Slurry Ice:
The Icelandic Solution

Fish of all sizes fit well in the Icelandic containers, with minimal bruising during unloading, which has been streamlined as well.

Photo courtesy of Sæplast

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By changing the way fish was stored and chilled onboard Icelandic fishing vessels the work of the local fishermen became a great deal easier and the industry as a whole could sell Icelandic fish at much higher prices.

It isn't widely known outside Iceland – your average Icelander might not even be aware of the fact – but this small nation of fishermen catches around half as much groundfish today as it did some 30 years ago. Meanwhile, the income of the country's seafood industry has doubled. "Effectively we create four times as much value as we used to from each kilogram of cod," says Mr. Sigurjon Arason, a professor at the University of Iceland and the chief engineer of Matis – the Icelandic Food and Biotechnology Research Institute.

Sigurjon (Icelanders always prefer if you use their first name) is one of the people who have been at the forefront of developing methods for improving the quality of Icelandic seafood. He recalls having to negotiate with his wife to let him spend his weekends in the small fishing villages and towns scattered around the island, where he would give fishermen and seafood plant workers seminars on how to properly handle the fish, and how to make sure that bleeding and chilling was done correctly.

As it turns out Sigurjon's seminars would also help to improve morale. "The fishermen and the workers at the seafood plants would sometimes be at each other's throats about the condition of the fish when it reached the processing stage," he says. "After a bit of listening and learning all misunderstandings would be resolved and they would become friends again."

Fish Was "Just Fish"

Sigurjon, who is now in his late 60s, first joined the crew of a fishing vessel at the age of 16. He would continue to work as a fisherman during the summer months to support himself through his studies in biochemistry during the winter. From his own experience he estimates that the methods used by US vessels are around 40 years behind the methods used in Iceland: "In the hold we would pile the fish into compartments that were about 60 cm (2 feet) deep. There I would have to put on waders and stand knee-deep in fish and ice. The ice was shovelled by hand and when moving the fish from the ship to the dock a crane would lower a metallic crate of sorts into the hold, where we would remove dividers to allow the fish to slide into the crate. I remember kicking the fish around, to get it out of the compartment," says Sigurjon. "Of course this meant that the fish would be bruised and battered, and nothing like the product we sell today. We had a very different attitude back then – that meat was food, and that fish was just fish. Of course we don't see things that way anymore. Now we know that high-quality fish is just about the best food you can get."

Product Made Better

Mr. Ragnar Konradsson has a similar story to tell. Ragnar is now in his late 50s, and captain of the ship ***Orvar SH*** which has its home port in the village of Rif (population 544), on one of Iceland's westernmost peninsulas.

He became a fisherman at the age of 15, following in the footsteps of his father and grandfather. "I have even been told that my great-grandmother was the captain of a small vessel," says Ragnar.

For Ragnar, new methods and technology on-board meant that life got a lot easier for him and his crew. "When I started we would hardly chill the fish and what we caught could barely be used by the processing plants. To compare our fish today with our fish back then is like comparing black and white."

Ragnar and his crew of 14 men are usually at sea for 3 to 4 days at a time and their catch averages from 60 to 80 tons. Like on all Icelandic fishing vessels they use plastic containers to store the catch and liquid ice to chill the fish. "We have a liquid ice machine from Icelandic manufacturer KAPP that takes seawater and cools it down to freezing temperature, allowing

Instead of having to shovel ice, Icelandic fishermen can apply slurry ice through a hose, and spread it over the fish. Photos courtesy of KAPP

us also to control the consistency of the slurry. We no longer have to bring a supply of ice out to sea, and instead of having to shovel ice we can apply the slurry through a hose, and spread it over the fish. This – along with other machinery we use on board – has transformed how we work on board and made life a lot easier for everybody while at the same time allowing us to deliver a much better product."

The Birth of the Container

Sigurjon explains how the industry improved step by step: First the vessels went from using compartments with dividers to putting the fish in single-walled plastic boxes. "These would come in two sizes; 50 litres and 90 litres (13 to 24 gallons) and the larger box would hold around 50 to 60 kilograms of fish (110 to 130 lbs.)," says Sigurjon. "The problem was that even the larger boxes weren't long enough to fit a properly sized cod. Not to mention the hard work that came with filling each box with fish and ice, piling up boxes in the hold, and then eventually having to empty the hold by hand."

