# Options for Removing Methanol from NGL in an Amine Treater


## Abstract

Methanol is commonly injected into hydrocarbon fluids to inhibit hydrate formation. Bulk methanol removal from a hydrocarbon fluid often occurs through separators as it is processed. However, a small amount of methanol in a processing plant's feed can often result in high concentrations (greater than 1,000 ppm) in the natural gas liquid (NGL) product. This work evaluates several methods for removing enough methanol in the amine sweetening unit to meet NGL specifications. It also discusses strategies for preventing methanol buildup in the NGL by understanding the phase behavior through the entire plant. A complete model of the operating plant was created and compared to operating data to make impactful decisions for operating the plant. This paper shows that methanol concentrations in the NGL product can be reduced in the amine treating system by increasing the condenser temperature, increasing amine solvent circulation rate, decreasing the lean amine loading, decreasing stripper pressure, and purging some or all of the stripper reflux.



## Submitted to SOGAT 2017 by:



*Justin C. Slagle*

*Sr. Consulting Engineer*

*Bryan Research & Engineering, Inc.*

*J.Slagle@bre.com*

*+1 979-776-5220*

*Donnie Joe Worth*

*Consulting Engineer*

*Bryan Research & Engineering, Inc.*

*D.Worth@bre.com*

*+1 979-776-5220*

*Jesus Mejorada*

*Engineering Manager*

*Empire Gas Services, LLC*

JesusM@gasempire.com

361-550-7438

## 1.0 INTRODUCTION

Hydrate formation is caused by numerous factors but, it is ultimately a function of pressure and temperature in the presence of water and hydrocarbons [1]. Because natural gas is generally saturated with water before processing, there are two common hydrate prevention methods: removing water from the gas stream and/or injecting a hydrate inhibitor, such as methanol. Methanol injection is often used for remote natural gas production where dehydration facilities are limited.

Methanol may be injected at several locations before it reaches a natural gas processing facility for natural gas liquid (NGL) removal, and it is common for the methanol flowrate entering the processing facility to be unknown.

Once the gas enters the processing facility it proceeds through a series of separators which provide bulk methanol removal. As NGL is recovered from the gas, high concentrations of methanol can be found in the NGL product [2]. When the NGL is processed into products, the methanol will follow the propane, often leading this product to be off specification. Therefore, methanol in the NGL product needs to be prevented or reduced.

One option to remove methanol from the NGL is to use a water wash. In many cases this option leads to very large amounts of water losses and contaminates the NGL with water, again putting it off specification. Another option is to attempt methanol removal in the NGL amine unit which may already be treating the NGL to remove $CO_2$.

The previous work by O'Brien, et al. provides significant background on the sources of methanol, common methanol NGL specifications, and a case study for Anadarko Petroleum Corporation's Chipeta plant in Utah, USA [2]. This paper also includes data from the GPA Research Report 184 showing the methanol phase behavior in amine solution [3]. **Table 1** shows the comparison of this research data to ProMax® Predictions.

***Table 1**: GPA RR184 Data Compared to ProMax® Predictions*

| | | MeOH in Amine Solution | MeOH in Vapor | |
|---|---|---|---|---|
| T (°F) | P (psia) | Data (%) | Data (ppm) | ProMax®(ppm) |
| 80 | 1000 | 1.197 | 63 | 64 |
| 80 | 1500 | 1.196 | 52 | 52 |
| 120 | 1000 | 1.194 | 224 | 172 |
| 120 | 1500 | 1.194 | 169 | 132 |
| 120 | 1000 | 1.15 | 208 | 176 |
| 150 | 52.5 | 1.16 | 4640 | 4998 |

The data from Anadarko's Chipeta plant and the GPA Research Report 184 establish benchmarks of a wide range of operating conditions. The O'Brien, et al. paper used ProMax® to evaluate process improvements for methanol reduction in NGL streams. This work seeks to expand on the ideas O'Brien and his coauthors presented, specifically surrounding the operation of the amine sweetening unit.

