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Final Report

National Transportation Safety Board
Frank Zakar

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Released by:
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Founder
Jordi Labs LLC

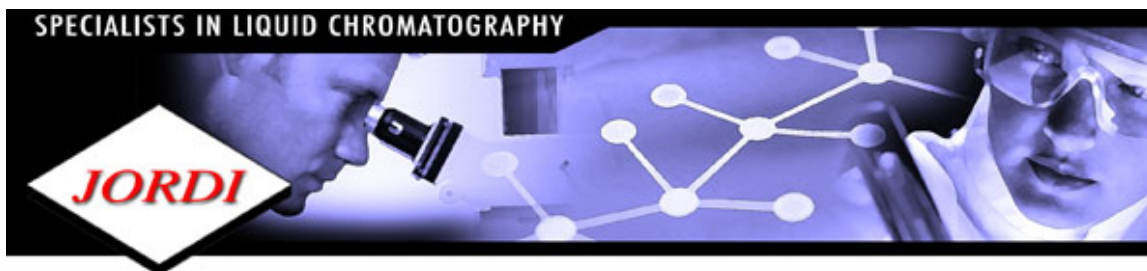
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September 10, 2014

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Dear Frank,

Please find enclosed the test results for your samples described as:

1. 8 Inch Pipe
2. Fitting

The following test was performed:

1. High Temperature Gel Permeation Chromatography (GPC-H)

Objective

The goal of this analysis was to determine the relative MW distribution, modality and PDI of the HDPE samples in order to verify the manufacturer's specifications. It was also reported to Jordi Labs that the samples are suspected to have a bimodal MW distribution.

Summary of Results

Table 1 below shows the resulting molecular weight values. **Figures 1-3** include chromatographic and plot overlays for the samples. The samples were consistent with a bimodal distribution

A small peak for a high molecular weight component was observed in both samples (see page 9). This peak was attributed to carbon black and was therefore not integrated.

Individual Test Results

A summary of the individual test results is provided below. All accompanying data, including spectra, has been included in the data section of this report.

GPC – GPC Background: A polymer is a large molecule which is formed using a repeating subunit. A polymeric sample does not have a single molecular weight but rather a range of values and thus an average value is used to indicate its molecular weight.

Three different molecular weight averages are commonly used to provide information about polymers. These are the number average molecular weight (Mn), the weight average molecular weight (Mw), and the Z average molecular weight (Mz).

Mn provides information about the lowest molecular weight portion of the sample. Mw is the average closest to the center of the peak and Mz represents the highest molecular weight portion of the sample. The different molecular weight averages can each be related to specific polymer properties such as material toughness, tensile strength, and total elongation.

By comparing the different averages, it is possible to define a fourth parameter called the polydispersity index (PDI). This parameter gives an indication of how broad a range of molecular weights are in the sample.

Results: Analysis by GPC requires that a suitable solvent be found to dissolve the sample. Samples were found to dissolve in Trichlorobenzene (TCB). Enclosed are refractive index chromatograms for each sample, as well as their cumulative weight fraction curves and molecular weight distribution curves. A calibration curve and chromatographic overlay of the standards are included. The average molecular weights are summarized in **Table 1**. An overlay of the refractive index (RI) signals, cumulative weight fraction curves and MW distribution curves can be found below.

Table 1.
Average Molecular Weight
Relative to polystyrene standards

8 Inch Pipe

Sample	Mn	Mw	Mz	Mw/Mn
2014-09-04_14;21;03_8947_8inchpipe_02.vdt	16,595	389,484	2.078 e 6	23.469
2014-09-04_14;52;45_8947_8inchpipe_03.vdt	16,006	399,889	2.078 e 6	24.983

Fitting

Sample	Mn	Mw	Mz	Mw/Mn
2014-09-04_15;56;11_8947_fitting_02.vdt	11,213	393,717	2.399 e 6	35.111
2014-09-04_16;24;19_8947_fitting_03.vdt	11,491	406,002	2.401 e 6	35.332

