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(adapted version of the German original)

Surface treatment technology: Thin insulating layer securely bonded

Plasma Adds Capacity in Gas Tankers

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When two of the world's largest liquefied gas tankers leave on their maiden voyages from Saint Nazaire in northern France in the coming weeks it will be due in part to a major contribution made by the Openair Plasma process. Only with the aid of this atmospheric pressure process developed by the German company Plasmatrete was it possible to ensure the precise bonding of the insulation layer needed in the tanks.



Work on them is proceeding apace. But in just a few weeks the two gigantic ships are due to put to sea for the first time from the "Les Chantiers de l'Atlantique" shipyard in Saint Nazaire in northern France. The "Provalys" and "Gaselys" constructed by the Norwegian shipbuilders Aker Yards are currently numbered among the largest natural gas tankers in the world. They are 300 m long, 42 m wide, 50 m high, their four tanks can carry a cargo of 153,000 m³ of liquefied natural gas (LNG) - and they are being launched with a newly developed insulation technology in their innards. This allows a more space-saving protective curtain between the liquefied gas at -163 °C and the ship's hull than has been possible to date. By suitable choice of materials - polyurethane foam and thin sheeting made of composite material - approximately 8,000 m³ of extra loading capacity is made available by comparison with other ships of the same size,.

As is customary in membrane tankers, these tanks too are encased in a double jacket. On the inside, that is to say in direct contact with the liquefied gas, there is a 0.7 mm thick metal membrane made of invar steel (a special alloy having a low coefficient of thermal expansion). Located behind this is an insulating layer composed of plywood and 10 cm of expanded polyurethane foam. This is followed by a thin "Triplex" sheet employed for the first time to insulate LNG tankers. It consists of two outer layers of glass-fibre reinforced plastic (GRP) and an inner aluminium layer. This composite material forms a second watertight barrier.

Between the Triplex panel and the inner metal hull of the ship there is a further 20 cm thick layer of expanded polyurethane. The insulating composite is adhesively bonded to the inside of the double metal hull. To ensure that the watertight layer provides a really tight seal the joining seams of the composite panels are bonded over with Triplex strips and then coated with a two-pack epoxide adhesive. In each tanker there are about 40 km of panel edges. To be sure of secure bonding the surfaces of the joints must be suitably pretreated. "We tested a number of methods for doing this, but the only really satisfactory results were obtained by pretreating with plasma" Yves Pelpel declared recently during the presentation of the gas tankers to the public in St. Nazaire. According to the Contract Manager from Aker Yards this technology developed in Germany was the only one which met all the



essential environmental, safety and efficiency requirements.

Although plasma technology was employed for the first time on large-area surfaces in the building of the LNG tankers, the process has already long proved to be effective in the cleaning, activation and coating of mouldings and films. "By using plasma, the efficiency of processes, such as the removal of mould release agents from mouldings, has been dramatically increased by comparison with conventional methods", Dipl.-Ing. Christian Buske explained. According to the Managing Director of Plasmatrete GmbH, Steinhagen, other examples of the successful in-line use of Openair Plasma include the removal of layers of organic deposits, stripping varnish and the partial removal of metallised coatings prior to adhesive bonding, the production of vehicle headlights and the treatment of reflectors.

The atmospheric pressure technology, developed by Plasmatrete, was employed for the first time on large-area surfaces in the building of the two LNG tankers owned by the energy supplier Gaz de France. It secured the really tight seal of the 40km insulation joining seams.

In high-technology adhesive joints the process allows precise pretreatment of the surfaces to be joined together and hence the use of modern solvent-free UV adhesives. "For example after suitable pretreatment of the surfaces, polycarbonate display windows can be glued into the half shells of mobile telephone housings by means of solvent-free UV adhesives", Christian Buske explains.

Plasma - the "fourth" state of matter - is matter at a highly unstable energy level. Energy input via the solid, liquid and gaseous states of matter always takes place in the form of heat. However, plasma technology does not stop at the gaseous state of matter: when additional energy is injected into matter by means of an electric discharge the electrons in it are given higher kinetic energy and leave their atomic shells. Free electrons, ions and fragments of molecules are formed. This state, however, can hardly be used under normal atmospheric pressure due to its instability. Only the "Openair" atmospheric pressure plasma process developed and patented by Plasmatrete opened up new possibilities here. By developing and making use of plasma jets success was achieved in applying this hitherto little used state of matter in production processes, even "in-line" in large installations. The jets are operated solely with air, possibly including a desired process gas, and with high voltage.

Depending on the geometry of the jets, the emerging plasma is available for deployment over a working width of up to 50 mm or at a treatment distance of 40 mm. A special feature of the emergent plasma beam is that it is electrically neutral, which greatly extends and simplifies the range of applications in which the process can be employed. Depending on the power supplied and the configuration of the plasma source, the temperature of the emerging plasma can be up to 300 °C. This allows very high handling speeds. Typical levels of heating that surfaces undergo during Openair Plasma treatment are less than 20 °C.

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LNG Market

The term liquefied natural gas (LNG) - the liquid form of natural petroleum gas - works like magic on the booming international energy markets. "By 2010 the volume of LNG traded worldwide will have increased from 190 billion cubic metres in 2005 to about 350 billion cubic metres", opines Harry Roels. According to the Chairman of the Board of RWE, Essen, this corresponds to a growth of between 60 and 80 % within only five years. This growth results from the steeply rising demand for gas worldwide. Thus, the United States Energy Information Administration (EIA) forecasts an average annual growth rate in world gas consumption of around 2.3 % up to 2025. This is distinctly higher than the annual growth rates for petroleum (1.9 %) and coal (2 %). Trade in natural gas is still very much dominated by transport by means of pipelines, nevertheless trade in the raw material in the form of liquefied natural gas using special ships is steadily growing in importance. Especially in the case of relatively great distances - as a rule of thumb a distance of 3,000 km is frequently mentioned - the transport of gas in the form of LNG by ship pays for itself according to an analysis by the Hypo-Vereinsbank of Munich.

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