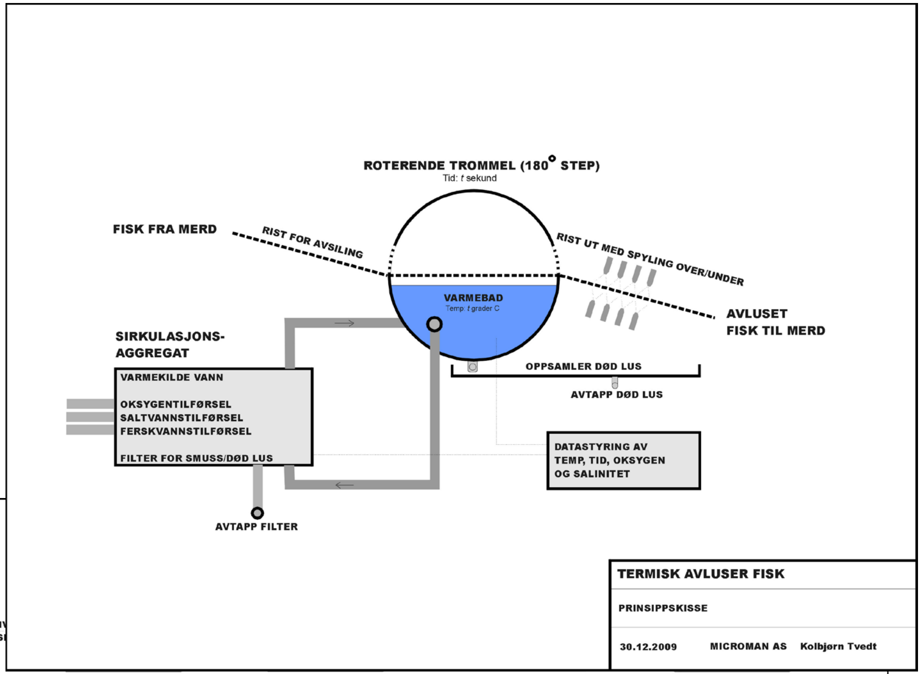
The principle utilizes the fact that the sea lice have large surface compared to its volume. This makes the lice immediately sensitive for sudden temperature changes. By suddenly heating the lice it will fall of the fish, either by loss of muscle control of shock. All lice in the system is filtered and safely disposed of.

