Sealing Onshore Aquaculture Facilities with Geomembranes

EXPERTISE | Professional Welding and Testing Equipment



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Management Summary

Starting Point

Fish and crustaceans are popular, healthy foods that are enjoyed all over the world. Because traditional fishing can no longer meet increasing global demand, fish and crustaceans are being bred in land-based systems, known as onshore aquaculture. Aquaculture facilities in earth ponds and round tanks sealed with geomembranes provide a controlled environment to optimize the conditions for the growth and health of the fish and crustaceans. In addition, the desired species and quantities can be produced according to plan using land-based breeding facilities.

Aims

Land-based aquaculture operators and producers have various objectives: They want to increase the quality of the products and protect the aquaculture facilities from disease. The aim is to avoid antibiotics and medication as far as possible as organic quality is becoming increasingly important. Fish ponds and breeding tanks should be long-lasting and sustainable in order to generate high yields over a longer period of time. The surrounding ecosystem must be protected. To achieve these goals, land-based aquaculture facilities must be professionally lined and sealed with geomembranes. In this white paper, the authors provide theoretical and practical knowledge about onshore aquaculture facilities and explain which geomembranes and welding equipment are required for professional sealing.

Practical Experience

Ponds and breeding pools for onshore aquaculture have been built around the world for decades. Lining with geomembranes has stood the test of time and offers numerous advantages.

This white paper explains in detail which geomembranes are most suitable, how they should ideally be installed, what quality testing options are available and what needs to be considered when maintaining breeding ponds and pools. The authors also provide practical knowledge about the requirements for welding equipment, explain various welding technologies and reveal what users need to pay attention to when sealing geomembranes.

Recommendations

Operators and manufacturers of onshore aquaculture facilities are well advised to pay attention to the quality of the geomembranes and the required welding equipment when constructing and operating fish ponds and breeding tanks. Even if investments in high-quality plastic liners and modern welding equipment appear steep at first glance, they are worthwhile in order to become and remain competitive in the long term in the face of increasing demand and growing quality requirements.

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1. Introduction

Fish and crustaceans, such as shrimp (also known as prawns), crabs and scampi, are popular, healthy foods and are enjoyed by people all over the world. Traditional fishing can no longer meet growing global demand. Fishing on the open sea is also becoming increasingly challenging. It requires expensive equipment, is energy-intensive and connections with suitable ports are needed.

Onshore aquaculture facilities are land-based systems in which fish and crustaceans are bred. Due to increasing demand, many new farms have sprung up around the world in recent decades. Aquaculture facilities in earth basins and round tanks sealed with geomembranes provide a controlled environment. This allows the conditions for the growth and health of the fish and crustaceans to be optimized. In addition, the desired species and quantities can be produced according to plan using land-based breeding tanks. Distribution channels can therefore be supplied reliably.

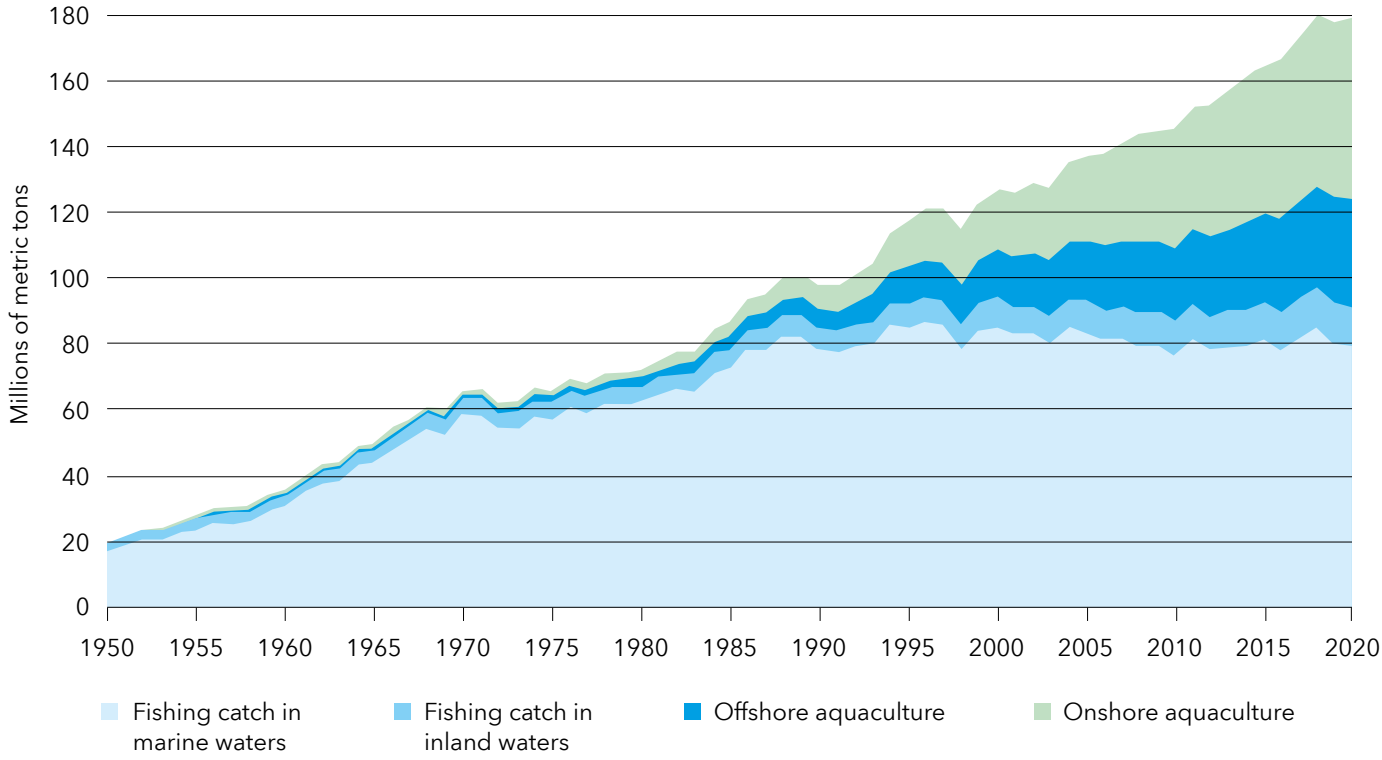
Operators and producers of land-based aquaculture facilities are confronted with the following questions in particular:

- How does aquaculture stay disease-free? And how can the quality of the products be improved at the same time?
- How can higher yields be generated sustainably and over a longer period of time?
- How is the surrounding ecosystem protected?
- How can the management process be stabilized?
- How can land-based breeding systems be lined with geomembranes, professionally and leak-tight?

