KUALA LUMPUR 2012 WORLD GAS CONFERENCE

25th world gas conference

"Gas: Sustaining Future Global Growth"

DEVELOPMENT OF INNOVATIVE MEMBRANE FOR OFFSHORE HIGH CO_2 SEPARATION

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Presentation Outline

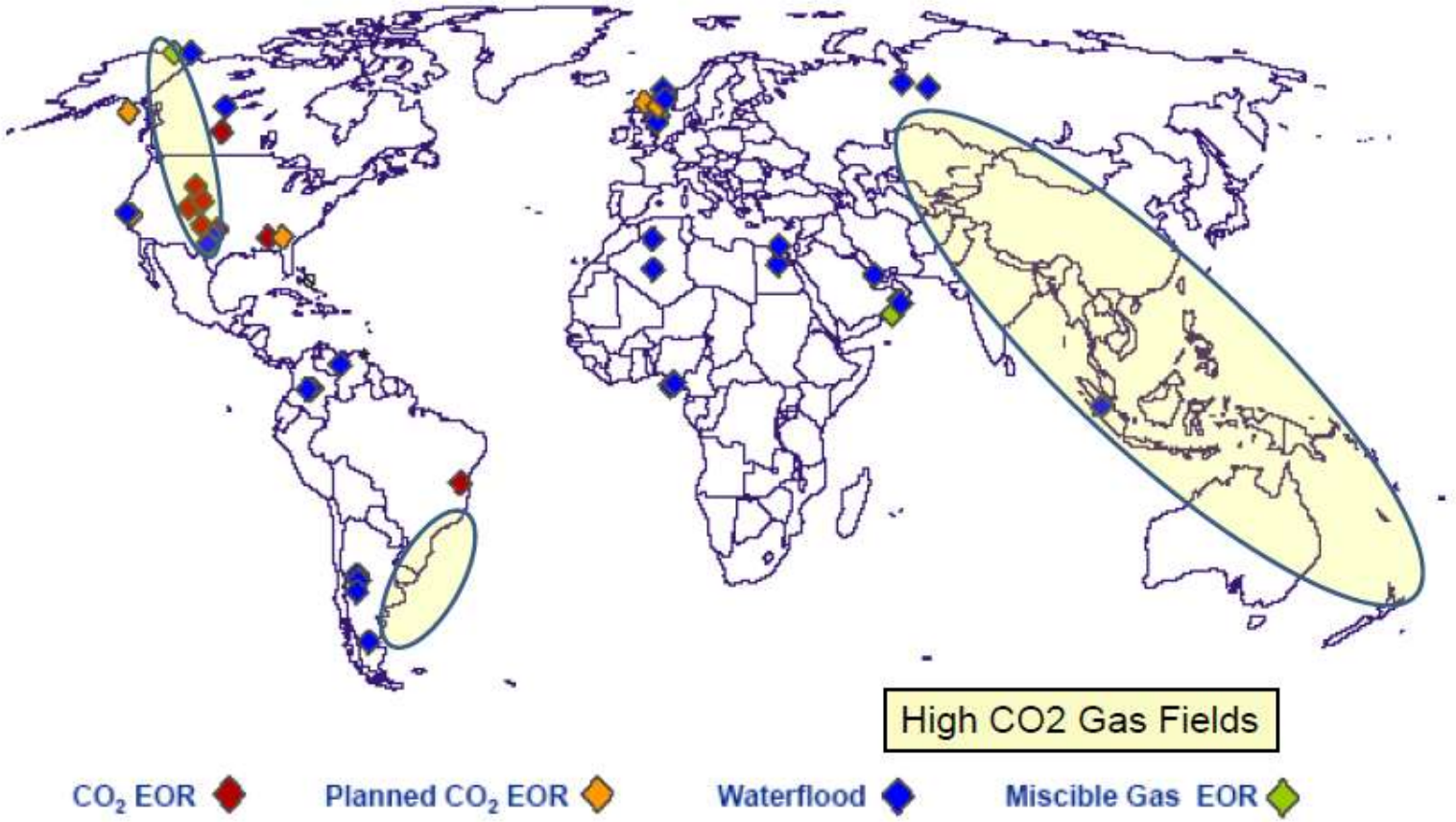
- Introduction
- Objective
- Methodology
- Result and discussion
- Conclusion