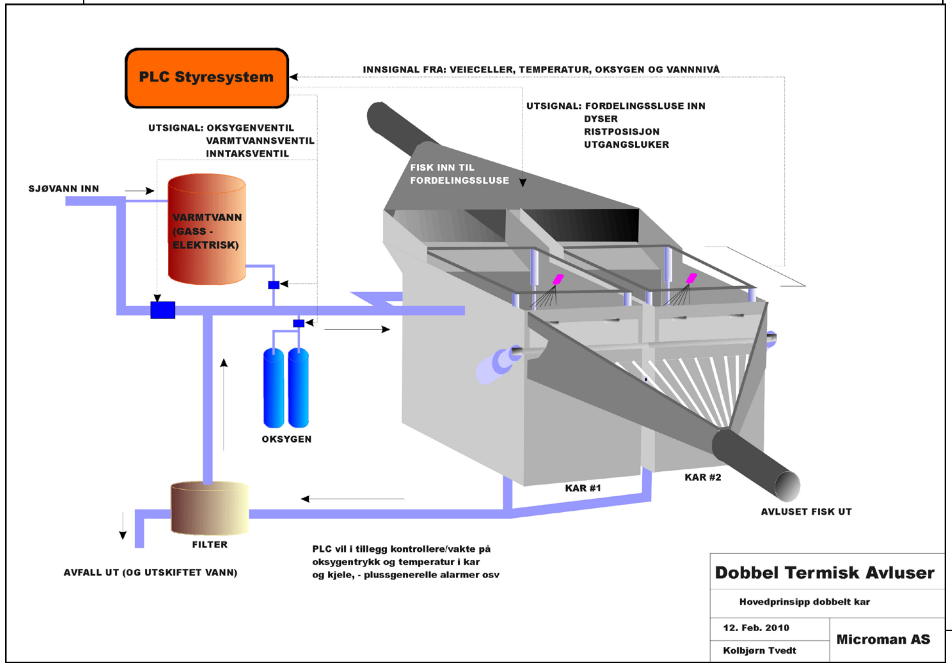
Early prototype…

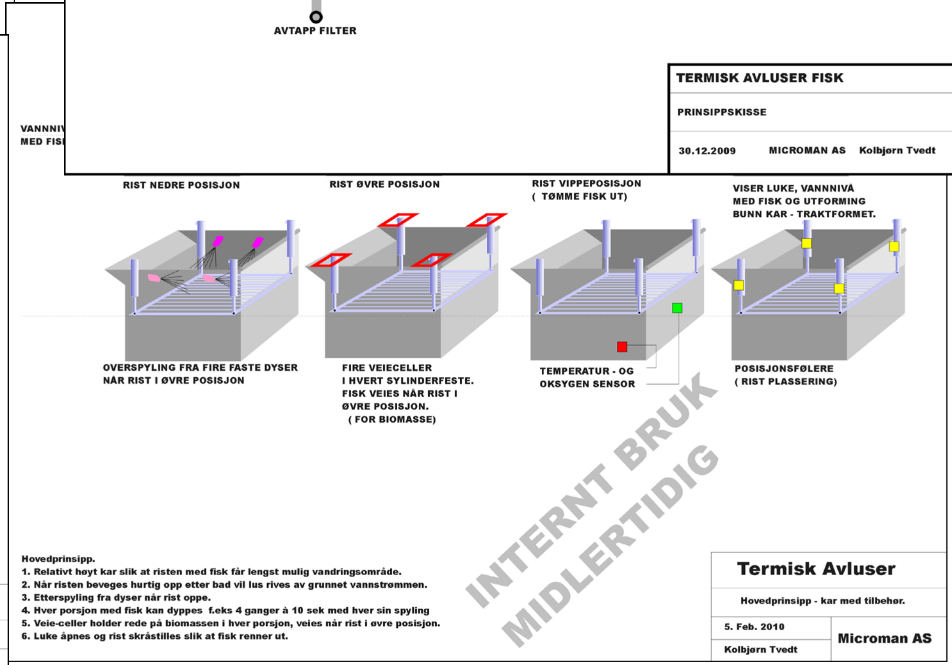


Early drafts





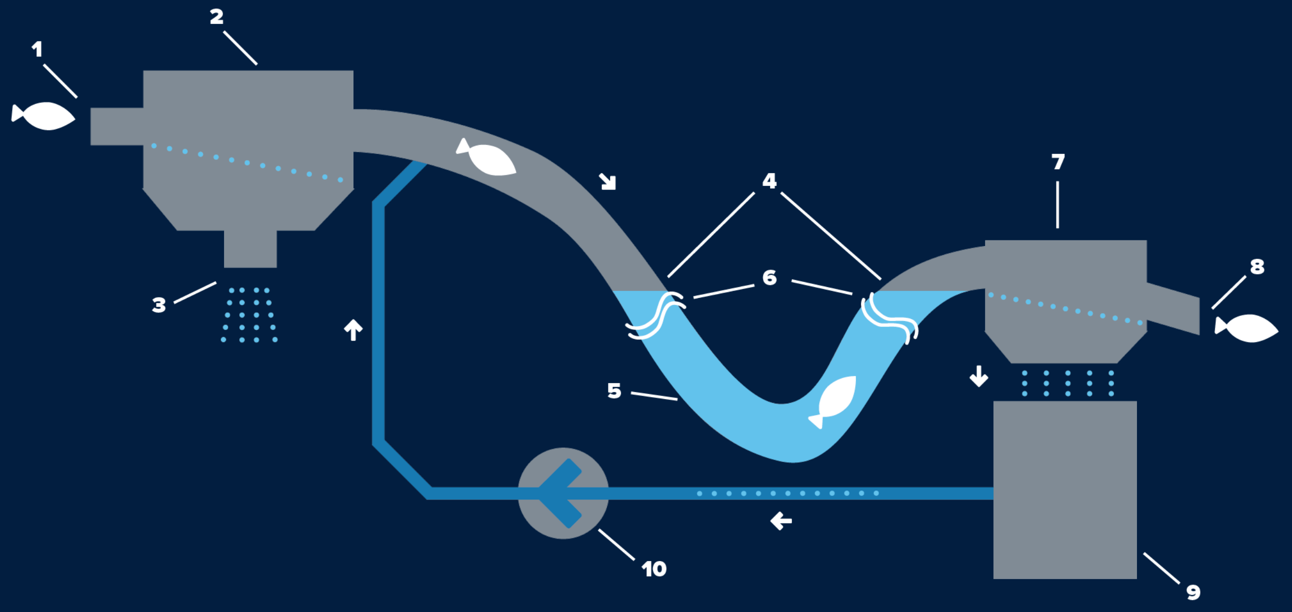




How does a Thermolicer work?

1. Fish enters Thermolicer after pumping.
2. Water separation.
3. Sea water is filtered and released
4. The fish is exposed to lukewarm water
5. Treatment loop
6. Water surface
7. Water separator for treatment water.
8. Fish exits the system
9. Heated water is circulated to water tank for filtration, aeration and reheating.
10. Treatment water is pumped back to the treatment loop

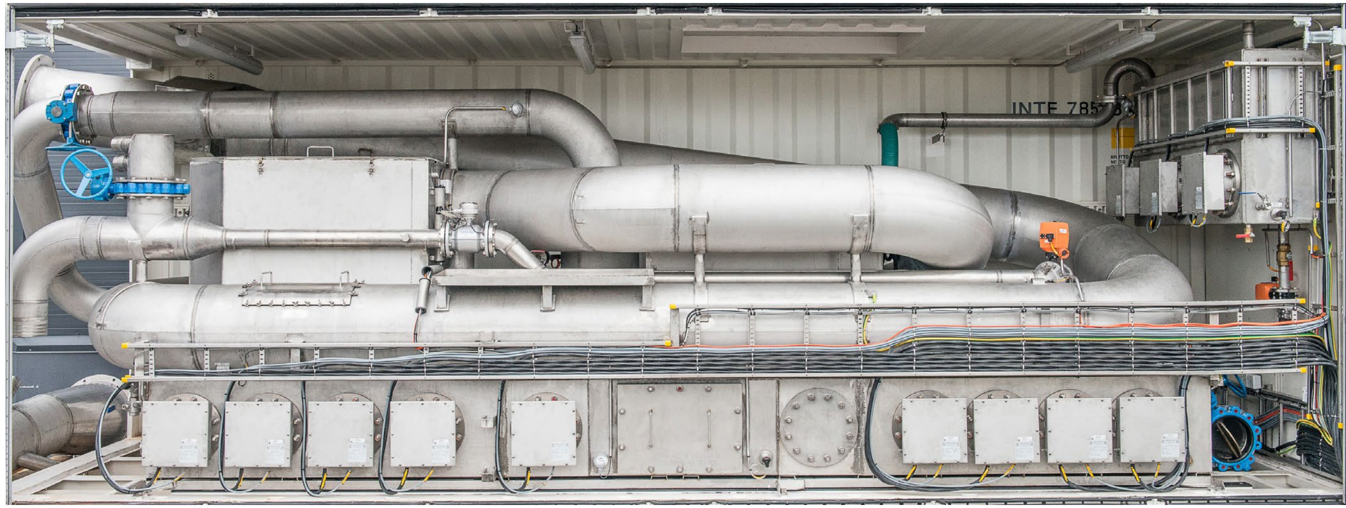
NB: The water treatment system is not shown.