In this white paper, the authors answer these questions and provide additional information on the topic of land-based aquaculture.



Global capture fisheries and aquaculture production
(Food and Agriculture Organization of the United Nations, 2022)



The image "Global capture fisheries and aquaculture production" visualizes the continuous increase in demand for fishery and aquaculture products over the past seven decades. This white paper is limited to the area of "Aquaculture – inland waters". Source: based on Food and Agriculture Organization of the United Nations, 2022

Global Expansion

Onshore aquaculture facilities in earth basins and round tanks for the production of fish and crustaceans are operated worldwide in various geographical zones near the equator.

The spread depends primarily on various factors:

- Climatic conditions
- Water resources
- Market demand
- Market regulations



Round breeding tank with steel frame and HDPE lining

The following are regions and countries where aquaculture is widespread:

Asia
Countries such as China, India, Vietnam, Thailand and Bangladesh lead the way in the aquaculture production of fish and crustaceans. These countries have a long tradition of aquaculture and use various methods, including earth ponds and round tanks.

Latin America
Countries such as Ecuador, Chile, Peru and Brazil have also become important players in aquaculture. Both earth ponds and round tanks are used to breed various fish and crustaceans in these regions.

North America and Europe
Earth ponds and round tanks are used in aquaculture in countries such as Spain, Greece and the southern United States in particular. These are operated with both fresh water and seawater.

Africa
Some African countries, including Egypt, Nigeria and South Africa, also practice aquaculture using a variety of methods.

Middle East
Saudi Arabia has several large producers of fish and shrimp.

Increasing Requirements

Hygiene is becoming an increasingly important aspect in food production. Requirements are also increasing in the aquaculture of fish and crustaceans. The main goals are to ensure high food quality, increase consumer safety and minimize environmental impact.

The required standards – high water quality, sustainability, environmental protection and disease prevention – are tough to meet with conventional earth basins without professional plastic sealing. The use of geomembranes in fish and crustacean farming contributes to achieving these standards. (Xprogeo, 2020)

Overview of Aquaculture Types

There are two types of aquaculture: offshore and onshore.
These will be explained below:



Offshore aquaculture

With offshore systems, farms (salmon, for example) are located in open waters, often close to the coast. These can involve cages or nets.



Onshore aquaculture

With onshore systems, aquaculture is carried out on land. This can be done with the help of tanks, ponds or using an indoor system, for example.

2. Geomembrane Sealing



Shrimp breeding facility, sealed with geomembranes and fully covered with bird protection nets

In the aquaculture management of ponds, the separation of water and soil using geomembranes has proven its worth for decades. Compared to ponds lined with earth, clay or concrete, this is a cost-effective solution in the medium term. In addition, ponds or tanks sealed with thermoplastic geomembranes have significant advantages in terms of hygiene, process safety, water quality and prevention of disease.

Additionally, aquaculture facilities lined with geomembranes have played an important role in increasing productivity in the past, particularly in Asia. This has now become established as best practice in the industry.

The cumulative benefits of the geomembrane installation have synergy effects that improve the yield, quality and overall profitability of projects. (Boyd & Ranjan, 2018), (Xprogeo, 2020)

Advantages of Waterproofing with Thermoplastic Geomembranes

As mentioned, there are many advantages to sealing ponds and breeding tanks for aquaculture with thermoplastic geomembranes. The most important are set out in this chapter.

Preventing Disease

Geomembranes act as a barrier between the soil and water in the pond or breeding tank. In this way, they prevent pollutants, bacteria and viruses from entering the water from the soil. Unlike floor surfaces made of organic material, geomembranes are resistant to microbiological attacks and prevent the introduction and progression of disease.

Disease poses a considerable risk in aquaculture because it can potentially lead to high breeding losses. Although completely avoiding disease is unrealistic, the use of geomembranes helps to minimize the risk of disease outbreaks in lined ponds and tanks.

In agriculture, it has been shown that the quantity and quality of breeding can be maintained after installing geomembranes in earth ponds, despite the fact that medication and antibiotics have been significantly reduced at the same time.

Drug-free crustaceans and fish have a higher market value. Breeding costs are also reduced by eliminating or minimizing the use of medication and antibiotics. (Xprogeo, 2020)

Water Quality

Consistently high water quality, accompanied by constant pH values, is crucial in aquaculture. It is decisive for the quantity and quality (size, color and taste) of the aquaculture facilities. These in turn are decisive factors for profitability.

Sealing aquaculture facilities with plastic membranes acts as a barrier and protects the water from becoming contaminated by soil or erosion. In addition, geomembranes reduce the loss of oxygen through infiltration into the soil. This also makes it easier to monitor the oxygen levels in the water and helps minimize the cost of oxygen supplementation. Overall, geomembranes reduce the introduction of soil elements that have a detrimental effect on aquaculture growth conditions. Higher water quality means fewer fish or crustaceans with dirty gills. And these command a higher price on the market. (Xprogeo, 2020), (Zhang, 2020)

In addition, water quality has a direct impact on the welfare of the fish and crustaceans:

"Fish are in direct contact with the aquatic environment through their gills, which is why adverse changes in water parameters have a direct impact on the fish. Even short-term fluctuations in water parameters can lead to mass mortality at a facility." (Segner, 2016)

Preventing Seepage

Without the retention of water by geomembranes, and depending on the region, ponds lose between 1.5 and 76.5 cm of water per month due to seepage. The average seepage rate is 23.1 cm per month. If there is no fresh water connection, this can lead to major difficulties. Even if water is added, this results in additional costs and an unstable process. Professionally installed geomembranes completely prevent the seepage of valuable water into the ground. (Boyd C. E., 2009)

Shorter Downtimes

In general, ponds must be dried out and cleaned after each breeding phase. This process can take 30 to 45 days, particularly in unfavorable weather conditions. The use of geomembranes reduces average downtime to 4 to 8 days. This increase in efficiency allows for more breeding processes per year, increasing the productivity and yield of the ponds. In addition, the use of geomembranes simplifies the cleaning process, especially during the rainy season. Under sunlight exposure, the black membrane dries quickly. (Boyd & Ranjan, 2018), (Xprogeo, 2020)

Easier Removal of Waste and Sediment

The smooth geomembrane surface can prevent sediments and deposits that accumulate during the breeding phase from settling. In contrast to the topographical characteristics of soil and clay substrates, which are susceptible to cumulative organic residue deposits due to their rough surfaces, geomembrane surfaces are flat.

