



The Novus Lathe used for the accurate machining of large diameter Camprofile gaskets.

Gasket installation made simple

Method for installing a gasket on a shell and tube heat exchanger without fully extracting the tube bundle

This article describes a novel method of replacing "Shell and Tube" heat exchanger gaskets without the need to fully extract the tube bundle. The method was originally designed for heat exchanger applications on FPSO (Floating Production, Storage and Off loading) vessels and has been successfully applied in this area but its principles are transferable to other areas of petrochemical and chemical production where removing the tube bundle from the exchanger is either impractical or costly.

By Dr. Gavin Smith, Technical Director and Mr. Geoff Booth, Engineering Manager, Novus Sealing Ltd., Cleckheaton, West Yorkshire, UK

1. What is an FPSO?

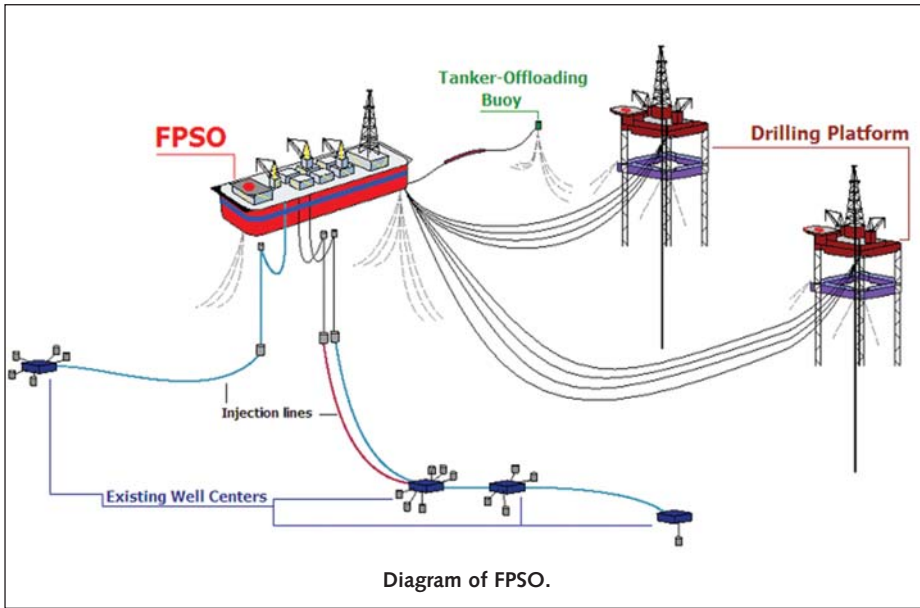
An FPSO vessel is a type of floating tank system used by the offshore and gas industry. It is designed to take oil or gas produced from nearby platforms and process and store it until offloading the oil or gas onto waiting tankers or into a

pipeline. To achieve this function, the vessel carries on board the necessary production and processing facilities normally associated with a fixed oil and gas platform but with the addition of storage tanks for the crude oil recovered from the wells on the seabed below. It is

moored permanently on location and is connected to the wells below by flexible risers.

2. What is the problem?

An FPSO will include facilities for processing crude oil from producing



wells for export, by separating water and gas. The equipment necessary for this operation will likely include a vertical shell and tube heat exchanger. Due to space limitations, removal of the tube bundle to replace the flange joint gasket is both logistically difficult and costly. Failure of the joint can therefore have major consequences to ship production. Traditionally, metal jacketed or spiral wound gaskets have been employed to seal shell and tube heat exchangers on FPSO tankers. In many cases these gaskets have sealed successfully but there have been reports of leakage problems on some FPSOs. While it is difficult to ascertain the exact cause of the failure, it is likely that gasket selection played a part. Metal jacketed gaskets, in particular, are prone to failure by leakage especially where conditions of thermal cycling exist. Following the failure of a metal jacketed gasket on the back face of a shell and tube bundle, the client contacted Novus Sealing to provide a replacement gasket which would meet the following criteria:

1. A long term leak free service life
2. Installation with minimal extraction of the tube bundle (~ 100 mm)

An extensive Research and Development program was undertaken at the Novus Sealing engineering test laboratory to find a solution to this problem.