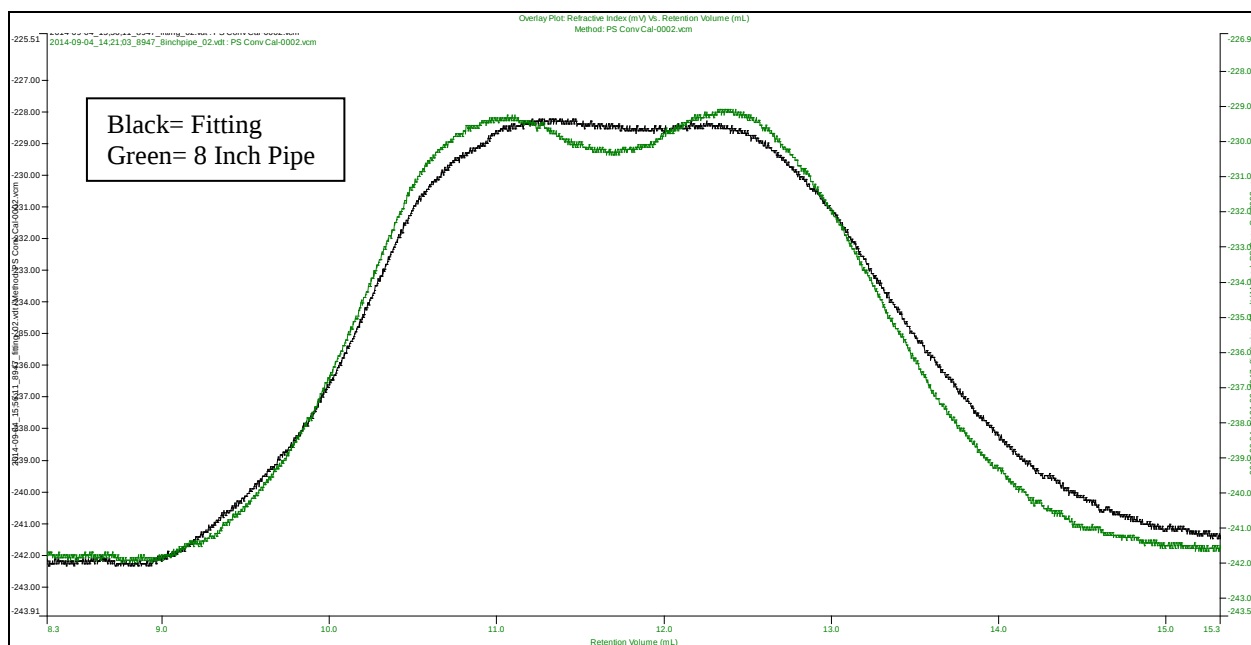


Figure 1: Overlay of Refractive Index (RI) signals for samples.

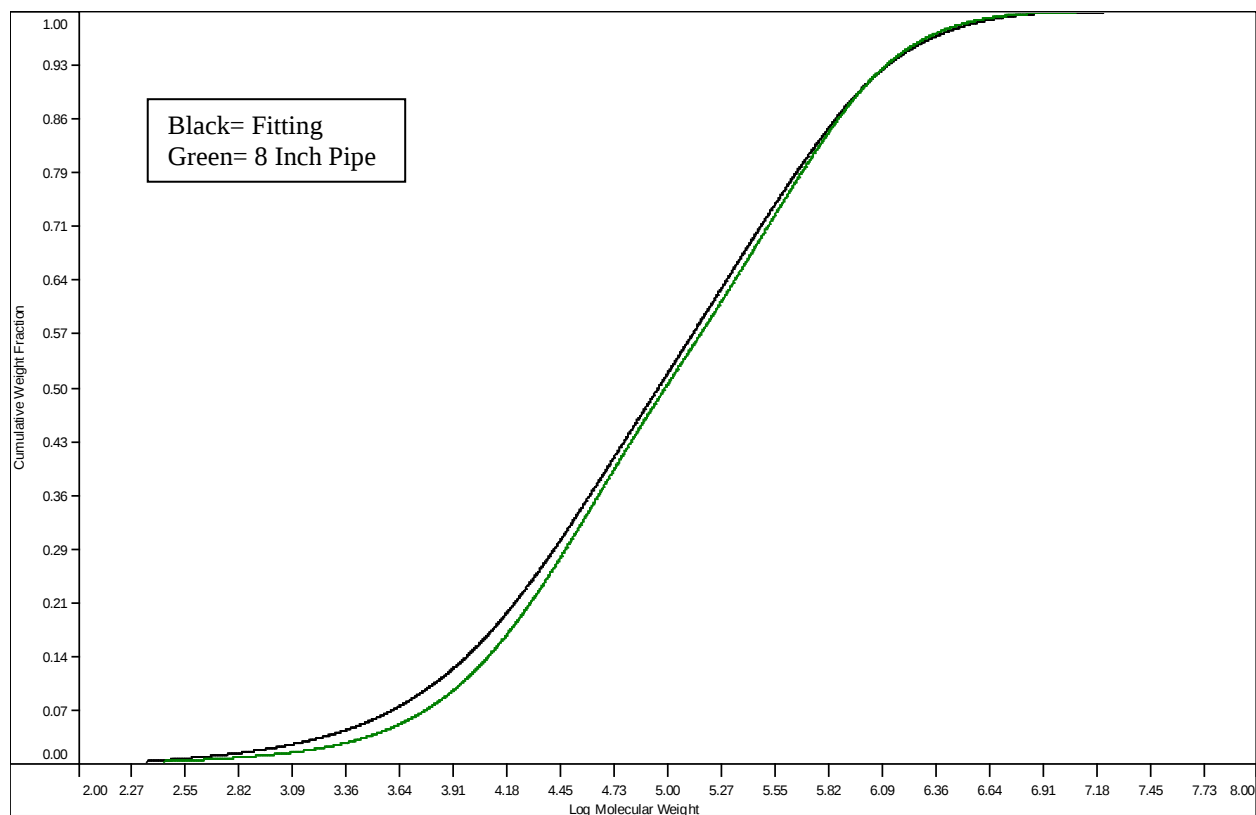


Figure 2: Overlay of cumulative weight fraction curves for samples.

