

HIGH-TECH SEAWATER DESALINATION

WITH MATERIAL FROM THYSSENKRUPP STAINLESS

Clean water thanks to titanium

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Source of life I Drinking water is rare and precious, and demand for it is rising all the time, particularly in the world's arid regions. Using an elaborate process, seawater desalination plants currently produce around 36 million cubic meters of drinking water a day worldwide.



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Titanium is a true all-rounder: only produced commercially since 1938, the metal is not only extremely strong and corrosion-resistant, it is also extremely light and elegant. Titanium has many uses in the aviation, aerospace, automotive, medical, architectural, sports equipment and jewelry sectors. One application which is becoming increasingly important is the use of titanium in seawater desalination plants.

On the next pages, the editorial team of ThyssenKrupp inside Steel describes how titanium tubes can help supply regions plagued or threatened by drought and aridity with adequate amounts of drinking water.



The tsunami in Southeast Asia demonstrated to the world once again at the beginning of this year that drinking water is a scarce and valuable resource. A lack of freshwater inevitably leads to disease, hunger and misery. No water equals no life, it's as simple as that. Today, more than a fifth of the world's population has no access to a proper water supply. According to experts' gloomy forecasts, 20 years from now half of the world's population will suffer from water shortages.

At first sight it's paradoxical: three quarters of the earth is covered by water. In fact the world has enough water, but only a fraction of it is freshwater that people can use for drinking, cooking, brushing their teeth, washing, farm irrigation and in industry. 97.4 percent of the earth's water is saltwater, just 2.6 percent is freshwater – and only 0.3 percent, i.e. a vanishingly small proportion, can be used as drinking water.

Water: rare and precious

So water is already a rare commodity but what makes the situation worse is the fact that water consumption has increased six-fold in the past 70 years, while the world's population has trebled over the same period. In Europe, every one of us consumes approximately 150 liters of drinking water a day – most of it for household and garden use, washing and personal hygiene and only a little of it for eating and drinking – whereas in India per capita consumption is currently 25 liters a day. However, the world's population is growing all the time and demand for water is increasing steadily, particularly in former Second and Third World countries.

The solution: seawater desalination

Regions such as the Middle East and other desert areas have next to no natural reserves of drinking water. What they do have in many cases, however, is plenty of seawater. What could be more logical therefore than to utilize this free resource and convert it into drinking water? This ancient dream of mankind was fulfilled in 1968. Today, there are some 12,000 seawater desalination plants around the world producing 36 million cubic meters of water a day – a significant amount but nowhere near enough. Demand is rising all the time. Over the next four years

Saudi Arabia alone plans to build four new plants with a total capacity of 2.2 million cubic meters a day, at a cost of 6,100 million US dollars.

Growth market with opportunities for tube manufacturers

Seawater desalination is therefore becoming a global challenge – and a significant growth market. It's a market in which two ThyssenKrupp Stainless companies, Titania and Deutsche Titan, based in Essen/Germany and Terni/Italy, are actively participating. They produce thin-walled titanium tubes which help turn saltwater into drinking water by evaporation and condensation.

Here's how it works: a seawater desalination plant consists of a series of chambers housing bundles of heat exchanger tubes. At the beginning of the process, seawater is boiled and the vapor produced is passed through the heat exchanger tubes in the first chamber. Cold seawater is sprayed onto the hot tubes from above. The vapor condenses in the tubes into freshwater which is collected at the ends of the tube bundle. At the same time, part of the cold seawater spray evaporates. This vapor is passed through the tubes in the next chamber, where the process is repeated.

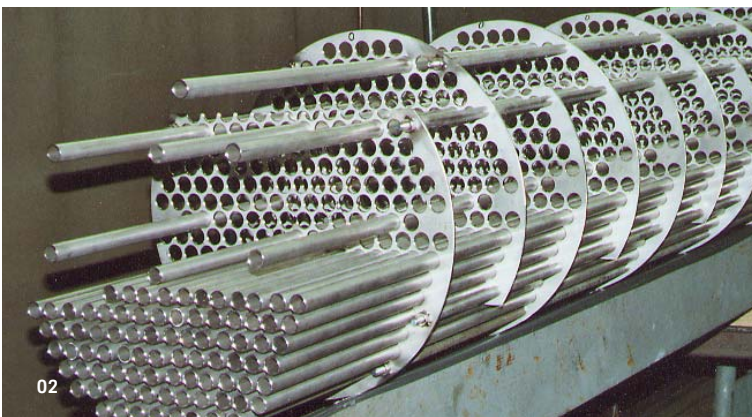
Titanium: top material for tube heat exchangers

"The advantage of titanium is that it is extremely strong and corrosion resistant and can withstand aggressive seawater like no other material," explains Dr. Markus Holz, managing director of the two titanium companies. "As well as that, titanium tubes are more environment-friendly than for example copper-nickel tubes as they do not release any pollutants into the water. This means that the heavy copper pollution that occurs in regions where there are lots of seawater desalination plants can be reduced."

