agru

The Plastics Experts.

Land and Sea-Based Aquaculture

THERMOPLASTIC FISH FARMING SOLUTIONS

The Plastics Experts.

At the heart of the food shortage problem is a lack of sustainable food sources. Aquaculture, the farming of fish, has grown tremendously over the last decade and has the potential to help alleviate the world's food shortage. To help businesses create truly sustainable operations, AGRU has leaned on its experience as the Plastics Experts to develop fish farming solutions using geosynthetics.

The AGRU success story has been unfolding for seven decades. Founded in 1948 by Alois Gruber, who set the company on the course for plastic manufacturing, AGRU has become one of the world's most important single-source suppliers for piping systems, semi-finished products, concrete protective liners and lining systems made from engineered plastics. AGRU uses only the finest grade thermoplastic polymers as raw materials. When it comes to application-technical consulting, AGRU is your best partner in the field.

Quality

The AGRU quality assurance system is compliant with multiple international standards and AGRU's procedures help ensure that products meet or exceed these international standards, on an ongoing basis. The start-to-finish attention to quality ensures that the products meet and beat the strictest technical specifications, providing safe operation even in challenging conditions.

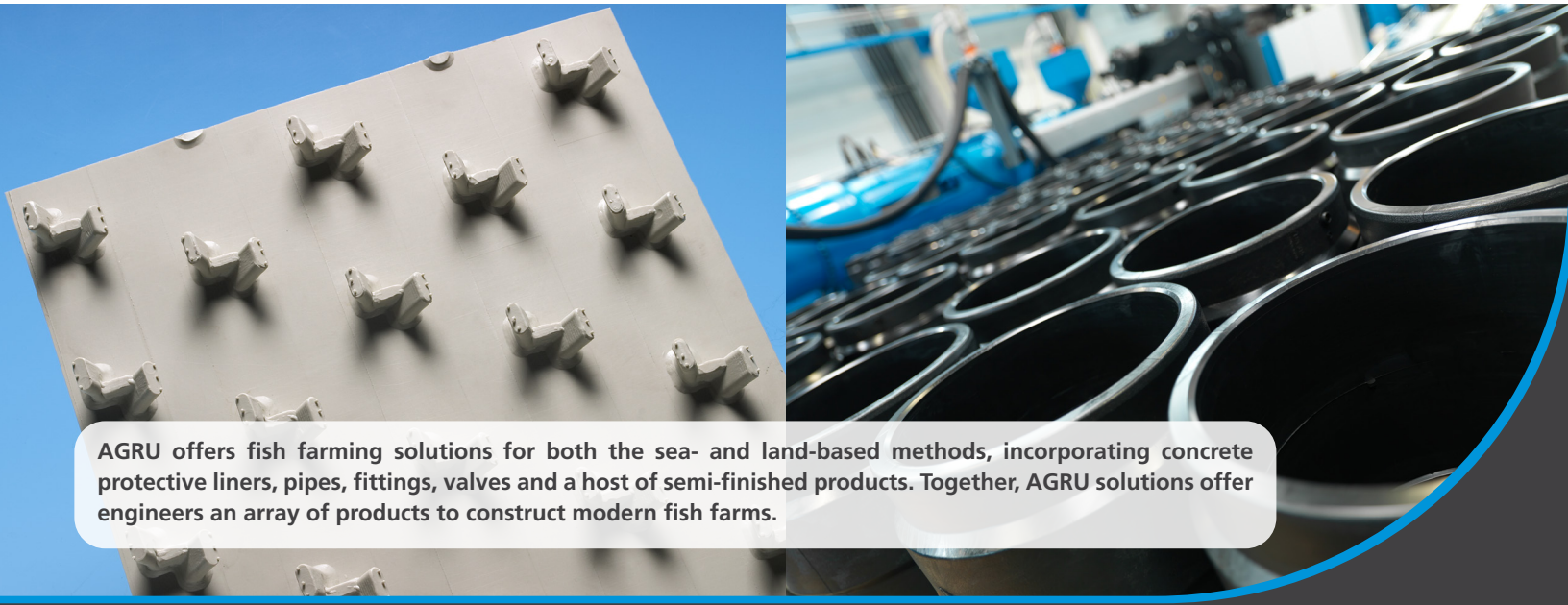
More Fish with Aquaculture

Global food consumption is on the rise, leading to an unsustainable load on ocean fisheries. To help meet demand, companies have turned to fish farming also known as aquaculture. Aquaculture has quickly become a multibillion-dollar industry and has been the fasting growing agricultural sector for more than 4 decades ***(1)***.