Standard Thermolicer

Treatment pipe= 22 m

Water speed= 0,9 m/s



Bespoke Thermolicer

Welfare documentation

Project done by the Norwegian veterinary institute

Excerpts from the report:

The present project documents both fish welfare and effect of thermal de-licing (Thermolicer®). Thermal de-licing is a new non-medicinal method representing an alternative to established medicines. Thermal de-licing should be used together with other measures as part of an integrated anti-lice strategy.

No significant acute injuries were observed, the fish fed well shortly after treatment and mortality levels were low.

No equivalent documentation relating to other de-licing methods, medicinal or non-medicinal has been identified.

Study done by the Norwegian ocean research institute on request from the Norwegian food authorities.

Conclusion

- **Salmon (2,5-3 kg) dipped in seawater of 34 °C for 30 seconds. No acute outer damage or development of damage after 14 days.**
- **The trial gave no deviation values for blood electrolytes or changes in mucous producing organs in the skin.**
- **There were no observable increased stress behavior during treatment compared to control group during or after treatment**

Dip test in tempered water (2017)

Veterinary and Animal Science 8 (2019) 100076

Contents lists available at ScienceDirect

ELSEVIER

Veterinary and Animal Science

journal homepage: www.elsevier.com/locate/vas

Sudden exposure to warm water causes instant behavioural responses indicative of nociception or pain in Atlantic salmon

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ARTICLE INFO

Keywords:
Behavioural response
Fish
Heated water
Nociception
Pain
Thermal delousing

ABSTRACT

Thermal treatment has become the most used delousing method in salmonid aquaculture. However, concerns have been raised about it being painful for the fish. We studied the behavioural response of Atlantic salmon acclimated to 8 °C when transferred to temperatures in the range 0–38 °C. Exposure time was 5 min or until they reached the endpoint of losing equilibrium and laying on their side, a sign of imminent death. At temperatures below 28 °C, none of the fish reached endpoint within the 5-min maximum. At 28 °C four of five fish reached endpoint, and fish reached endpoint more rapidly as temperature increased further. Fish transferred to temperatures above 28 °C had higher swimming speed immediately after transfer and maintained a high swimming speed until just before loss of equilibrium. Their behaviour was from the start characterised by collisions into tank walls and head shaking. Just before loss of equilibrium they started breaking the surface of the water, swimming in a circle pattern and in some instances displayed a side-wise bending of their body. In other words, salmon transferred to temperatures above 28 °C showed instant behavioural responses indicative of nociception or pain.

1. Introduction

As the salmon louse (*Lepeophtheirus salmonis*) has increasingly developed resistance against chemotherapeutants, thermal delousing by exposing fish to heated water (appr. 28–34 °C, sometimes higher) has become the most used delousing method in salmonid and especially Atlantic salmon (*Salmo salar* L.) aquaculture in Norway (Gismervik, Gåsnes, Nielsen, amp; Mejdell, 2018b; Overton et al., 2018). Thermal delousing is also used against *Caligus elongatus*, particularly in Northern Norway, and *Caligus rogercresseyi* in Chile (Sitjà-Bobadilla & Oitmann, 2017). Thermal delousing has been promoted as an environmentally friendly delousing method, as it only uses heated water. There is, however, often elevated mortality after thermal delousing compared to delousing the salmon with chemical baths or mechanical removal of lice by seawater flushing (Overton et al., 2018). Concerns have also recently been raised about thermal delousing being experienced as painful by the fish (Poppe, Dalum, Røislien, Nordgreen & Helgesen, 2018).

The ability of subjective experience, i.e. some level of consciousness or awareness, is by definition a prerequisite for experiencing pain IASP (1994), and there is an intense debate in the scientific literature on whether fish have this ability (see for example Key, 2016 and Sneddon et al., 2018 and the threads of responses to these articles). Absolute evidence for subjective experience in fish or other animals are obviously hard to obtain, and following the precautionary principle fish are included in European welfare legislation: EU directive 98/58/EC Article 2 includes 'fish' in the term 'animals', and Article 3 states that owners or keepers of animals must take all reasonable steps to ensure the welfare of animals under their care and to ensure that those animals are not caused any unnecessary pain, suffering or injury. The Norwegian Food Safety Authorities are therefore concerned that thermal delousing violates EU directive 98/58/EC and the Norwegian animal welfare act stating that keepers of animals, including fish, must ensure that the animals are treated well and are protected from danger of unnecessary stress and strains.

Fish have nociceptors for heat (Nordgreen et al., 2009; Sneddon, Brathwaite & Gentle, 2003), and salmonids exposed to warm water respond with abnormal behaviour such as jumps from the water, collisions and sudden swimming bursts (Elliott, 1991; Ineno, Tsuchida, Kanda & Watabe, 2005). From delousing operations in the industry, there are anecdotal reports about loud bangs and noises from within the treatment chambers, and flight reactions during treatment are

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Dip test in tempered water (2019)

Excerpt from conclusion

The struggling behavior during exposure to warm water would increase the risk for **mechanical damage**, which may contribute to the relatively high mortality associated with thermal delousing (Overton et al., 2018).