Introduction

- Currently, about 40% or 2600 Trillion Cubic Feet (Tcf) of the world's natural gas reserves are in the form of sour gas where H_2S and CO_2 compositions exceed 10% volumetric of the raw produced acid gas.
- More then 300 Tcf of very sour stranded gas *(2008 estimate – IHS source)*
- In Southeast Asia, non-developed and potential gas reserves are estimated at 182 Tcf, Malaysia alone holds an estimated 37 Tcf of natural gas [1].
- Currently, membrane is a leading technology for bulk CO_2 removal offshore. It has been utilised for more than 15 years for offshore operation.
- In the past five years, the size of hollow fibre membranes has increased to 30" in diameter by 72" in length from the 16" in diameter by 72" in length.

Introduction

High CO2 Gas Fields and CO2 EOR Locations

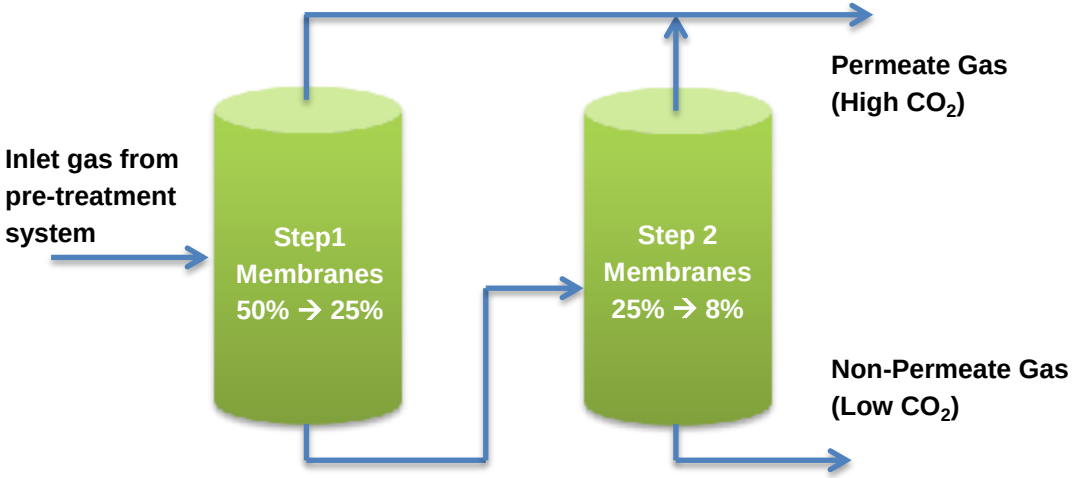


Objective

To optimise the current membrane technology to address the challenges in developing large offshore gas fields with high CO_2 content, to be a commercially viable field development project.

Methodology

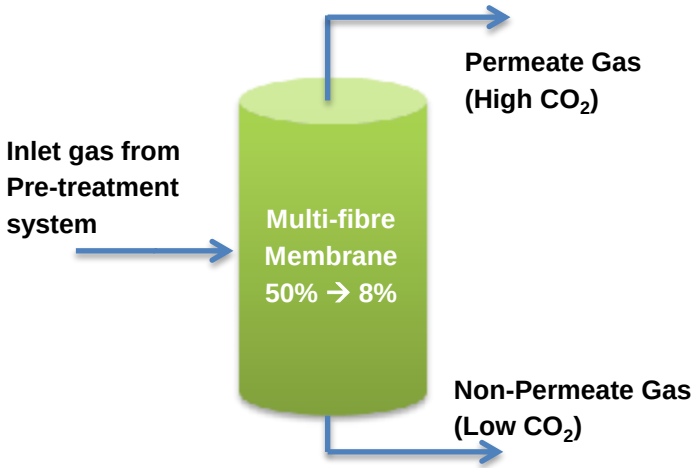
- Current membranes are fabricated with the same type of fibre materials. These membranes are limited to a single set range of performance characteristics even though the properties and gas volumes change throughout the membrane as permeation occurs



