



Analysis of Environmental Samples for Gamma Ray Producing Nuclides

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Introduction

This is a summary of the work flow for the analysis of the environmental samples to support the Bureau of Radiation Protection (BRP) investigation of samples from the oil and gas industry to determine the extent of naturally occurring radioactive materials (NORM). It is anticipated that the lab would expect to analyze 30 - 40 samples over a month long period. The samples could include the following matrices:

1. Drill Cuttings
2. Drill fluids/muds
3. Frac Sands
4. Flowback Fluids
5. Production Fluids

Additional samples for possible consideration include any new media found on site to check on their initial background levels (new sands, new drilling mud, etc.).

Sample Receipt

Two samples were received at the Ohio Department of Health Laboratory on November 20, 2012 at 10:20 am. (A copy of the Laboratory Analysis Request Form is attached). The samples were delivered by Mr. Robert Leidy and were received at room temperature. Upon receipt the sample information was input into the laboratory's sample receipt database, and chain of custody signed. The following sample identifiers were provided by Mr. Leidy:

- 1) BRP -02-019-001-PW – Production Water
- 2) BRP-02-067-001-US – Unused Sand

Sample Preparation

Samples were stored at room temperature until analysis. No additional sample preparation methods were used on the samples.

Sample Analysis

On the date of analysis the entire sample (production water) or a homogenized aliquot of the sample (e.g. unused sand) was then transferred to an air tight container for analysis. The samples were counted for two hours.

The samples were analyzed for gamma ray producing nuclides using high purity germanium detectors (HPGe). Samples were distributed among the four (4) gamma detectors in the laboratory.

- Canberra Model GC 2019
- Canberra Model BE2825 (2 instruments)
- Nuclear Data Model RG-11 BC

The data generated was analyzed using the APEX Software (Canberra v 1.3, 2011).

Please note that the sample analysis procedure for Radium – 226 and Radium – 228 is not validated for these matrices. The indirect measurement method using progeny radionuclides is employed for the analyses of Ra-226 and Ra-228 isotopes. The quantitation of Ra-226 is inferred from the quantitation of Pb-214 and Bi-214. The Ra-228 quantitation is inferred from the quantitation of Ac-228.^{1, 2, 3}

Results

The results for the gamma ray analysis of the six BRP samples received on November 20, 2012 are summarized in Table 1. Day 1 for the analyses is when the samples were transferred to the appropriate air tight containers and sealed with shipping tape. All the samples were counted on day 1 to measure the activity of radionuclides. These samples were then allowed to equilibrate for 21 days prior to counting to compare with the results obtained on Day 1. Samples were equilibrated to allow the radium progeny radionuclides to reach equilibrium: an equal decay rate of the elements in the decay chain from radium downwards.

References

1. Gilday, W. M., Edick, R. G., "An Investigation of Naturally Occurring Radioactive Materials (NORM) in Oil and Gas Wells in New York State", New York State Department of Environmental Conservation, April 1999.
2. Chang, K. M., "Analytical Methodology for the Determination of Radium Isotopes in Environmental Samples", International Atomic Energy Agency, Vienna, 2010, IAEA Analytical Quality in Nuclear Applications No. IAEA/AQ/19.
3. Rowan, E.L., Engle, M.A., Kirby, C.S., Kraemer, T.F., "Radium Content of Oil- and Gas-Field Produced Waters in the Northern Appalachian Basin (USA): Summary and Discussion of Data, Scientific Investigation Report 2011-5135 (US Geological survey).

Table 1: Analytical Results

BRP Sample Number	ODH Lab Sample Number	Sample Description	Date Sampled	Date Analyzed	Nuclides observed above MDA	Activity (day 1)*	Actual MDA	Activity (after 21 days)	Actual MDA	Units
BRP-02-019-001 PW	R6481-01	Production Water [#]	11/19/2012	11/20/2012	K-40	746 +/- 82.9	218	590 +/- 77.2	200	pCi/L
					Co-57		26.6	42.4 +/- 15.5	24.5	pCi/L
					Ru-103		27.8	1230 +/- 750	19.8	pCi/L
					Pb-212	275 +/- 18.3	35.6		26.7	pCi/L
					Bi-214 ^{a,1}	128 +/- 15.2	76.4	838 +/- 31.3	84	pCi/L
					Pb-214 ^{a,1}	135 +/- 12.8	77.2	947 +/- 29.6	46.7	pCi/L
					Ac-228 ^{b,1}	1110 +/- 26.5	90.6	1070 +/- 27.5	43.4	pCi/L
BRP-02-067-001 US	R6481-02	Unused Sand	11/19/2012	11/20/2012	K-40	0.169 +/- 0.0607	0.127	0.352 +/- 0.0793	0.0477	pCi/g

*Day 1 (Date and Time when the sample was transferred to a marinelli/jar, sealed and counted)

Sample **R6481-01**: 11/20/2012 @ 11:20 am

Sample **R6481-02**: 11/20/2012 @ 11:16 am

The sample results reported in pCi/L were calculated using the density of water (1000g/L). The actual density of individual samples was not measured due to the unique differences in the samples provided.

a - May be indicative of Ra-226

b - May be indicative of Ra-228

1 - Gilday, W. M., Edick, R. G., "An Investigation of Naturally Occurring Radioactive Materials (NORM) in Oil and Gas Wells in New York State", New York State Department of Environmental Conservation, April 1999.