Does the thermal component of warm water treatment inflict acute lesions on Atlantic salmon (Salmo salar)?

Published oktober 2020

Conclusion: Exposure of Atlantic salmon to sea water at a temperature of 34 °C for 30 s did not lead to any statistically significant change in the prevalence of acute lesions except an increase in minor fin injuries.

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journal homepage: www.elsevier.com/locate/aquaculture

ELSEVIER

Does the thermal component of warm water treatment inflict acute lesions on Atlantic salmon (*Salmo salar*)?

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ARTICLE INFO

Keywords:
Delousing
Injuries
Tissue damage
Welfare indicator scoring
Histopathological examination

ABSTRACT

Warm water treatment, i.e. exposure to sea water at a temperature of 28–34 °C for 20–30 s, has in recent years been widely used for delousing of Atlantic salmon (*Salmo salar*) and rainbow trout (*Oncorhynchus mykiss*) in Norwegian aquaculture. High mortality and various lesions (e.g. injuries and/or bleedings in skin, fins, eyes, brain, and gills) have, however, been reported after industrial warm water treatments. The objective of this study was to reveal whether the thermal component of warm water treatment inflicts acute lesions on Atlantic salmon. The study was conducted by exposing individual, sedated Atlantic salmon post-smolts ($\overline{w} = 1117 \pm 250$ g) to sea water at a temperature of 34 °C (warm water treatment, $n = 40$) or 9 °C (control treatment, $n = 20$) for 30 s, and subsequently conducting welfare indicator scoring and histopathological examination of their skin, fins, eyes, snout, nasal pits/mucosa, palate, gills, thymus, pseudobranch, brain, heart, liver, kidney, pyloric caeca, pancreas, and spleen. The results showed that the prevalence and severity of acute lesions were not significantly different between the two treatment groups, except for higher prevalence of injuries on the caudal ($p = 0.002$), dorsal ($p = 0.002$), and right pelvic fins ($p = 0.014$) in the warm water treatment group. The main cause of these fin injuries may have been a strong behavioural reaction displayed by the fish when exposed to warm water. Possible consequences of fin injuries, the use of anaesthetic, and statistical limitations were discussed. It was concluded that exposure of Atlantic salmon to sea water at a temperature of 34 °C for 30 s did not lead to any statistically significant change in the prevalence of acute lesions except an increase in minor, possibly behaviour-related, fin injuries. Detection of a lower lesion prevalence than was possible in this study, but which may concern many individuals in an industrial setting, requires examination of a larger number of fish.

1. Introduction

Warm water treatment has in recent years been widely used for delousing of Atlantic salmon (*Salmo salar*) and rainbow trout (*Oncorhynchus mykiss*) in Norwegian aquaculture (Overton et al., 2018), despite effects on fish welfare not being adequately documented (Noble et al., 2018; Hjeltnes et al., 2019). There are different warm water treatment systems (e.g. Thermolicer® from Steinsvik, Inc., Førresfjorden, Norway, and Optilice® from Optimar, Inc., Valderøy, Norway), but the treatments mainly follow the same procedure: the fish are crowded in the sea cage and pumped past a dewatering strainer into a treatment chamber where they are exposed to sea water at a temperature of 28–34 °C for 20–30 s (Holan et al., 2017; Noble et al., 2018). Although water temperatures in this range are lethal within 10 min for Atlantic salmon, the fish can survive such temperatures for shorter periods of time (Elliott, 1991; Elliott, 2010; Elliott and Elliott, 2010; Nilsson et al., 2019). The delousing mechanism is assumed to be that the lice, due to their smaller size, are heated more rapidly to a harmful temperature than their hosts and detach from the fish (Brunsvik, 1996; Grøntvedt et al., 2015; Holan et al., 2017).

The delousing effect and impact on fish welfare from warm water treatment have been assessed by independent research institutions for the Thermolicer® (Grøntvedt et al., 2015) and the Optilice® (Roth, 2016) systems in the developmental stage of the technologies. In both reports, it is concluded that the respective systems are effective and safeguard fish welfare. The assessment of the final systems includes,