Geomembranes often have a dark, homogeneous surface structure, which makes it easier to visually monitor pond deposits. This characteristic puts pond managers in a better position to assess the condition of water bodies and, if necessary, to take appropriate quality control measures. (Xprogeo, 2020)

More Oxygen Increases Yields

In general, sealing ponds facilitates more intensive aeration. As already explained, geomembranes eliminate the loss of oxygen into the soil. Increased oxygen content in the water can boost the breeding yield per pond area.
(Boyd & Ranjan, 2018)

Erosion Protection

Wind and rain create waves in the pond. The use of aerators also accelerates the formation of waves. These waves lead to erosion on the sides of the pond, with this erosion entering the pond and polluting the water. A plastic lining protects the slope from this erosive process, thus securing the pond wall. (Boyd & Ranjan, 2018), (Xprogeo, 2020)

Shorter Catch Time

A plastic membrane prevents the accumulation of weeds and sludge on the pond floor. This simplifies the catching process, as clearer visibility means fishing can be more efficient. (Xprogeo, 2020), (Zhang, 2020)

Lower Operating Costs

The use of geomembranes can reduce the costs of running an aquaculture operation. Considerable reduction is achievable, particularly in terms of medication, water and maintenance costs. Lining ponds with plastic membranes enables a steeper slope and greater depth. This increases the volume of the ponds, which generates higher yields. (earthshields.com, 2022)

Better Occupational Safety

Geomembranes stabilize pond slopes and edges. They prevent the floor from shifting unexpectedly and thus promote occupational safety. (Xprogeo, 2020)

Protecting the Ecosystem from Salinization

Aquaculture is practiced both near the ocean and inland. Depending on the breeding species, the inland facilities need to be artificially salinated.

Laying geomembranes blocks the interaction between salt water and soil. Geomembranes protect against unintentional water leakage, ensuring that neighboring areas are not salinated. They thus ensure the safety of surrounding ecosystems. (Jory, 2017), (Boyd & Ranjan, 2018)

Requirements for Geomembranes

Geomembranes can consist of different materials. Aquaculture ponds are often lined with geomembranes made of HDPE (High Density Polyethylene). A thickness of between 0.5–1.0 mm is often used for HDPE. If the focus is on investment costs, this is often reflected in a lower thickness of the geomembranes, which are then usually 0.5 mm or thinner. However, in practice it has been found that material thicknesses of less than 0.75 mm do not always meet requirements. They may not be able to withstand the water pressure or are damaged during installation. It should not be forgotten that many species of farmed fish have sharp fins that can penetrate a thin film.





Round breeding tanks with steel frame and HDPE lining

HDPE is characterized by its resistance to ultraviolet (UV) light thanks to the anti-ultraviolet substances it contains. Using chemical additives, it is possible to withstand the damaging effects of sunlight (UV rays) and ensure long-lasting stability. The thicker the geomembranes, the higher their resistance to UV radiation. (Boyd & Ranjan, 2018), (SF Chen Brothers, 2022)

"In terms of design, UV resistance can be improved very effectively by using sufficiently thick geomembranes, as the penetration depth of UV radiation through the carbon black is low. The damage, therefore, only occurs in the part of the geomembrane close to the surface, so that it does not lose its sealing properties." (Baldauf & Tarnowski, 2005)

The thickness of the geomembrane influences its mechanical properties and durability.

"A laboratory accelerated ageing test on the depletion of antioxidant from three HDPE geomembranes (e. g., 1.5, 2.0, and 2.5 mm) at four different temperatures has been described. Based on the results presented herein, it can be concluded that geomembrane thickness has a significant impact on the depletion of antioxidants with the thicker geomembrane giving the longest antioxidant depletion time." (Islam & Rowe, 2007).

To meet all challenges, a thickness of 1.0 mm, but at least 0.75 mm, is recommended for aquaculture pond membranes. Many manufacturers of HDPE membranes guarantee the use of their products for 5 to 10 years under normal conditions. (Boyd & Ranjan, 2018), (SF Chen Brothers, 2022)

Bird Protection

Breeding facilities are often completely covered with bird protection nets or sometimes even constructed in completely enclosed tents. This is to prevent birds from eating the farmed fish or introducing diseases.



Fully enclosed shrimp breeding facility in translucent tents



Internal view of a fully enclosed shrimp breeding facility



Completely protected with bird protection nets during operation with standard aeration wheels (paddle wheel aerator)

3. Welding Plastic Liners

Wedge welding technology has proven itself worldwide in the permanent joining of HDPE plastic liners. The hot wedges are heated electrically or with hot air. Detailed work is carried out using hot gas extrusion welders.

Hot Wedge and Combi-Wedge Welding Processes

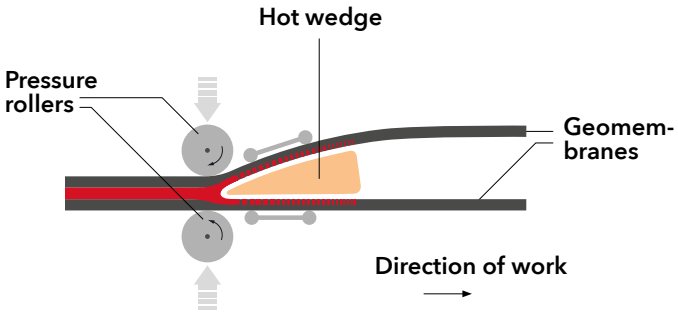
For the professional welding of plastic liners (geomembranes), special emphasis must be placed on the welding technique. This involves melting the plastic surfaces of the sealing sheet in the joining area with the right amount of energy up to the required plasticizing temperature and joining them with the correct joining force. Modern, high-quality welding machines perform these main tasks largely automatically and offer great ease of use.

