CO_2 Leak Test Updates

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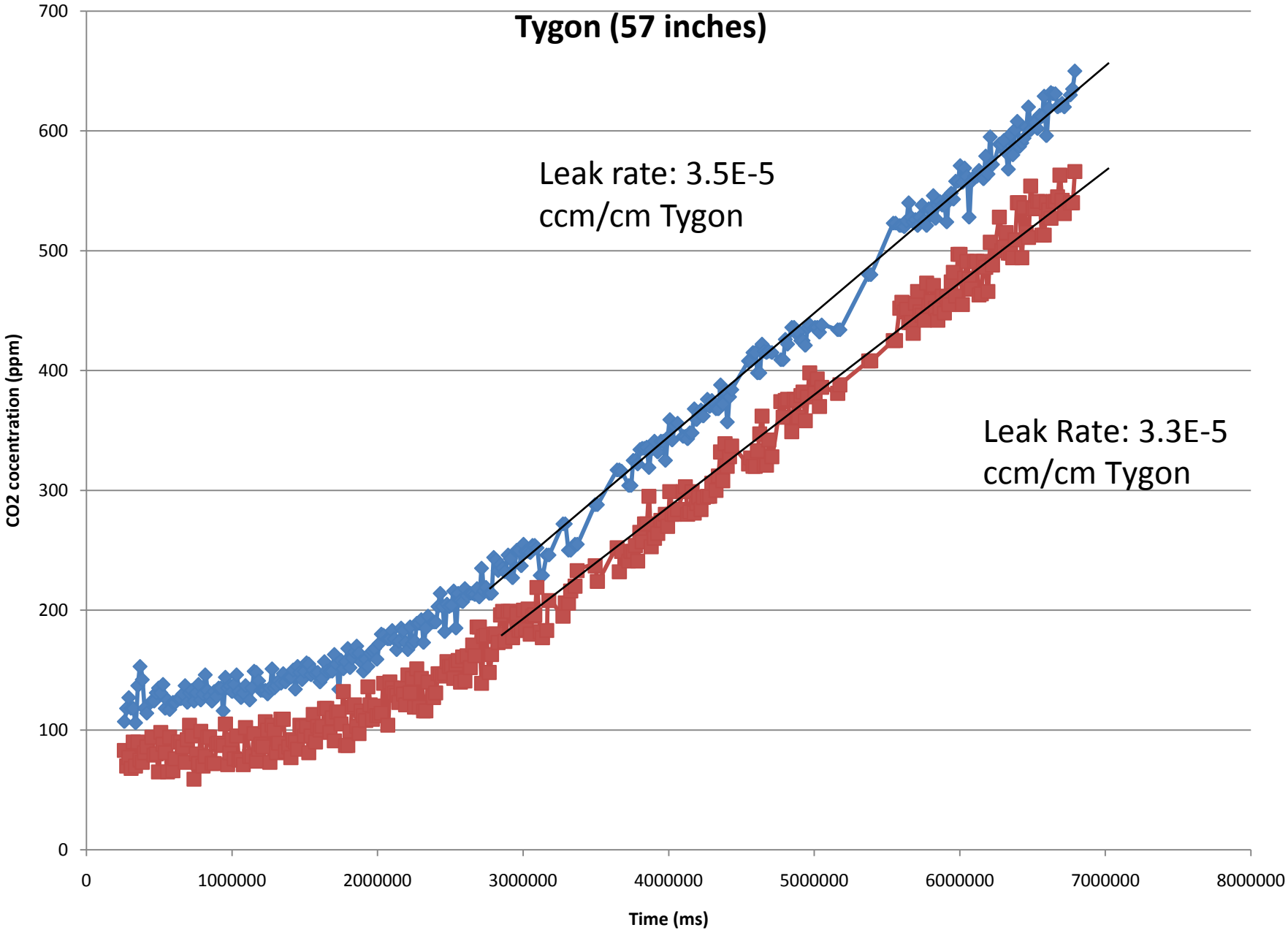
Tygon Tests

- Flexible PVC tubing that is compatible with barbed fittings
- Bypass the heat seal step
- Barbs would allow for leak test repeatability if necessary

- The method for using Tygon as a substitute for Polyflow was almost identical except for the sealing process.
- A total of 4 straws (3 from batch 2, 1 from batch 1 PPG) were tested with Tygon tubing
- The following results were obtained through multiple tests