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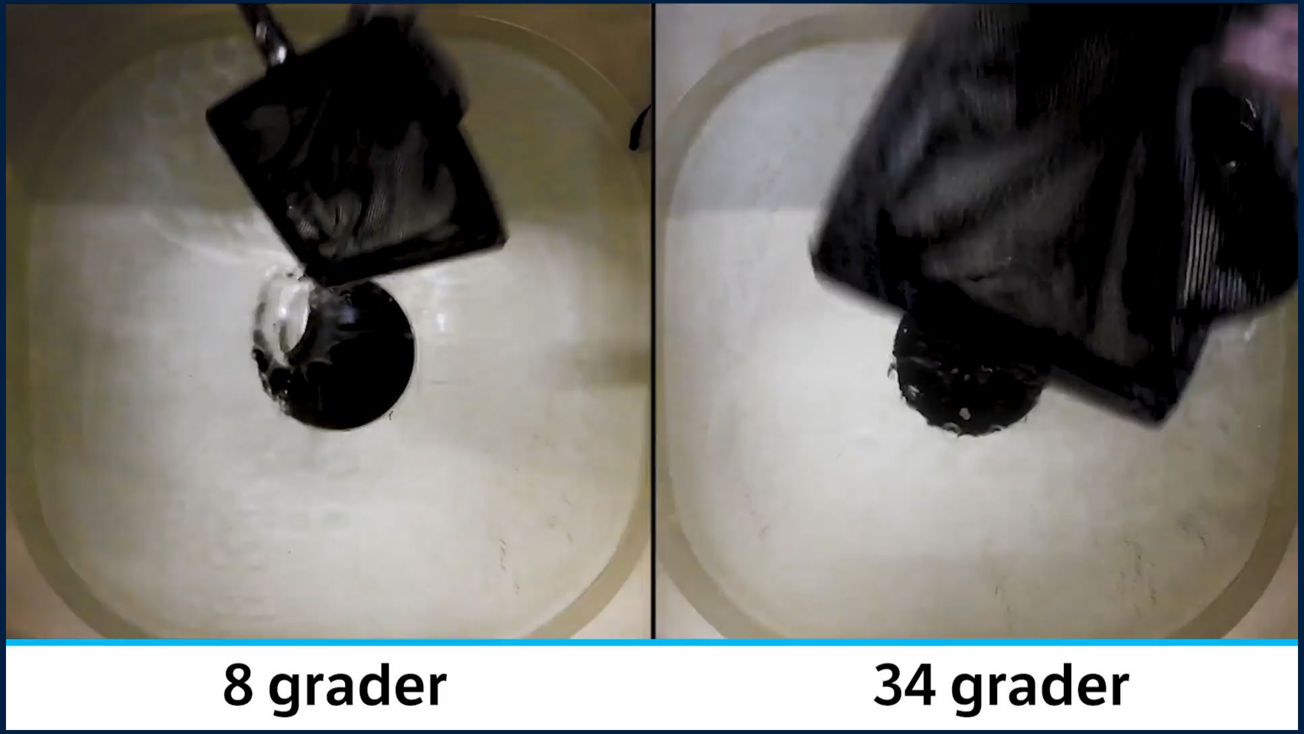
Diptest in tank

What happens when a stressed fish is exposed to heated water?



Thermolicer advantages

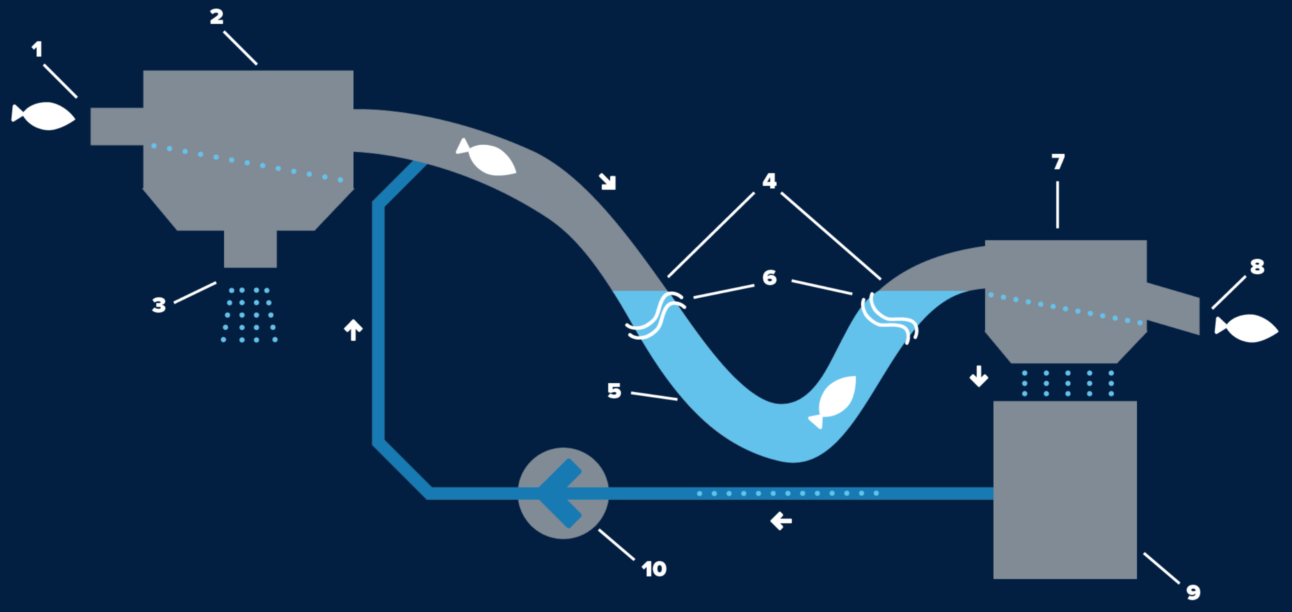
No acceleration

No walls

No moving parts

No edges

No light



Tradeoff = Holding time not 100% accurate.