Caution is advised with inexpensive welding machines: Their temperature control is often inadequate or fluctuates massively. This has a negative effect on weld quality. If temperatures are too low, the welding result is often inadequate.

Excessive temperatures can damage the sealing sheet. In many cases, the damage caused cannot be seen with the naked eye. For example, the expansion properties of the geomembranes are lost or antioxidants are destroyed, which has a negative effect on UV stability and therefore material durability. Both of these things can lead to failure directly next to the weld seam. Refurbishing fully installed structures is time-consuming and expensive. It is therefore advisable to work with welding machines that have precise temperature control (known as closed-loop technology), sufficient power reserves and meet the generally applicable safety requirements.

Hot Wedge Technology

With hot wedge technology, the plastic membrane is pressed against the surface of the hot wedge. The physical contact transfers the heat energy into the membrane, causing it to plasticize. Hot wedge technology is very efficient for welding HDPE.



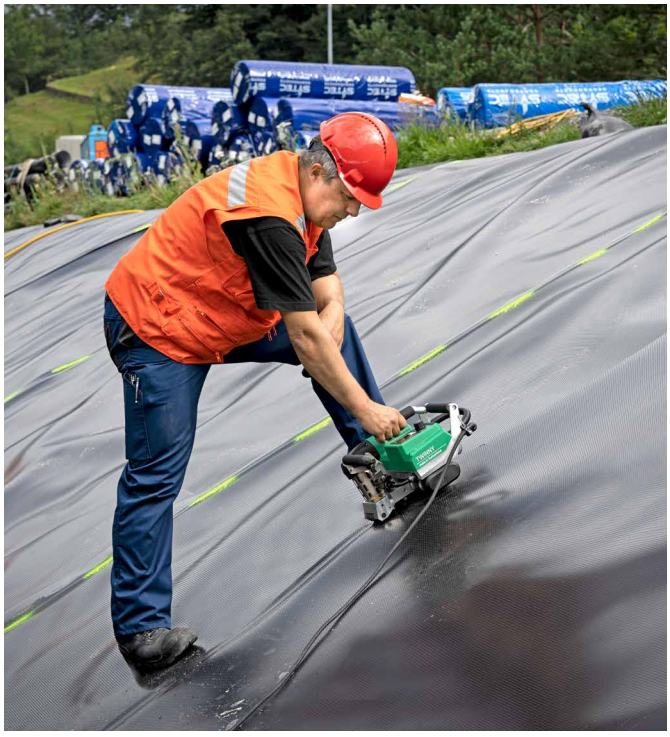
Hot wedge welding principle diagram



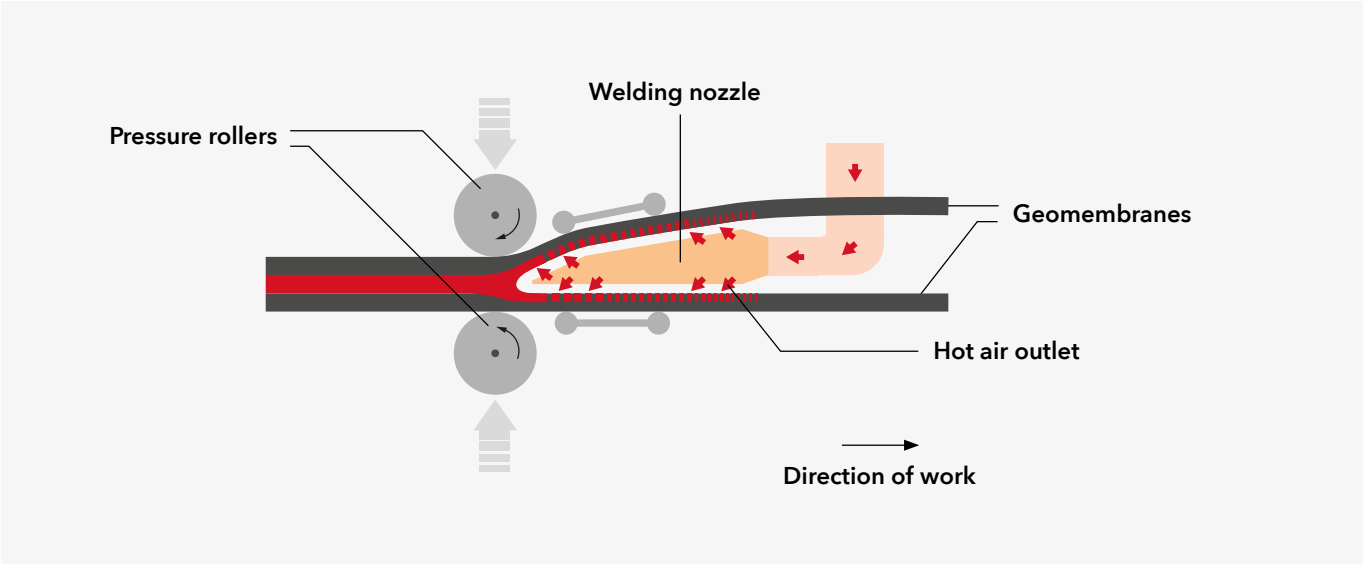
Hot wedge welding with the COMET 700 automatic welding machine from Leister

Combined Wedge Technology

Combined wedge welding machines are available on the market as an alternative to hot wedge welding machines. In combined wedge welding machines, the energy is introduced into the material via a combination of hot air and physical contact with the wedge surface. Hot air also has the advantage of drying out residual moisture and blowing away any dust. Combined wedge welding machines can weld HDPE, LDPE and PVC materials without changing configuration. This makes them all-round welding machines with a wide range of applications.



