ASSESSING THE COMPATIBILITY OF CURRENT PLASTIC AND ELASTOMERIC MATERIALS USED WITHIN THE AUSTRALIAN GAS PIPELINE NETWORK WITH HYDROGEN-CONTAINING FUEL

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Todays Talk

- Impact of hydrogen on
  - Plastic pipes
    - Testing methods
    - Results
  - Elastomers
    - Testing methods
    - Results
  - Real world testing

Todays Talk

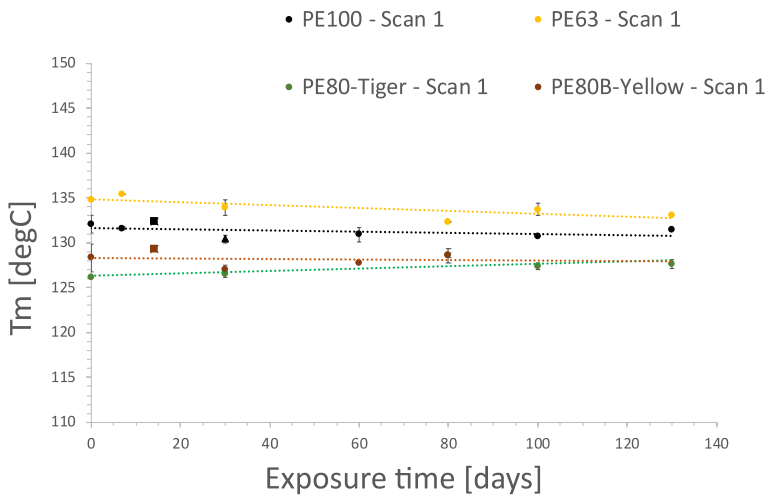
- Plastic Pipes
  - Pipes tested

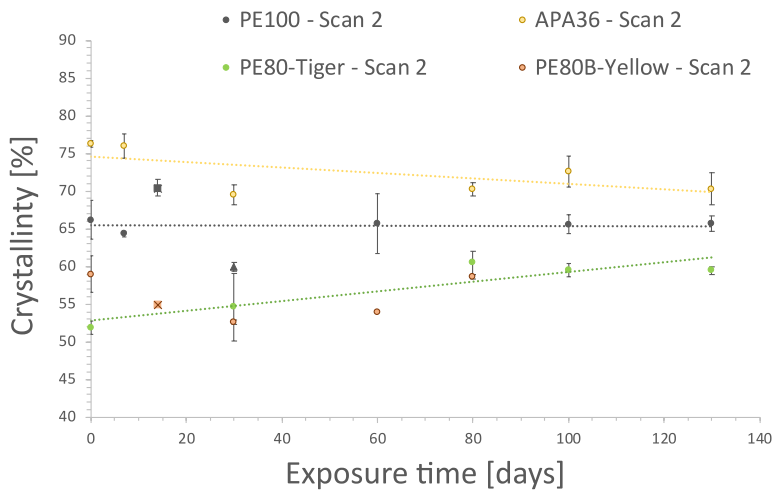
Pipe Type	Name used in Report	Used Y/N	Location (used pipe) / Manuf. Date (unused pipe)
PE63	APA36	Y : installed 1983, removed 2019	Rankine St, Parafield Gardens, SA 5107
PE80B Yellow	PE80B Yellow	N	Manufactured in 2000
PE80 Tiger	PE80 Tiger	N	Manuf. unknown
PE100	PE100	N	Manufactured 2018
PA11	PA11	N	TBC
PA11	PA11used	Y: installed 2017; removed 2018	Unknown

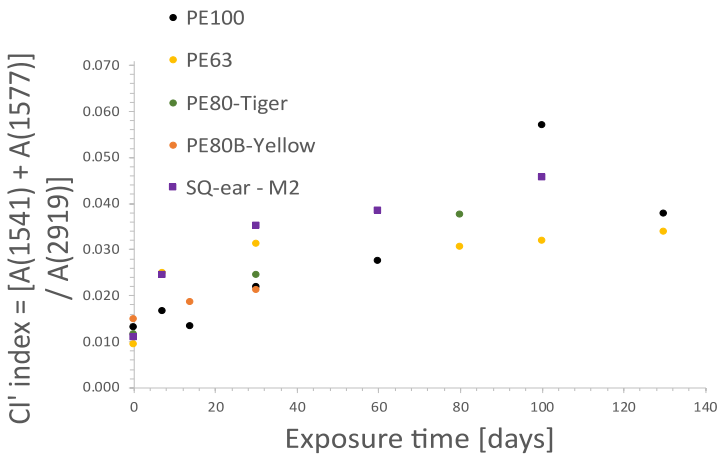
- Tests conducted : OIT/OOT, Thermal properties, CI index , SCGR

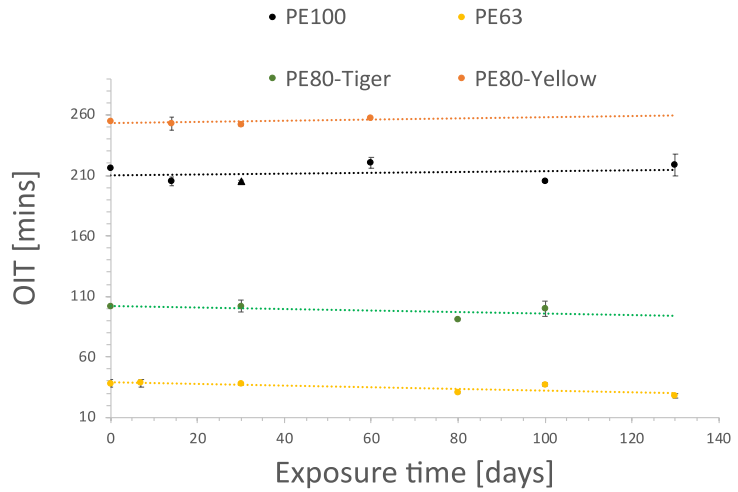
Material Properties

PE resins: PE63, PE80(yellow), PE80(tiger), PE100









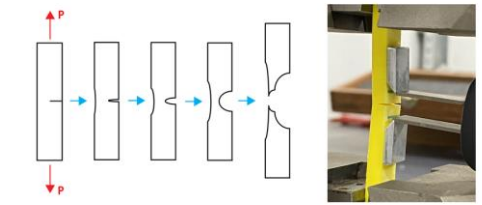
No significant changes – subtle changes appear but all within an acceptable error range for pipe materials (inherent inhomogeneity)

