Membrane Makers

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A master of membranes: No one knows the spinning machine as well as Peter Aigner. He makes sure only top-quality superfine hollow membranes reach the bobbins

There's a long tradition of producing plastic fibers in Upper Austria. In the town of Schörfling, plastic fibers are used to make membranes that could revolutionize natural gas purification worldwide

Sometimes the pace of progress can be slow. A machine is winding a bunch of fibers in a criss-cross pattern, layer by layer, onto a meter-long coil that is rotating slowly and serenely. Buzzing in a steady rhythm, the spindle moves back and forth again and again along the entire length of the winding machine—until a huge golden plaited braid eventually becomes visible.

Peter Aigner was initially annoyed by the machine's sluggish pace. "The lethargy of the process was the biggest challenge for me," he says. Aigner is a shift foreman at the Evonik plant in the town of Schörfling in Austria. After working for thirty-four years as a chemical process engineer, he's become accustomed to much faster speeds. Here on the shores of Lake Atter in Upper Austria, factories have been spinning plastics into fibers for almost a century—viscose in the early days, polyimide today. Normally, the threads run off the machine at a much faster pace.

However, these are not "normal" fibers like those that are used for functional clothing, bedding, tea bags or baby wipes. In this factory hall in the middle of a small industrial park, the machines are producing hollow fibers—ultrafine structures similar to macaroni, whose interiors can barely be seen by the naked eye. Each of these fibers can separate two gases from each other by enabling one to diffuse into the fiber's interior and leaving the other one outside. Under the brand name Sepuran, these plastic straws are packed into thick bunches and built into steel tubes to serve as high-performance filters for the chemical industry and biogas plants. In its most recently developed func- →

tion, Sepuran is used to purify natural gas, which often contains a large proportion of CO_2 when it emerges from the earth. If the natural gas were used in its unfiltered form, it would quickly erode pipes and connecting pieces.

Visitors who travel from Salzburg to Schörfling during the winter are usually focused on skiing vacations rather than market-leading plastics expertise. Schörfling is not far from the renowned skiing areas Dachstein West and Krippenstein-Obertraun. But the picturesque region around Lake Atter has also been known for decades as a manufacturing center for textile and plastic fibers. The neighboring town of Lenzing is the headquarters of the Lenzing Group, which today is a globally operating company with a rich tradition and from which the Evonik location in Schörfling originated.

Peter Aigner is one of the employees who are responsible for membrane production. This is a job for experts. It's no easy task to perfectly shape liquid plastic

Not losing the thread: Evonik runs a three-shift operation in Schörfling, where Peter Aigner pulls the strings

Gigantic: This machine produces polyimide fibers for the membrane

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VARIANTS of Sepuran membranes are offered by Evonik

"I grew up with polyimides, but what we're producing here is completely different"

PETER AIGNER, MACHINE OPERATOR

into an endless straw with an interior that is slightly porous and an exterior that is a film with precisely defined chemical properties. "I grew up with polyimides, but what we're producing here is completely different," says Aigner.

TURNING TWO INTO ONE

The fibers are extremely delicate, but the machine that creates them seems colossal. The fibers that are now filling the stainless steel coil are flowing out of a gigantic steel construction that's as high as a house and several garages wide. If you approach this structure, climb up one of its steel stairs, and look through the window into its interior, in the entire space you'll see just a few delicate threads being drawn through steaming liquid baths. The threads begin at the other end of the spinning machines, behind a tangle of pipes and cables wrapped in foil. Here you'll find the spinnerets, which extrude a polymer solution as hollow straws.

The starting material is delivered to the factory in two man-sized white plastic tanks from the town of Lenzing, where Evonik produces polyimide. One of the tanks contains the "dope solution," which is gold-colored and as sticky as honey, and the other contains a solvent. Both of these components, the viscous plastic and the volatile solvent, must be brought together in

Control is better: A membrane cartridge is inserted into a pressure tube in order to test its performance

the spinnerets in such a way that they emerge flawlessly and evenly from the ring mold as endless "macaroni." "The external shape isn't the only important feature," says Götz Baumgarten, who is responsible for the membrane business at Evonik. The outer surface of the fiber must also be reliably produced with the desired separating properties. Every single aspect of this machine is a precious trade secret, ranging from the temperature of the water bath to the operating speed and the number of threads that are spun simultaneously.

TACKLING THE NATURAL GAS MARKET

Even though the process itself seems very slow, "our competitors in the gas separation market are amazed by how fast we are," says Baumgarten proudly. He's referring to the speed with which Evonik has established itself in recent years as an important supplier for companies that process nitrogen and biogas—and also to the fact that the company has opened up new areas of application in such a short period of time. Evonik's most recent coup is the use of Sepuran in the processing of natural gas. Here the Group has tackled a conservative market in which there have been no real innovations for a long time. Most of the time, natural gas is purified with the help of nitrogen-based chemicals. This process is expensive, requires intensive maintenance, and is not very environmentally friendly. Today separation membranes still have only a small share of the market, because so far they have not been very efficient or durable. But Baumgarten is confident that many plant operators will switch over to the new material from Austria. The design of the factory in Schörfling enables it to react quickly to increasing demand.