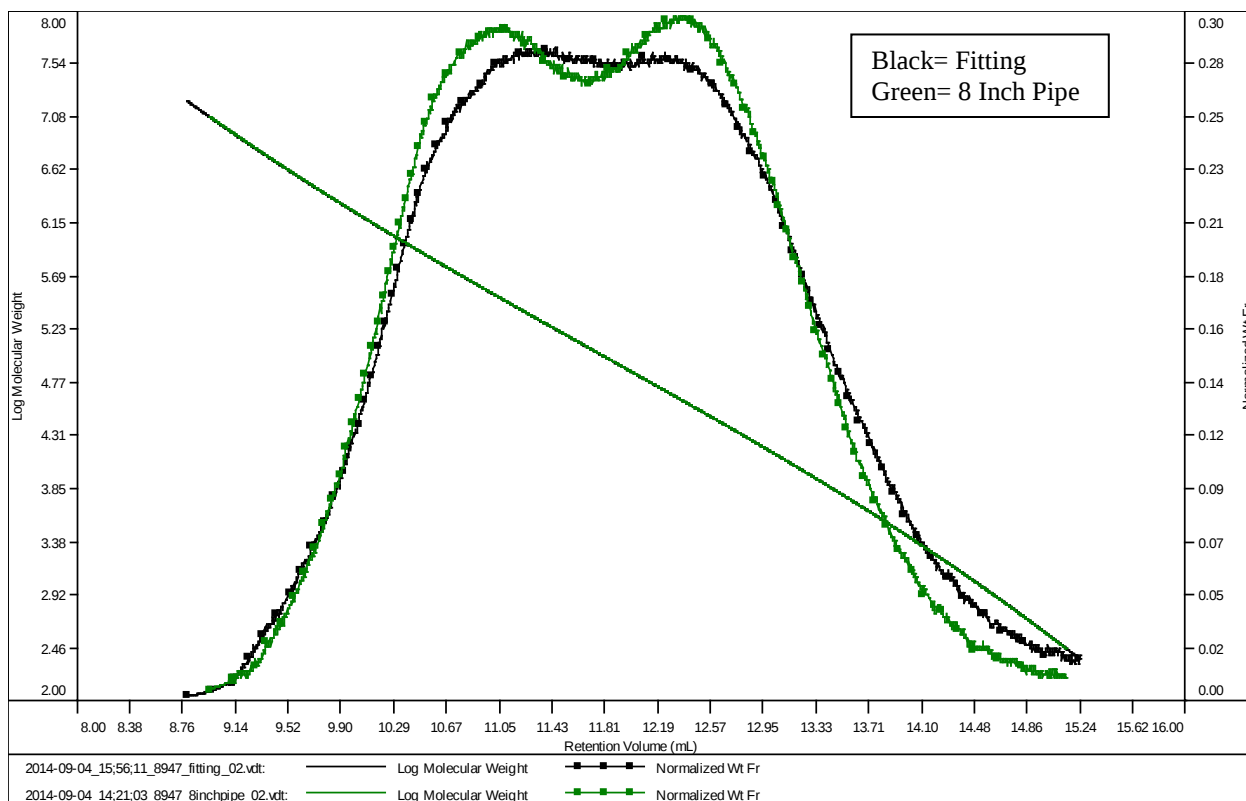


Figure 3: Overlay of Mw distribution curves for samples.

Analysis Conditions

GPC-H

The samples were dissolved in Trichlorobenzene (TCB) to a concentration of ~2.5 mg/ml with 1.0 mg/ml antioxidant added. The samples were placed on a 150°C stir plate for 75 minutes for dissolution prior to analysis. The samples were then filtered using a high temperature filtration unit, and stored at 120° C.

The system was run at a flow rate of 1.0 ml/min on 2x PLgel Mixed B LS columns, 300 x 7.5 mm each. The column temperature was maintained at 160°C. Injection size was 200µL of the sample solution. Polystyrene standards with a concentration of 0.5 mg/ml were used (Molecular weight as follows: 8910K, 4410K, 1044K, 549K, 277K, 130K, 17.6K, 8.4K, 3.25K & 474) with injection size of 200 µL. The samples were monitored using a Viscotek 350A HT-GPC instrument. Data acquisition and handling was made with VISCOTEK OMNISEC software.

Closing Comments

Jordi Labs' reports are issued solely for the use of the clients to whom they are addressed. No quotations from reports or use of the Jordi name is permitted except as authorized in writing. The liability of Jordi Labs with respect to the services rendered shall be limited to the amount of consideration paid for such services and do not include any consequential damages.

Jordi Labs specializes in polymer testing and has 25 years experience doing complete polymer deformulations. We are one of the few labs in the country specialized in this type of testing. We will work closely with you to help explain your test results and solve your problem. We appreciate your business and are looking forward to speaking with you concerning these results.