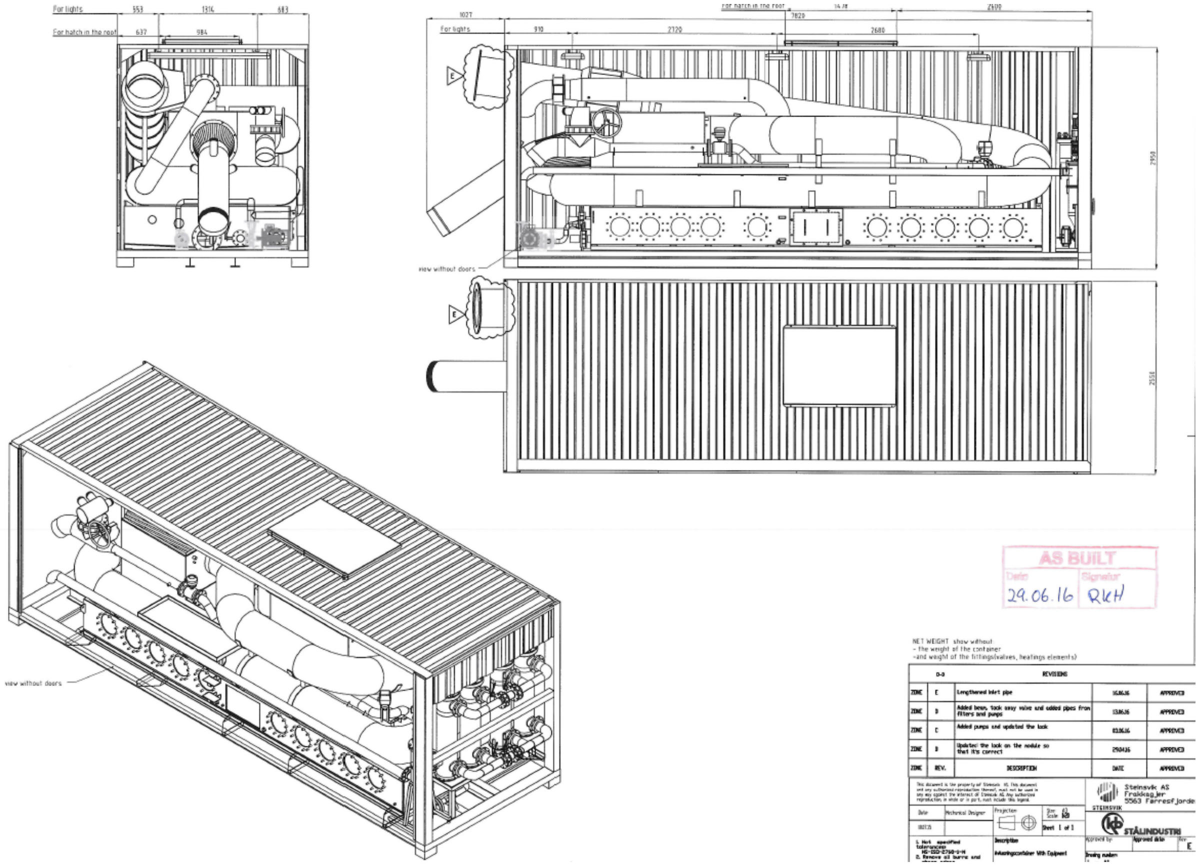
Standard Thermolicer

Pipe length: 22 meters

Dimension: Dn500

Water speed: 0,9 m/s

Max capacity: 90 t/h



Service vessel Thermolicer

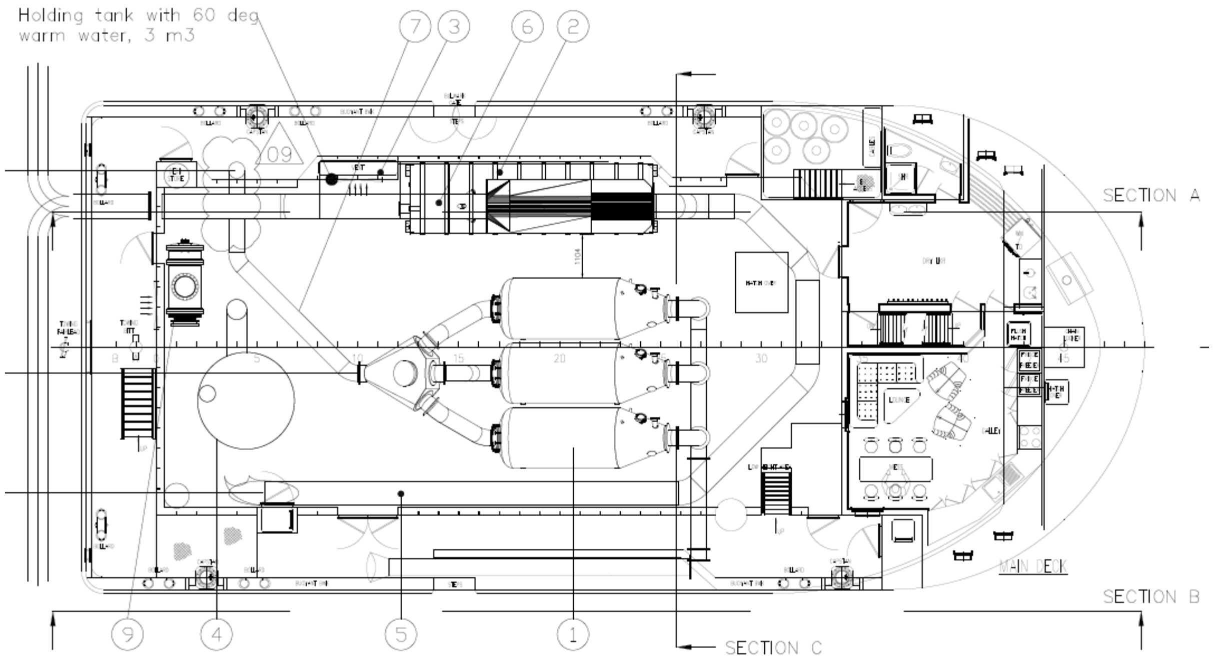
(Uk workboat code)