Straw Number	Preparation	Leak Rates
7T	5 minute epoxy, new endpieces, Tygon tubing	Large leak, straw removed immediately
7T test 2	828 Epoxy, old endpieces, Tygon	Far end was clogged, no airflow, used a drill bit to clear clogg, sensors saturated after 50 minutes
8T	828 Epoxy, new endpieces, Tygon	S1: (52.6 ± 2.0)E-5 ccm S2: (54.9 ± 2.0)E-5 ccm
8T test 2	828 Epoxy, old endpieces, Tygon	S1: (35.7 ± 1.0)E-5 ccm S2: (43.1 ± 0.8)E-5 ccm
9T	828, old endpieces, Tygon	S1: (39.2 ± 0.8)E-5 ccm S2: (43.6 ± 0.6)E-5 ccm
9T try 2	Excess 5 minute on far end	S1: (25.7 ± 0.9)E-5 ccm S2: (26.3 ± 0.7)E-5 ccm
9T try 3	Excess DP110 on far end barb, Excess 5 min on near end	S1: (60.3 ± 1.3)E-5 ccm S2: (63.5 ± 0.9)E-5 ccm
10T	(PPG1 half straw) 828 epoxy, new endpieces, Tygon	S1: (61.3 ± 1.7)E-5 ccm S2: (62.5 ± 1.2)E-5 ccm
10T try 2	Shorter tygon near end tubing	S1: (24.3 ± 1.8)E-5 ccm S2: (24.2 ± 1.4)E-5 ccm


Tygon (57 inches)
Leak rate: 3.5E-5 ccm/cm Tygon
Leak Rate: 3.3E-5 ccm/cm Tygon
CO2 cocentration (ppm)
Time (ms)
0
100
200
300
400
500
600
700
0
1000000
2000000
3000000
4000000
5000000
6000000
7000000
8000000

Resumed Polyflow Tests

Straw ID	Tygon Leak	Leak Rates
7PF	N/A	S1: (28.6 ± 0.9)E-5 ccm S2: (31.9 ± 0.7)E-5 ccm
8PF	S1: (35.7 ± 1.0)E-5 ccm S2: (43.1 ± 0.8)E-5 ccm	S1: (30.2 ± 0.8)E-5 ccm S2: (31.6 ± 0.4)E-5 ccm
9PF	S1: (25.7 ± 0.9)E-5 ccm S2: (26.3 ± 0.7)E-5 ccm	S1: (32.4 ± 0.7)E-5 ccm S2: (35.3 ± 0.4)E-5 ccm
10PF	S1: (24.3 ± 1.8)E-5 ccm S2: (24.2 ± 1.4)E-5 ccm	S1: (22.2 ± 0.6)E-5 ccm S2: (26.9 ± 0.6)E-5 ccm
11PF	Not tested with Tygon	S1: (21.9 ± 0.1)E-5 ccm S2: (21.7 ± 0.1)E-5 ccm

York Straw Tests

Straw Number	First Leak Rates	Second Leak Rates
1	S1: (21.1 ± 0.7)E-5 ccm S2: (20.4 ± 0.7)E-5 ccm	S1: (22.8 ± 0.9)E-5 ccm S2: (23.7 ± 0.7)E-5 ccm
2	S1: (26.7 ± 1.4)E-5 ccm S2: (27.1 ± 1.4)E-5 ccm	S1: (31.3 ± 0.8)E-5 ccm S2: (30.7 ± 0.6)E-5 ccm
3	S1: (36.2 ± 0.7)E-5 ccm S2: (38.8 ± 0.8)E-5 ccm	S1*: (19.3 ± 0.5)E-5 ccm S2*: (23.1 ± 0.5)E-5 ccm
4	S1: (17.2 ± 0.6)E-5 ccm S2: (20.9 ± 0.6)E-5 ccm	S1: (21.2 ± 0.6)E-5 ccm S2: (21.6 ± 0.4)E-5 ccm
5	S1: (24.6 ± 0.3)E-5 ccm S2: (26.4 ± 0.3)E-5 ccm	S1: (24.0 ± 0.7)E-5 ccm S2: (26.0 ± 0.5)E-5 ccm

* a segment of the polyflow tubing that was in excess was cut off in an effort to detect a change in the rate due to the polyflow

York Straw Continued

Straw Number	First Leak Rates	Second Leak Rates
6	S1: (20.6 ± 0.8)E-5 ccm S2: (22.3 ± 0.5)E-5 ccm	S1: (23.8 ± 0.4)E-5 ccm S2: (25.5 ± 0.4)E-5 ccm
7	S1: (26.7 ± 1.4)E-5 ccm S2: (28.2 ± 0.5)E-5 ccm	S1: (32.9 ± 0.7)E-5 ccm S2: (35.5 ± 0.8)E-5 ccm
8	S1: (22.2 ± 0.8)E-5 ccm S2: (24.2 ± 0.6)E-5 ccm	S1: (24.1 ± 0.8)E-5 ccm S2: (28.4 ± 0.8)E-5 ccm
9	S1: (19.9 ± 1.0)E-5 ccm S2: (23.2 ± 1.1)E-5 ccm	S1: (24.4 ± 0.8)E-5 ccm S2: (23.3 ± 0.8)E-5 ccm
10	S1: (24.6 ± 0.3)E-5 ccm S2: (26.4 ± 0.3)E-5 ccm	

Polyflow tabulated leak

- Cole Parmer lists polyflow with a permeability coefficient of 280 ($cc \cdot mm \cdot cm^{-2} \cdot s^{-1} \cdot cmHg^{-1}$)

$$Permeability = \frac{Volume\ of\ permeant\ \times thickness\ of\ tubing}{area \times \Delta t \times \Delta P}$$

7.26E-5 ccm per cm of polyflow