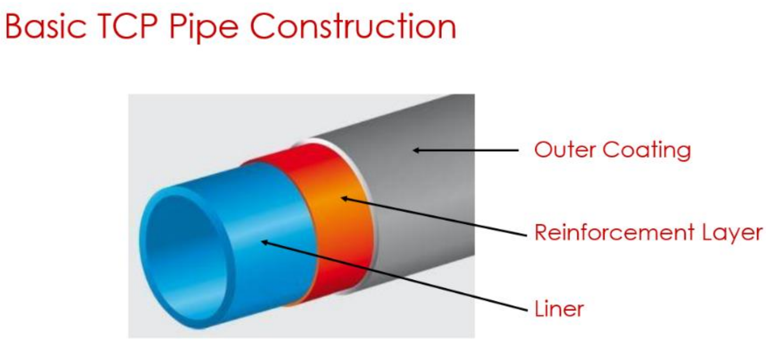
HIVE Composites Ltd
Advanced Technology Innovation Centre
Loughborough University Science & Enterprise Park
5 Oakwood Drive, Loughborough, Leicestershire LE11 3QF
Tel: +44 (0)1509 642600
www.hivecomposites.com

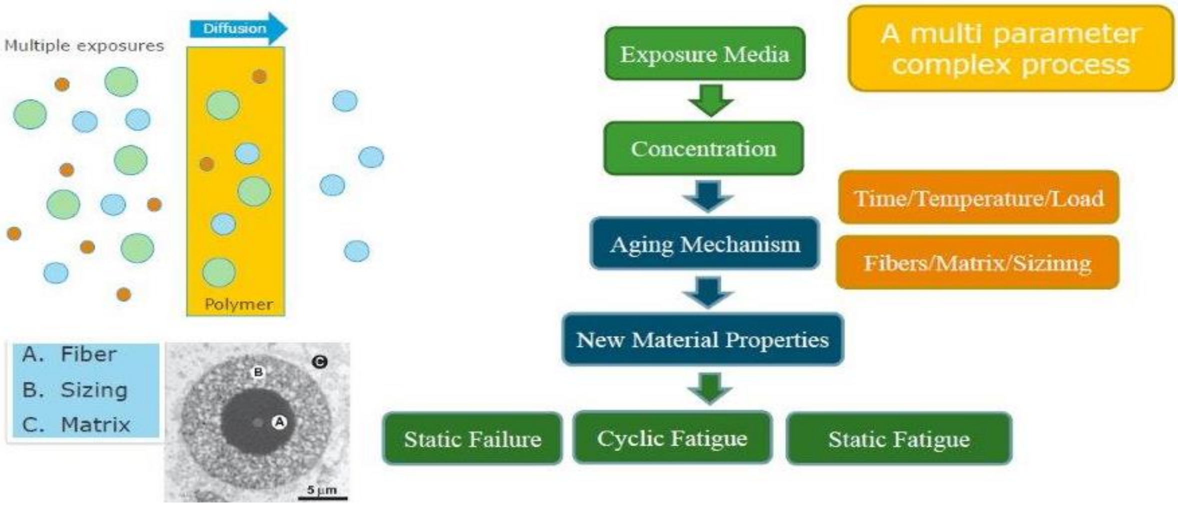
Traditionally, oil and gas pipelines are manufactured from corrosion resistant steel which are manufactured in discreet 12 m lengths that are subsequently welded together to create a continuous pipe. This is a slow process and the alloy is a heavy and expensive steel that still degrades over time.

An alternative thermoplastic composite solution has recently been developed to overcome the issues associated with steel pipelines. These thermoplastic composite pipelines can be manufactured in continuous lengths using an extruded liner to create a barrier to the conveyed fluid which is overwrapped by a pressure resistant glass or carbon fibre reinforced thermoplastic tape, welded to the liner. The pipe is completed with an extruded jacket to create a protective and impervious coating.



The resulting thermoplastic composite pipeline is flexible and can be spooled and onto a tight radius drum, enabling multi-kilometre lengths of pipe to be stored on a single drum. This spooled pipeline can be deployed at a much faster rate than traditionally welded steel pipelines.

Polymer-based materials used in these polymer pipelines do not corrode like steel however they may go through an ageing process that degrades their properties over time due to effects such as plastisization, swelling, leaching of additives, chemical degradation and permeation. These effects can be exacerbated at elevated temperatures.



For composite materials such as those used in the reinforcing tape the ageing is more complex due to the different degradation effects on the reinforcing fibres, the matrix and their interface.
In order to accurately design a thermoplastic composite pipeline structure that is suitable for operation over a number of years it is imperative that we understand the polymer and composite (tape) performance after it has been degraded through environmental and thermal ageing.

We have identified a number of projects to help achieve this, in order of interest:

1. composite mechanical degradation testing (of a number of commercial tapes) after exposure to hot water
2. determination of the degradation mechanisms of the polymer and composite (eg interfacial) after exposure to hot water (and oil?) and their correlation to mechanical properties vis a vis #1.
3. diffusion and degradation modelling through the wall of the pipe (oil/gas inside, water outside)
4. barrier development to improve permeation resistance to production oil and gas from the inside and water from the outside

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Short project descriptions

1. composite mechanical degradation testing (of a number of commercial tapes) after exposure to hot water

The tapes are put under strain (eg 0.1%, 0.5%, 1%) whilst exposed to water in a temperature range (eg 20, 40, 60, 80C but at east 60C) for a period of times such as 0, 1, 5, 10 ,24, 100, 200, 500, 1000, 2000 hours. The exposed tapes should be tested for tensile strength. The data should be analysed on a log scale to determine regressed tape strengths and extrapolated to 10, 20 and 50 yrs.

Anticipated equipment:

- water baths.
- sytem to put tape under strain
- universal test machine (tensile test)

2. determination of the degradation mechanisms of the polymer and composite (eg interfacial) after exposure to hot water (and oil?) and their correlation to mechanical properties vis a vis #1.

The tapes as exposed in #1 above (take sample of same tape prior to mechanical testing) are analysed to determine the degradation mechanisms of environmental exposure with respect to environment (water but maybe also oil??) time, temperature and strain. Determine the mass change, water uptake, and volume change over time. Microstructural and chemical/spectroscopal analysis to evalaute the degardation mechanisms. Attempt to determine the key degradation processes and effects and correlate to the performance as per #1.

Anticipated equipment:

- Microscopy
- Mass balance
- XPS (or other spectroscopic / analytical eqt)

3. diffusion and degradation modelling through the wall of the pipe (oil/gas inside, water outside)

Create a model showing the diffusion (rates) of water from the outside of the pressurised (material under biaxial strain) three layer pipe (and possibly oil {or H2S} from the inside?). Calculate time to saturation. Working with the results of #1 and #2 above, create a degradation model highlighting the effects of diffusion (combined with material degradation #2) and environment on the structural performance (#1) of the pipe. Can the diffusion-based effects be reduced by thickening the walls?

Anticipated equipment:
FE Software

4. barrier development to improve permeation resistance to production oil and gas from the inside and water from the outside

Investigate alternative materials to improve the permeation resistance of the pipes of the diffusion and permeation of water and other chemicals / molecules typically encountered in oil and gas production pipes. Materials can be coated on the surface (eg by vapour deposition) or by inclusion into the manufcaturing process (eg coextrusion). Would the reduced permeation affect the performance of the pipe in operation over time (as per 1-3 above).

Anticipated equipment:
CVD
Extruder
Permeability rig