80Bar, points taken at different exposure times up to 130 days

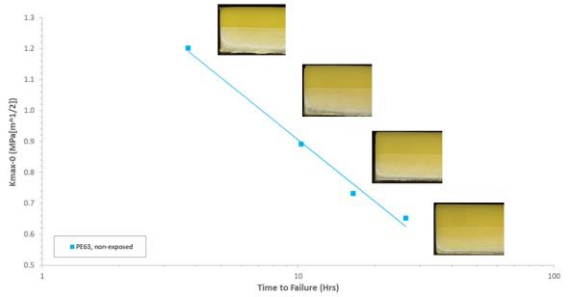
Failure mode: slow crack growth resistance

PE63 and PE80(Yellow)

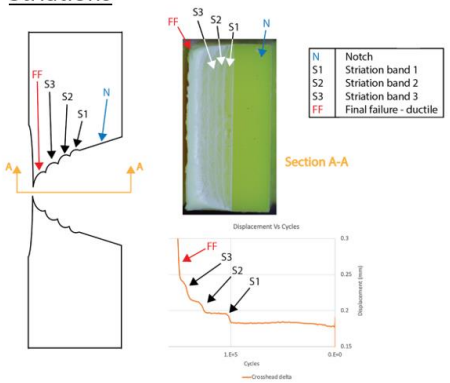
CPENT

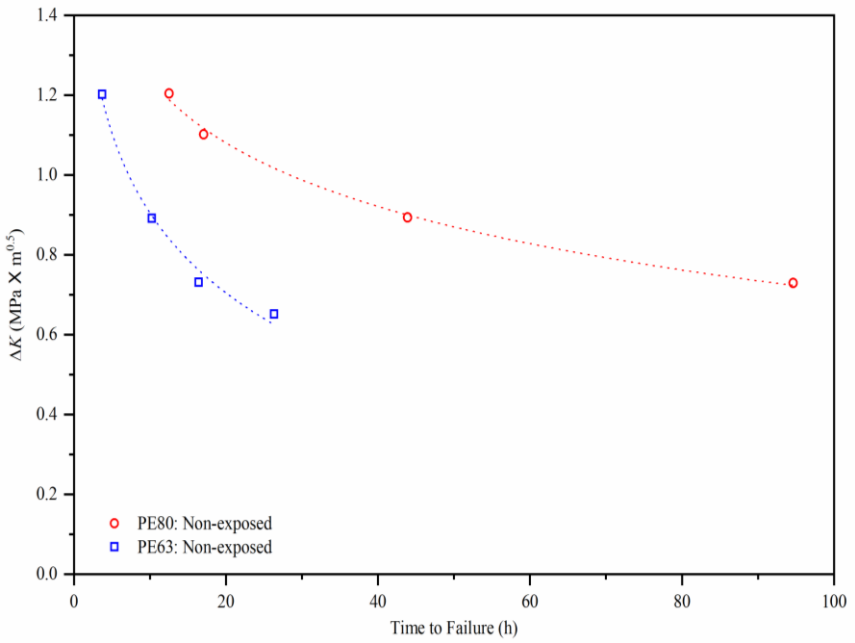


CPENT

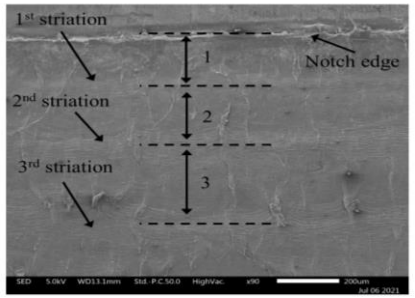


Striations

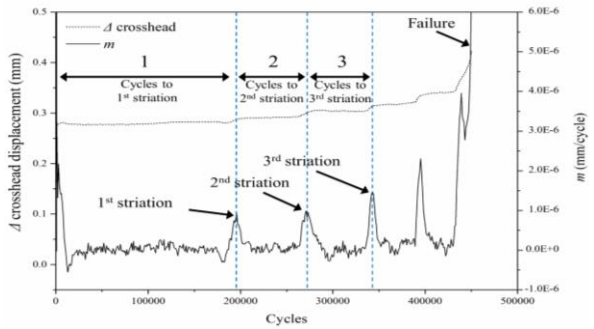




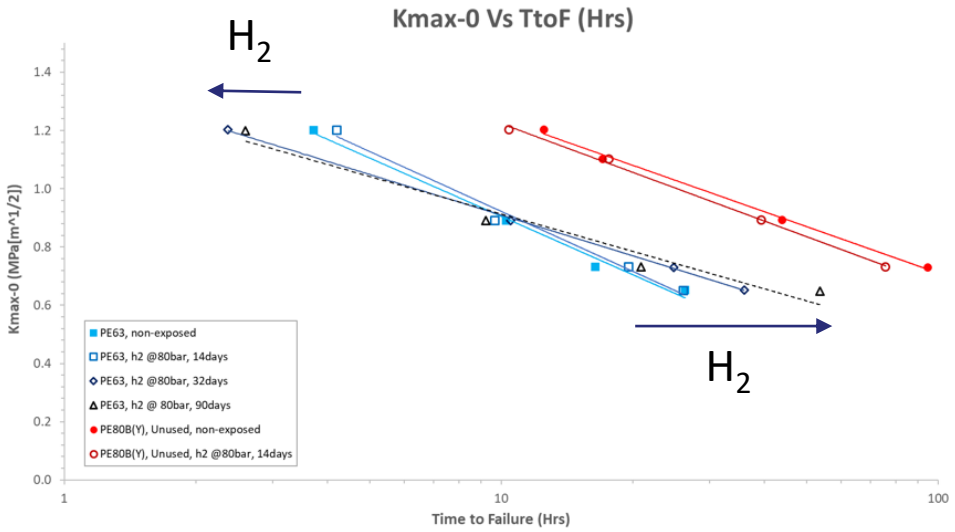
a)