2.1. Long Term Leak Free Service

A detailed analysis of the application led to the selection of a Camprofile as the

most suitable choice of gasket. Camprofile gaskets consist of a metal core, generally stainless steel, with concentric grooves on either side. A sealing layer, normally graphite, is applied on both sides to provide an excellent seal and to protect the flange surface from damage. Camprofile gaskets have a proven track record in sealing problematic heat exchanger applications throughout the world. The secret of Camprofile success is that the gasket focuses the available bolt load into very small concentrated, areas, forming a labyrinth of high density "gates" that are virtually impenetrable by the media. In order to function correctly, the Camprofile must be precisely machined; failure to do so will result in poor sealing performance and ultimately flange leakage.



Camprofile Core. Graphite is applied on both sides to provide an excellent seal.



The Novus test rig designed to replicate the dimensions of the tube sheet and the restriction caused by the tubes.

Novus Sealing has an unrivalled pedigree in manufacturing Camprofile gaskets that stems from its origins as part of the Hofland Group, the company that developed the modern Camprofile gasket. This foundation has ensured that our engineers have a deep understanding of the design principles and manufacturing requirements and this knowledge assisted the company in meeting the second requirement of the application.

2.2. Minimal extraction of the tube bundle

A test rig was built at Novus Sealing to replicate the dimensions of the tube sheet and the restriction caused by the tubes. The rig is shown in the Figure on the top right of this page and allowed the chosen design to be tested under conditions likely to be encountered in service. A variety of Camprofile designs of different dimensions were trialled but none proved to be successful and it was clear from these initial tests that a standard Camprofile with its relatively rigid core was unable to fit around the tube bundle. A spiral wound gasket was also trialled for the application but, like the standard Camprofile, it proved to be insufficiently flexible to allow the necessary manipulation.



Side view of the test rig.

The results from the initial testing led to work on the modification of the Camprofile core. The core was modified in order to impart sufficient flexibility to allow the necessary manipulation over the tubesheet. A solution was found but it became clear that in manipulating the gasket over the test rig there was a risk of damage to the graphite facing. Following discussion with the client it was agreed to supply a Camprofile core only, with the graphite facing to be applied on site after fitting. A detailed method on how to apply the graphite correctly was supplied in order that the procedure could be employed on site.

The gasket was fitted successfully in 2006 and has remained leak free to date. Another client has also ordered the modified Camprofile design for a similar FPSO application and is awaiting the right time to fit the gasket. In both cases significant cost savings have been identified.

While the method has so far been confined to FPSO applications, there are real advantages for Shell and Tube applications in other areas of petrochemical and chemical production. By allowing a gasket to be fitted with minimal extraction of the tube bundle significant cost savings can be realised.



Geoff Booth (left) and Gavin Smith (right)

About the Authors

Dr. Gavin Smith BSc, PhD

Dr. Gavin Smith was born in Switzerland and grew up in Ilkley, West Yorkshire. He gained a first class honours degree in Metallurgy and completed his PhD on the "Testing of the Percolation Theory of Ferritic Stainless Steel" at UMIST. He then worked for 4 years within the technical department at Corus before being employed as Technical Manager at Klinger Limited. In 2004, Dr. Smith was involved in the purchase of Novus Sealing Limited from the Econosto group and was appointed as the Company's Technical Director, where he oversees all technical activities within the company.

Mr. Geoff Booth MIIIE (Mech)

Following a Mechanical Engineering Technician Apprenticeship at David Brown Gears Ltd in Huddersfield, Geoff joined Flexitallic and worked as Engineering Manager responsible for production engineering, machine building and all technical activities within the company. Geoff joined Econosto as Engineering Manager in 1998 and has been responsible for some of the major developments within the company including the development of the Uniflon restructured PTFE grades. Geoff has worked on sealing problems both on and offshore and has a world wide reputation for the design, manufacture and application of static sealing systems.

About Novus Sealing

Novus Sealing provide a comprehensive range of high quality sealing products to National and International Standards, together with specific customer designs in accordance with the ISO 9001-2000 and ISO 14001-2004. They are the UK's only manufacturer of Compressed Synthetic Fibre Sheet Jointing Materials (Novus Range) and also a manufacturer of restructured PTFE Products (Uniflon Range), Graphite Products, Spiral Wound Gaskets, Camprofiles, Metal Jacketed Gaskets, Ring Type Joints, Soft Cut Gaskets, Flange Insulation Kits, Compression Packings plus many more. They also have in-house Laser and CNC machining facilities. The company has grown rapidly since its inception in 2004 and now has operations in China, Australia, South Africa and of course the UK. Novus Sealing have a global reputation for solving problematic sealing applications