Combined wedge welding with the automatic welding machine TWINNY T7 from Leister



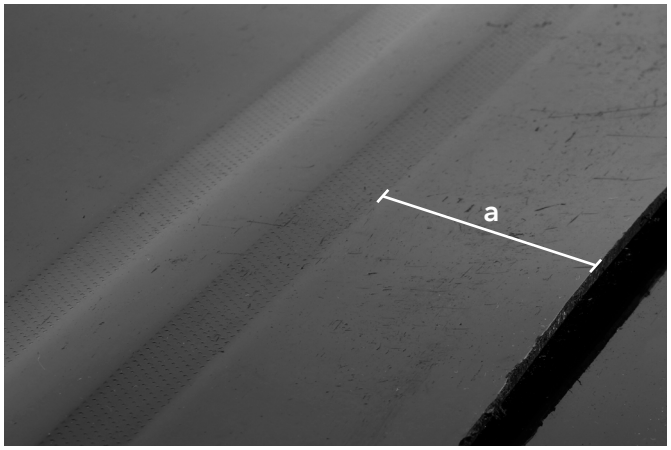
Combi-wedge welding principle diagram

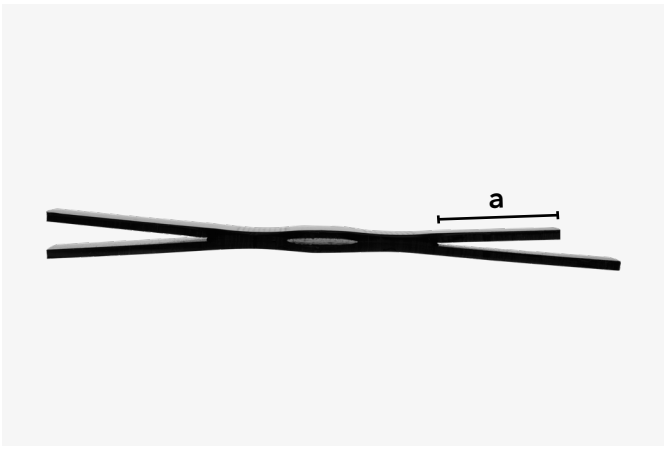
The following points must be observed for hot wedge and combined wedge welding:

- Only weld materials of the same type together
- Only weld dry, clean surfaces
- Do not use chemicals to clean the joining area
- Welding parameters (temperature, speed and joining force) must match the material, ambient conditions (ambient temperature, solar radiation, wind, etc.) and meet applicable standards
- Always carry out test welds, check welding results and note welding parameters

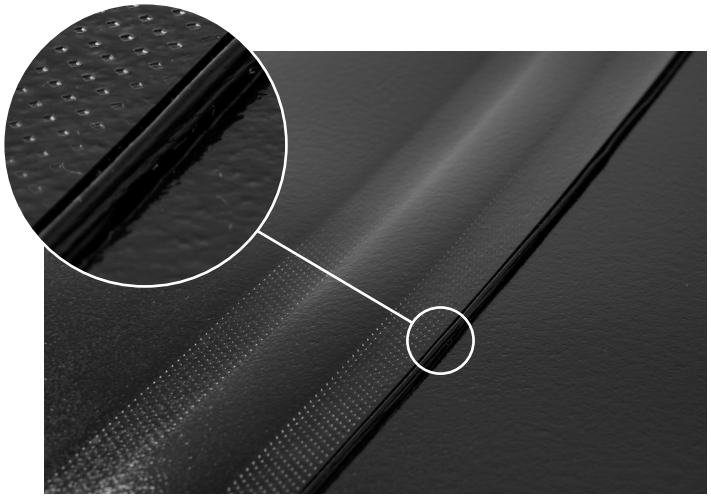
Zero overlap welding

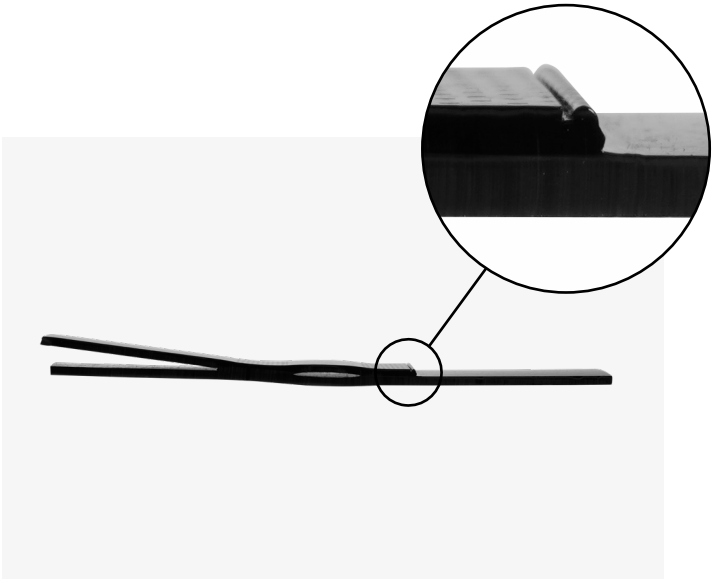
Whether hot wedge or combined wedge technology, welding geomembranes for the construction of aquaculture ponds presents an additional challenge: the weld seam geometry: No protruding edges are wanted on the side filled with water (surface) due to unwelded edge zones, where dirt could accumulate. This means that the membrane must be completely welded on without any protruding flaps. This can be achieved with an additional extrusion weld. However, using an automatic welding machine with a suitable material guide (stop) is more efficient. This material guide makes it possible to automatically produce a precise seam geometry. Reworking with extrusion welding is no longer necessary.