Treatment pipe: 22 meter

Pipe dimention: Dn600

Water speed: 0,9

Max capacity: 126 t/h



Mowi UK

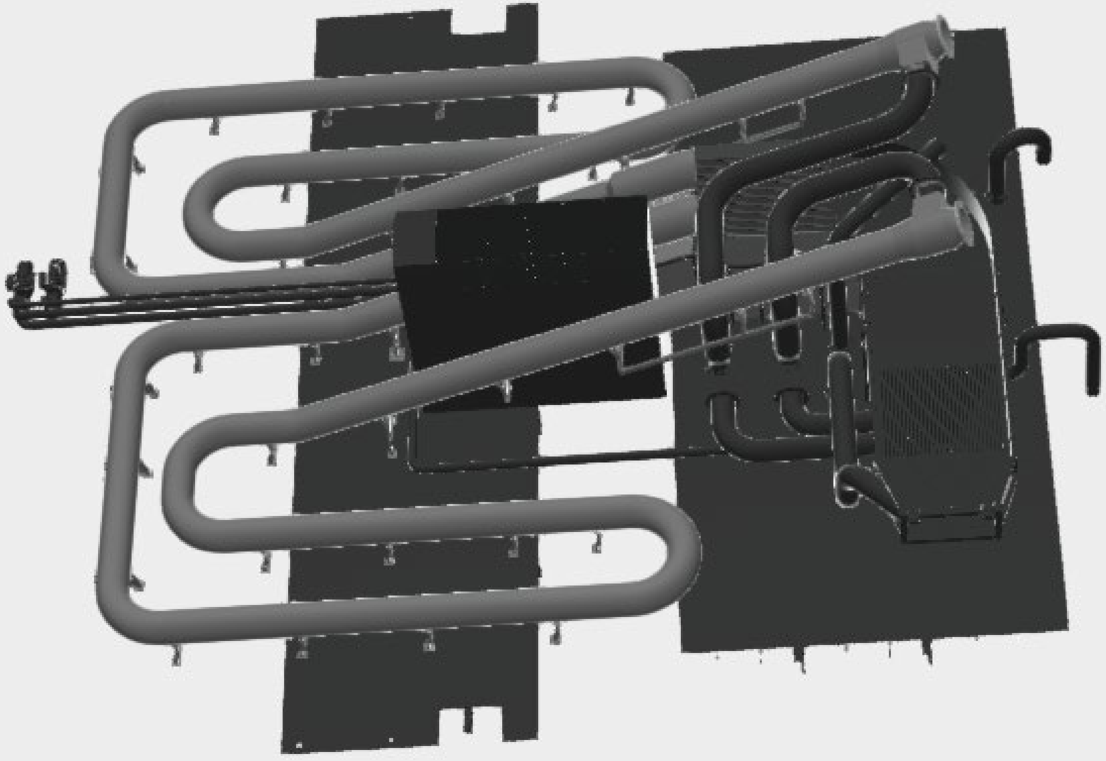
Twin Thermolicer

Rørlengde: 38m

Rørdimensjon: Ø500

Vannhastighet: 1,26 m/s

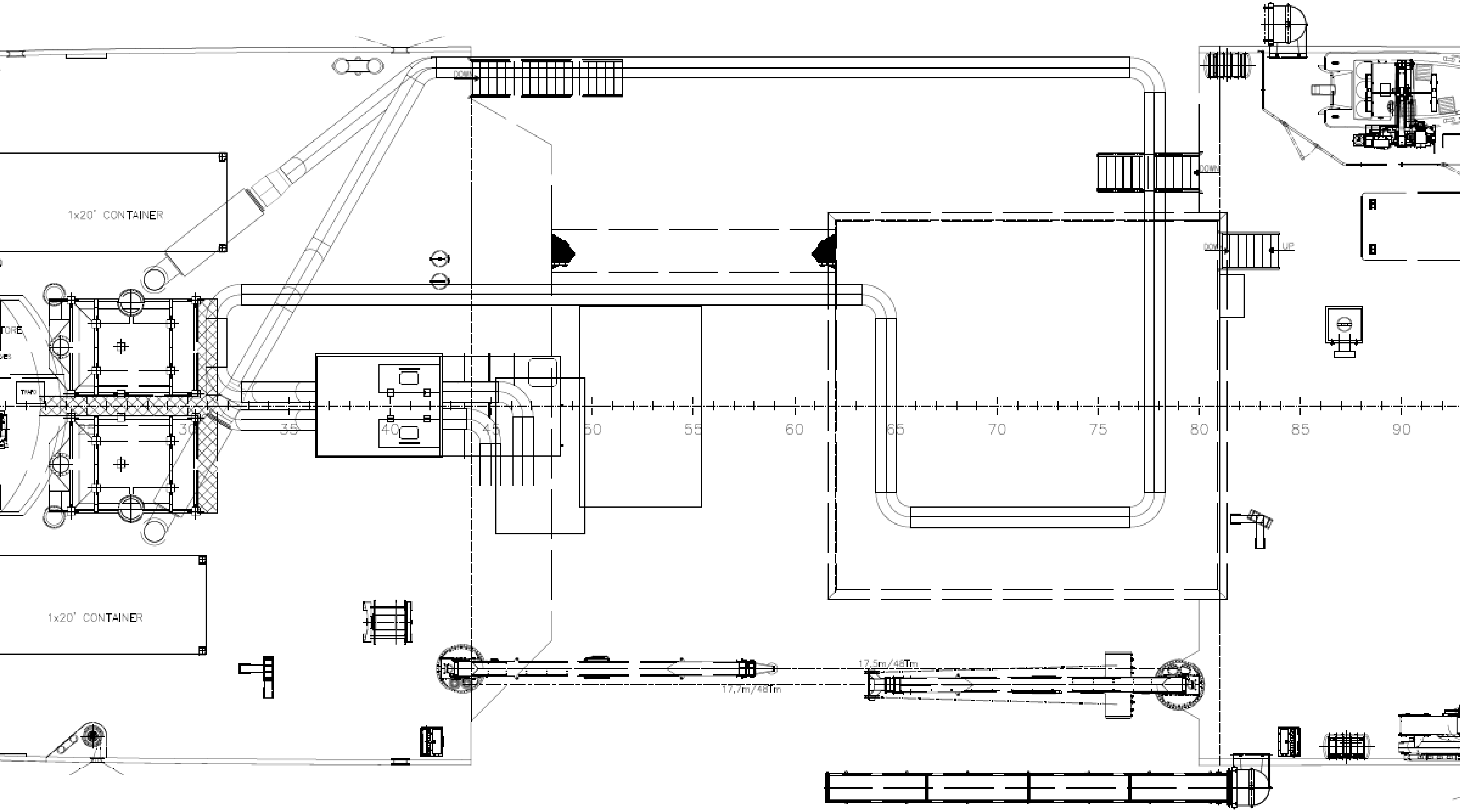
Max kapasitet: 250 t/t



Rørlengde: 33 meter x 2

Vannhastighet: 1,1 m/s

Max kapasitet: 254 t/h


1x20' CONTAINER
1x20' CONTAINER
