

Santoprene[™]
Specialty Products

TPV Seal Geometry Effects On Compression Set (CSet) and Compression Load Deflection (CLD)

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Welcome to More. That's Santoprene[™] Specialty Products.

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TREXEL INC.
MUCOH Processes

Innovative elastomeric solutions
from **ExxonMobil Chemical**

Outline

- Background
- Study objectives
- Approach
- Sample production
 - Materials
 - Process
- Results
- Conclusions

Background

- Primary and secondary automotive weatherseals are complex, multifunctional profiles that:
 - Control or affect:
 - Water ingress
 - Wind noise
 - Door closing effort
 - Aesthetics at vehicle entry
 - Typically consist of:
 - Sponge sealing section
 - Dense polymer
 - Metal reinforcement
 - Trim
 - Secondary lip
 - Skin coat



Background

- Performance requirements for weatherseal sponge
 - Surface contact area for sealing
 - Conform to sealing surface imperfections and build tolerances
 - Low compression force
 - Withstand high deformations
 - Provide rapid, elastic deformation recovery
 - Operate over a wide temperature range
 - Maintain properties with cyclical deformations
 - Provide consistent properties over long product life

Background

- Meeting weatherseal performance needs requires:

Materials

- Designed for performance
 - Foamability
 - Surface aspect
 - Low CLD
 - Low CSet
 - Elongation

Process

- Trexel MuCell™ process
 - Closed cellular structure

Part Design

- Geometry
- Dimensions
- Sponge specific gravity



Background

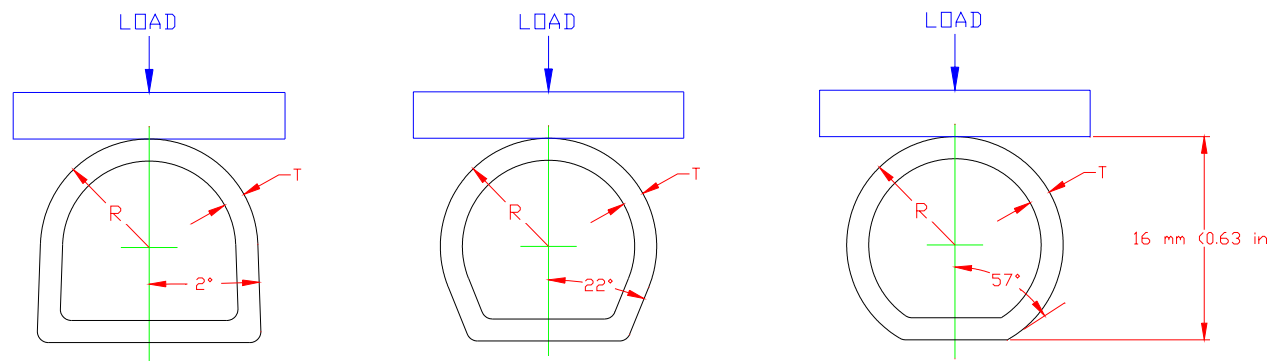
- EPDM material properties \neq TPV material properties
 - Current weatherseal designs based on EPDM properties
 - Historical material of choice
 - Seal designer and manufacturer experiences
 - Different design rules anticipated for optimal seal performance with TPV

Objective

- The objective of this investigation was to quantify the effects of varying TPV profile design on key weatherseal performance criteria to define TPV sponge designs for optimal weatherseal performance.
 - Study variables
 - Profile shape
 - Profile wall thickness
 - Sponge density
 - Measured results
 - CSet
 - Short term
 - Long term
 - CLD