So titanium's stock is rising in the seawater desalination market: "We are currently expanding our tube capacities to meet the challenges of the market over the next ten years," says Titania's head of engineering Dr. Arduino Lannaoli.



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01 Titanium tubes | Titania is expanding its tube capacities to meet the challenges of the market over the next 10 years, adding a third production line to satisfy high demand for titanium tubes.

Photo: **Rainer Kayzers**

02 Tube heat exchangers | Key components in the production of drinking water: high-strength titanium tubes in tube heat exchangers withstand corrosion and extreme temperature loads.

Photo: **Rainer Kayzers**

03 Drinking water production | Seawater desalination plants – such as the one shown here in the United Arab Emirates, Dubai – produce drinking water from saltwater. Tubes made of extremely corrosion resistant titanium play a key role.

Photo: **Fisia**



03



High-tech | Research chief Fabio Guglielmi (left) and Sergio Cervo check the microstructure of the tube welds to ensure they meet the specifications for seawater desalination plants. Photos: **Rainer Kayzers**



Expert discussion | Titanium tubes for seawater desalination plants are a major market success, agree the experts of the Titania Group Dr. Arduino Lannaoli, head of engineering, Dr. Markus Holz, managing director, and Fabio Guglielmi, head of research and development (from left). Last fiscal year, the Titania Group sold 650 tons of tubes; this year sales of 830 tons are expected.

Alongside two existing lines capable of producing 25 meter long tubes of 40 millimeter diameter and 1.7 millimeter wall thickness, the company has recently completed the construction of a further line in Terni/Umbria to meet strong demand for titanium tubes. "Since May we have been using the new line to make tubes with diameters up to 65 millimeters and wall thicknesses of 2 millimeters," explains Fabio Guglielmi, head of research at Titania. "Larger diameters and thinner walls provide greater surface area, allowing desalination plants to process more water and bring it to the required temperature faster to produce more drinking water."

Know-how transfer and value creation in the Group

Titania seems to have backed the right horse: "Last fiscal year we sold 650 tons of tubes – this year we are expecting to sell 700 tons and achieve revenues of 15 million euros," says a delighted sales manager Helmut Jost.

What is particularly pleasing is that a large number of companies from the ThyssenKrupp Group are benefiting from the market success of titanium tubes. "For example, in Korea, where there are a lot of seawater desalination plant manufacturers, we are working closely with our sister company ThyssenKrupp VDM," says Holz. "VDM helped us to develop the market there – a textbook example of know-how transfer."

Numerous Group companies are also involved in the actual production of the tubes – "We utilize our internal value chain to the full," says Holz. Ingot melting is carried out at Deutsche Titan GmbH in Essen, from where the ingots are sent to Società delle Fucine in Terni, Italy for forging into slabs. ThyssenKrupp Acciai Speciali Terni (AST) rolls the slabs into coils and cuts them into 30 to 120 millimeter wide strips on slitting and cut-to-length lines. These strips then return to Titania where they are welded into tubes, packaged and then transported to customers via a direct rail connection. Customers finally fit the tubes locally in their seawater desalination plants.

Titanium: deposits and method of production



Titanium sheet | The coils rolled at ThyssenKrupp Acciai Speciali Terni are cut into 30 to 120 millimeter wide strips at the C.S. Inox service center. The strips are then laser welded into tubes at Titania. Photo: **Rainer Kaysers**



Photo: **Rainer Schröer**

Titanium metal is found in nature only in combined form – most frequently in the mineral ilmenite and the polymorphs of titanium dioxide.

The main deposits are in Australia, South Africa, Scandinavia, North America and Ukraine. The lightweight metal is produced as follows: enriched titanium dioxide, usually from ilmenite, is reacted chemically with chlorine to form titanium tetrachloride. The compound is then reduced with liquid magnesium to form titanium. To produce titanium alloys, which can ultimately be machined, the titanium sponge produced by reduction is remelted in a vacuum arc furnace and alloying elements are added.