While aquaculture and fish farming do have the potential to help solve problems associated with overfishing, a growing human population, and food shortages, there are rooms for improvement in how these systems are designed. The sea-based fish farming, for example, relies on the placement of cages or containment structures in the ocean. Designing durable sea-based fish farming systems that do not fail is essential for sustaining a healthy fish farm as well as protecting the ecosystem.

Another approach to fish farming is the land-based closed fish farming method, which uses concrete tanks and a piping system to help regulate water temperature and nutrients. Also known as the basin method, this approach is more hands-on and requires a careful control of the system to manage waste, nutrients, stock health and more. However, even in the most controlled settings, the concrete basins are susceptible to corrosion or biological buildup over time, which can impact stock health. To counter this problem, operators can institute a regular maintenance schedule or apply concrete protective linings.

1. T. L. Win, "World's fish consumption unsustainable, UN warns." ***Reuters.*** (2018). Accessed online 27 July 2020 at https://www.reuters.com/article/us-global-fisheries-hunger/worlds-fish-consumption-unsustainable-u-n-warns-idUSKBN1JZ0YA.



AGRU offers fish farming solutions for both the sea- and land-based methods, incorporating concrete protective liners, pipes, fittings, valves and a host of semi-finished products. Together, AGRU solutions offer engineers an array of products to construct modern fish farms.

AGRU Aquaculture Solutions

Common problems associated with aquaculture infrastructure include a need to enhance durability and chemical resistance (sea-based containment) as well as growing costs to the bottom line due to inadequate concrete protection and leaking pipes/pipe joints (land-based containment).

AGRU **Sea-Based** Aquaculture Solutions address durability and operational costs to:

- Improve reliability and margins of safe and dependable yields by preventing biological growth or corrosion on containment walls (containment approach).
- Help ensure fish stock do not escape, which can be a significant setback as the fish farm would need to start over.
- Prevent nonnative fish stock from escaping into waters, which can incur high retrieval costs *(2)*.

AGRU **Land-Based** Aquaculture Solutions address maintenance and operational costs to:

- Improve reliability and margins of safe and dependable yields by preventing biological growth or corrosion on containment walls.
- Reduce variable operating costs by preventing leaks in the piping system.
- Lower utilization and decreased life of existing facilities—leaks can reduce the service life of treatment and conveyance systems by requiring system expansions that would not otherwise be required.

AGRU's Aquaculture Solutions incorporates three product categories: Ultra Grip concrete protective liner (CPL), PE 100-RC pipes, fittings, valves and thermoplastic semi-finished products. Together, these products support the creation of modern fish farms in a variety of environments.

2. L. V. Mapes and H. Bernton, "Please go fishing, Washington state says after farmed Atlantic salmon escape broken net." ***The Seattle Times.*** (2017). Accessed online 27 July 2020 at https://www.seattletimes.com/seattle-news/environment/oops-after-accidental-release-of-atlantic-salmon-fisherman-being-told-catch-as-many-as-you-want/.

Sea-Based Aquaculture

Sea-based fish farming is essential to modern aquaculture, with most industrially farmed finfish species transferred to outdoor ponds or sea-based structures for the final growth phase. Norwegian salmon farms, for instance, are up to 157 m in circumference and can hold as many as 200,000 fish. Typical farms in this setup can contain between 8 and 16 cages ***(3)***.