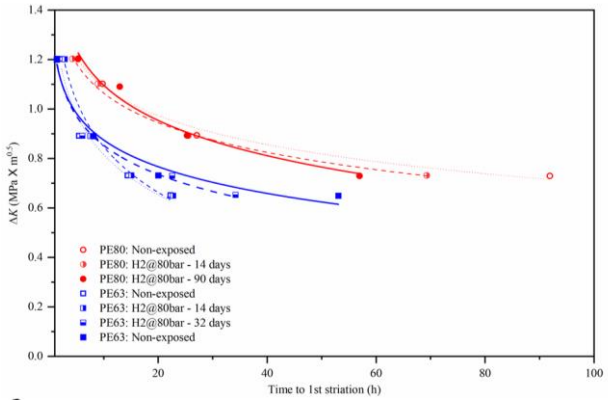


b)

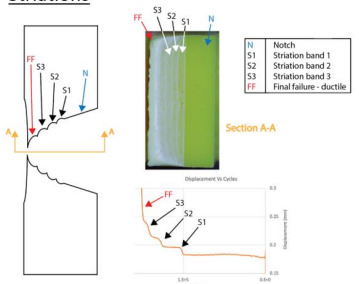


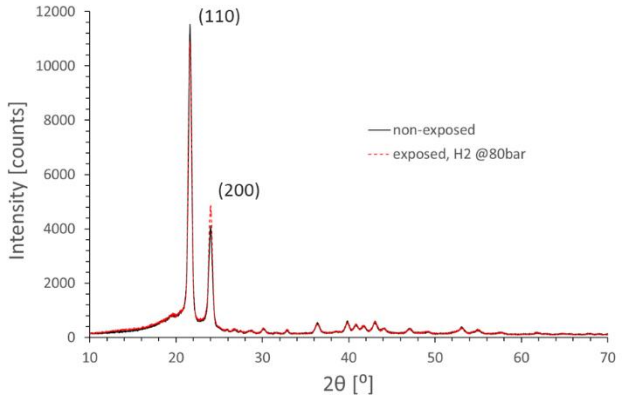
SCGR: impact of H_2

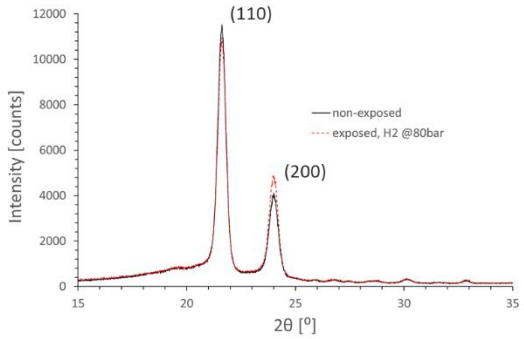


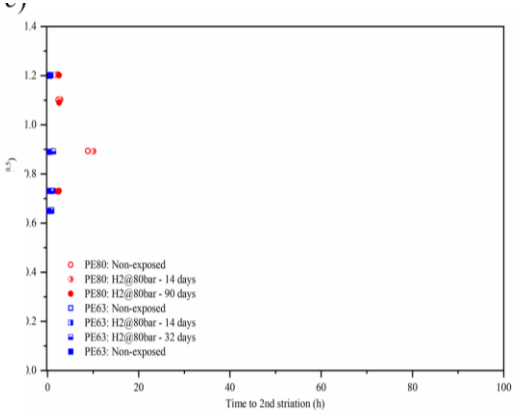


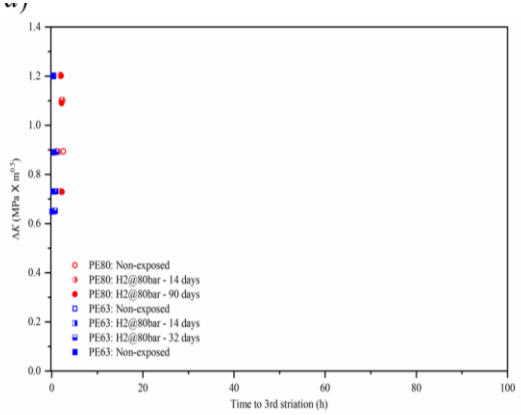
Striations







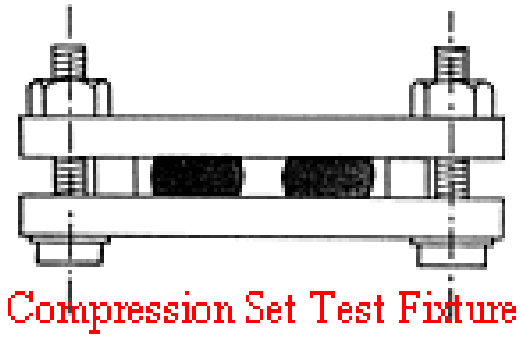




Todays Talk

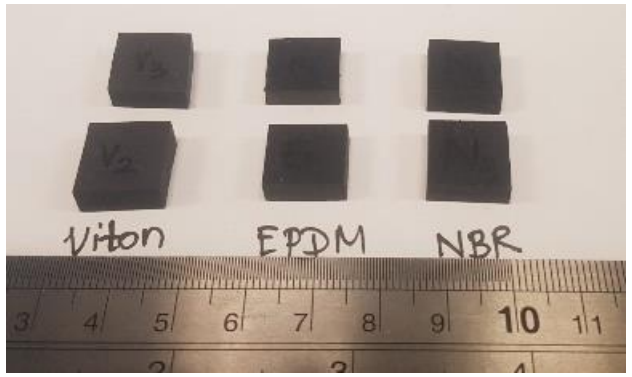
- Elastomers
  - Testing methods
  - Results