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EMPLOYEES are involved in membrane production

The natural gas business is actually not considered a great opportunity for suppliers. Projects in the sector have lead times of 18 to 24 months, and the suppliers typically fill a huge order and then have no more orders for long time. "Once we've configured the machine, we can produce plastic fibers for months without a break," says Aigner. "We operate 24 hours a day, seven days a week, all year long." The question now is: How can the factory manage to stay in continuous operation? →

Cooperation: Evonik manager Götz Baumgarten (right) developed the Sepuran production process together with Peter Aigner and his colleagues

The answer can be found a few meters behind the winding machine, which shapes the bunches of fibers into natural gas filters. Here there is a second assembly line, in which an apparatus resembling a mill wheel is winding threads onto a polygon with meter-long edges. "This is called a reel or a spool," Aigner explains. Spinning mills have been using such devices for ages to wind yarn and thread into manageable bunches.

A BRAID OR A BUNCH?

At Evonik, such bunches are formed into membranes for biogas, nitrogen or helium, while the braided shape is used only for natural gas membranes. In other words, the factory produces several different kinds of products whose quantities are increased or decreased according to demand. "That's how we can serve various different markets simultaneously and have a continuous production process," says Baumgarten.

Rotation: The fiber bunches are wound onto mandrels

"Every module we make here is as valuable as an expensive watch"

GÖTZ BAUMGARTEN, BUSINESS MANAGER MEMBRANES

The shape in which the fibers are produced—a braid or a bunch—depends on how the gas is supposed to stream through the apparatus. "For the separation of nitrogen or biogas, we feed the gas through the interior of the fiber; in the case of natural gas, we feed the gas along the outside of the fibers," Baumgarten adds. Straight fibers are more suitable for the first type of separation, while wound fibers are better for the second type. The winding ensures that the natural gas flows smoothly. The flow should be just fast enough to allow the carbon dioxide molecules to diffuse through the membrane into the hollow interior of the fibers. During this process, the stream of natural gas becomes ever purer—that is, the concentration of methane increases.

In an adjacent production hall, towering furnaces stand along the walls, ready to provide the fresh bunches of fibers with the necessary finish. The technical term for this is "tempering." This is skilled manual work, just like every other process that takes place as soon as the "harvest" is removed from the spinning machine. Whether the fibers come in a bunch or a braid, shaping them into a membrane module is high-precision work. After all, the final products have to function correctly for many years on production platforms and in refineries.

"Every module we make here is as valuable as an expensive watch," says Baumgarten. The use of workbenches instead of assembly lines makes the work atmosphere in Schörfling seem more like a workshop than a factory. First, the bunches of fibers are neatly cut off. Next, they are closed at each end with a resin plug in a centrifuge.

TESTING UNDER REAL-LIFE CONDITIONS

"Potting" is the name of this process, which is more complex than it seems at first glance. If you've ever cast a leaf or an insect in resin in order to make a transparent paperweight, you probably didn't mind if your creation contained a few air bubbles. They don't keep a paperweight from working. But for a membrane module, every casting must be perfect, every fiber must be well-coated, and impermeability must be guaranteed.

A wide range: Natural gas membranes lie next to membranes for biogas, nitrogen, and noble gases in the distribution warehouse

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DEGREES
is the operating temperature of the Sepuran membranes

At the end at which the CO_2 has to flow out of the interior of the hollow fibers, the resin plug is sawed off in order to expose the open ends of the fibers. Later, a stainless steel cap will enclose this end, where the natural gas that is streaming out will accumulate and be channeled away through a pipe.

After the fiber bunches have been packed into a sheet of black heat-shrink tubing and provided with stainless steel end pieces, the modules have to be individually tested to ensure that they are absolutely flawless. The truth waits behind a roller door, in the shape of a compressed air station that simulates real operation for a period of 20 minutes. If a membrane module does not make a clean enough separation of the compressed air that is injected into it during the test, it will probably fail in real operation as well. A roll container full of rejected membranes standing in front of the door shows that Evonik's claim to excellence is justified.

The prospect that the Sepuran membranes will conquer completely new terrain in the natural gas market, with turnover in the millions and the potential for worldwide application is not causing any anxiety here in Schörfling. Their work goes on, in three daily shifts, and it's concentrated but relaxed. "If you become hectic, you just make things worse," says Aigner. Sometimes a sluggish pace is exactly right.