Seeing that there was room for improvement, the head of the Icelandic Fisheries Laboratories (now a part of Matis), got Sigurjon and specialists from companies like the manufacturer Saeplast, to find a better solution. "We thought of making the boxes longer, or making a larger box out of four smaller ones, and what we came up with were the plastic containers [also referred to as totes, tubs or bins]," explains Sigurjon. "One problem we wanted to solve right at the outset was how to drain the containers. The box-system had the added flaw of having water and blood leak from the top boxes onto the ones underneath. So what we did was to put a hole with a plug on the bottom of one of the sides of the plastic container. Also, to facilitate loading and unloading each of the four corners of the container would have a gap to attach a lifting hook."

Fish of all sizes could fit quite comfortably in the new containers, there would be minimal bruising during unloading and the work of the crew became easier. "While you would previously need around eight men working eight hours to unload 100 tons of fish when using boxes, the new containers would cut the work down to just two hours and could be handled by three or four men."

Development didn't stop there and the industry would later switch to shallower containers, 40 cm (16 inches) rather than 60 cm (24 inches) deep. "The area of the containers remained the same, or 1.03 by 1.23 meters (around 40.5 by 48.5 inches), which meant easy stacking in cargo containers when needed," says Sigurjon and adds that with this change there was less weight resting on the bottom-most fish in each container, resulting in even less bruising and better water retention:
"What we have to bear in mind is that the flesh of the fish – the muscle – is very different from the meat we would get from cattle or sheep. In the sea the density of the muscle of the fish is the same as the density of his environment, so it doesn't need the same structure and the same amount of the fibrous protein collagen. Meanwhile farm animals require about 40 times the amount of collagen just so that the muscle doesn't fall of the bone. It's because of the absence of these fibrous proteins that we have to handle fish very carefully – and also why we often have to find a comfortable sofa to lie down and digest a serving of beef, while we still feel light on our feet after a plate full of fish."

From By-Products to Medical Products

The improvements didn't stop with the new containers. Some 20 to 25 years ago Icelandic fishermen started to pre-chill the fish before placing it in the hold. They would put the fish in Saeplast-type containers filled with KAPP-type slurry ice and seawater. There the fish would bleed and cool very quickly before being placed in a second container with other fish, to be stored in the hold, usually with thin layers of liquid ice. According to Sigurjon this meant that the total ice content of each container went from around 30 percent to just 10 percent.

This was possible due to the superior thermal insulation of the containers, when compared to the single-walled boxes used previously. With an insulation value (R-value) as much as three times higher than that of single-walled boxes – and five times high-

er if a lid was added – the catch could be kept at optimal freshfish temperature until the moment of processing.

Now all the pieces were in place, and with insulated plastic containers and liquid ice technology from companies like Saeplast and KAPP, Iceland's seafood industry was ready to take a giant leap forward. "Having the fish in containers meant we could better track when and where the fish was caught and monitor how both the quality of the product and the market price would correlate with improved freshness. The fleet quickly shifted from being at sea for 10-12 days down to around 4-5 days to have a fresher product to sell," explains Sigurjon. "And with almost every part of the fish reaching the factories, we could develop new products like dried fish-heads for the Nigerian market."

The focus also shifted to turning each fish into various different products:
chilled high-end loins would be sent by air to European and American markets, while the rest of the fish might be sold as single frozen fillets ideal for restaurants and ready-made meals. "With the ships delivering fish of the highest quality to the factories came the opportunity to further automate the processing, e.g. by using water jet cutters combined with cameras and artificial intelligence to extract as much value as possible out of each fillet," says Sigurjon. "The quality of the by-products also improved, which meant better raw material for cod-liver oil production and smoked cod liver. In recent years biotech start-ups have even begun using by-products from the fishing industry to make medical products and food supplements which they sell to some of the world's most demanding customers."

Fish are placed in containers filled with slurry ice and seawater where they bleed and cool very quickly before being placed in a second container with other fish and thin layers of liquid ice. Photo courtesy of KAPP.

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Containing Quality

From The Sea to The Consumer

Harvest fresh from the sea and place into a Sæplast container with slurry ice will optimize the quality of your catch

Photo courtesy of Sæplast

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Icelandic Processing Technology
Adds Days to the Shelf Life

"THE FIRST FIFTEEN MINUTES AFTER THE FISH IS OUT OF THE SEA are crucial to the quality of our product," says Sveinn Ari Gudjonsson. He is in charge of salted products at Visir hf., in the town of Grindavik in south-west Iceland, just a ten minute drive from the famed Blue Lagoon.

