CANADA

DEPARTMENT OF ENERGY, MINES AND RESOURCES MINES BRANCH OTTAWA

TENTATIVE SPECIFICATIONS:

TEST FOR PERCOLATION RATE, OR COEFFICIENT OF PERMEABILITY, OF FILL

GROUND CONTROL RESEARCH GROUP,

MINING RESEARCH CENTRE

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Tentative Specifications: TEST FOR PERCOLATION RATE, OR COEFFICIENT OF PERMEABILITY, OF FILL

by

Ground Control Research Group,
Mining Research Centre,
Mines Branch

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ABSTRACT

To provide the benefits of obtaining a measure of the percolation rate of fill that can be related to previous experience and to the practices of others, a tentative standard is proposed for use by Canadian mining companies. A draft of this tentative specification was examined by selected companies of the Mining Association of Canada which made suggestions for modifications. It is possible that further improvements can be made which will come to light after using the procedure. In this way, it is expected that the specification will evolve into a firm standard for Canada.

The report includes the specifications for a Quick Test to be used for routine quality control. Specifications for a Long Test are also provided for use in special studies and research.

Direction des mines,

Bulletin technique TB 101

Spécifications à titre d'expérience:

ESSAI POUR DÉTERMINER LE TAUX DE PERCOLATION DU REMBLAI, OU SON COEFFICIENT DE PERMÉABILITÉ

par

Le groupe de chercheurs en matière de contrôle des terrains,
Centre de la Recherche Minière,
Division des Mines

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RÉSUMÉ

Si un essai standard du taux de percolation du remblai était fait, l'expérience antérieure serait plus utile qu'à présent. Conséquemment, il est propose qu'un tel essai soit entrepris pour usage par les societes minieres canadiennes. Des compagnies choisies, de la Mining Association of Canada, ont commence à examiner ce memoire preparatoire sur les specifications en vue d'y apporter quelques changements, si necessaire. Il serait possible d'ameliorer ce procede apres qu'il aurait ete mis en application. De cette maniere nous comptons que ce memoire sur les specifications evoluera en une reglementation reconnue à travers le Canada.

Ci-inclus dans le rapport, se trouvent les details d'un essai rapide employe ordinairement pour determiner le contrôle de la qualite du remblai. Les details d'un essai prolonge sont aussi fournis pour les cas d'etudes spécialisees et pour la recherche.

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INTRODUCTION

On many occasions, operators involved in backfilling have remarked that the variation of test methods makes it difficult to compare percolation rates on different materials and therefore to utilize other people's experiences. In the light of this general situation, one company suggested that the Mines Branch should attempt to develop a standard percolation test for the Canadian mining industry. A draft report (FMP 67/15-MRL) was circulated in 1967 to certain mining companies selected by the Mining Association of Canada, which were requested to make suggestions for modifications to the proposed apparatus and procedures. As a result of the suggestions received, minor changes were made to yield the present report.

The main purpose of the percolation test is to control the quality of the fill that is being produced in the mill for transportation to the stopes underground. The tests should be as simple and quick as possible, so that frequent testing is feasible and undesirable production can be quickly changed. For this purpose the QUICK TEST, as described on pages 2 and 3, is proposed.

At the same time, for special studies and research on the fill material it may be useful to have a testing procedure that will produce more accurate results. For example, the variation in permeability of the fill between the mill and the stopes might be significant. In this case, to obtain a valid measure of the effects of transportation (possibly decreasing the resultant permeability), it would be desirable to avoid introducing error arising from a factor such as the difference in temperature of the pulp water. For this more complex type of study, the LONG TEST, as described below, is more suitable.

QUICK TEST

Apparatus

1. Percolation tube approximately 50 cm long x 5 cm ID (18 in. long x 2 in. ID) with or without an overflow tube at 5 cm (2 in.) from one end. If no overflow tube is provided, wrap scotch tape around top to indicate 5 cm (2 in.) and 7.5 (3 in.) distances from the end.*

2. 500-ml Erlenmeyer flask with a perforated rubber stopper containing a length of glass tubing approximately 7.5 cm long x 1 cm OD (3 in. x 0.4 in.) with the end outside the flask cut at 45 deg. (This item is required if the percolation tube does not have an overflow tube.)