Approach

- Produce “D” shaped profiles of equal height varying:
 - Shape



- Wall thickness 1.5 and 2.0 mm
- Sponge density 0.55 to 0.65 gm/cc

- Assess performance differences

Sample Preparation

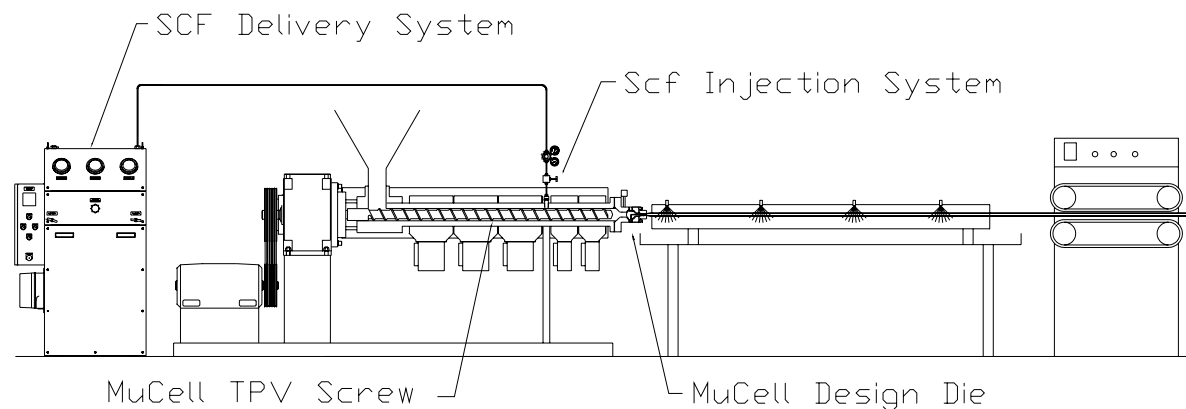
- Process

- MuCell™ foam extrusion process

- Physical foaming technology
 - Direct injection of supercritical N₂ or CO₂

- Equipment

- Trexel extrusion system 63 mm diameter, 32:1 L/D
 - Throughput 45 kg/hr (100 lb/hr)



Sample Preparation

- Materials

- Santoprene™ X121-60F150 polymer

	<u>typ. properties</u>	<u>test method</u>
• Specific gravity	0.97 g/cc	TPE-0105/1
• Hardness	60 Shore A	TPE-0104
• Ultimate tensile str.	4.5 MPa (650 psi)	TPE-0153
• Elongation @ break	390%	TPE-0153

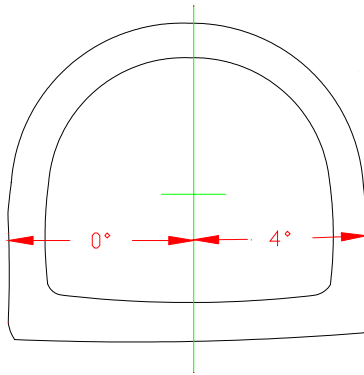
- SCF

• Type	N ₂
• Delivery pressure	172 bar (2,500 psi)

