Market driven materials selection & characterization of thermoplastic flexible riser pipelines used in offshore and subsea applications

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Background

- The most economic oil & gas transportation method rely on pipelines. Thermoplastic Composite Pipelines (TCPs) have emerged as a competitive and recyclable option against metallic pipes for off-shore Carbon Capture and Storage or sequestration (CCS) applications, where CO_2 needs to be transported in supercritical state (over 73 bar and 31°C) to secure geologic sites such as depleted sub-sea oil or gas fields[1].
- To have a chance of finding an alternative cost-competitive TCP solution to TCPs currently rendering service a market driven material selection is needed.
- This work navigates the Technology Readiness level (TRL) scale all the way from TRL1 to TRL5 going through materials selection, manufacturing and proof of concept testing for TCPs compatible with CCS applications manufactured by scalable cylindrical composite manufacturing methods, such as Automated Tape Placement (ATP).

Objectives

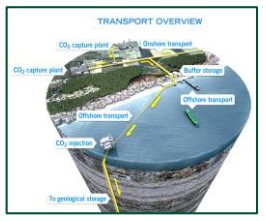
- ✓ To explore cost-effective TCP alternatives for commercial CCS applications.
- ✓ To manufacture and test a TCP proof of concept to assess potential commercialization.

Carbon Capture & Sequestration (CCS) needs potentially cost-effective Thermoplastic Composite Pipelines (TCP) to be market-competitive

Making profit out of not polluting the environment with CO_2 emissions is possible!

Materials & Methods

Materials Combination + ATP manufacturing Tech.



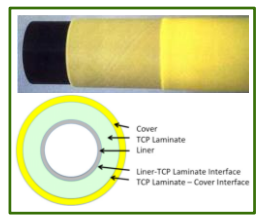


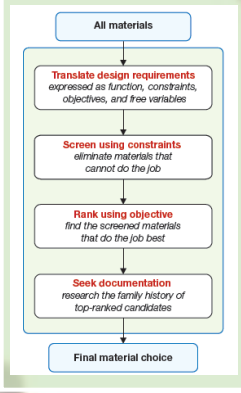
Fig 1. Offshore CO_2 capture, transportation and storage (CCS) transportation concept.[2] (left), and TCP pipeline schematic (right)

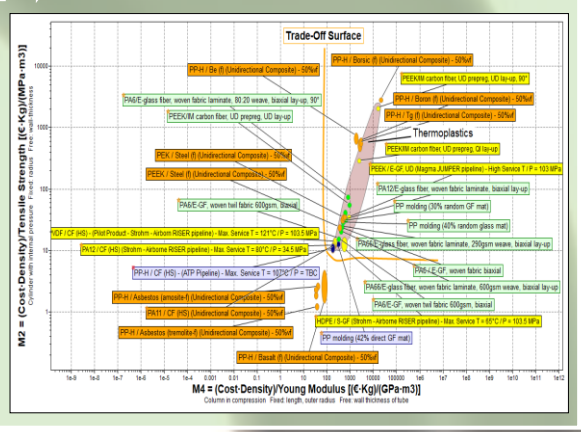
Liner	HDPE
Int. Laminate	CF/PP
Cover	PE-100
Interface	Acrylic Adhesive

Materials Selection

Ashby Methodology → **Example: Ashby selection chart for one loading case of the Int. Laminate layer**

over 4,000 candidates





MANUFACTURING JOURNEY

FAIL IT UNTIL MAKE IT

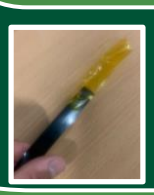
Lack of Adhesion

Adhesion achieved

Last Bonding Strategy: Acrylic Adhesive

1st Bonding Strategy: Compatibility Tape

Cost-Effective Materials Combination



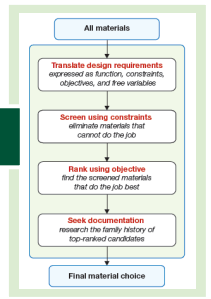
Liner	HDPE
Int. Laminate	CF/PP
Cover	PE-100
Interface	Acrylic Adhesive

Lack of Adhesion

VIABLE DEMONSTRATOR FOR TESTING

Int. Laminate: CF/PP

Materials Selection



Results & Conclusions

- ✓ A cost-effective alternative to commercial TCPs has been found.
- ✓ Further research is needed to enhance liner-to-intermediate layer compatibility and avoid the employment of adhesives.

TCP Layer/Mission	Relevant Result
Inner Liner protecting the intermediate layer from the product being transported	HDPE renders the best permeability performance after the oil & gas benchmark Polyamide (PA)
Reinforced Intermediate Laminate responsible for structural integrity	CF/PP int. laminate & PE-100 cover layers render comparable mechanical properties to materials employed by leading companies in the TCP sector
Outer Cover protecting the intermediate layer from the outer environment	

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