DOWN
DOWN
DOWN
UP
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25
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85
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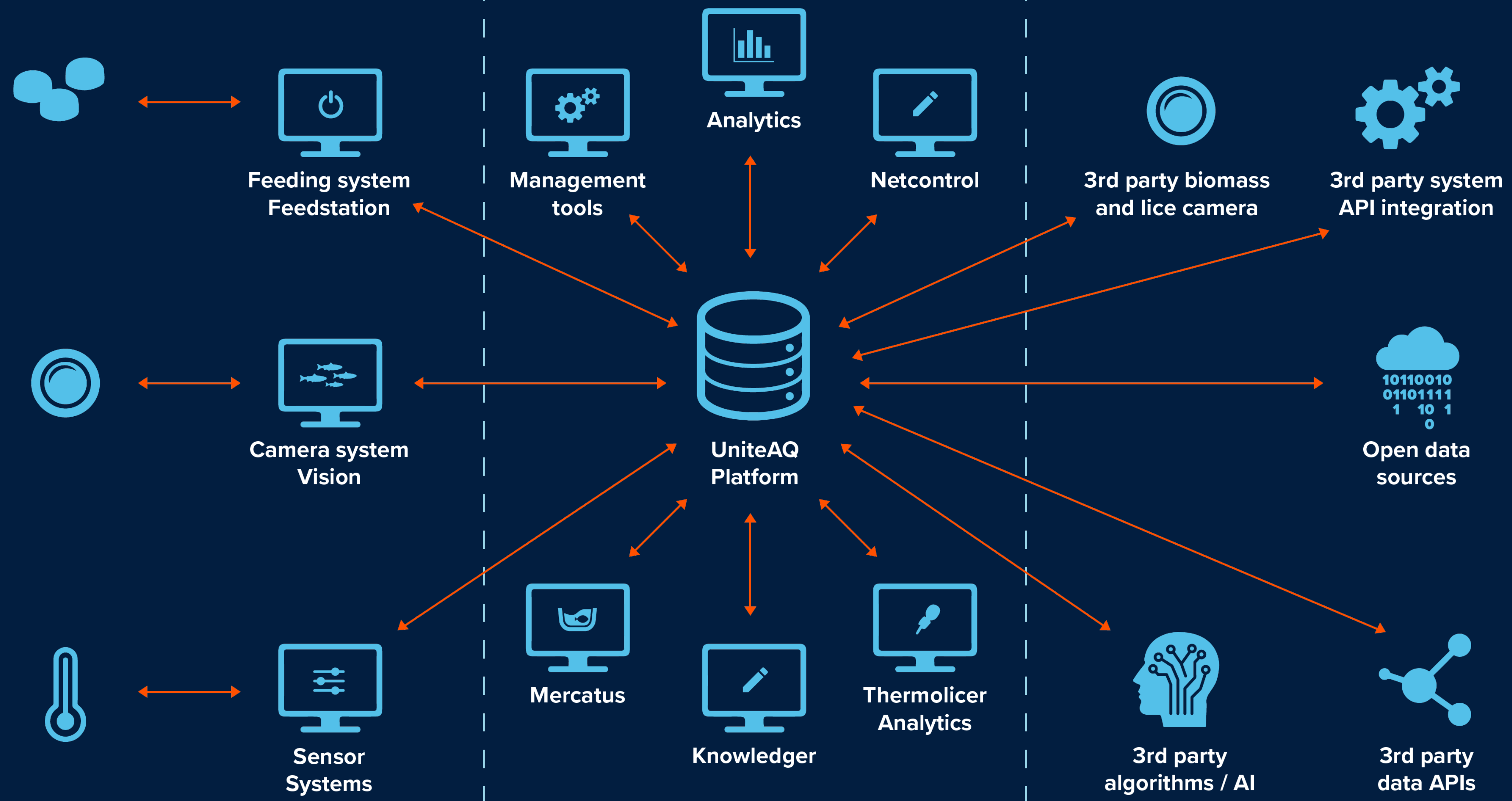
17,5m/48Tm
17,7m/48Tm

OPERATIONAL SYSTEMS

SCALEAQ CLOUD BASED SERVICES

THE OUTSIDE WORLD CLOUD TO CLOUD



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