## 2.0 REMOVING METHANOL FROM NGL USING AN AMINE SWEETENING UNIT

In 2016, a plant operating in Texas, USA experienced methanol concentrations exceeding 1,200 $ppm_w$ in the NGL product. The NGL proceeded through an amine sweetening unit which only managed to reduce the methanol to 350 $ppm_w$, well above the 200 $ppm_w$ specification. The plant is outlined in **Figure 1**.

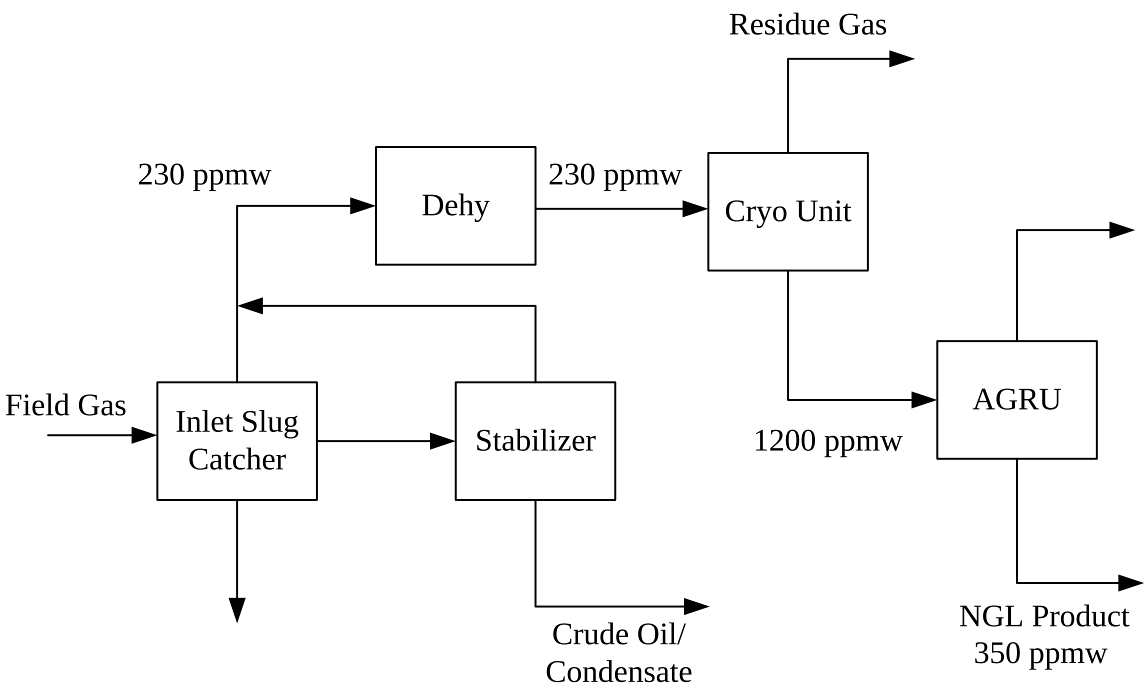


***Figure 1**: Methanol Concentrations in the Texas Gas Processing Plant*

Plant operations were modified to meet both methanol and $CO_2$ specifications in the Texas plant. Shown in **Figure 2**, the following amine sweetening unit variables were considered during optimization:

- Regenerator Condenser Temperature
- Solvent Circulation Rate
- Lean Loading/Reboiler Duty
- Stripper Pressure
- Reflux Purge