Our approach : Testing Elastomers

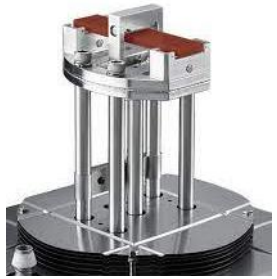


D-395-18(Method-B) completed in situ

Visual inspection, dimensional change , FTIR, TGA



DMA for material properties such as storage and loss modulus



Elastomers investigated : Viton, HNBR, NBR70*, NBR45, EPDM

*Supplier : Easterseal, Seallteam

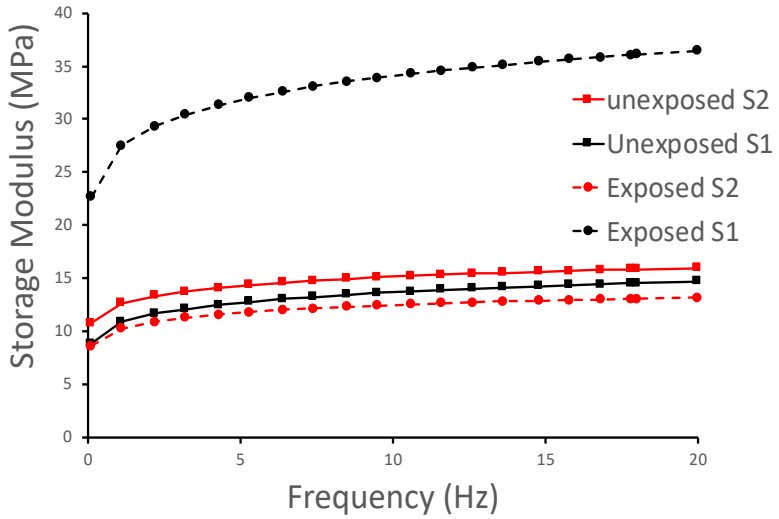
THERBAN® 3907
General Sales Specification

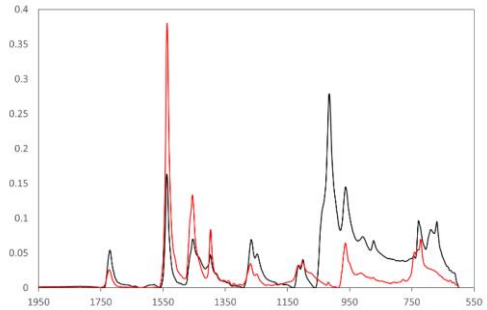
ARLANXEO
Performance Elastomers

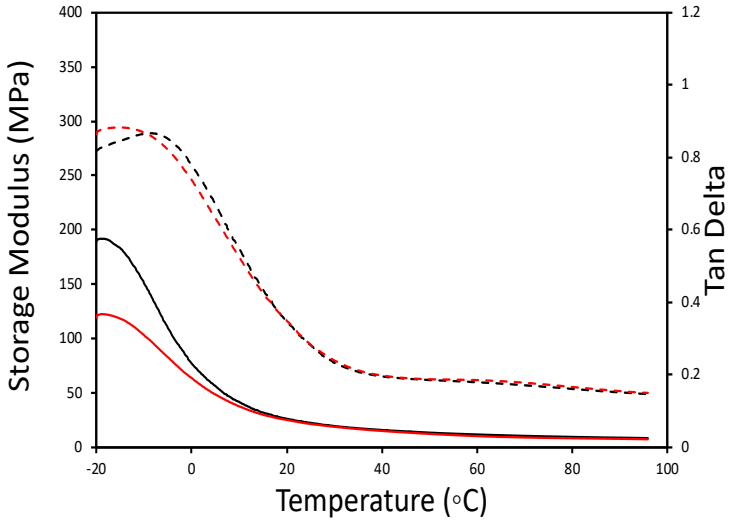
NBR70:

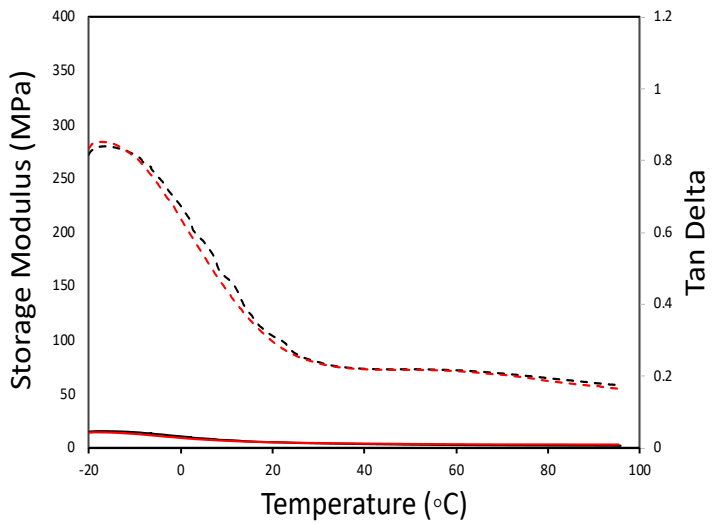
From 2 different suppliers S1:supplier 1 S2 :supplier 2

80bar , 7days









Supplier 1 shows significant increase in storage modulus

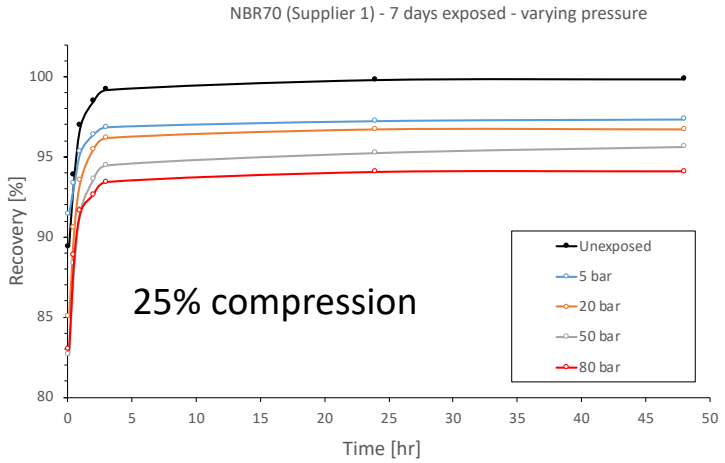
Temperature profile is different

Tan Delta difference – S1 poorer damping abilities

Both show poor low temperature compatibility

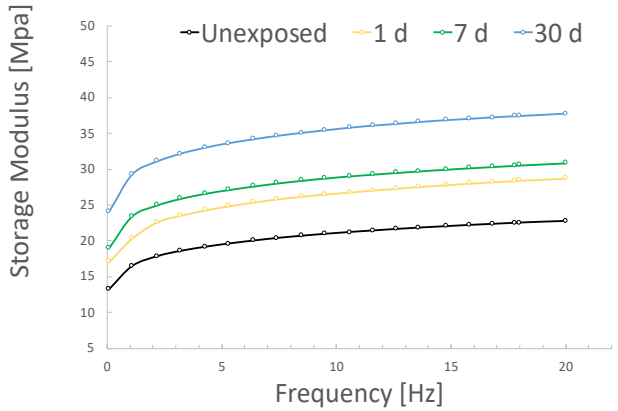
NBR in depth look: NBR 70 supplier 1

a)



