

Technical Circular T-10/04

Date: November 4, 2004

To: All HQ Directors: Operations, Planning and Major Projects
All Regional Directors
All District Managers Transportation
All Project Managers

Subject: ARD TESTING AT QUARRY AND ROCK CUT SITES

Purpose:

This Technical Circular establishes a policy for the testing of Acid Rock Drainage (ARD) and Metal Leaching (ML) at quarry sites and within major rock cuts along highways.

Background:

The production or collection of acid rock drainage as a result of highway construction projects has become a widespread issue in British Columbia. Quarry sites used for the production of rock fills or rip rap materials may be susceptible to the production of ARD or metals leaching (ML). Rock cuts constructed as part of new highway construction may also be susceptible to ARD or ML.

Policy:

Where quarry or bedrock cut material is to be used for purposes of the Ministry of Transportation in the construction of rock fills or rip rap protection, the material must be evaluated for the potential production of ARD or ML. The Ministry will require that at least three representative test samples of the quarry or bedrock cut be analyzed for the potential to produce ARD or ML.

In private quarries, the Owner is required to engage a professional engineer or geoscientist (P.Eng. or P.Geo.) who is responsible for field mapping of the quarry, collecting representative rock samples from the areas of the quarry specifically being developed, completing a petrographic/mineralogical assessment of the potential for ARD or ML conditions, and, if required, commissioning the necessary laboratory tests to evaluate the potential for ARD or ML. A report summarizing the results of the evaluation is to be certified by the registered professional and presented to the Ministry. The professional is responsible to ensure that the evaluation reasonably represents the conditions within the currently proposed quarry development areas.

For new bedrock cuts, it is the responsibility of the designer to provide this assessment as part of the preliminary design process. This requirement will apply for any quantities of rock (quarry, fill or cut) exceeding 1000 cubic metres.

The following analytical procedures are generally recommended for ARD/ML prediction.

1) Initially, a petrographic/mineralogical assessment must be conducted to determine whether or not any sulphate or acid producing mineralogy is present within the rock. If these materials are not present, then no further work is required.

2) If acid production is deemed possible from the petrographic/mineralogical assessment, then at least three representative samples should be collected and acid-base accounting tests conducted.

Mineralogy and other geological properties:

- Acid-base accounting:
- petrographic and microscopic examination
 - total sulphate and sulphide-sulphur
 - bulk neutralization potential
 - carbonate content
 - pH

Where, one or more positive tests (ie. Indicate that ARD/ML is likely) occur, then at least three more tests must be conducted to disprove or show that the positive response was anomalous.

Accepted test methods for acid base accounting will include:

Sobek, et al 1978 – EPA 600/2-78-054

Or

Modified Acid Base Accounting – Coastech, 1989

*** See attachments for lab methodologies

Contact:

Robert G. Buchanan, P.Geo.

Senior Geoscientist

(250) 387-7702



Dirk Nyland, P.Eng.
Chief Engineer

W:\ENG\Shared\Circulars - Technical & General\Current Technical Circulars\
TCircs2004\TC10-04 ARD/ML on highways.doc

NEUTRALIZATION POTENTIAL – EPA (SOBEK) METHOD

Principles

The amount of neutralizing bases, including carbonates, present in overburden materials is found by treating a sample with a known excess of standardized hydrochloric acid. The sample and acid are heated to insure that the reaction between the acid and the neutralizers goes to completion.

The calcium carbonate equivalent of the sample is obtained by determining the amount of unconsumed acid by titration with standardized sodium hydroxide.

Comments

A fizz rating of the neutralization potential is made for each sample to insure the addition of sufficient acid to react all the calcium carbonate present.

During digestion, do not boil samples. If boiling occurs, discard sample and rerun. Before titrating with acid, fill burette with acid and drain completely. Before titrating with base, fill burette with base and drain completely to assure that free titrant is being added to the sample.

Chemicals

1. Carbon dioxide-free water: Heat distilled water just to boiling in a beaker. Allow to cool slightly and pour into a container equipped with ascarite tube. Cool to room temperature before using.
2. Hydrochloric acid (HCL) solution, 0.1N, certified grade (Fisher So-A-54 or equivalent).
3. Sodium hydroxide (NaOH), approximately 0.5 N; Dissolve 20.0 g of NaOH pellets in carbon dioxide-free water and dilute to 1 litre. Protect from CO₂ in the air with ascarite tube. Standardize solution by placing 50 ml of certified 0.1 N HCL in a beaker and titrating with the prepared 0.5 N NaOH until a pH of 7.00 is obtained. Calculate the Normality of the NaOH using the following equation:

$$N_2 = (N_1 V_1) / V_2, \text{ where}$$

V_1 = Volume of HCL used

N_1 = Normality of HCL used

V_2 = Volume of NaOH used

N_2 = Calculated Normality of NaOH

4. Sodium hydroxide (NaOH) approximately 0.1 N: Dilute 200 ml of 0.5 N NaOH with carbon dioxide-free water to a volume of 1 litre. Protect from CO₂ in air with ascarite tube. Standardize solution by placing 20 ml of certified 0.1 N HCL in a beaker and titrating with the prepared 0.1 N NaOH until a pH of 7.00 is obtained. Calculate the Normality of the NaOH.