Visir employs technology to improve Icelandic seafood products. In their fish processing facilities they use artificial intelligence, coupled with cameras and X-ray machines, to guide a precise system of water jet cutters that remove bones and cut the fish into the desired portions. Visir even goes so far as to recycle the leftover salt from their salt cod production, cleaning the used salt

in a purpose-built tumbler and then selling it to the local authorities for removing ice from roads in the winter months.

A Better Looking Product

Visir employs around 300 people, owns five line trawlers and operates two fish processing plants; one for salted fish and the other for chilled and frozen products. Salt cod – bacalao as it's called in Spain – makes up around 40 percent of Visir's sales and Sveinn explains how crucial it is for the company that the fish is handled correctly from start to finish:

"On the processing deck we gut the fish and simultaneously let it bleed and chill, and finally place the catch in plastic containers where we spray the fish with a layer of slurry ice," he says. "This, along with the fact that we use a line rather than a net, means that we don't bruise the fish so the flesh will have a nice and bright color."

It is this appetizing color that the discerning bacalaobuyer is looking for. "There are certain parts of Spain, Italy and Greece where we have very demanding customers who are happy to pay a premium for superior quality bacalao. In these places the fishmonger will often take out a wooden crate of ours, filled with 25 kg (55 lbs) of salt cod, remove the lid and simply leave standing on his counter – allowing the customer to scan for the best looking pieces."

Consistent Quality

Sveinn notes that not only does the technology used on-board help Visir make a more valuable product, but the crew's work becomes considerably easier. Sveinn, who has worked in the fish industry all his life, knows first-hand how much more convenient it is to rely on the slurry-ice. Instead of having to bring flake-ice on-board, needing to shovel it by hand and break the ice into smaller pieces, a member of the crew only has to flip a switch and spray the slurry-ice through a hose.

But most important of all is that proper chilling, storing and transporting, using slurry-ice and plastic containers, allows Visir to supply Europe's most demanding chefs and supermarkets with an outstanding product: "In my opinion, it gives the Icelandic seafood industry a competitive edge. In the case of Visir this means we control exactly how the fish is handled every step of the way, from how it is caught, bled, chilled, processed and delivered."

A Longer Shelf Life

For Olafur Rognvaldsson, quickly chilling the fish For Olafur Rognvaldsson, quickly chilling the fish means that his products will not only be of a superior quality but also have a much longer shelf life. This allows him to send chilled fish to the European market by sea, rather than by air, resulting in considerable savings without sacrificing the freshness of the product.

Olafur is the CEO of Hradfrystihus Hellissands hf. (HH) in the town of Hellissandur in Iceland's Western Region. Each year the company processes around 5,000 tons of fish, mostly cod but some haddock as well, employing around 50 people on land and 28 on two longliners.

HH's main market is the UK, where they sell cod loins and smaller fillets, with Belgium and France also buying some of the company's cod while a portion of the haddock products go to the US.

"Our chilled products go into 3 kg (7 lbs) or 5 kg (11 lbs) boxes made of thick expanded polystyrene, which we then have trucked either to Reykjavik harbor or Keflavik international airport. The frozen products meanwhile are packed in units of 500 kg which we place in a container and ship abroad for further processing," he says.

The chilled fish fetches a far better price than the frozen products, and that's

where Icelandic bleeding, cutting and chilling technology comes into the picture.

"It takes around 2 hours from when the fish is out of the sea, about 7–8 °C (44.5-46.5 °F) warm at the time, until it has been chilled to just below 0 °C (32 °F). The quick cooling results in a chilled product that has a shelf life of around 18 days."

More Flexible Shipping

The resulting improvement in quality allows HH to charge a higher price for its chilled products, and the long shelf life gives both Olafur and his customers more flexibility with regards to how the fish reaches the consumer. "By taking advantage of fast shipping routes connecting us with Europe it takes only a couple of days for our fish to leave our factories and reach European stores with plenty of shelf-life remaining. We can alternate as needed between shipping by air or by sea, and the buyer can decide whether he prefers to get fish sent quickly by air – giving him a couple of extra days to sell the product – or have it sent by sea for added savings and the chance to offer a more competitive price to the consumer," he says and adds that unfortunately the shipping routes to the US are slower so all the Icelandic chilled fish sold there must go by air.

"We are able to sell our product at a premium – though we would always prefer slightly higher prices – but what gives us the most important advantage is that the buyer knows we will consistently provide a quality product with a long shelf life, so he will do business with us before going anywhere else."

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