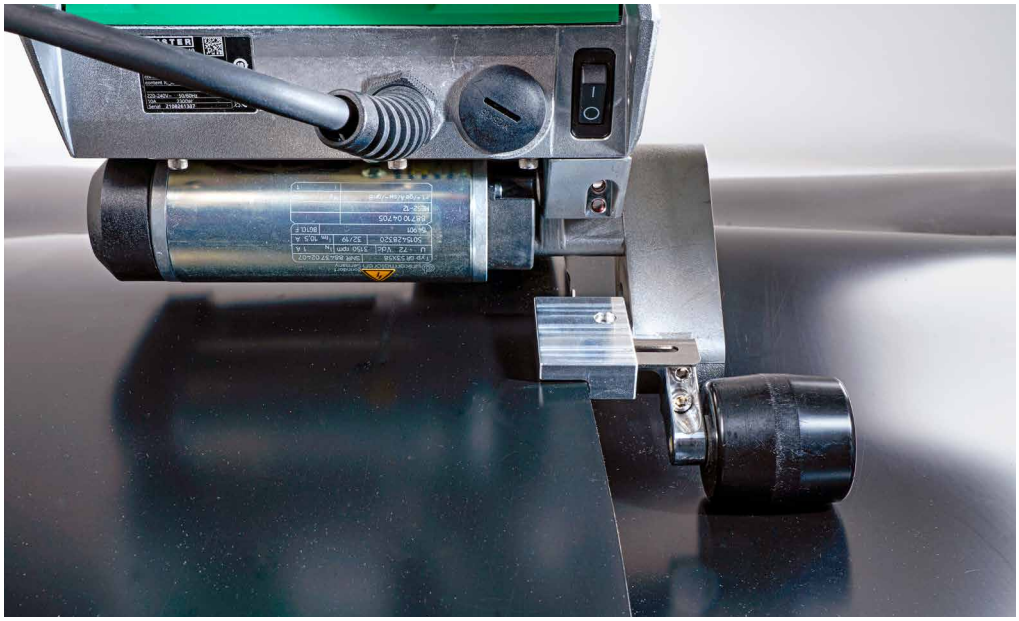
Cross-section of a regular overlap weld with test channel



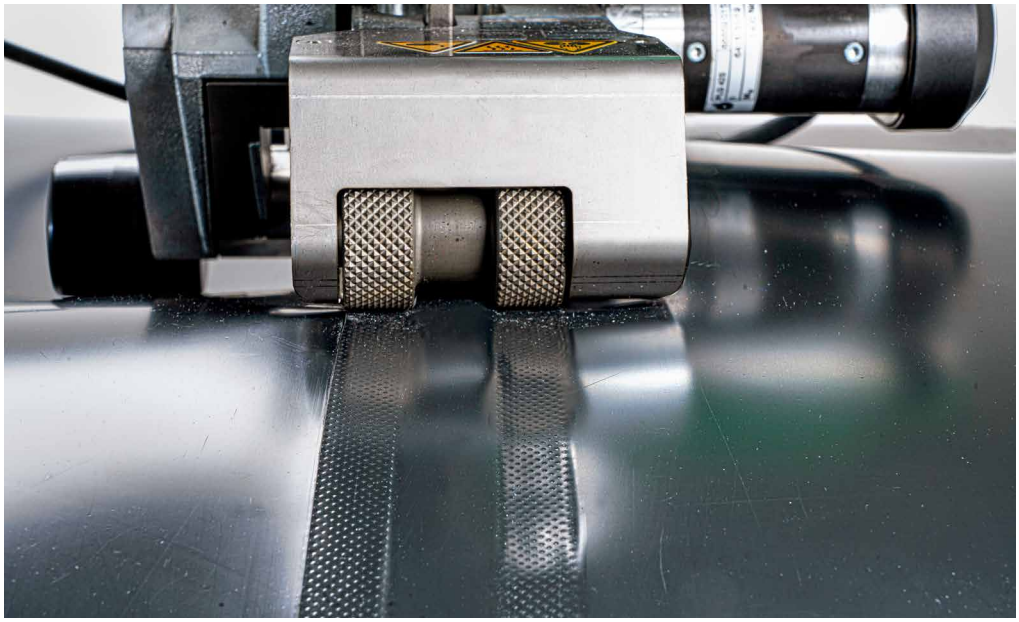


Cross-section of an overlap weld seam with test channel, welded with the zero overlap guide

The additional guide can be fitted to the welding machine in just a few simple actions. This practical material guide ensures automatic welding of the geomembrane without protruding flaps.