Sincerely,



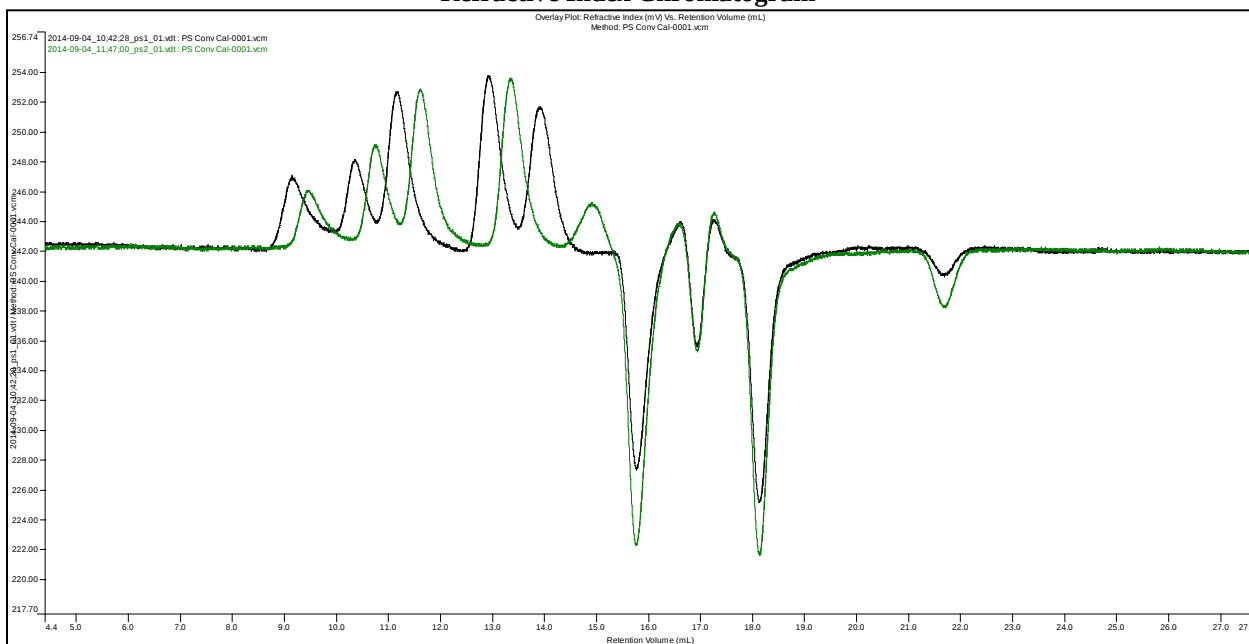
Laurie Scharp
Chemist
Jordi Labs LLC



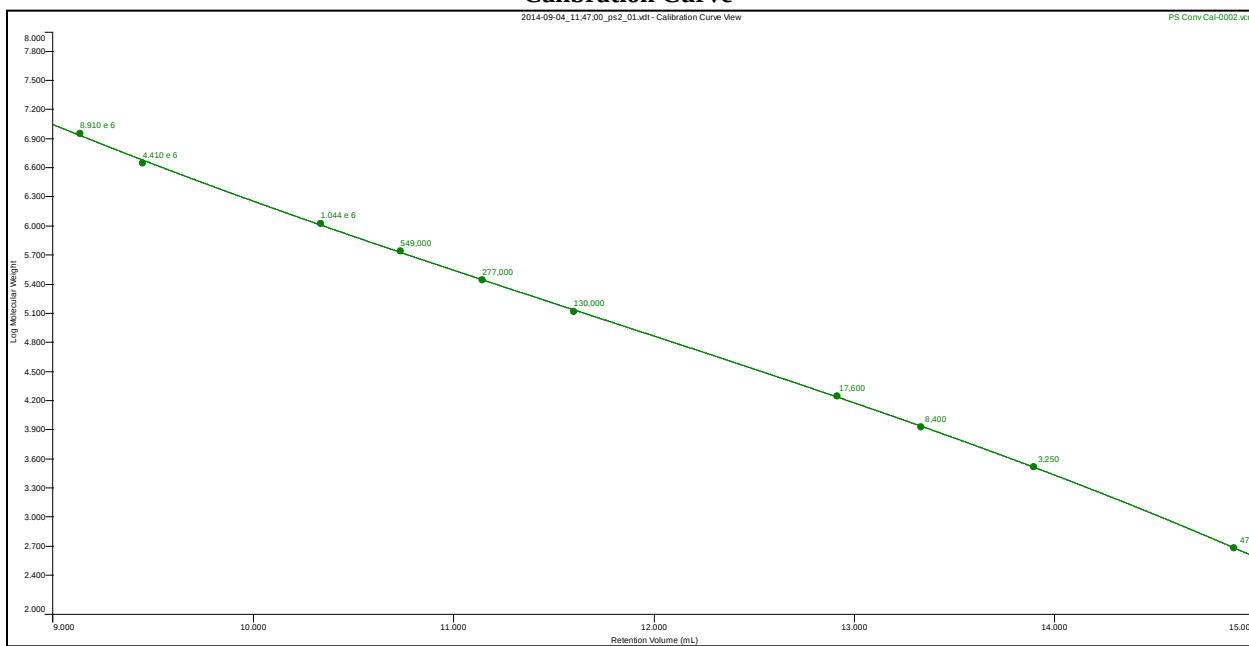
Howard Jordi, Ph. D.
Founder
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GPC-H Data