3. No. 100 mesh screening and rubber O-rings to fit over the bottom of the percolation tube.

4. 400-ml beaker.

5. 250-ml graduated cylinder.

6. Water supply tank, plastic tubing, funnel, and spatula.

7. Distilled water (untreated water may be used if not too high in impurities).

8. Supporting frame and clamps.

Procedure

1. Attach the No. 100 mesh screening with the O-rings to the bottom of the percolation tube.

2. Fill the percolation tube with fill pulp either to within 1 cm ($\frac{1}{2}$ in.) of the overflow tube or to within 5 cm (2 in.) to 7.5 cm (3 in.) from the end of the tube if there is no overflow tube. Take the temperature.

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*The tube diameter could be as low as 32 mm (1-1/4 in.) without significantly affecting results.

3. If the percolation tube has an overflow, start water flowing into the tube from the water tank to maintain the head at the level of the overflow tube. If the percolation tube has no overflow, fill the Erlenmeyer flask with water, place the stopper and glass tube in the flask, and clamp in an inverted position over the percolation tube with the 45 deg. cut end 1 cm ($\frac{1}{2}$ in.) above the level of the fill. The water should be at a temperature as close to 20°C (68°F) as possible.

4. Allow about 30 minutes of percolation for settlement of the fill pulp in the percolation tube.

5. Empty the beaker and then collect the percolation water for a minimum of 30 minutes, timed as accurately as possible, measuring the water in the graduated cylinder.

6. Calculate the approximate percolation rate, or coefficient of permeability, k, from:

$$k = Q/A \text{ cm/min},$$

$$\text{or} \quad k = 23.6\, Q/A \text{ in./hr},$$

where Q = flow rate in cc/min, A = cross-section area of fill sample in cm^2.

Precautions

1. Appearance of pulp should be checked for segregation; samples with any segregation should be discarded.

2. If the percolation tube is overfilled, discard the sample.

3. The No. 100 mesh screening should be washed after each test and discarded when its porosity is seriously decreased by unmovable particles.

4. If the temperature of the pulp is much different than 20°C (68°F), a correction can be made as in the LONG TEST. The reported value should be described as having been corrected.

LONG TEST

Apparatus

1. Percolation tube approximately 50 cm long x 5 cm ID (18 in. long x 2 in. ID), with or without an overflow tube at 5 cm (2 in.) from one end. If no overflow tube is provided, wrap scotch tape around top to indicate 5 cm (2 in.) and 7.5 cm (3 in.) distances from the end.*

2. 500-ml Erlenmeyer flask with a perforated rubber stopper containing a length of glass tubing approximately 7.5 cm long x 1 cm OD (3 in. x 0.4 in.), with the end outside the flask cut at 45 deg. (This item is required if the percolation tube does not have an overflow tube.)

3. No. 100 mesh screening and rubber O-rings to fit over the bottom of the percolation tube.

4. 400-ml beaker.

5. 250-ml graduated cylinder.

6. Water supply tank, plastic tubing, funnel, and spatula.

7. Distilled water (untreated water may be used if not too high in impurities).

8. Supporting frame and clamps.

9. Balance (0.1 g sensitivity and a minimum of 1000 g capacity).

10. Drying oven (up to 200°C, with approximately 12 in. x 12 in. x 10 in. inside dimensions).

11. Hot plate.

12. Thermometer.

13. Stop clock.

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*The tube diameter could be as low as 32 mm (1-1/4 in.) without significantly affecting results.

14. Metre stick.

15. Rubber mallet.

16. 600-ml beaker.

18. 500-ml graduated cylinder.

18. Evaporating dishes of 765-, 1285- and 2100-ml capacity.

Procedure

1. Attach the No. 100 mesh screening with the O-rings to the bottom of the percolation tube.

2. Fill the percolation tube with fill pulp at a temperature as close to 20°C (68°F) as possible, either to within 1 cm ($\frac{1}{2}$ in.) of the overflow tube or to within 5 cm (2 in.) to 7.5 cm (3 in.) from the end of the tube if there is no overflow tube.