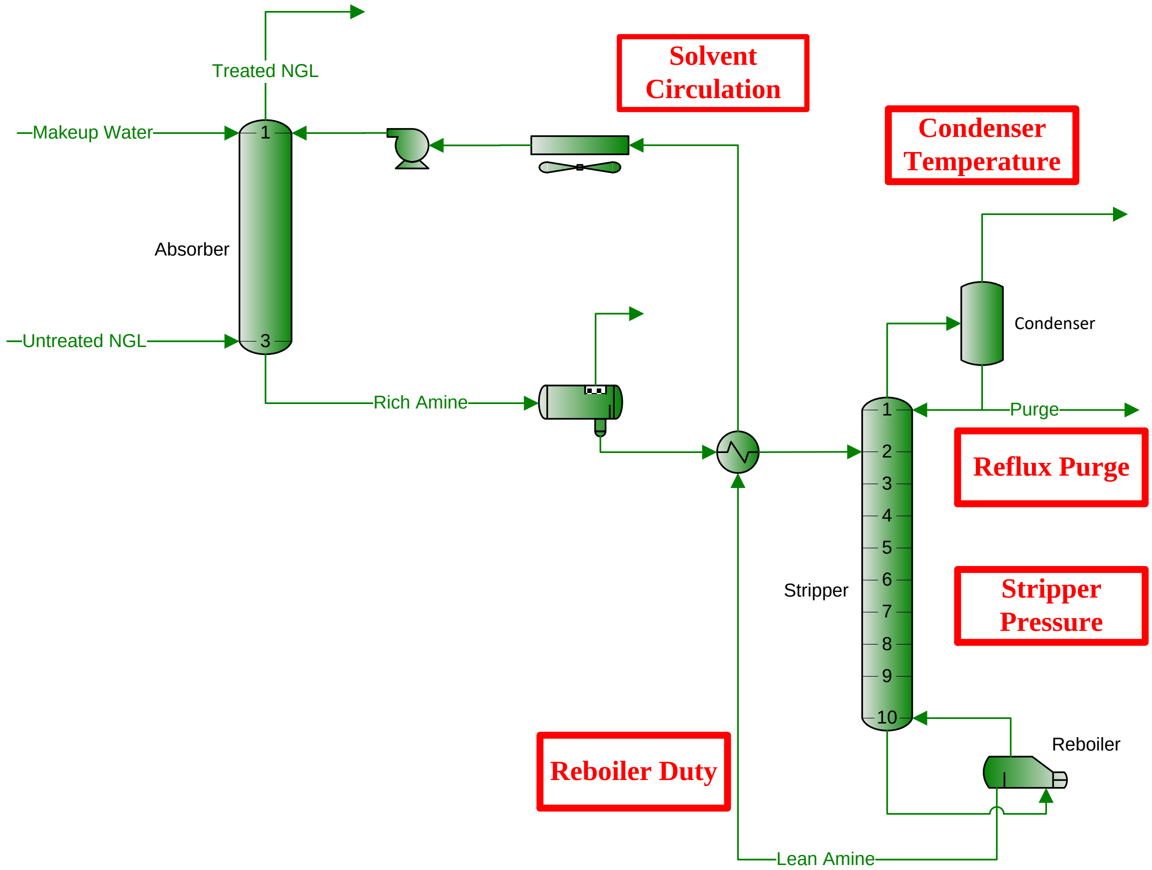


***Figure 2:*** *Texas Plant's NGL Treater (Considered Variables are Bold and Red)*

### 2.1 Condenser Temperature

The condenser section of the amine stripper contains the highest concentration of methanol in the system. Because methanol has a low boiling point, increased condenser temperatures result in more methanol in the vapor leaving the condenser. Doing so reduces the NGL methanol concentration and increases water losses from the amine solvent. This relationship is shown in **Figure 3**.

