Development of Evaporation Logging Equipment and Accuracy Check

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1. Introduction

A new evaporation logging equipment[1), 2)] was made for measuring evaporation in disturbed zone near tunnel wall. The evaluation of hydraulic properties change of the disturbed zone is very important for the estimation of long term performance of tunnel in the nuclear waste disposal field. Evaporation logging seems to be an effective tool that can measure the temporal change of evaporation. And estimate the hydraulic properties change is also evaluated from the evaporation change. However, the accuracy of the measurement is not clarified yet. The accuracy of the measurement by the new equipment is examined by the laboratory test.

2. Measurement Equipments and Method

A new evaporation logging equipment was made in order to measure the distribution of evaporation in a borehole drilled near the tunnel wall. This equipment is installed into the borehole. Figure1 schematically illustrates the evaporation measurement in a borehole drilled in the disturbed zone behind the tunnel wall. The new evaporation logging equipment is a type of double packer equipment as shown in figure 2 (Tokyo KEISOKU). Both ends of the equipment are completely sealed with two air packers and dry air is injected from the inner packer1 towards the tunnel wall using a transparent fiber tube. A steel bar of one meter length is existing between the two packers and it is moveable along the longitudinal axis of the equipment. A two-sensor type evaporation meter is attached on an end of steel bar. The sensor part of this evaporation meter is pressed on the borehole wall by air pressure during the measurement. Other sensor for measuring the relative humidity and temperature of the out flow passed through the test interval is the set at the end of the equipment. The relative humidity and temperature of the injected air is also measured. The total evaporation from whole of test interval is also calculated from the absolute humidity difference between the injected air and outflow. By pulling or pushing the steel bar, the location of the evaporation meter can easily be changed and the location can be recorded in computer. Constant dry air input is maintained throughout the session of every experiment.

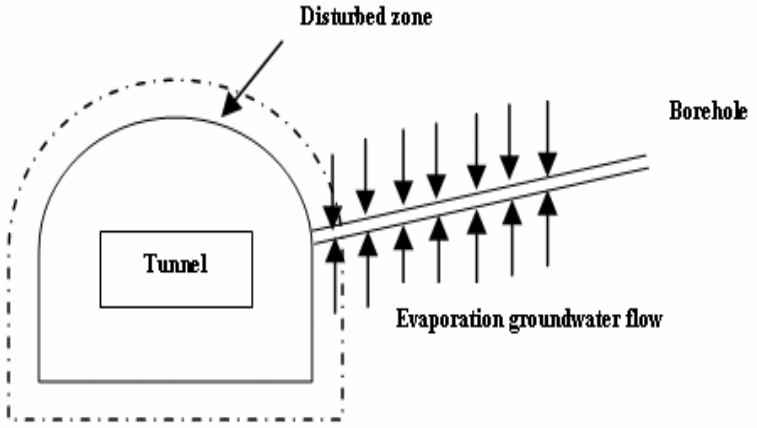

Figure1. Schematic diagram of evaporation distribution around tunnel wall

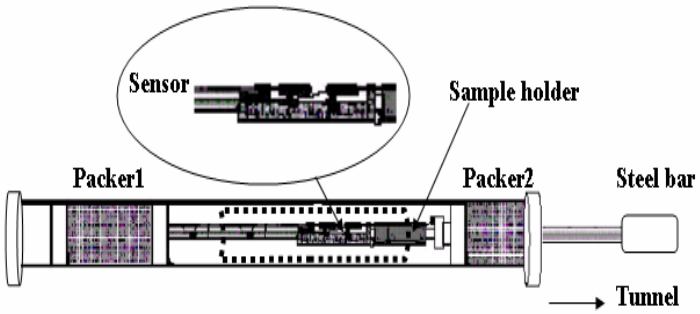

Figure2. Evaporation Logging Equipment

3. Accuracy of the measurement

To examine the accuracy, evaporation from a wet paper was measured by the two ways: evaporation logging equipment and the measurement of the weight change of the paper. Paper was installed on inner side of the tube that was a modal of borehole wall (see Figure 2). The weight of wet paper was measured by electronic balance before and after the experiment. The true evaporation during the experiment can be calculated from the weight change. Also, the evaporation rate from the paper can be measured by the evaporation meter. The accuracy of the evaporation meter can be examined by comparing the two values.