Decreased recovery with ↑ in H_2 pressure

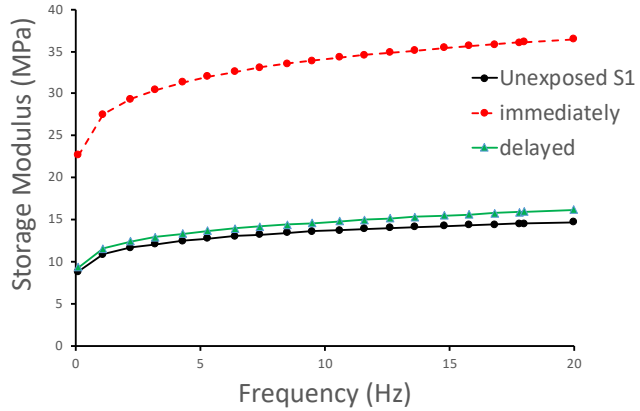
b)



↑ Increase exposure time

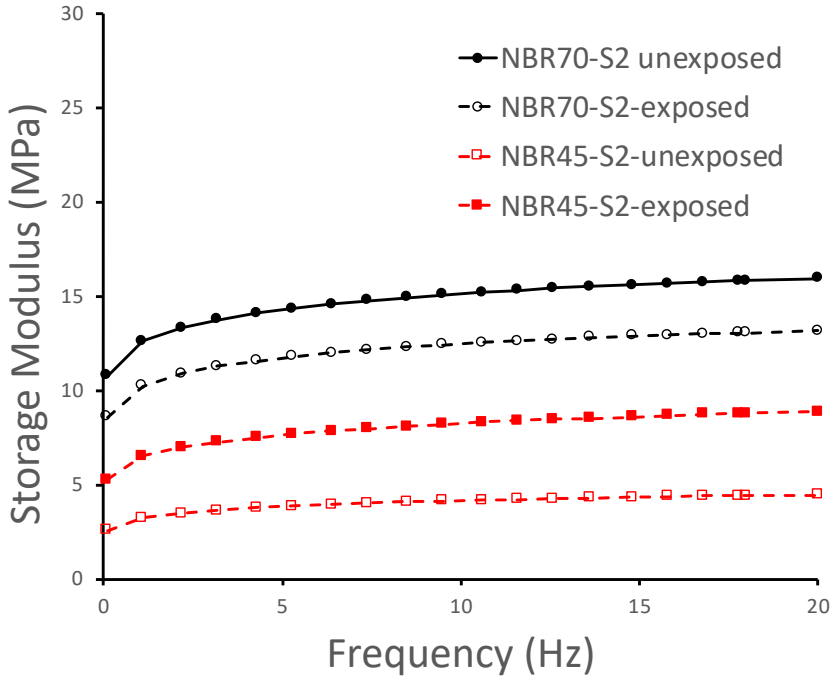
↑ Increase in property change : here stiffer material by 200%

c)



Non permanent changes

NBR in depth look: NBR 70 supplier 2



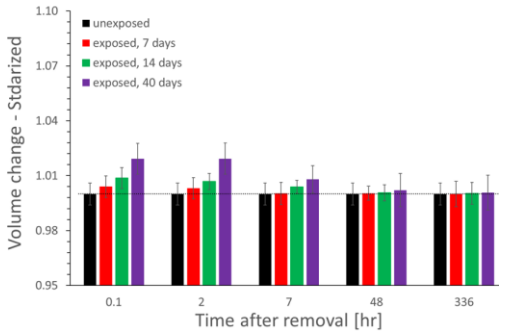
Supplier 2
H_2 gas has the opposite effect when compared with Supplier 1

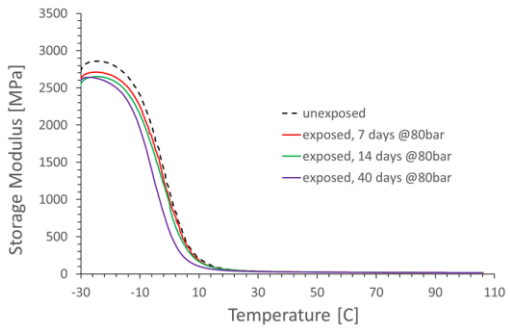
The impact is less and the storage modulus is reduced suggesting increased flexibility

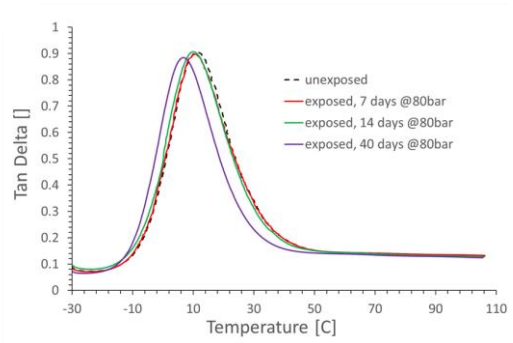
*Different suppliers , different recipe, different response to H_2 gas