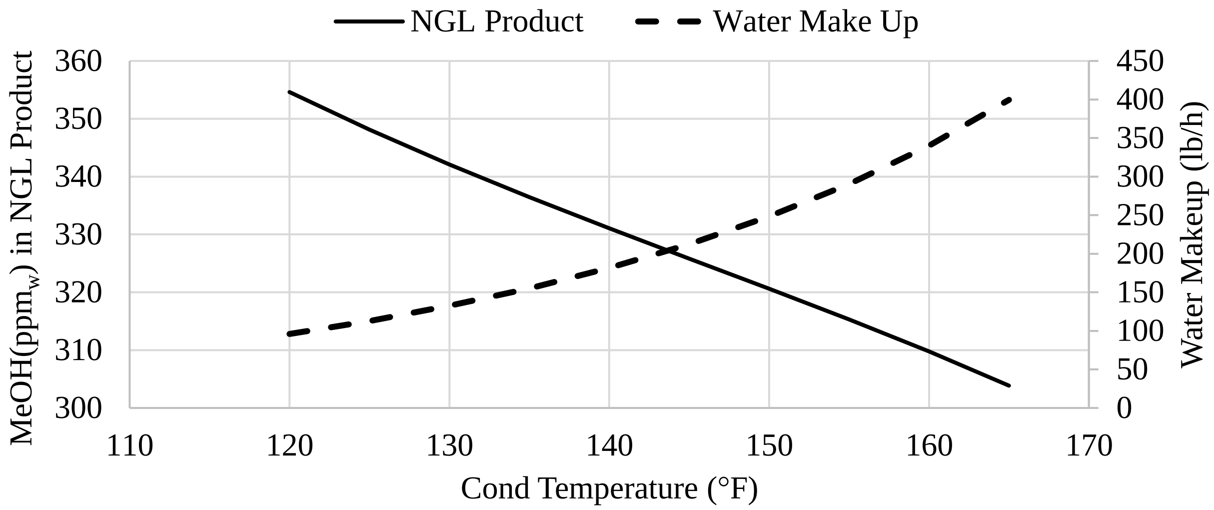


***Figure 3**: NGL Methanol Content and Water Makeup vs. Condenser Temperature*

Increasing the condenser temperature from 120 °F to 165 °F has the potential to reduce the NGL methanol content from 355 to 305 ppm$_w$, but it increases water losses by 300 lb/h. This option is economically better than installing a water wash but does not reduce NGL methanol concentrations to the desired specification.

**2.2 Solvent Circulation Rate**

The solvent circulation rate was evaluated with a constant condenser temperature of 140 °F. The trend is shown in **Figure 4**.

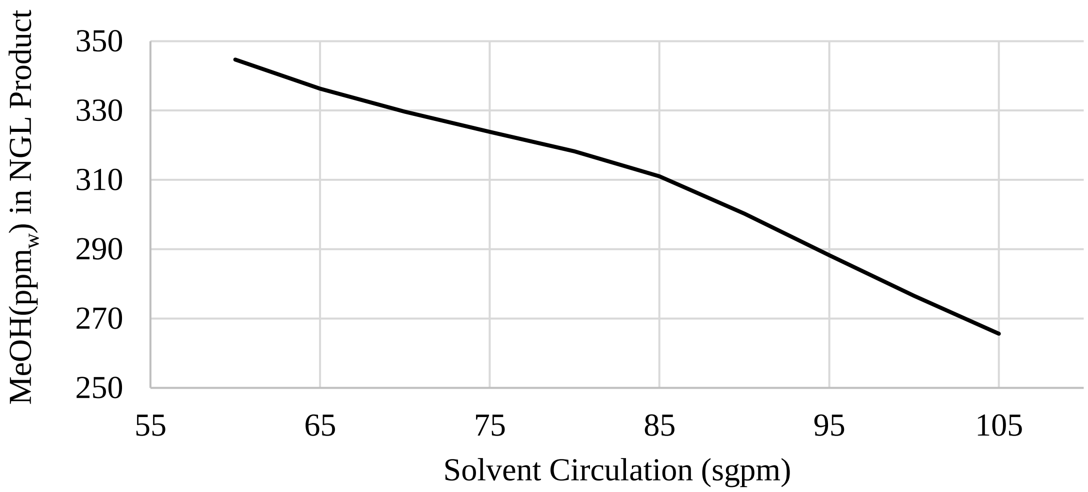


***Figure 4**: The Effect of Solvent Circulation Rate on NGL Methanol Content*

There is a clear trend showing a reduction of methanol in the NGL with increasing solvent circulation rates. This trend will likely result in a higher reboiler duty, as amine sweetening rules of thumb indicate that doubling solvent circulation rates also doubles reboiler duties [4].