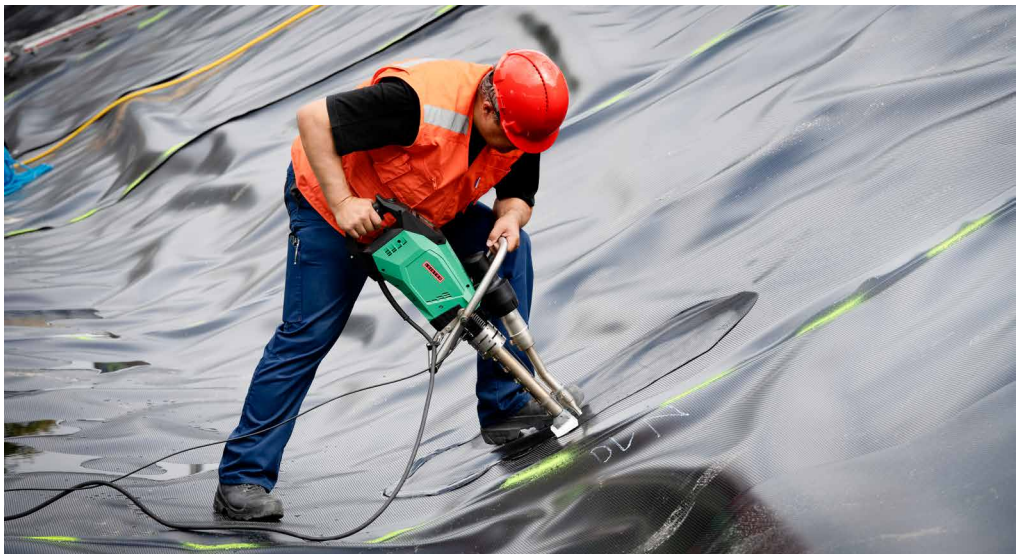


Welding machine with mounted zero overlap guide and fixed geomembrane



Welding result with zero overlap guide

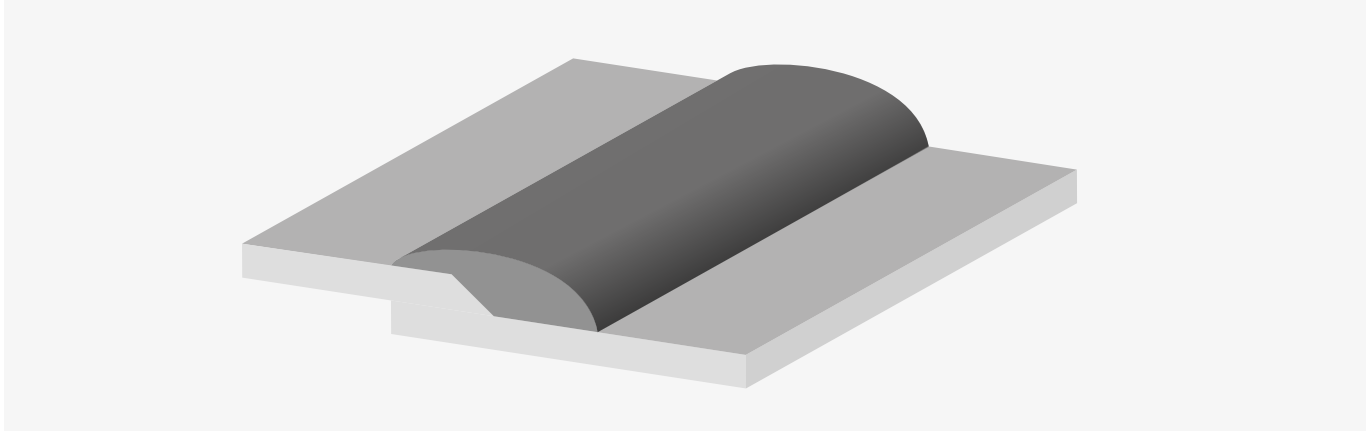
Extrusion Welding



Extrusion welding of an HDPE sealing sheet with the WELDPLAST 605 extruder from Leister

Hand extruders are used for detailed work and where it is not possible to work with hot wedge welders for reasons of space or due to limited technical possibilities. This welding process is defined as hot gas extrusion welding and the geometry of the weld seam as an application seam.

Hand extruders require a material additive, known as welding rod, which is drawn in by the device, plasticized and pressed out as a malleable mass. The seam geometry is determined through the selection of the welding shoe (usually made of Teflon®). To ensure that the plasticized plastic compound bonds permanently with the plastic liners, the surfaces of the sealing sheets to be joined must be heated with hot air. This is how the outer layers of the plastic membranes are plasticized.



Cross-section of an extrusion application seam

The following work is typically performed with hand extruders:

- Patching holes and leaking T-joints
- Welding pipe connections
- Welding corner joints
- Welding connections or joints to existing structures

The following points should be considered when choosing a hand extruder:

Output volume

Typically, extruders with an output of 2–3 kg/h are used for detailed work. Extruders with an output of 3–6 kg/h are used for larger projects or longer welding seams.

Welding rod feeder

Extruders are mainly available on the market for processing welding rods with diameters of 3–4 mm or 4–5 mm. Professional extruders have two welding rod feeders: one on the left and one on the right of the machine. This enables comfortable working because the welding rod can be inserted as the skilled worker prefers.

Plasticizing system

There are two different plasticizing system principles available on the market: air-heated extruders and directly heated extruders. With air-heated extruders, the plastic compound is heated via an extrusion screw and an air-heated barrel.
With directly heated extruders, the barrel is heated with a coil heater. Air-heated extruders usually have a simpler design, making them cheaper to purchase. Compared to extruders with separate heating circuits for air and plastic heating, their ease of use is limited.

Preheating system

The preheating system (hot air blower) must generate a sufficiently high air volume so that enough preheating energy is introduced into the plastic liner even at cooler ambient temperatures. Aside from temperature, the amount of air is a decisive factor that significantly affects the welding quality of a weld seam. In order to produce high-quality application seams, a hand extruder should be selected in which both the temperature of the preheating air and the air volume are adjustable.

Drive system

The drive for the extrusion screw is a weak point in many extruders. Commercially available drilling machines are often used as a full drive unit for low-cost extruders. However, these are not designed for the required torques, which is why they often become defective after just a few working hours. Professional extruders have a powerful motor especially developed for the screw drive. Sometimes, brushless drive motors are used, which have been developed for durable, reliable and maintenance-free operation of the extruders.

Temperature control of plastic mass and pre-heating air

The temperatures of the plastic compound and the preheating air must be set by the user and controlled electronically by the hand extruder. Ideally, the hand extruder will have closed loop control for both parameters. This means that temperatures are constantly checked and regulated automatically. This ensures that welding parameters are maintained even if the mains voltage fluctuates.

Electrical safety

Attention must be paid to electrical safety. Double-insulated hand extruders offer users extra safety, as they do not require a protective conductor (earth conductor) due to their double insulation. With extruders that require an earth connection, it must always be ensured that this connection is guaranteed along the entire connecting cable.

Maintenance and service

Hand extruders must be serviced regularly to ensure their operational safety. It is particularly important to ensure that the welding shoe retains the original geometry.

The following points must be observed during extrusion welding:

- The material of the welding rod must be compatible with the material of the plastic liner (geomembrane). To ensure this, it has proven beneficial in practice to purchase both materials from the same manufacturer.
- The welding rods must be stored in a dry and clean place.
- Plastic liners to be welded must also be clean and dry in order to prevent foreign matter in the weld seam and to ensure the seam quality.
- The area to be welded must be well prepared. This means that the geomembranes must be fixed with a hot air blower or a semi-automatic welding machine and their surfaces must be smoothed with a suitable grinder.
- The welding parameters of the hand extruder must be set correctly. To this end, the material properties and ambient conditions must be taken into account.
- Test welds must be carried out. Their results must be checked and documented.
- The hand extruder must be cleaned after welding. Special attention must be paid to the area around the plastic outlet of the welding shoe.

Testing the Weld Seam

When testing the weld seams of geomembranes, a basic distinction is to be made between two test objectives: leak-tightness and seam strength.

Leak-Tightness of the Weld Seam

For the leak test, the test channel of the weld seam (unwelded area between the double seam) is pumped up to the required pressure level with a test needle. The required pressure level depends on the applied test standard. Then for around 10 minutes (depending on the standard), it is observed whether the pressure is maintained or drops. A tight weld seam can only be assumed with sustained pressure. For weld seams without a test channel, for example an extrusion application seam, the leak-tightness is tested using a vacuum testing device. To do this, the area to be tested is sprayed with a solution that forms bubbles.