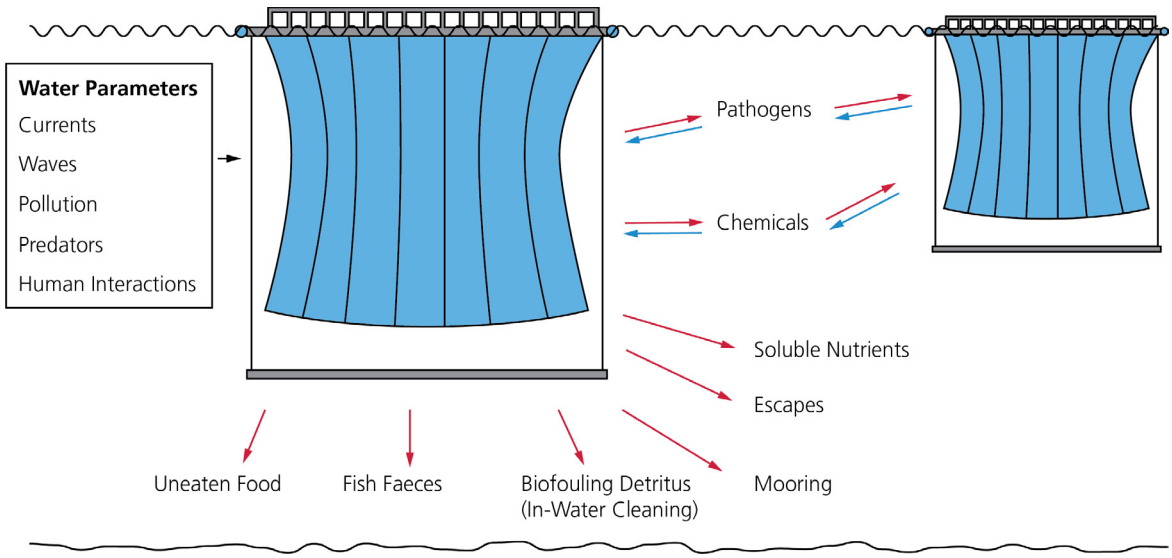
There are two approaches to sea-based aquaculture: caged approach and full containment approach. The cage approach uses a net attached to a floating structure while the full containment approach uses a floating enclosed tank.

The surface collar in cage designs in North America are typically made with high-density polyethylene (HDPE, see Figure 1). HDPE is generally favored in Canada and the United States due to its lower capital costs and its ability as a wave conformer—capable of bending with passing energy of a wave rather than remain rigid ***(4, 5)***.

3. M. Føre ***et al.***, "Precision fish farming: A new framework to improve production in aquaculture." ***Biosys. Eng.*** (2018). Accessed online 27 July 2020 at https://www.sciencedirect.com/science/article/pii/S1537511017304488.

4. M. Halwart, D. Soto, J.R. Arthur (eds.), "Cage aquaculture – Regional reviews and global overview." FAO Fisheries Technical Paper. No. 498. Rome, FAO. (2007). Accessed online 27 July 2020 at http://agrilife.org/fisheries2/files/2013/09/Cage-Aquaculture-Regional-reviews-and-global-overview.pdf.

5. F. Cardia and A. Lovatelli, "Aquaculture operations in floating HDPE cages: a field handbook." ***UN FAO.*** FAO Fisheries and Aquaculture Technical Paper No. 593. Rome, FAO. 152. Accessed online 27 July 2020 at http://www.fao.org/3/a-i4508e.pdf.



Note: Blue arrows indicate external factors acting on structures and/or fish; red arrows indicate impacts of cages on the environment

Figure 1. Diagram of the main interactions cage–environment–cage *(5).*

Innovations in how sea-based aquaculture farms are managed promises to streamline operations and improve scalability. Precision fish farming (PFF), for instance, is a novel framework that seeks to incorporate new tools to assist with monitoring and controlling the production process without increasing the workforce (see Figure 2). Tools that are being implemented today include those that assist with the observation phase of fish farming operations, helping with the collection of data as well as automated feeding and data analysis.

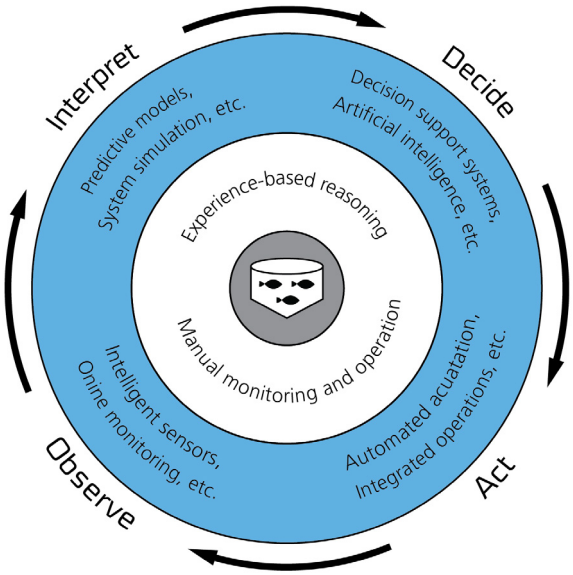


Figure 2. A cyclical representation of precision fish farming (PFF, *3*).