### 2.3 Reboiler Duty

The stripper generates steam in the reboiler to remove $CO_2$ from the rich solvent, and increased reboiler duties increase steam generation. Because the boiling points of water and methanol are 250 °F and 183 °F, respectively [5], at 30 psia (the operating pressure of the regenerator), methanol concentrations in the lean amine stream are reduced as the reboiler duty is increased. As the steam generation increases, it strips the $CO_2$ and methanol from the rich solvent. While the reboiler temperature will remain constant at the solvent boiling point, the column temperature profile will shift according as the reboiler duty changes. When the duty increases, the column will have high temperatures farther up the column, continuing to vaporize more methanol.

The trend in **Figure 5** shows the NGL methanol content decreasing as the reboiler duty increases. At a 140 °F condenser temperature and 70 sgpm solvent circulation rate, the 200 $ppm_w$ methanol concentration spec is met with a duty ratio of 880 BTU per gallon of solvent being circulated.

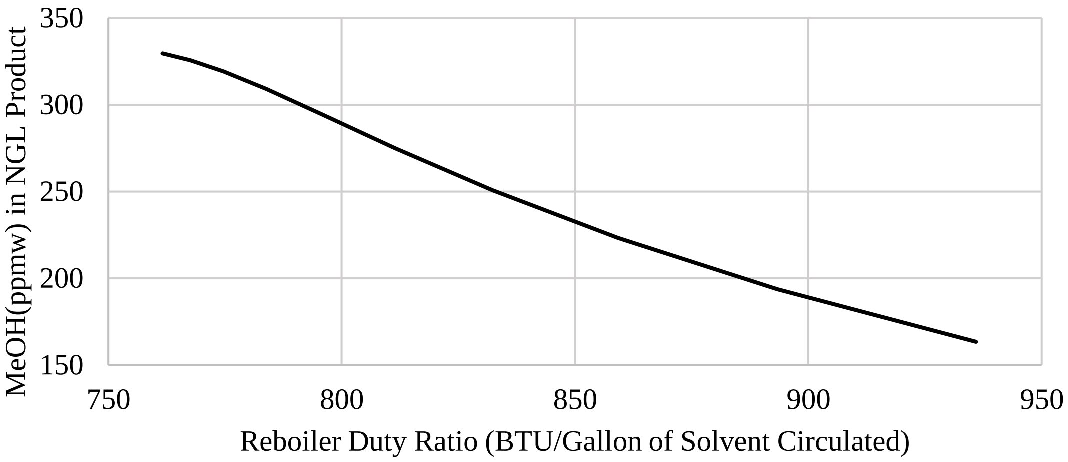


***Figure 5****: NGL Methanol Content vs. Reboiler Duty Ratio at 70 sgpm Solvent Circulation Rate and 140 ℉ Condenser Temperature*

### 2.4 Stripper Pressure

As previously mentioned, increasing the reboiler duty is one way to increase water vaporization and $CO_2$ removal from the rich amine solvent. Another way is to decrease the stripper pressure, which lowers the solvent boiling point temperature. The previous variables were evaluated for a stripper operating at 30 psia. Steam production should increase if the pressure is decreased at constant reboiler duty because the boiling point of the solvent decreases. Shown in **Figure 6**, this increased methanol and water vaporization results in lower NGL methanol concentrations and higher water losses from the amine solvent.