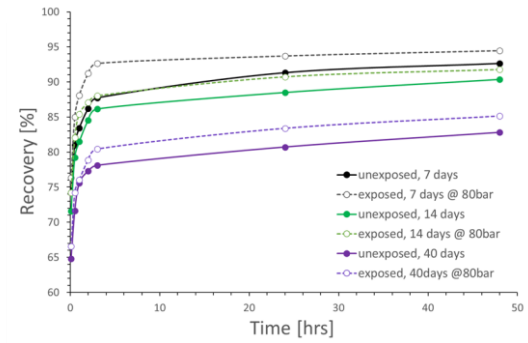
Technical elastomers HNBR ad Viton

HNBR

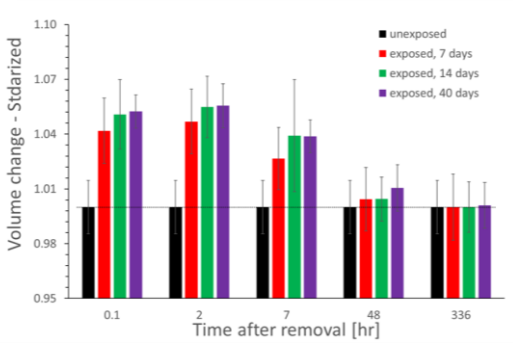


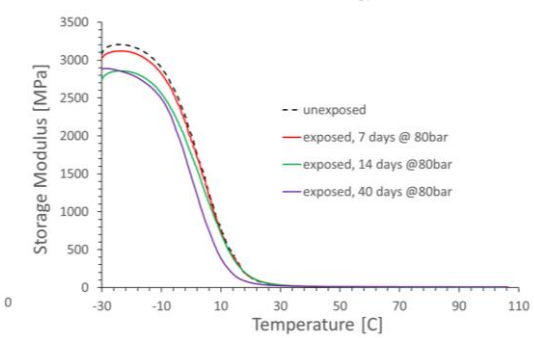


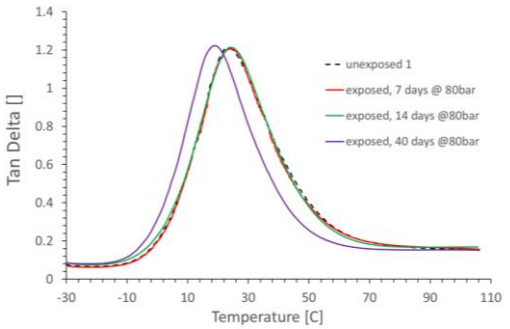


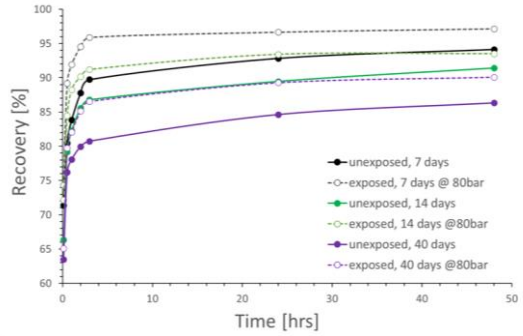


Viton









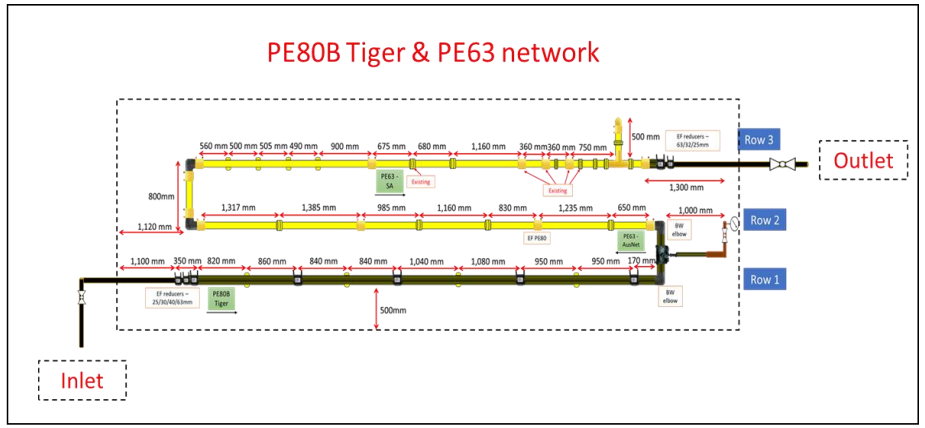
Todays Talk

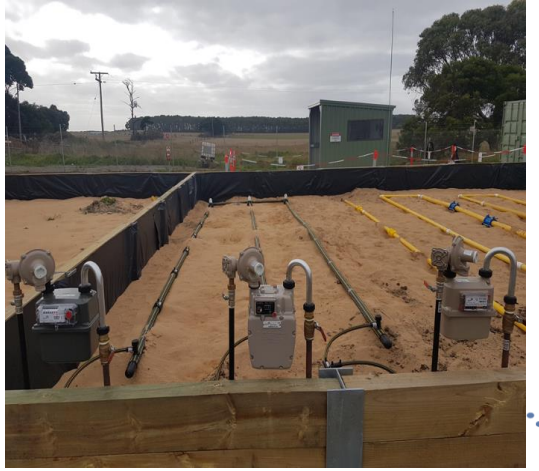
- Real world testing

RP3.1-07: Testing in the real world

Hydrogen demonstration test bed 100% Hydrogen

Each “sandpit” to represent distribution network across Australia



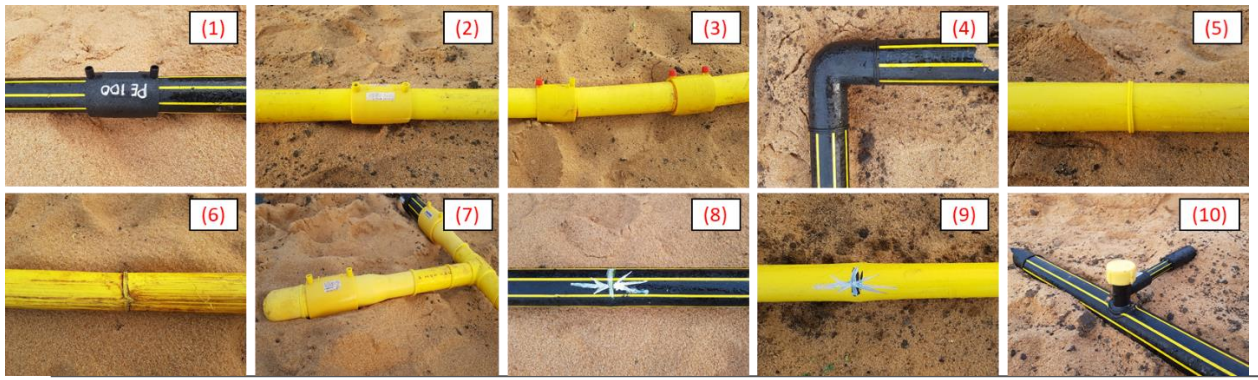


All joins and materials have been incorporated

Testing will be completed at the completion of the project to provide information regarding material integrity