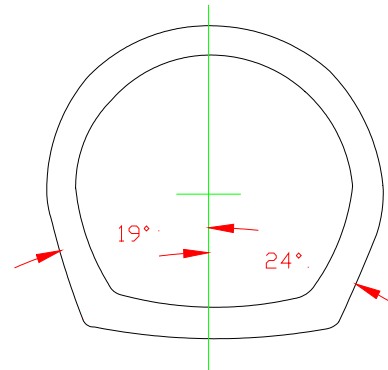
Results

- Samples Produced
 - Actual optical comparator tracings

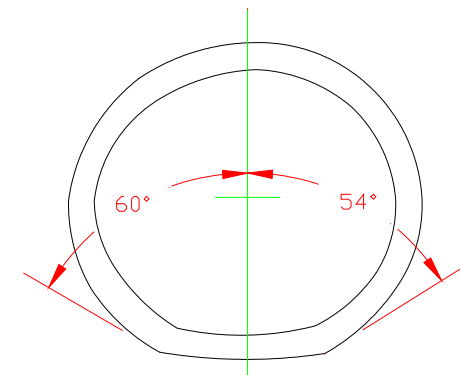
-2° Profile



22° Profile



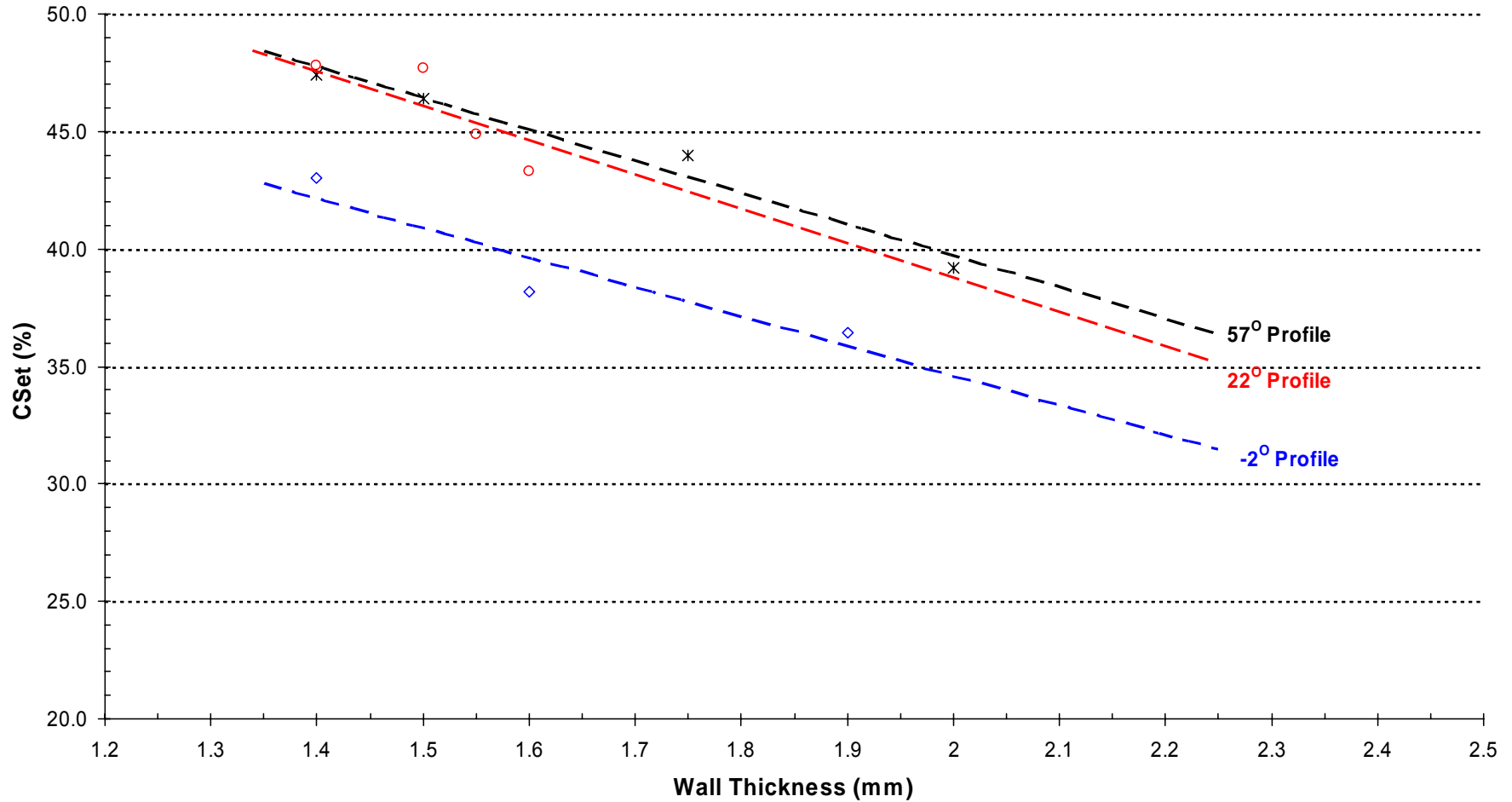
57° Profile