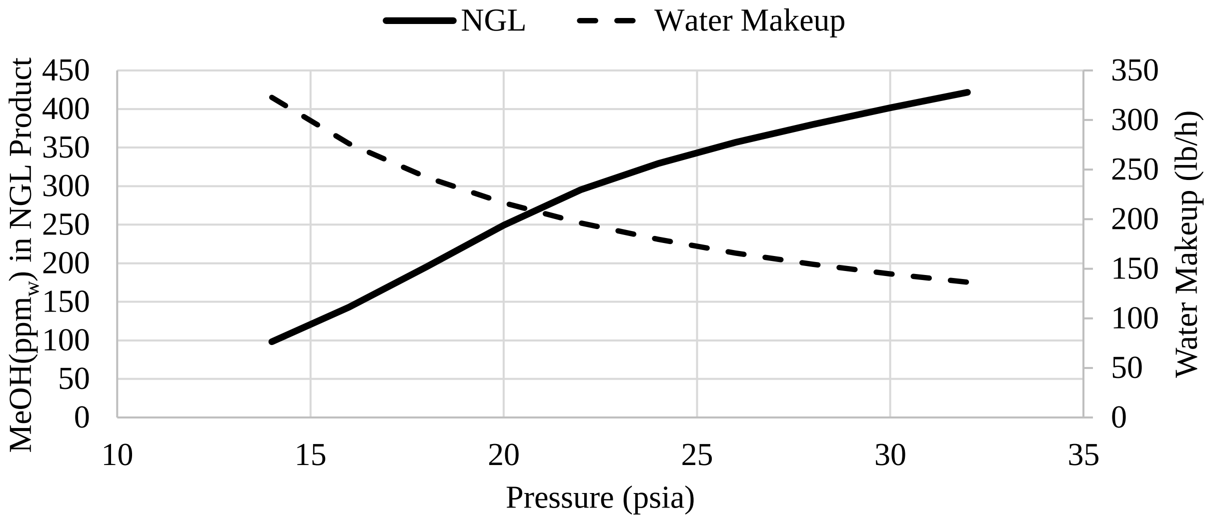


***Figure 6****: Stripper Pressure Impact on Methanol in the NGL and Water Makeup*

### 2.5 Reflux Purge

The final evaluated variable was the stripper reflux purge rate. In the stripper reflux stream, component concentrations are highest for methanol, minimal for $CO_2$, and negligible for amine. This was the solution chosen by the Anadarko Chipeta plant to lower methanol in the NGL product. This plant purged 100% of the reflux in one train because the reflux rate was too low to easily return only a fraction of the reflux to the stripper. The second train was optimized to purge 10-15% of the reflux, returning the balance to the stripper [2].

The Texas plant's reflux purge effects are shown in **Figure 7**.