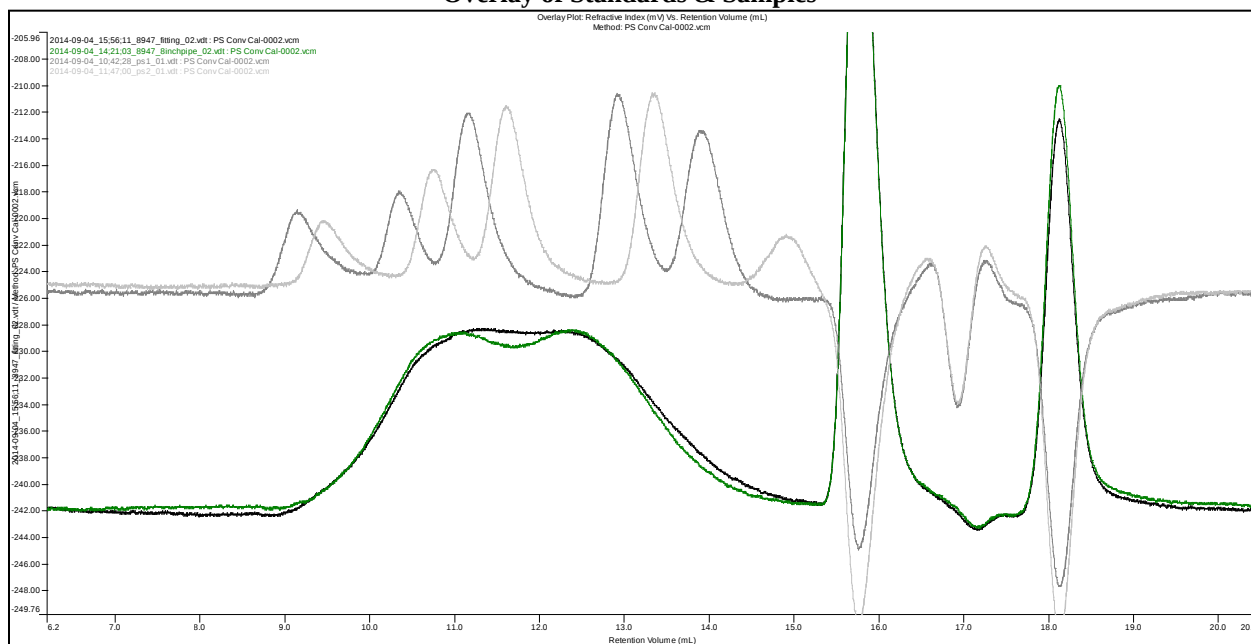
Normalized Overlay of Polystyrene Standards Refractive Index Chromatogram