Current membrane configuration

Methodology

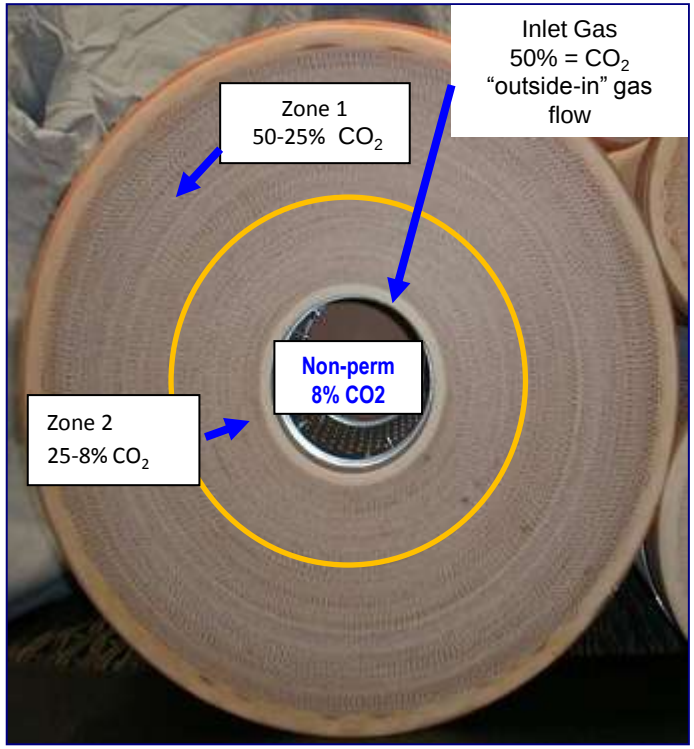
- The new innovative invention (PN1) improves the performance of the membrane module by increasing the overall capacity, thereby reducing or eliminating the need for multiple processing or separation steps



New invention application (US Patent, no. 20100212501)

Methodology

- A higher separation (lower capacity) fibre is located in Zone 1 to reduce hydrocarbon loss and a higher capacity (lower separation) fibre is located in Zone 2 to improve capacity where CO_2 is lower



PN1 membrane system configuration (percentage of CO_2 shown are indicative).