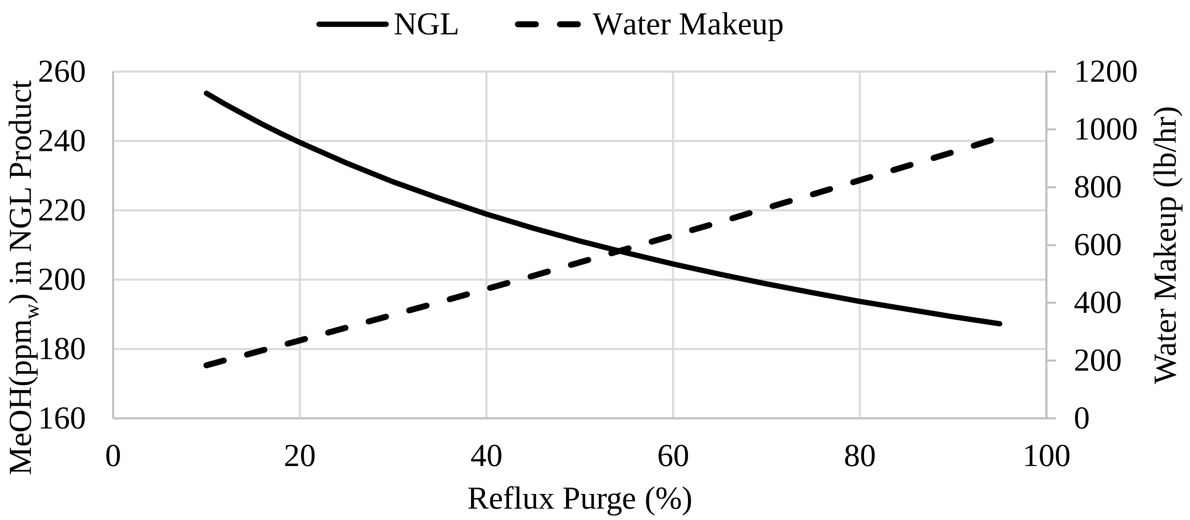


***Figure 7****: Reflux Purge Effect on Methanol in the NGL and Water Makeup*

As expected, the methanol in the NGL decreases as more reflux is purged. In fact, if the plant makes no other alterations, the NGL methanol specifications are satisfied at a 70% purge.

However, meeting the specification comes at the expense of nearly 800 lb/hr of water – more than double the water losses seen with other options.

## 3.0 DISCUSSION

Each plant is unique, leading to different solutions. While the Chipeta plant chose to use a reflux purge, the Texas plant implemented an "all of the above" approach.

Instead of changing one variable, the Texas plant was able to meet NGL specifications by making small changes in condenser temperature, solvent circulation, reboiler duty, and stripper pressure. The plant only considers a reflux purge when there is a sudden increase in the inlet methanol. Once the changes were made, the Texas plant reported methanol levels below the 200 $ppm_w$ threshold in the treated NGL.

### 3.1 Max Inlet Methanol to the Plant

The maximum methanol concentrations the plant can accept while keeping methanol in the NGLs below 200$ppm_w$ is shown in **Table 2**.

***Table 2****: Maximum Treatable Methanol Concentrations vs. Current Operating Conditions*

| | Cryo Inlet ($ppm_w$) | NGL Treating Inlet ($ppm_w$) | Treated NGL ($ppm_w$) |
|---|---|---|---|
| Maximum | 1,700 | 5,400 | 200 |
| Current | 230 | 1,245 | 200 |

The maximum values shown in **Table 2** exhaust the methanol mitigation options evaluated while maintaining a 100% reflux purge. With the current equipment, this plant cannot accept gas with methanol concentrations higher than 1,700 $ppm_w$.

## 4.0 CONCLUSION

Methanol has been increasingly identified as a contaminant in NGL production and processing. This paper shows how facilities can use their existing equipment to provide necessary methanol removal. Anadarko's Chipeta plant discussed in O'Brien, et al. and the Texas plant discussed in this work used the model to successfully troubleshoot and evaluate plant operations with changes in the field properly represented by the model. The two facilities used one or more of the following plant adjustments to meet NGL specification:

- Increase condenser temperature
- Increase solvent circulation rate
- Decrease lean loading
- Decrease stripper pressure
- Purge some or all of the stripper reflux

The Texas plant is currently maintaining less than 200 $ppm_w$ methanol in the NGL products.

## Works Cited


[1] A. L. Kohl and R. Nielsen, Gas Purification, Gulf Professional Publishing, 1997.

[2] D. O'Brien, J. Mejorada and L. Addington, "Adjusting Gas Treatment Strategies to Resolve Methanol Issues," in *Laurance Reid Gas Conditioning Conference*, Norman, 2016.

[3] G. P. Association, "GPA RR-184: Vapor-Liquid Equilibrium Studies on Water-Methanol-MDEA-Hydrocarbon Systems," 2003.

[4] L. Addington and C. Ness, "An Evaluation of the General "Rules of Thumb" in Amine Sweetening Unit Design and Operation," 2010.

[5] Bryan Research & Engineering, Inc., "ProMax 4.0," Bryan, 2015.