3. If the percolation tube has an overflow, start water flowing into the tube from the water tank to maintain the head at the level of the overflow tube. If the percolation tube has no overflow, fill the Erlenmeyer flask with water, place the stopper and glass tube in the flask, and clamp in an inverted position over the percolation tube with the 45 deg. cut end 1 cm ($\frac{1}{2}$ in.) above the level of the fill. The water should be at a temperature as close to 20°C (68°F) as possible.

4. Allow about 30 minutes of percolation for settlement of the fill pulp in the percolation tube. Mark the tube at the top of the sample with a grease pencil (the height of the material in the tube is required to calculate void ratio and density).

5. Select a graduated cylinder that will hold the flow of about 1 hour. Start the test by recording the time, water level in the graduated cylinder, and water temperature. Take readings approximately every 10 minutes.

6. After one test, lightly tap the percolation tube with the rubber-headed mallet. Again, after 30 minutes of percolation, mark the height of the fill on the tube and repeat Step 5.

7. Repeat Step 6, again increasing the density of the material, obtaining a third set of readings.

8. Turn off water and measure length of sample to each density level.

9. Allow remaining water to percolate from the tube for 24 hours.

10. Remove fill from the tube and weigh.

11. Dry fill at 110°C for 24 hours and weigh accurately. Calculate water content, w, by:

$$w = (T - W)/W$$

where T = total weight of water and solids, W = weight of solids.

12. Decant water from graduated cylinder; then remove (washing if necessary) the solids into a large evaporating dish and dry for 24 hours at 110°C. Weigh and express ratio of fines washed out, f, by:

$$f = F/W \quad .$$

where F = the dry weight of fines, W = the weight of solids in the percolation test.

13. Plot graduated cylinder readings (y-axis) versus time (x-axis); measure the average slope giving the flow rate in cc/min.

14. Calculate the percolation rate, or coefficient of permeability, k, from:

$$k = QL/(AH) \text{ cm/min}$$

$$\text{or} \quad k = 23.6\ QL/AH \text{ in./hr},$$

where Q = flow rate in cc/min, L = length of sample in cm, A = cross-section area of sample in cm^2, H = head of water over bottom of sample in cm.

15. Correct percolation rate, or coefficient of permeability, for viscosity of water to give equivalent values at 20°C by multiplying by:

1.54 if temperature is 4°C (40F)
1.32 if temperature is 10°C (50F)
1.12 if temperature is 16°C (60F)
0.97 if temperature is 21°C (70F)
0.86 if temperature is 27°C (80F)

16. Calculate dry density, in g/cc, at each level of density by dividing the dry sample weight by its volume. (To convert to pounds per cubic foot, multiply by 62.4.)

17. Calculate the void ratio at each density:

$$e = \frac{GV}{W} - 1$$

where G = specific gravity of solids, V = volume of sample in cc, W = dry weight of sample in g.
(Porosity, n, can be calculated by: $n = e/(1 + e)$.)

18. Plot percolation rates, or coefficients of permeability, against void ratio and interpolate for the void ratio of the in situ fill underground.

19. Calculate the degree of saturation, S, after 24 hours in the percolation test by:

$$S = Gw/e,$$

where G = specific gravity of solids, w = water content (weight of water/weight of solids), e = void ratio.

Precautions

1. Appearance of pulp should be checked for segregation; samples with any segregation should be discarded.

2. If the percolation tube is overfilled, discard the sample.

3. The No. 100 mesh screening should be washed after each test and discarded when its porosity is seriously decreased by unmovable particles.

4. If the water contains an excessive amount of air, the accuracy of the test might be diminished. The influence of air in the water can be determined by de-airing before the percolation test. This is done by heating the fill pulp sample slowly to a light boil. The sample is then allowed to cool at room temperature. It is then agitated and poured into the percolation tube for testing as above. A significant difference in results shows that the air content was excessive.

ACKNOWLEDGEMENTS

The work was originally suggested by members of Falconbridge Nickel Mines Limited who were particularly helpful in providing information. Selected members of the Mining Association of Canada, through the Research Coordinator, Dr. W.R. Horn, reviewed the draft report and suggested modifications. The report was written by D.F. Coates and checked by Y.S. Yu.