Initial charging leakage at many mechanical joins, now holding

Elastomers within joins will be tested



Conclusions

Commenced working towards developing a database of material compatibility with hydrogen impact of charging conditions

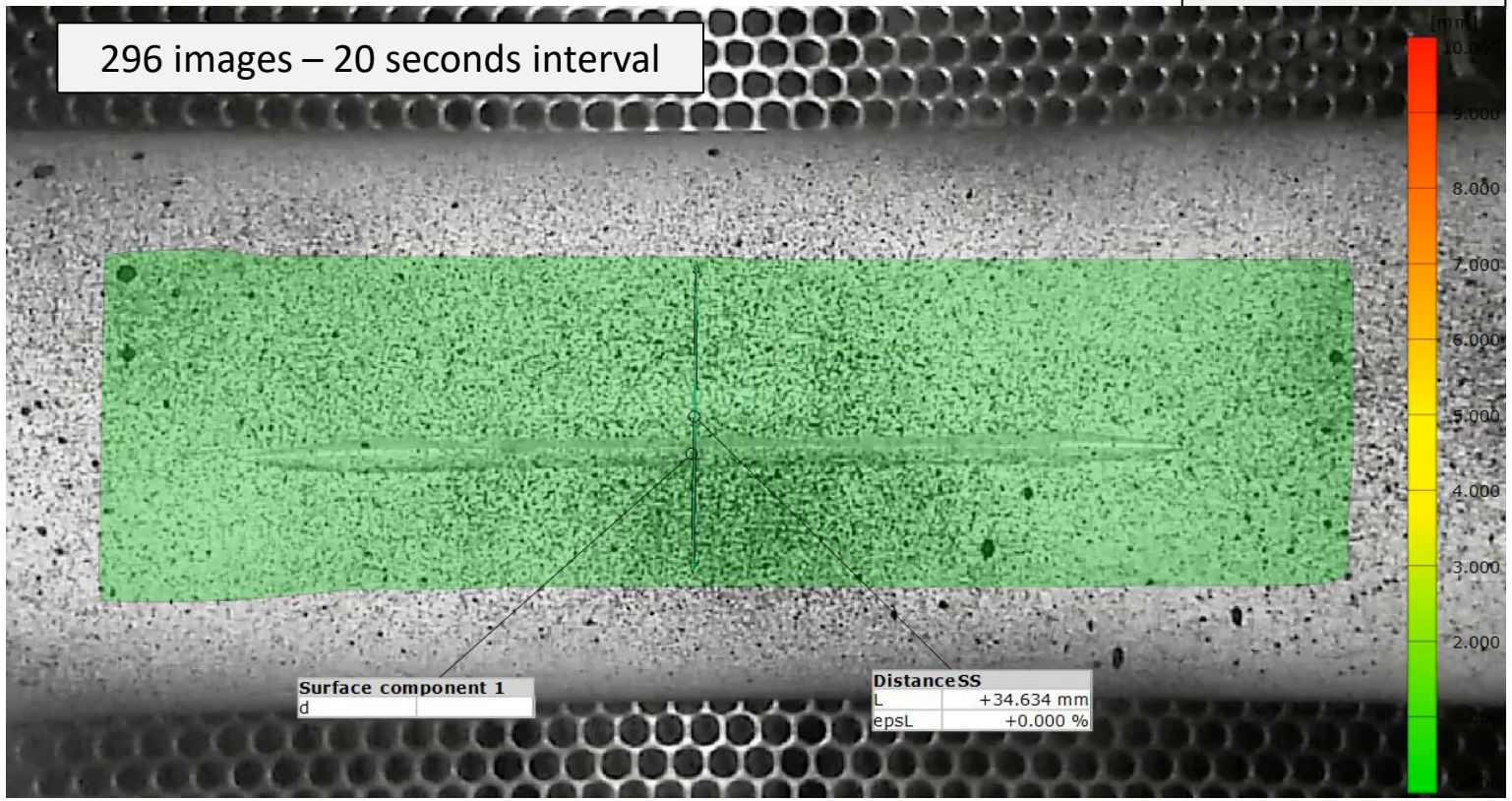
Pipes: No significant material property changes for the bulk pipe, failure mode and time to failure is impacted by hydrogen which is more significant for PE63, XRD showed a clear change in crystal orientation due to hydrogen, this will change the crack pathway.

Elastomers: Tested to date are showing property changes with hydrogen gas – significantly depends on charging conditions, and elastomer type –supplier differences noted for same marketed material