Methodology

30 inches membrane

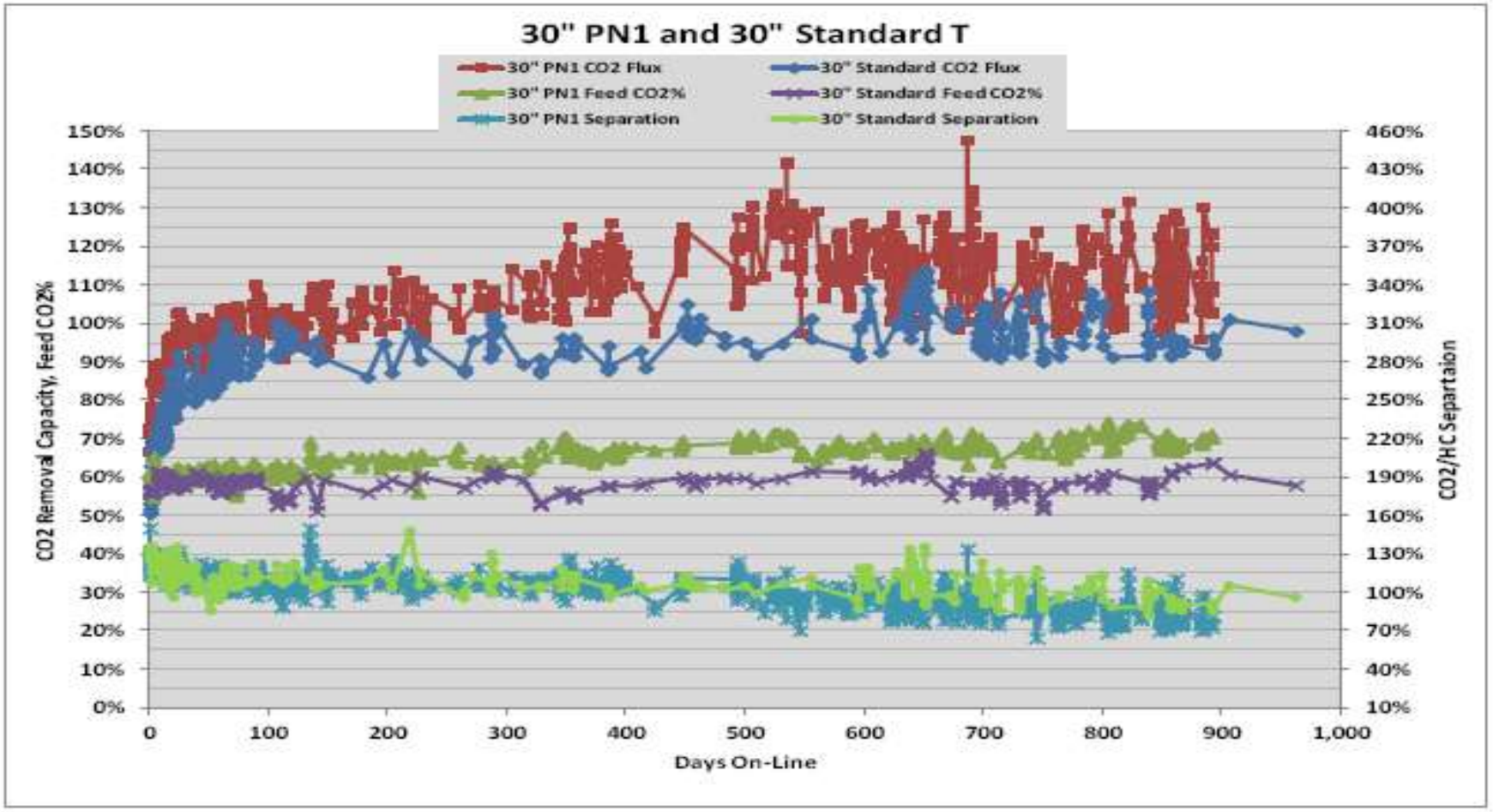
16 inches membrane

Result and Discussion

The tests were carried out at two separate sites.

Parameters	Testing conditions Site 1 (Onshore)
Inlet flow	20 - 36 MMscfd
Inlet pressure	34 - 36 bar(g)
Inlet temperature	19 - 28^{o}C
Inlet membrane CO_2 Content	55 – 75%
Non permeate membrane CO_2 Content	17 - 25%

Result and Discussion – Onshore testing result (Site 1)