Results

Short Term Cset - 22hr @ 70°C

Santoprene™ X121-60F150, Sponge S.g. 0.54 - 0.60 g/cc, Test Method TPE 0016

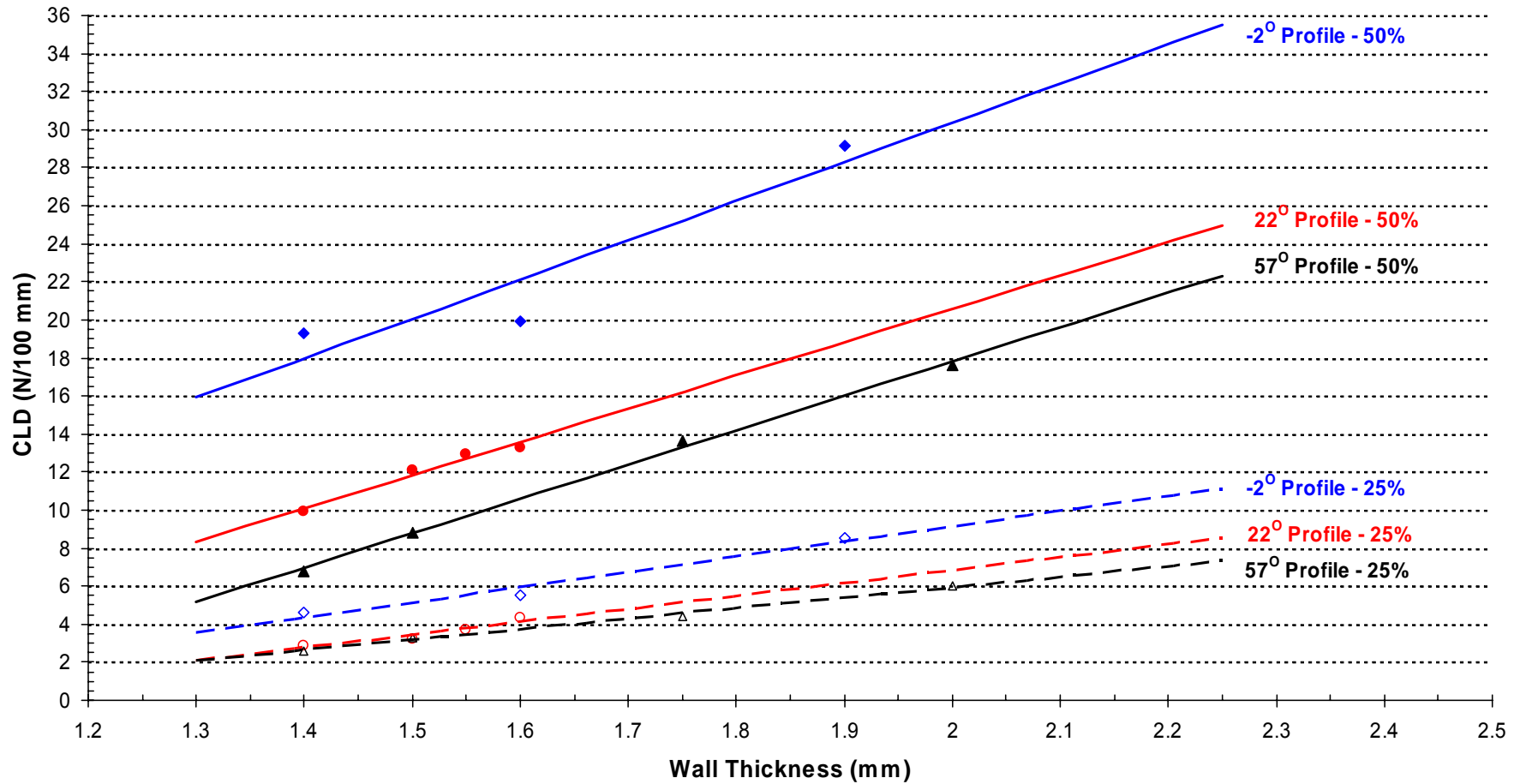


Results



CLD - 50% and 25% Compression