Figure 3. Sea-based containment solution using AGRU PE 100-RC (polyethylene) sheets.

AGRU Sea-Based Aquaculture Solution

AGRU's sea-based aquaculture solution incorporates specialized semi-finished products to help engineers create highly durable, long-lasting and easy-to-maintain sea-based containment systems for fish farming.

AGRU Products

Semi-Finished Products

AGRU semi-finished products are available in PE 100-RC and more, offering high durability, flexibility and chemical resistance. AGRU sea-based aquaculture solution can be used to create modern fish farms. See page 11 for more details.

AGRU Sea-Based Aquaculture Solution in Practice

In 2014, a client sought to create a sea-based fish farm to further expand their aquaculture capabilities. In this project, the client wanted to create an enclosed system using a containment tank rather than the more commonly used cage method for sea-based fish farming. Sea-based containment systems can be difficult to create, transport, and maintain especially if they are manufactured from traditional construction materials like concrete or steel. Seeking a better solution, the client turned to AGRU.

Sea-based aquaculture solution using AGRU polyethylene sheets that were fabricated into specified dimensions for the containment system (see Figure 3) have been implemented as an innovative design to construct floating sea farm structures The sheets were made of PE 100-RC, an enhanced resin with improved strength, durability and stress crack resistance.

Semi-Finished Products

Land-Based Aquaculture

Land-based fish farming continues to be a popular option for modern aquaculture, especially in the United States where local regulations can inhibit the creation of sea-based farms. And even in areas where sea-based farms can be deployed, land-based systems are often an essential step in the production process for the hatchery phase ***(3)***.

Land-based aquaculture designs are constantly changing as new techniques are developed. One of the most important developments has been water recirculation technology. Recirculation technology enhances fish farming by reusing the water in production, which can decrease costs and improve the overall quality of the tank. Even a low-intensity recirculation system can reduce the use of water by about 90%. High-intensity recirculation systems are capable of reusing more than 99% of the water every year ***(6)***.

Essential to modern land-based aquaculture is (a) **proper tank design**, (b) **right tank material**, and (c) **efficient piping system**. Depending on the fish species being raised, the tank design should support self-cleaning ability. Circular tanks, for instance, offer the highest self-cleaning ability as the fluid flow characteristics work the best with this design. Other designs offer benefits in other areas (see Table 1). In most cases, the right tank material is concrete. However, to get the most performance out of concrete in a recirculation system, a concrete protective liner (CPL) is recommended. CPL reduces the buildup of material within the tank and keeps the concrete from direct contact with the water, improving the service life of the structure and reducing the need for frequent maintenance. Additionally, the smooth surface of the CPL prevents unsightly abrasions in the event that the fish may brush up against the walls. White, grey, and other lighter colored CPL liners enhance the performance of fish farming.

Finally, an efficient piping system is also essential to any land-based fish farm and is especially important for those intending to recirculate the water. Most piping systems leak. Over time, these leaks can be costly in terms of exfiltration and waste. The use of PE 100-RC pipe fittings at key connection points produce joints that don't leak.

3. M. Føre ***et al.***, "Precision fish farming: A new framework to improve production in aquaculture." ***Biosys. Eng.*** (2018). Accessed online 27 July 2020 at https://www.sciencedirect.com/science/article/pii/S1537511017304488.

6. J. Bregnballe, "A Guide to Recirculation Aquaculture." ***UN FAO and EUROFISH.*** (2015). Accessed online 27 July 2020 at http://www.fao.org/3/a-i4626e.pdf.

AGRU Land-Based Aquaculture Solution

AGRU's land-based aquaculture solution combines state-of-the-art Ultra Grip concrete protective liner with AGRULINE piping system to help engineers create highly durable, long-lasting and efficient land containment systems for fish farming. Specialized solutions can also be constructed out of AGRU semi-finished products.