5. Hydrochloric acid (HCL) approximately 0.5 N: Dilute 42 ml of concentrated HCL to a volume of 1 litre with distilled water. Standardize solution by placing 20 ml of the known Normality NaOH prepared in a beaker and titrating with prepared HCL until a pH of 7.00 is obtained.

Calculate the Normality of the HCL using the following equation:

$$N_1 = (N_2V_2)/V_1, \text{ where}$$

V_2 = Volume of NaOH used

N_2 = Normality of NaOH used

V_1 = Volume of HCL used

N_1 = Calculated Normality of HCL

6. Hydrochloric acid (HCL), approximately 0.1 N: Dilute 200 ml of 0.5 N HCL to a volume of 1 litre with distilled water. Standardize solution as before, but use 20 ml of the known Normality NaOH.
7. Hydrochloric acid (HCL), 1 part acid to 3 parts water: Dilute 250 ml of concentrated HCL with 750 ml of distilled water.

Materials

1. Flasks, Erlenmeyer, 250 ml
2. Burst, 100 ml (one required for each acid and one for each base)
3. Hot plate, steam bath can be substituted.
4. pH meter (Corning model 12 or equivalent) equipped with combination electrode.
5. Balance, can be read to 0.01 g.

Procedure

1. Place approximately 0.5 g of sample (less than 60 mesh) on a piece of aluminum foil.
2. Add one or two drops of 1:3 HCL to the sample. The presence of CaCO_3 is indicated by bubbling or audible "fizz."
3. Rate the bubbling or "fizz" in step 2 as indicated in Table 2.
4. Weigh 2.00 g of sample (less than 60 mesh) into a 250 ml Erlenmeyer flask.
5. Carefully add HCL indicated by Table 2 into the flask containing sample.
6. Heat nearly to boiling, swirling flask every 5 minutes, until reaction is complete.
NOTE: reaction is complete when no gas evolution is visible and particles settle evenly over the bottom of the flask.

Table 2: Volume and Normality of Hydrochloric Acid Used for Each Fizz Rating (from Sobek et al., 1978)

Fizz Rating	HCL (ml)	HCL (Normality)
None	20	0.1
Slight	40	0.1
Moderate	40	0.5
Strong	80	0.5

7. Add distilled water to make a total volume of 125 ml.

8. Boil contents of flask for one minute and cool slightly above room temperature. Cover tightly and cool to room temperature. CAUTION: Do not place rubber stopper in hot flask as it may implode upon cooling.
9. Titrate using 0.1 N NaOH (concentration exactly known), to pH 7.00 using an electrometric pH meter and burette. The concentration of NaOH used in the titration should correspond to the concentration of the HCL used in step 5. NOTE: Titrate with NaOH until a constant reading of pH 7.0 remains for at least 30 seconds.
10. If less than 3 ml of the NaOH is required to obtain a pH of 7.0, it is likely that the HCL added was not sufficient to neutralize all of the base present in the 2.00 g of sample. A duplicate sample should be run using the next higher volume or concentration of acid as indicated in Table 2.
11. Run a blank for each volume or normality using steps 5, 7, 8, and 9.

Calculations

1. Constant © = (ml acid in blank) / (ml base in blank)
2. ml acid consumed = (ml acid added) – (ml base added x C)
3. Tons CaCO₃ equivalent/thousand tons of material = (ml of acid consumed) x (25.0) x (N of add).

Reference

This procedure taken directly from:

Mills, Chris; 2000; "Acid Base Accounting (ABA) Test Procedures;" – <http://www.infomine.com/technology/enviromine/ard/welcome.htm>

Sobek, A., Schuller, Freeman, W.J. and Smith, R. (1978), *Field and Laboratory Methods Applicable to Overburdens and Minesoil*, (West Virginia Univ., Morgantown College of Agriculture and Forestry): EPA report no. EPA-600/2-78-054 p. 47-50.

COASTECH MODIFIED BIOLOGICAL OXIDATION TEST

Some of the disadvantages of the BC Research Confirmation Test can be reduced by adopting the following modifications to the standard procedure. The modified test has been used routinely for a number of years.

The initial sample weight is selected on the basis of the sulphur content as follows (basis: 50 ml nutrient solution):

Table 1: Sample Weight for Various Sample Sulphur Contents, Coastech Modified Biological Oxidation Test (from Lawrence, R.W. and Sadeghnobari, A., 1986b)

%Sulphur	Sample Weight, g
<4	10.0
4-8	7.5
8-15	5.0
>15	3.0

At the end of the test, following the full addition of extra sample, if the pH is still below 3.5, sodium hydroxide solution (3 to 6 N) is added to the pulp, stoichiometrically equivalent to the acid added initially to bring the pH into the biochemical oxidation range. The final pH is recorded after 1 hour. This procedure removes the bias towards an acid classification.

Original References

Mills, Chris; 2000; "Acid Base Accounting (ABA) Test Procedures;" – <http://www.infomine.com/technology/enviromine/ard/welcome.htm>

Lawrence, R.W., Poling, G.W. and Marchant, P.B., (1989), *In-House Development of a Modified Biological Confirmation Test for AMD Prediction*, Coastech Research.