Santoprene™ X121-60F150, Sponge S.g. 0.54 - 0.60 g/cc, Test Method ASTM D 1667

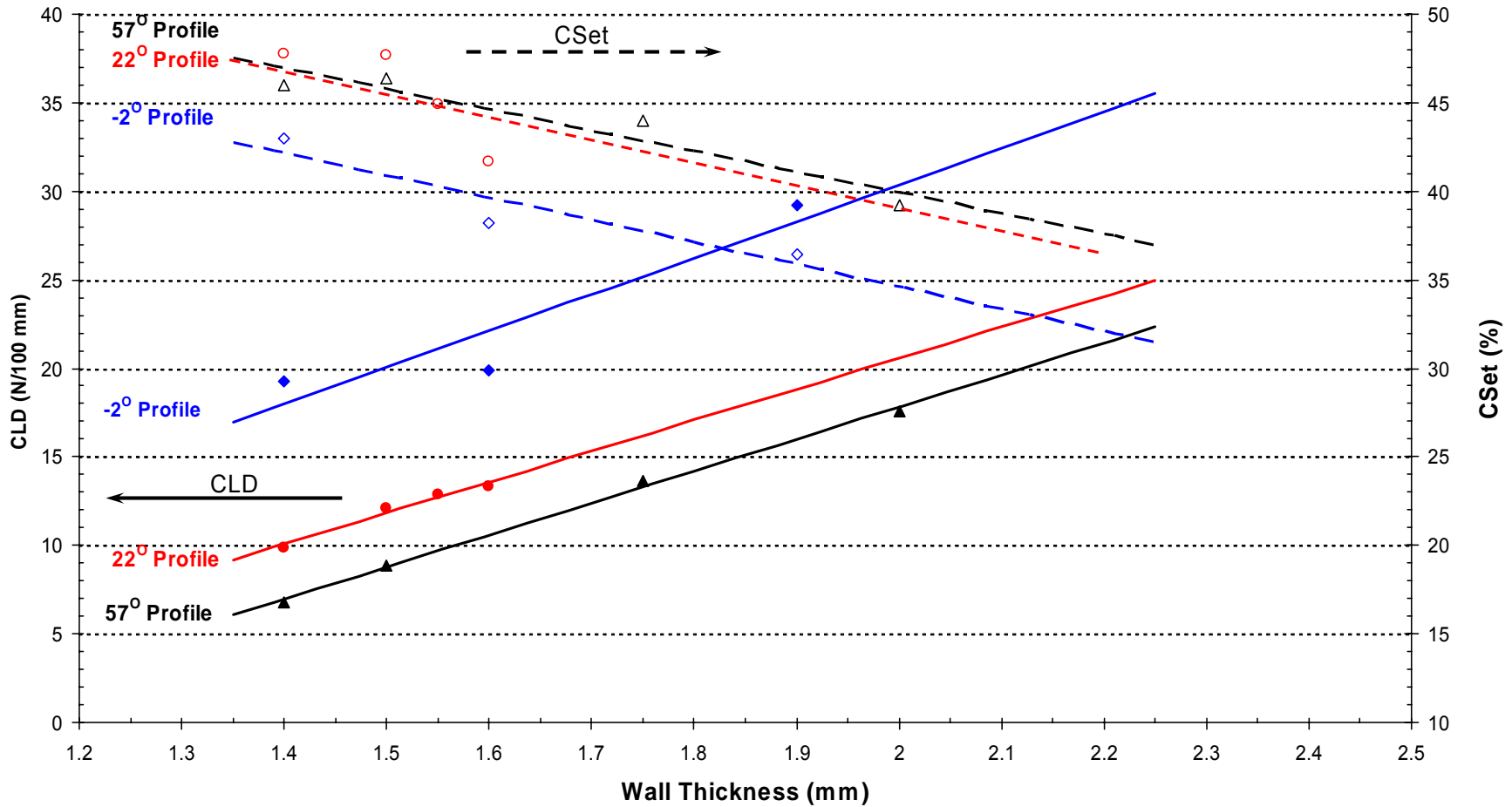


Results



50% Compression CLD vs. Short Term CSet

Santoprene™ X121-60F150, Sponge S.g. 0.54 - 0.60 g/cc, Test Methods ASTM D 1667 & TPE 0016