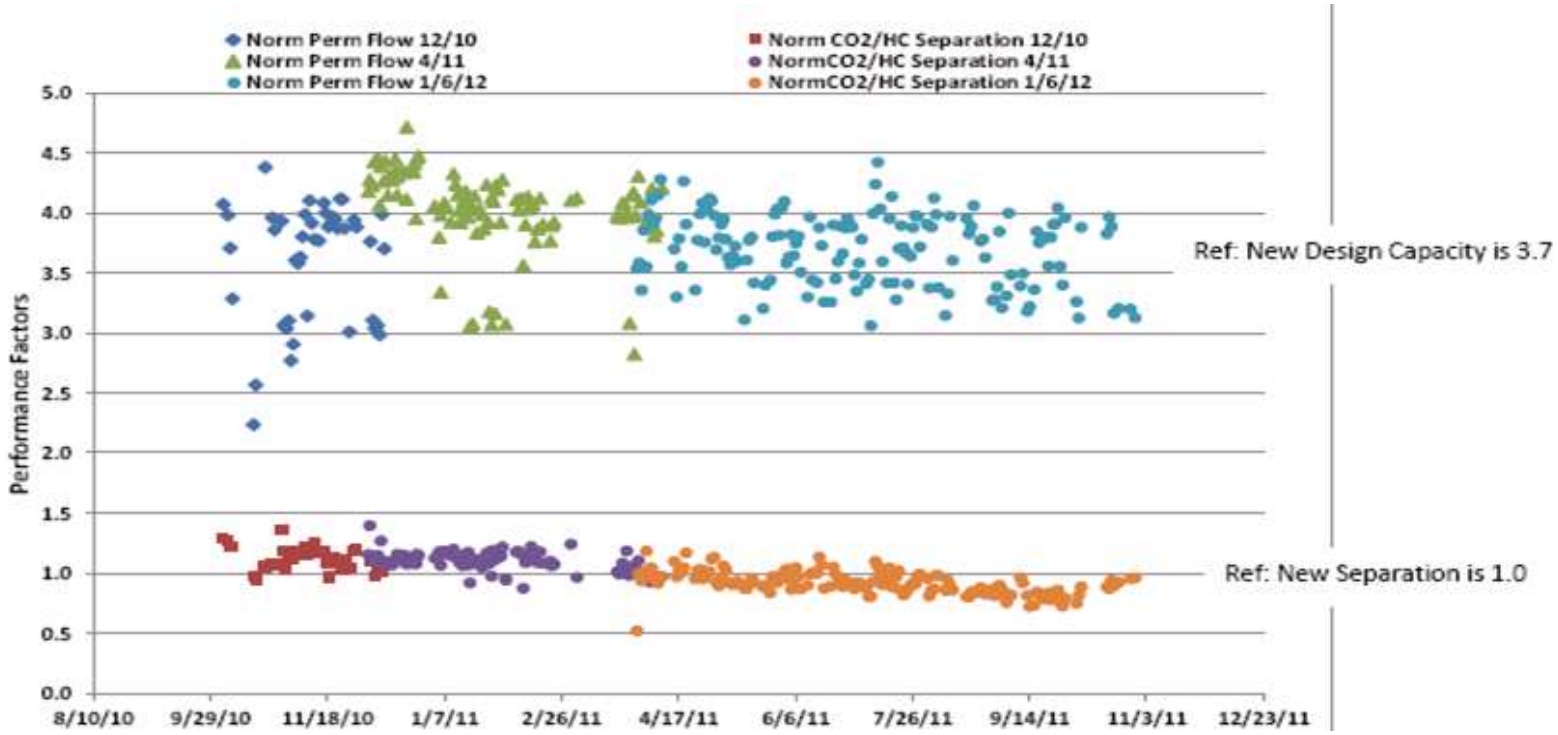
Results of 30” PN1 membrane as compared to 30” commercially available membrane

Result and Discussion

The tests were carried out at two separate sites.

Parameters	Testing conditions Site 2 (Offshore)
Inlet flow	14 – 22 MMscfd
Inlet pressure	39 – 45 bar(g)
Inlet temperature	19 - 41^{o}C
Inlet membrane CO_2 Content	35 – 40 %
Non permeate membrane CO_2 Content	9 – 19 %