AGRU Products

Ultra Grip HDPE CPL

Unlike typical fish farming basins that lack concrete protection, AGRU's land-based aquaculture solution includes an industry-leading CPL in the form of Ultra Grip. Ultra Grip not only protects the concrete basin against saltwater, the CPL also ensures that the concrete basin is easily cleaned with a smooth surface that also inhibits biological growth and protects the fish from unsightly abrasions. See page 10 for more details.

AGRULINE Pipes, Fittings and Valves

Create leak-proof joints with AGRULINE fittings, which includes AGRULINE fittings, transtion fittings, electrofusion couplers and tapping saddles. AGRULINE also includes XXL PE piping system for sea water intake and outfall. See page 11 for more details.

Semi-Finished Products

AGRU semi-finished products are available in PE 100-RC and more, offering high durability, flexibility, and chemical resistance. AGRU sea-based aquaculture solution can be used to create modern fish farms. See page 11 for more details.

AGRU Basin Aquaculture Solution in Practice

In 2009, a client sought to create a land-based fish farm in Smolten, Norway. The salmon and draught breeding farm would be used to raise stock that would later be transported to a sea-based system. Maintaining the health of the fish during the hatchery phase can be difficult, especially if tank conditions are poor. Seeking a better way to line their tanks, the client turned to AGRU.

AGRU presented a land-based aquaculture solution using its CPL Sure Grip Type 560, which was fabricated into specified dimensions for easy installation (see Figure 4). The 3 mm CPL was stabilized against ultraviolet radiation and was food grade certified.

Figure 4. Land-based containment solution using AGRU high-density polyethylene (HDPE) concrete protective liner (CPL).

Tank Properties			
	Circular Tank	D-ended Raceway	Raceway Type
Self Cleaning Effect	5	4	3
Low Residence Time of Particles	5	4	3
Oxygen Control and regulation	5	5	4
Space Utilization	2	4	5

Table 1. Different tank designs give different properties and advantages. Rating 1-5, where 5 is the best *(6)*.

Product Overview

ULTRA GRIP

The latest innovation on Sure-Grip, Ultra Grip offers unparalleled backpressure resistance through a revolutionary redesign of the 13 mm Sure-Grip anchor.

Features

- Comes standard as Type 562, with 13 mm stud height.
- Pull out resistance of up to 820 kN/m2 with HDPE at 20°C.
- Manufactured with HDPE or PP, depending on project requirements.
- Distinctive V-shape anchor can resist long-term sustained backpressure of up to 1.75 bar (at 20°C or 68°F).
- Product is available in rolls and sheets of up to 16.4' (5.00 m) in width and up to 470mil (12mm) in thickness.
- The Plastics Experts are available to offer project-specific guidance for the best solution.

For complete details about Ultra Grip, visit:
https://agruamerica.com/products/ultra-grip

Or, for more information:
https://www.agru.at/en/products/concrete-protection

AGRULINE Pipes, Fittings, and Valves

AGRULINE fittings includes transition fittings, electrofusion couplers and tapping saddles made of HDPE.

Features

- Fittings can be welded to create leak-proof joints.
- Manufactured using state-of-the-art production processes and machined to perfection.
- Made with certified PE100 and PE4710 materials, with high corrosion resistance, high resistance to slow crack grow, and high rupture strength.
- Components are designed for interoperability with decades-spanning positive service record.
- The Plastics Experts are available to offer project-specific guidance for the best solution.

For complete details about AGRULINE fittings, visit:
https://agruamerica.com/product/pipe-fitting-systems

Or, for more information:
https://www.agru.at/en/products/agruline-piping-systems

Semi-Finished Products

AGRU manufactures semi-finished products made of high-grade thermoplastics offering acid and alkali resistance across a range of applications.

Features

- Semi-finished products can be made of PE, PP, or other thermoplastics depending on project requirements.
- Products offer high chemical resistance and durability.
- Available as sheet stock and round bars for easy fabrication.
- The Plastics Experts are available to offer project-specific guidance for the best solution.

For complete details about AGRU Semi-Finished Products, visit:
https://agruamerica.com/product/semi-finished-products

Or, for more information:
https://www.agru.at/en/products/semi-finished-products

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