Coalbed-Methane Produced-Water Treatment

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Project Objective

The objective of this project is to demonstrate that treatment of Coalbed-Methane (CBM) produced water, by ozonation, magnetic seeded filtration, and electrosorption, to discharge criteria is possible. The reuse of produced water could alleviate issues of storing the waste water, as well as providing clean water in dry areas of the country where it is desperately needed.

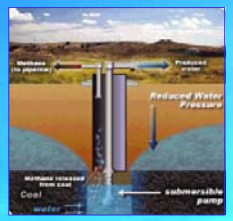

Figure 1. diagram of coalbed-methane extraction process.[1]

Background

CBM accounts for about 7.5 percent of the total natural gas production in the United States. Along with this gas, water is also brought to the surface. The amount of water produced from most CBM wells is relatively high compared to conventional natural gas wells because coal beds contain many fractures and pores that can contain and transmit large volumes of water. The physical and chemical properties of produced water vary depending on the geographic location of the field, the geological formation in which the produced water has been in contact for thousands of years and the type of hydrocarbon product being produced. Produced water properties and volume can also vary throughout the lifetime of a reservoir.

The major contaminants of produced water are:

1.Total Dissolved Solids or minerals including;
- a. Bicarbonate/carbonate ions
- b. Sodium ions
- c. Chloride ions

2.Organics

This project is focused on CBM produced-water treatment by a combination of approaches including (i) ozonation, (ii) magnetically seeded filtration, and (iii) electrosorption. The experiments presented in this poster pertain to the first approach, ozonation.

Ozonation/UV has been shown to achieve the following contaminant reductions from the aqueous phases:
- 99%+ removal of Volatile Organic Compounds
- Between 50 and 99+% removal of Polycyclic Aromatic Hydrocarbons
- Between 10 and 99+% removal of phenolics
- Between 20 and 90% removal of cyanide
- Between 20 and 99% removal of sulfide

Materials and Methods

Ozonation

1. Air to O_3 generator
2. O_3 out to system
3. O_3 to gas liquid reactor
4. O_3 to UV (O_3 Trap)
5. Reacted stream O_3 to spectrophotometer
6. O_3 to hood from spectrophotometer
7. Reacted O_3 to hood
8. Reacted O_3 to flow meter

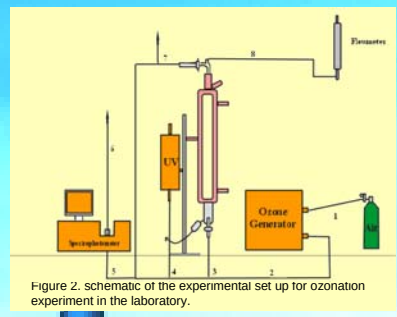

Figure 2. schematic of the experimental set up for ozonation experiment in the laboratory.

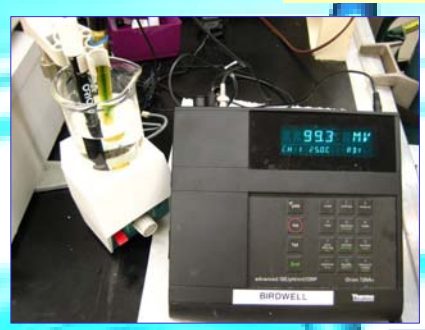

Figure 3. Picture of Ion Selective Electrode.

Chloride Ion Analysis

Samples were diluted 17 fold in distilled water. Ionic Strength Adjustor was added. Chloride ion was measured using an Ion Selective Electrode.

Carbonate/Bicarbonate Measurements

By using a 0.01 N HCl solution samples were titrated from pH 6.29 (untreated) and 5.92 (treated) to pH 3.7, using a Metro-Ohm Titrino.

Figure 4. Picture of Metro-Ohm Titrino.

Figure 5. Picture of HP 5890 II series Gas Chromatograph.

Organic Content Measurements

Samples were acidified from pH 6.29 (treated) and 5.92 (untreated) to pH 2 using a 1 N HCl solution. Organic materials were extracted using methylene chloride and spiked using 2,4,6 tribromophenol in methylene chloride. Samples were analyzed using HP 5890 II series Gas Chromatograph.

Results

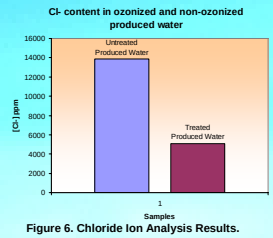

Figure 6. Chloride Ion Analysis Results.

Sample	$[HCO_3^-]$ ppm	$[CO_3^-]$ ppm
Untreated PH_2O	2.51	1590
Treated PH_2O	0.019	3.51

Figure 7. Carbonate/ Bicarbonate analysis Results.

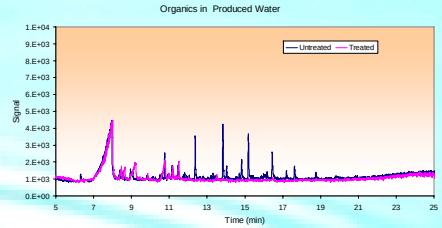

Figure 8. Organic Content Measurements Results.

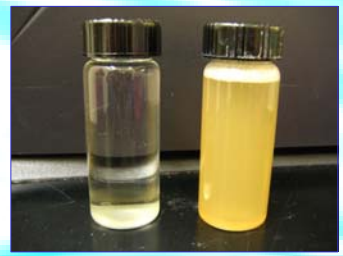

Figure 9. Picture of Samples before and after ozonation.

Conclusion

Chemical analysis revealed that there is a reduction in the amount of contaminants present in produced water. Salinity was reduced from about 14% to 5%. Based on the GC results, approximately one third of the organics were removed, this portion encompasses the longer-chain aliphatic hydrocarbons, and the n-alkanes (C_{12} to C_{19}). The same way the carbonate/ bicarbonate ions concentration were reduced to about to almost 0%.

Acknowledgments

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References

[1] ALL Consulting, Handbook on Coal Bed Methane Produced Water: Management and Beneficial Use Alternatives. Tulsa, Oklahoma : 2003 . American Public Health Association, American Water Works Association, Water Pollution Control Federation. STANDARD METHODS :For the Examination of Water and Wastewater . Washington ,DC: APHA, AWWA, WPCF, 1985.

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