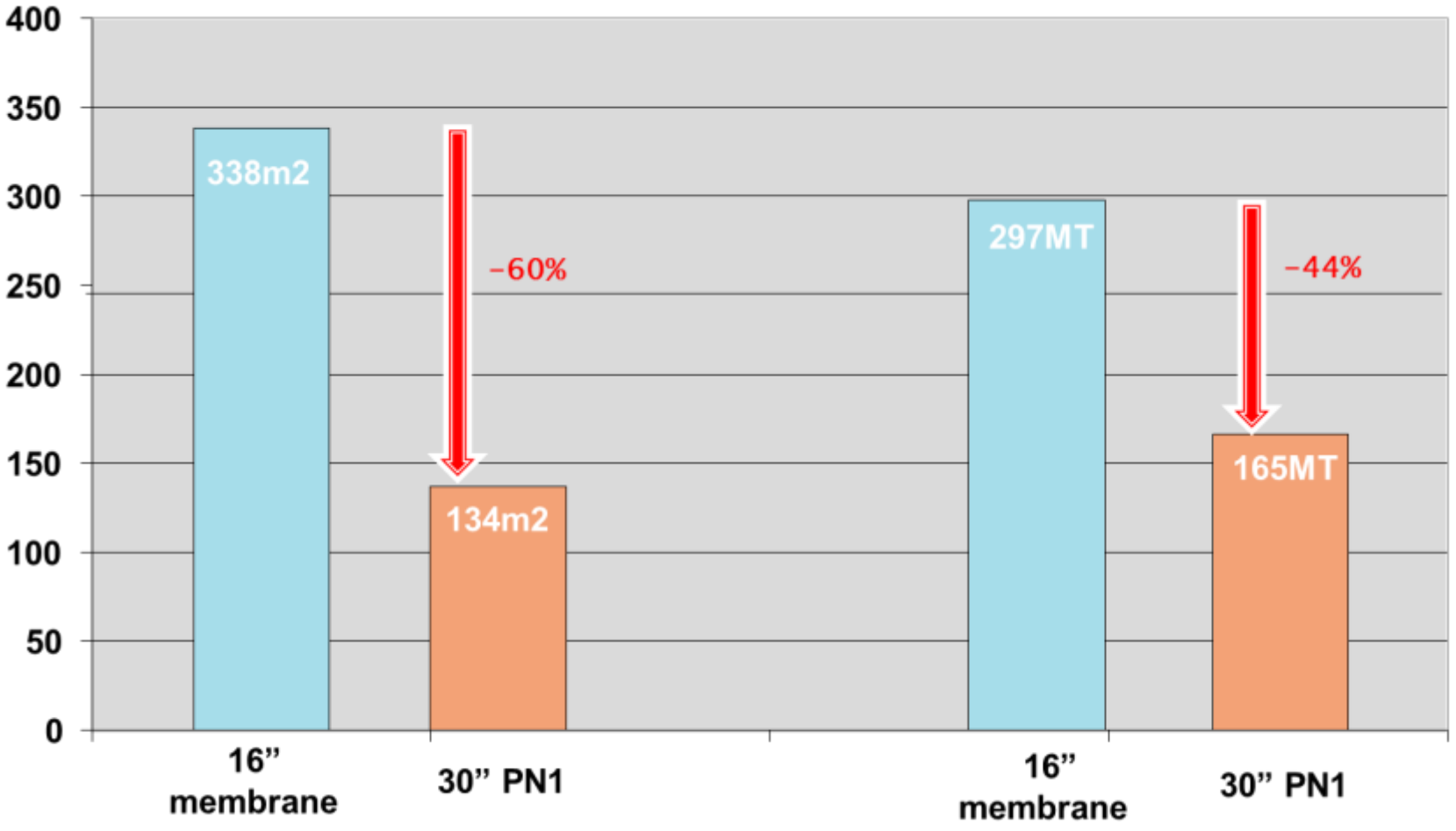
Result and Discussion – offshore testing result (Site 2)



Results of 30” PN1 membrane as compared to 16” commercially available membranes

In terms of CO_2 removal capacity, the field data validates that PN1 30” has 3.7 times the capacity of commercially available 16” membranes.
For CO_2/HC separation performance, PN1 showed almost similar performance

Result and Discussion – space and weight reduction



Results of 30" PN1 case study on footprint and weight reduction as compared to 16" commercially available membranes.

Result and Discussion

Advantages of 30” PN1 membranes:

- Footprint and weight reduction
- Elimination of interconnecting piping
- No requirement for feed gas balancing

Conclusion

- Development of PN1 membrane is found to be more efficient in removing high CO_2 content natural gas from large gas fields as compared to single-layer commercially available membranes.
- PN1 has 10% more CO2 removal capacity (flux) compared to 30” commercially available membranes.
- PN1 has 3.7 times CO2 removal capacity (flux) compared to 16” commercially available membranes.
- Estimated footprint and weight saving, 60% and 40%, respectively.

THANK YOU