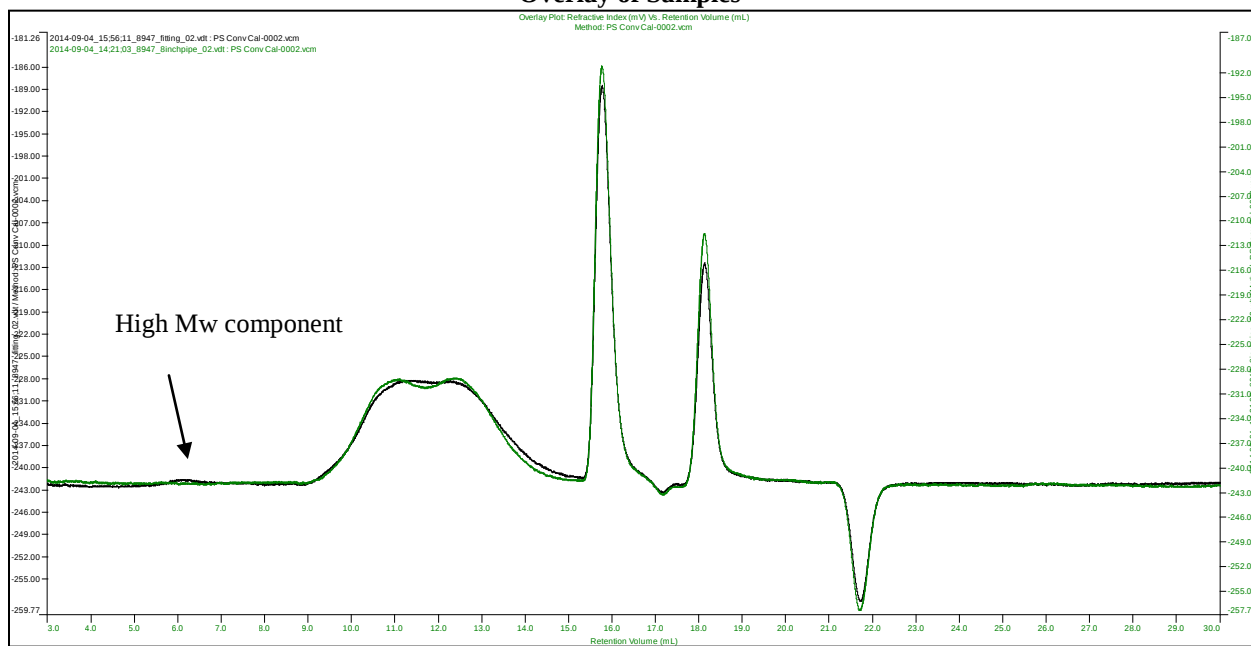
Calibration Curve



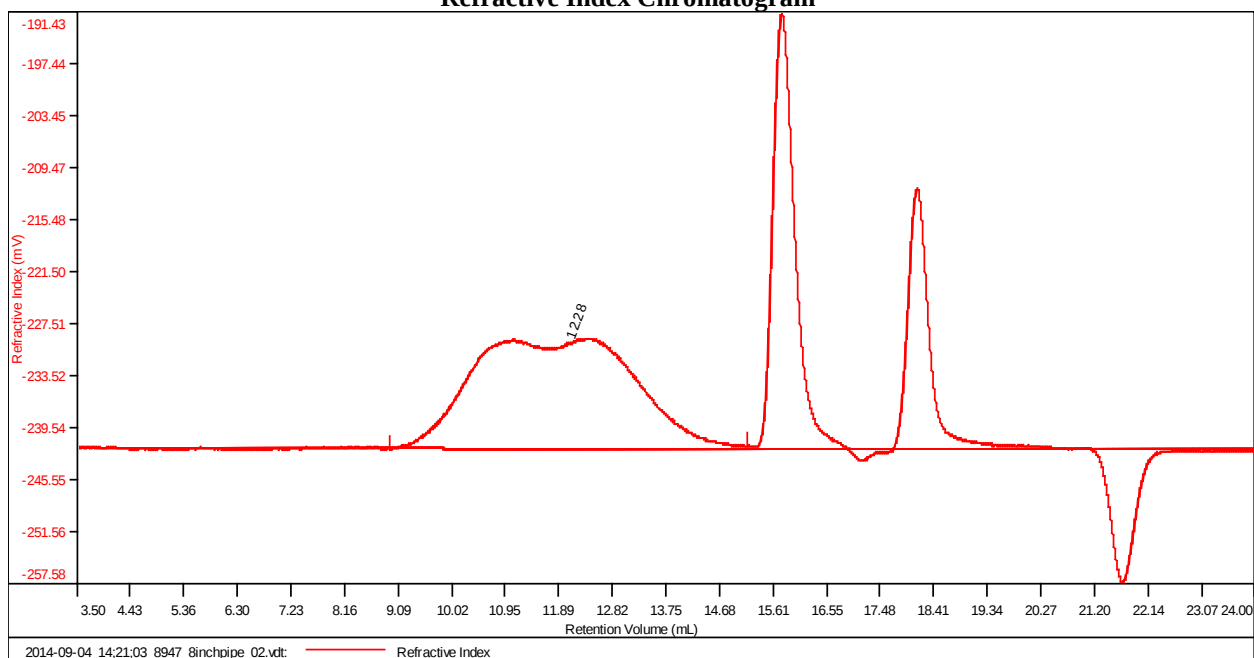
Overlay of Standards & Samples