Key words: two-sensor type evaporation meter, transient evaporation, accuracy check
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4. Results

Table.1 shows the accuracy of the measurements. Both values are about the same and it inlays that the measurement is accurate. Evaporation calculated from absolute humidity and air velocity of in flow and out flow is compared with true values. Figure 3 illustrates the distribution of evaporation rate measured by the two sensor type evaporation meter. Upon sensor reaching to the paper part, evaporation rate should be increased. However, measured the value is influenced by the turbulent flow. The effect of the turbulent flow was examined. Figure 3 shows the results of transient change of evaporation distribution along the traverse line with different amount of dry air input. Evaporation rates are observed to be highest in the middle portion of the sample and gradually decreasing towards the edge. Generally the amount of dry air and the evaporation rate are closely related. The red lines inlay true evaporation rate. The measurement line is much deformed from the real one. The difference may be induced by the turbulent of air flow, so that, regulation of flow is the big problem remained.

Weight (g)	Measurement evaporation(mg/sec)	True evaporation(mg/sec)
7.17	0.39	0.45
7.29	0.52	0.58
7.10	0.82	0.87
7.18	0.91	0.98

Table1. Comparison of results

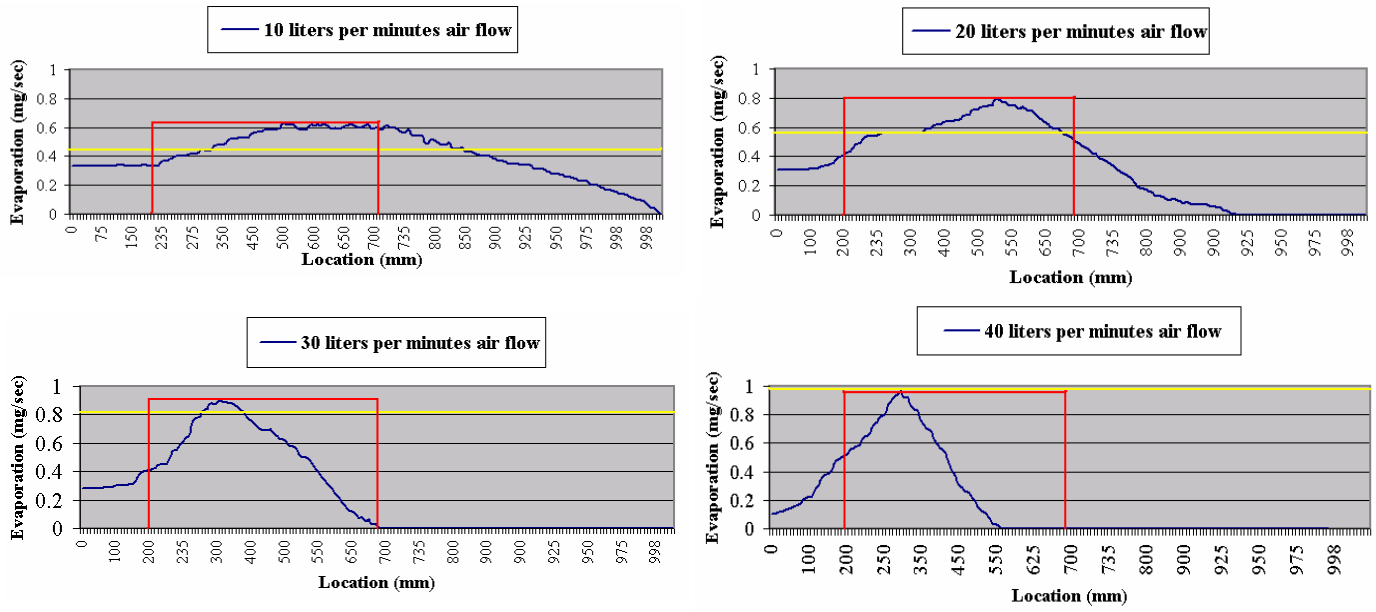

Figure.3 Evaporation distribution along the traverse line with different air flow rate

5. Conclusion

Accurate estimate of evaporation measurement has carried out in the laboratory. It can be found that the evaporation logging equipment give accurate total evaporation value. However, the evaporation distribution could not be well measured due to the turbulent flow. The improvement of the air flow regulation is needed for more accurate measurement.

Reference

Watanabe .K, Saegusa H, Imai. H and Morita, Y. (2001): Evaporation distribution measurement along two boreholes in the MI niche and the estimation of hydraulic conductivity of the Opalinus clay. Report to the Mont Terri Project.