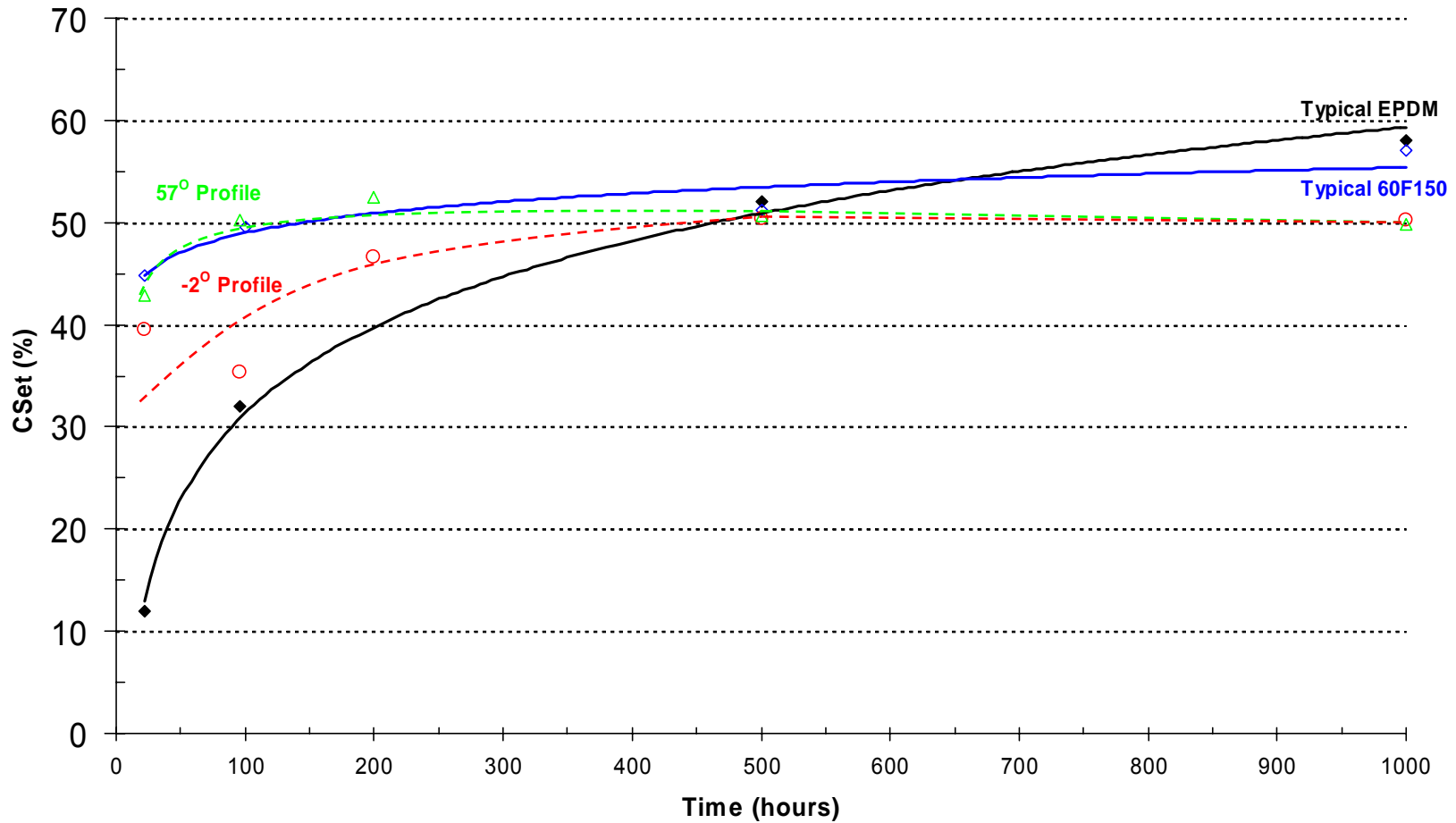


Results



Long Term Cset - 1,000 hours @ 70°C

Santoprene™ X121-60F150, Sponge S.g. 0.54 - 0.60 g/cc, Test Method TPE 0016



Results Summary

Santoprene™ X121-60F150 Sponge 0.54 – 0.60 g/cc

- Anticipated CLD and CSet range:

	<u>Min.</u>	<u>Max.</u>	<u>Units</u>
CLD (25% compression)	2.6	10.8	N/100 mm
CLD (50% compression)	7.0	34.5	N/100 mm
CSet	32	48	%

Shape and wall thickness changes from 1.4 to 2.2 mm.

- Sponge density changes did not affect CSet or CLD.
- Short term CSet is reduced with:
 - Shape change parallel to load \approx 5% points at fixed wall thickness.
 - Wall thickness increase \approx 1.4% points/0.1 mm increase.
 - A total of 16% points with both shape and wall thickness changes.

Results Summary

Santoprene[™] X121-60F150 Sponge 0.54 – 0.60 g/cc

- CLD is reduced with :
 - Shape change to more round profiles at fixed wall thickness
 - ≈ 11 to 12 N/100 mm (50% compression)
 - ≈ 1.7 to 3.8 N/100 mm (25% compression)
 - Decreased wall thickness
 - ≈ 2 N/100 mm for a 0.1 mm wall thickness reduction (50% compression)
 - ≈ 1.7 N/100 mm for 0.1 mm wall thickness reduction (25% compression)

Conclusions

- Profile shape has a large effect on TPV sponge CSet and CLD.
- Profile shape for TPV can be optimised for CSet and CLD independently of sponge specific gravity.
- TPV CSet is consistent over time
- TPV sponge CSet \leq EPDM sponge CSet after 700 hours (29 days).

THANK YOU FOR YOUR ATTENTION!

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