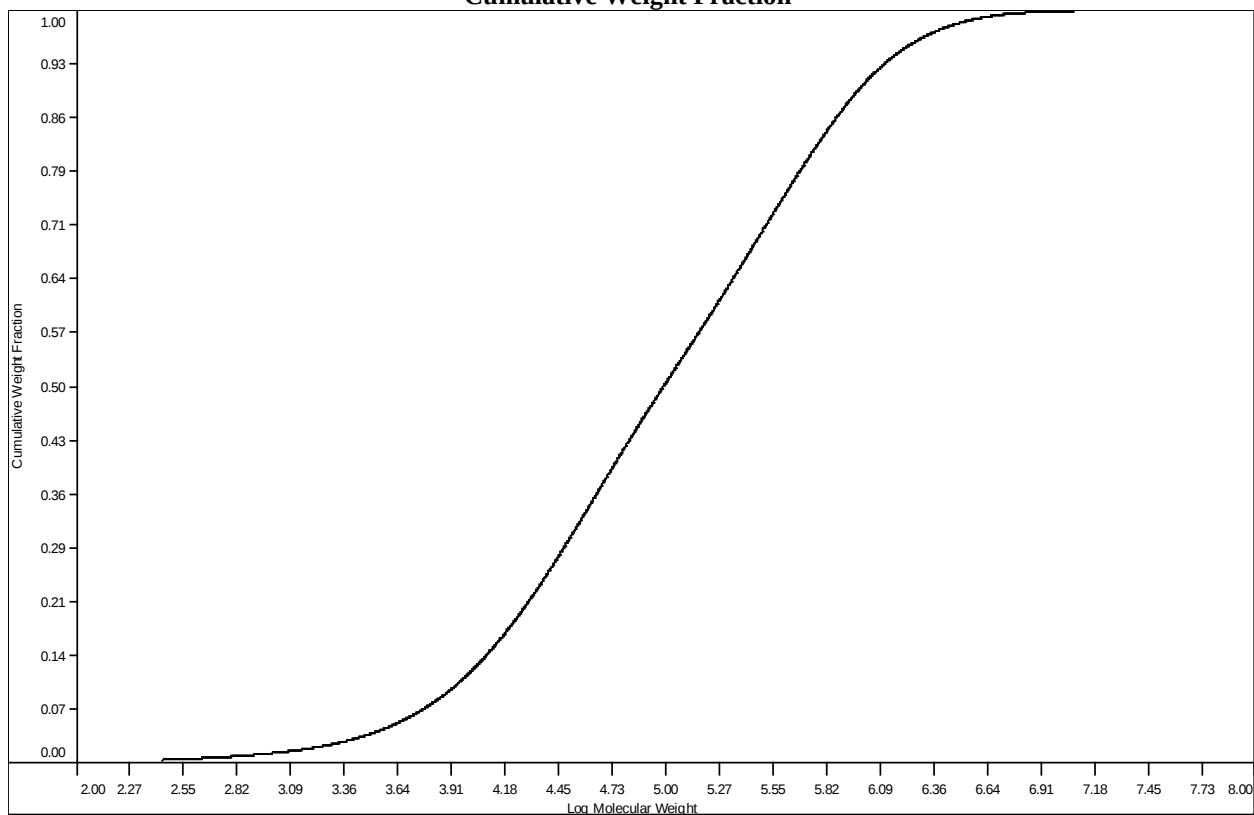
Overlay of Samples



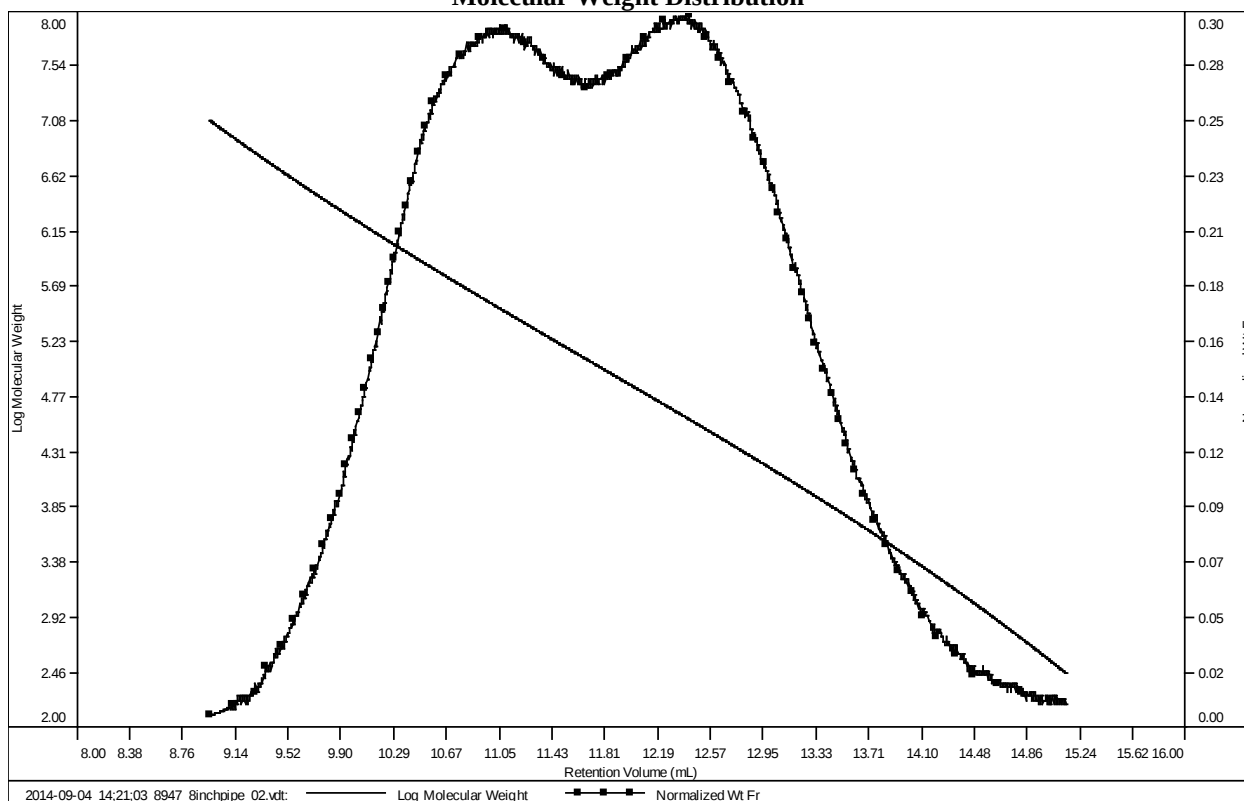
**Sample 8 Inch Pipe
Refractive Index Chromatogram**