The vacuum testing device then generates a vacuum. If there is a leak in the sealing sheet or in the weld seam, this is visually recognizable by the formation of bubbles.

Strength Test

For the mechanical strength test, test samples are taken from the weld seam. These are usually punched out at the beginning and end. The test samples (test coupons) have a width of 20 or 25 mm and are tested destructively using an appropriate tensile tester (tensiometer). When removing the test samples, care must be taken to use professional equipment so that the test specimens are punched evenly and symmetrically from the membrane.

Destructive testing with a tensiometer is defined in the standards as a peeling test and shear test. The test looks at the breaking force, elongation and failure behavior.



Strength test of the weld seam quality with the EXAMO 100 tensile tester from Leister

Practical Experience and Recommendations

This section lists practical experience and the resulting recommendations for the construction of land-based aquaculture facilities.

Design of Onshore Aquaculture Facilities

The topographical conditions, construction logistics and the requirements of the future operation must be taken into account when constructing the breeding ponds. In addition, water inflow and outflow possibilities as well as access for construction and ongoing operations (feeding, cleaning, harvesting and maintenance, etc.) must be taken into account. It is advisable to use a central drain. It must be properly planned and installed in advance. An electrical connection is essential in most cases so that the water pumps and aeration systems can work. (Boyd & Ranjan, 2018)

Calculation (Return on Investment)

Before the choice of materials is made, it is essential to take the expected service life into consideration in the calculation.

The rule of thumb for the useful life of onshore aquaculture facilities sealed with geomembranes is as follows: Every tenth of membrane thickness results in a service life of around one year. This leads to an approximate service life of 15 years for waterproofing with a 1.5 mm thick geomembrane.

However, this rule does not apply to thin, homogeneous membranes less than 0.7 mm thick. Due to their lower puncture resistance, they often break after just a few breeding phases. The puncture resistance of HDPE increases with higher material thickness. (Shehane, 2017)

"The puncture resistance of a plastic sheet is the force that plastic sheets can withstand without failure when applied to it by an external hemispherical penetrator." (Presto Testing Instruments, 2020)

Choice of Materials

It is advisable to select materials based on expected service life. Geomembranes for aquaculture should be made of pure plastic, without recycled content (planetliner.com, 2021)

As geomembranes may be exposed to sunlight throughout their lifetime, adequate UV protection is essential. (earthshields.com, 2022)

Reputable geomembrane suppliers will provide corresponding data sheets and certificates on request. It is recommended to request these.

Transportation and Storage

Great attention must be paid to the transportation and storage of geomembranes. It must be ensured that geomembranes arrive at the construction site without mechanical or chemical damage. In addition, a suitable place must be arranged in advance for storage at the construction site in order to prevent subsequent damage caused by transportation on site.

Preparing the Construction Site

Proper preparation is required so that the breeding pond or tank can be completely lined with geomembranes. The substrate should be dry, compact and smooth. This means free of coarse roots, stones and sharp objects. This is the only way to ensure that geomembranes are not damaged during installation. (Boyd & Ranjan, 2018)

Installation

The geomembranes must be rolled out and cut to size using suitable methods. This work should only be carried out in favorable weather conditions. This means no precipitation and little wind. In addition, the geomembranes should not be scratched or soiled during the process, as this will reduce their service life. After rolling out, the geomembranes must be weighed down with sandbags or similar so that they do not blow away.

Residual material left over from cutting the geomembranes to size can be used for later repairs. It is therefore advisable to keep leftover material.

Welding the Geomembranes

As previously mentioned, only dry and clean membranes may be welded. Make sure that the membranes are dry on both sides. If the temperature falls below the dew point, the membranes may also get wet on the underside. Important: Before starting the final welds, test welds must always be carried out to determine the correct welding parameters. This is the only way to ensure the quality of the weld seam.

It is also recommended to use high-quality welding machines, hand extruders and hot air blowers to weld the geomembranes in a professional and expert manner. This investment is worthwhile if the aquaculture facility is to achieve its predicted service life without expensive repairs.

Onshore Aquaculture Maintenance

Onshore aquaculture facilities must be monitored sporadically throughout their operating life. Potential damage to the geomembranes must be repaired between breeding phases to prevent consequential damage. It is therefore an advantage if trained specialist staff and the necessary welding equipment (hand extruders and hot air blowers) are available on site.

4. Conclusion

Around the world, we are seeing a shift from earth basins to onshore aquaculture facilities sealed with plastic membranes. The reasons for this are clear: As explained in this white paper, professional sealing with geomembranes can improve both quality standards and breeding results.

There are various manufacturers of membranes and welding equipment on the market. Their products are not always of the required quality, however. The following points must be taken into account to ensure that investments pay off:

- Use high-quality geomembranes that retain their properties when exposed to UV rays and demonstrate sufficient mechanical resistance.
- The minimum thickness of the geomembranes is 0.75 mm. To ensure a long service life of the aquaculture facility, it is recommended to use geomembranes with a thickness of 1.0 mm to 1.5 mm. These are more resistant to mechanical influences and sunlight.
- Modern welding machines, hand extruders and hot air blowers are used for professional welding of plastic liners. They have the necessary technical properties to ensure adherence to the welding parameters so that the weld seams meet the required quality in the long term.
- Before welding the geomembranes, test welds must be carried out (directly on site) so that the appropriate welding parameters and device settings can be defined.
- After welding, the weld seam must be checked for leaks and mechanical strength using professional equipment.
- The welding equipment must be cleaned daily, and serviced and checked periodically.

In order to remain successful as an operator and producer of land-based aquaculture facilities, it is essential to pay attention to these points. This is because the quality of the geomembranes, the welding equipment and the welding work plays a decisive role in the service life and yield of onshore aquacultures.

The investment in high-quality material and welding equipment is worthwhile because the growing global demand for fish and crustacean products and increasing quality requirements mean that new onshore aquaculture facilities, professionally sealed with geomembranes, are being created worldwide.

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