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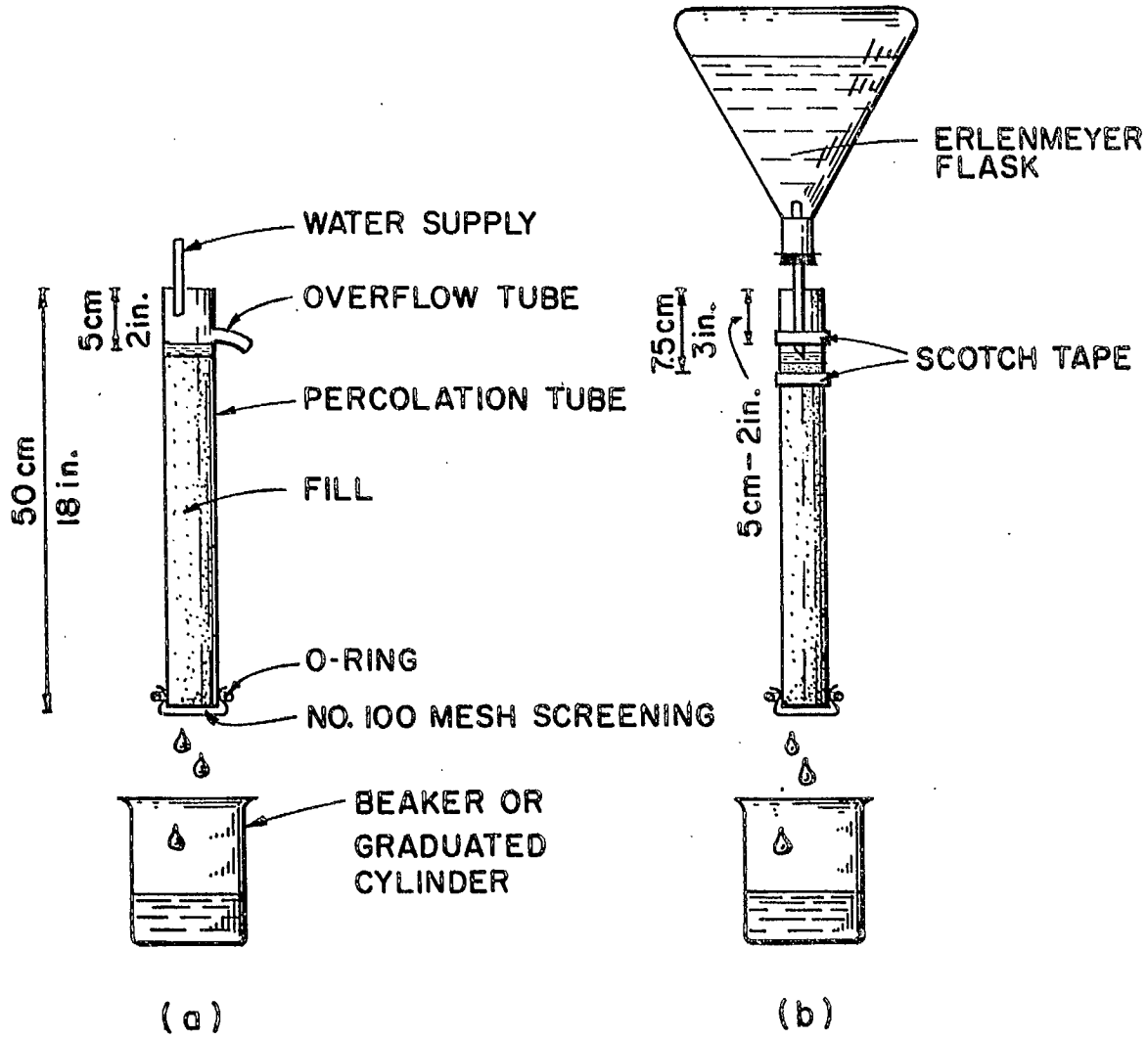

Figure 1. (a) Test Apparatus with Overflow Tube
(b) Test Apparatus without Overflow Tube.

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Comments on "Tentative Specifications Test for Percolation Rate, or Coefficient of Permeability, of Fill"

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