What is Next

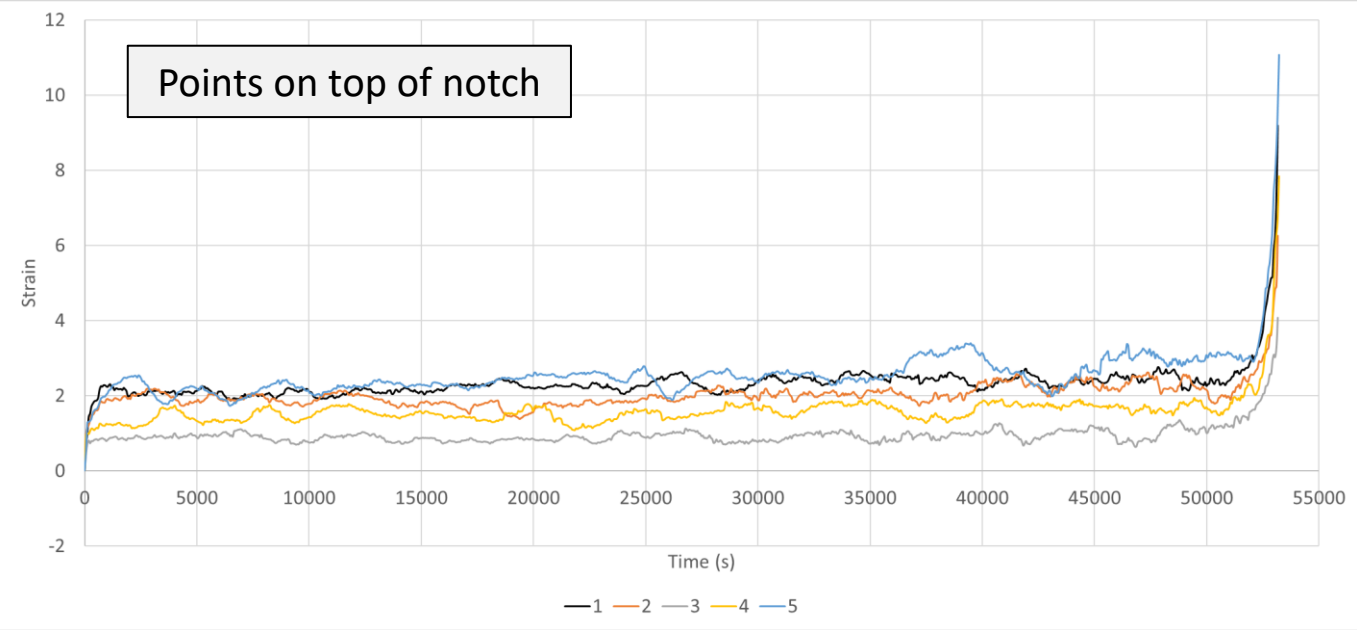
- From coupon to pipe testing

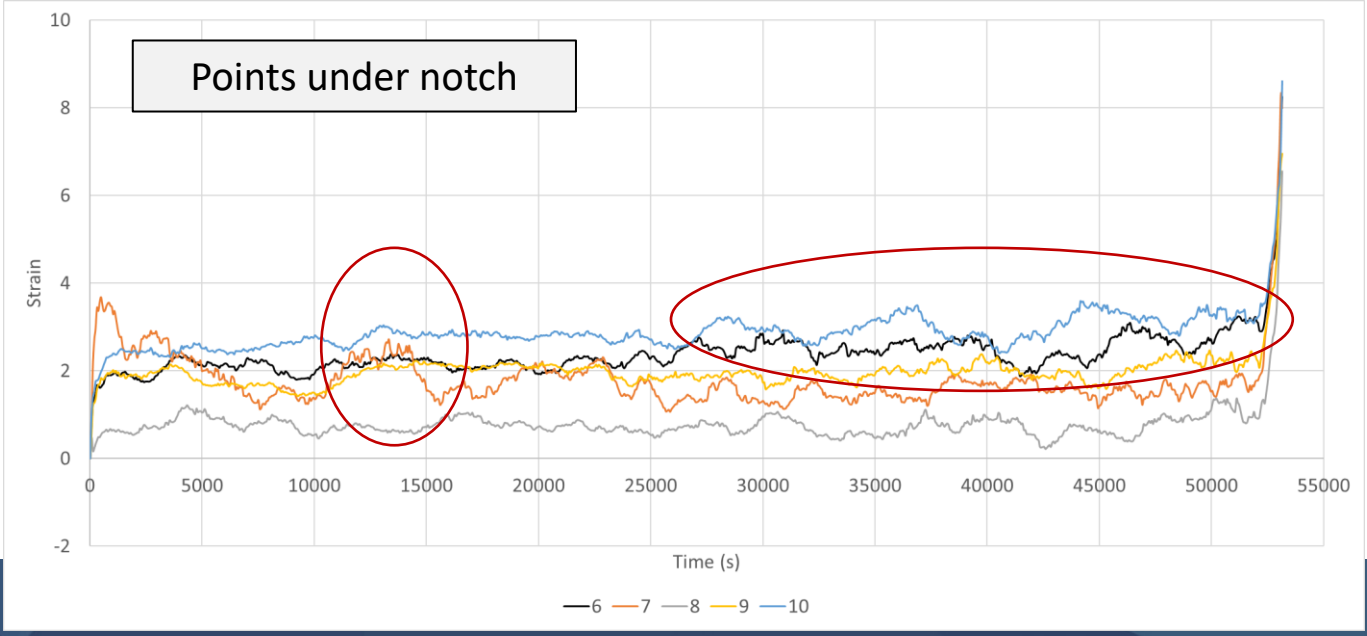
Major strain %



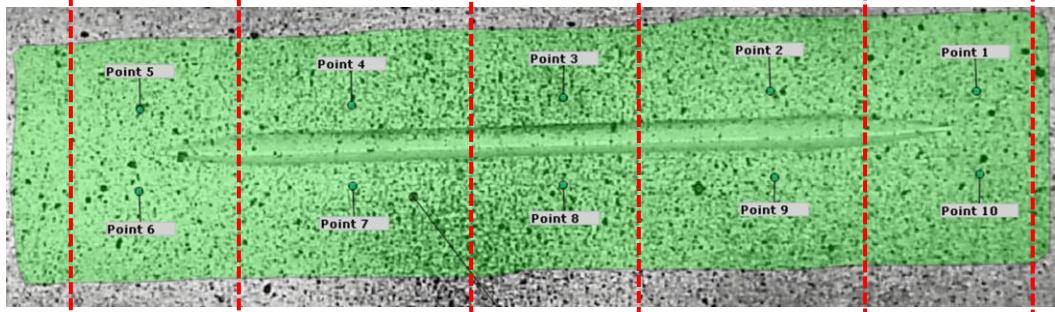
Different failure conditions different profile

Does H_2 change this profile ?





Overall, this area experienced the lowest strain



Overall, these areas experienced the highest strain

Enabling the decarbonisation of Australia's energy networks

Acknowledgements

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Research Team: *Sebastian Manjarres Espinosa, Sadegh Ghanei, Michael Neave, Matthew Zampatti.*

Sadegh

Sebastian

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Thank you for your attention.