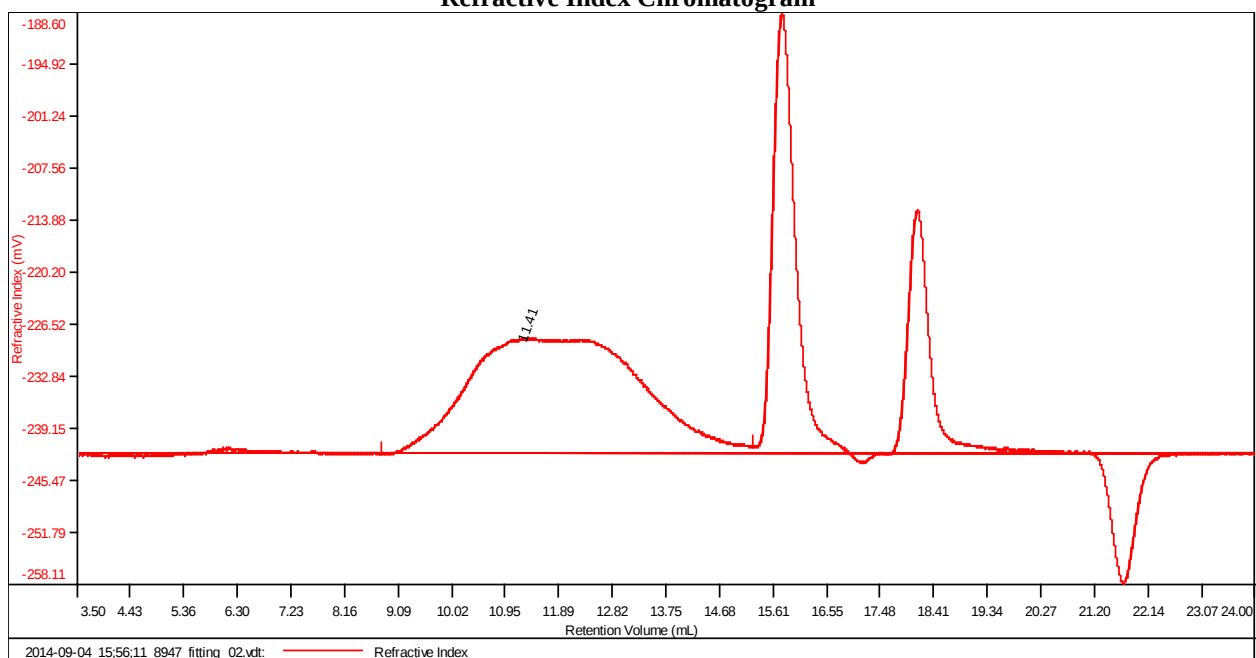
**Sample 8 Inch Pipe
Cumulative Weight Fraction**



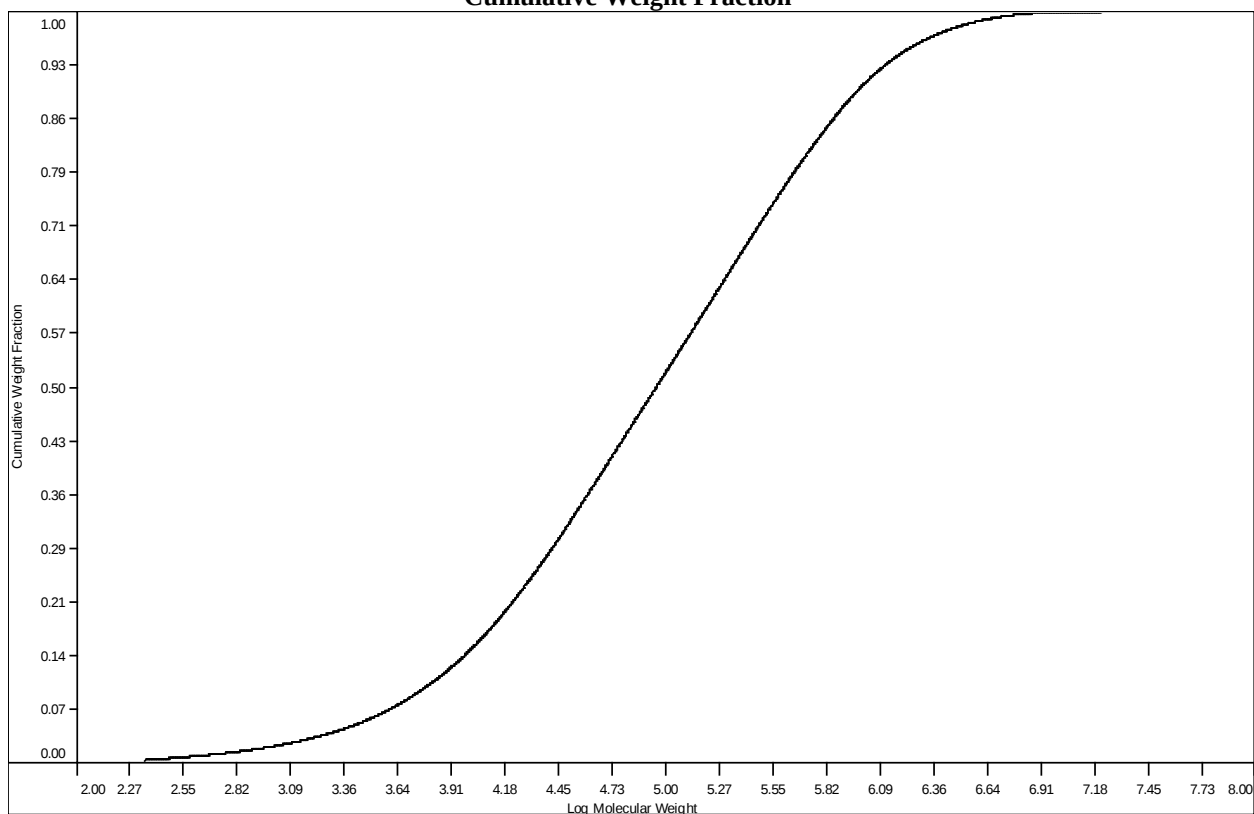
Sample 8 Inch Pipe Molecular Weight Distribution



Sample Fitting Refractive Index Chromatogram



Sample Fitting Cumulative Weight Fraction



Sample Fitting Molecular Weight Distribution

