The background

Industrial development in the Middle East

In the Middle East many new refineries and petrochemical plants are being built close to the Gulf coast and using sea water for cooling purposes. In the past the sea water intake and outfall pipes would be constructed of Glass Reinforced Plastic (GRP) or concrete but more recently engineers are turning to polyolefin materials as they start to realise the considerable benefits from using them. For example, polyolefin pipes are tough and corrosion resistant and able to absorb much higher impact loads without failure and unlike GRP, polyolefin materials are homogeneous and can be fusion welded which produces joints as strong as the pipe itself and well able to resist the axial towing loads during installation and the movements during operation.

The challenge

Producing and welding the large diameter intakes and outfall pipes

Although in Europe, German machine supplier and pipe producer Bauku has manufactured some very large diameter pipes by spiral winding using High Modulus Block Polypropylene (PP-B HM) material, this type of construction had not been previously used in the Middle East. In addition it was decided to butt weld the pipe lengths together to provide the maximum resistance to the load exerted on the pipes during installation and the longest operational life – a process that had not been performed on such thick walled PP-B HM pipes.

New high quality polypropylene pipe systems

The sea water intake and outfall pipes for the Takreer refinery in Abu Dhabi are 3 and 2 metres in diameter respectively and were produced locally by Union Pipes Industry (UPI) using polypropylene material also produced locally in the Borouge Ruwais plant. In the production process the PP-B HM BorECO BA212E material was extruded onto the rotating mandrel to form the basic pipe and to provide extra stiffness a small diameter corrugated PP “core tube” was wound around the outside of the pipe and covered with additional extruded PP-B HM material.

Prior to butt welding the pipes a joint investigation was carried out by UPI and Borouge to establish the optimum welding parameters. Initial trials using the method specified in the German standard DVS 2207-11:1999 and extrapolated jointing parameters recommended for thinner walled pipes did not give satisfactory joints. Results suggested that there was insufficient heat in the joint and therefore it was decided to increase the heater plate temperature to 240°C and at the same time adopt a dual pressure welding regime as used in the UK for welding thick walled PE pressure pipes (refer WIS 4-32-08:1994). The objective of dual pressure welding is to allow allow the molten polymer to cool under minimal shear stress, thus allowing the crystal structure to develop without distortion or orientation. This produced excellent results and was subsequently used for the pipeline construction.

On site the pipes were butt welded together to form 300 metre long sections each terminating in a flange. The externally wrapped “core tube” was then filled with an easy flowing concrete grout to give the pipe
the desired level of negative buoyancy. Each 300 metre section was connected to a large diameter inspection chamber for easy access, which was also produced from PP-B HM material. The long lengths were then transported on rails to the shore line where they were pulled by a tug into the sea supported for the first 500 metres on a raft made of 630mm PE pipes and the finally pulled into a pre-dredged trench in the sea bed. The whole process was designed to minimise the bending loads on the pipe and the pipe joints and progressed steadily without a hitch.

The benefits

The use of corrosion resistant PP-B HM BorECO BA212E material provided many benefits during the construction and operation of these large diameter industrial sea intakes and outfalls. The flexibility of the spiral winding production process enabled the desired stiffness to be engineered into the product in a cost effective way and the pipes were relatively lightweight and easy to handle in the manufacturing and transportation process. Butt welding the pipe lengths together ensured that they could easily handle the axial stresses imposed during installation and provide a durable structure that will provide a long maintenance free operational life.

Summary table

<table>
<thead>
<tr>
<th>Customer Name</th>
<th>Union Pipes Industry</th>
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<tbody>
<tr>
<td>Application/Product</td>
<td>Large diameter sea water intake/outfall pipes</td>
</tr>
<tr>
<td>Grade(s) Used</td>
<td>High Modulus Block Polypropylene (PP-B HM) BorECO™ BA212E</td>
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<tr>
<td>Functional Requirements</td>
<td>• Resists loads applied during installation • Provides a long maintenance free life</td>
</tr>
<tr>
<td>Benefits</td>
<td>• Flexible manufacturing process • Relatively lightweight structure • Welded joints providing high axial strength • Pipe design facilitates simple buoyancy control • Corrosion free in sea water • Long maintenance free life</td>
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