PERMEABILITY PERFORMANCE OF SINGLE ROCK FRACTURE UNDER THERMAL CONDITIONS

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1.INTRODUCTION

Since long-term performance of underground water in rock mass has been a focus of attention in a few years, it is important to examine the flow in fractured rocks. The coupled processes have been discussed in previous research considering the external stress and fluid pressure [1]. Hydro-thermal influence has a significantly change in the contacting asperities. And mechanical creep deformation should be grasped by permeability evolution. In this study, long-term [2] and short-term measurement of permeability in a single rock fracture under constant confining pressure are carried by triaxial vessel in indoor experiment. This paper reports the short-term experimental results. Considering the experimental results, the permeability of single rock fracture by the influence of different conditions should be considered.

2. EXPERIMENTAL CONDITIONS

A series of permeability experiments was conducted for a cylindrical granite specimen with a single vertical fracture as shown in **Fig 1**. The specimen was fastened into the triaxial vessel and sealed with the heat shrinkable tube (**Fig.2** [1]). Changing the confining pressure from 1.0 MPa to 3.0 MPa in a stepwise manner at every 0.5 MPa, we conducted the transient pulse permeability test. Loading and unloading of confining pressure was repeated three times. This test was carried out under three different temperatures, namely, 19±2℃, 60±1℃ and 90±0.5℃.

Fig.1 Cylindrical granite core of 50 mm in diameter and 100 mm in height split into two halves to create a vertical single fracture

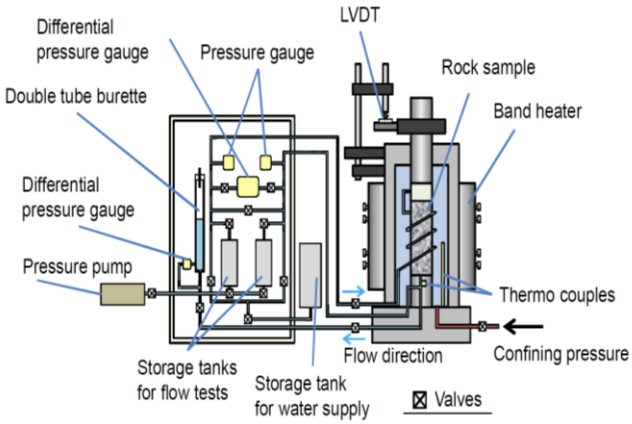

Fig.2 Triaxial vessel used in this study [1]

3. EXPERIMENTAL RESULTS

Figs 3 to 5 show permeability change with confining pressure in triple repetitions of loading and unloading in different temperatures. As a start point shows in **Fig.3,** we can see permeability reduced by increasing the confining pressure and the permeability is sensitive to change at the first cyclic. Except for the first cycle of loading-unloading at 20°C, the permeability had a reversible behavior against confining pressure in spite of increasing the temperature. That is, mechanical influence plays an important role in short-term performance. It is different from the long-term experimental result which indicated an irreversible change over time [2]. **Fig. 6** shows the permeability curves in the third cycles for each temperature. From this figure, we can clearly see that permeability decreases with increasing temperature, and permeability at 90°C is about 2 magnitudes lower than that at 20℃. It implies that heat transfer generated the dilatancy of the fracture surface and

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enlarged the contact area. In the long-term experiment at 20°C, permeability had an unrecoverable phenomenon from the short-term 20°C [2]. Chemical action and mechanical creep deformation in the fracture interface should be considered and pressure solution in the contacting asperities cannot be ignored, which irreversibly deforms the fracture interface. And chemical analysis is need to check.

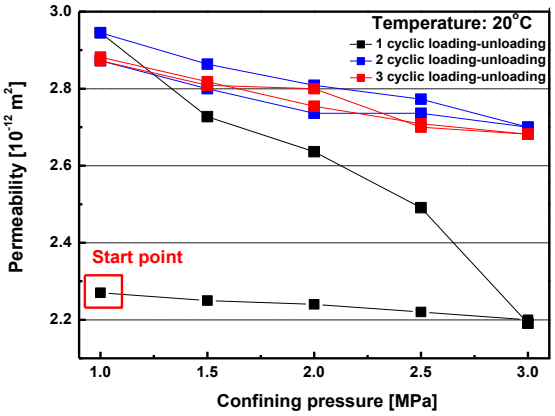

Fig.3 The permeability in triple repetitions of loading and unloading process. temperature of 20°C

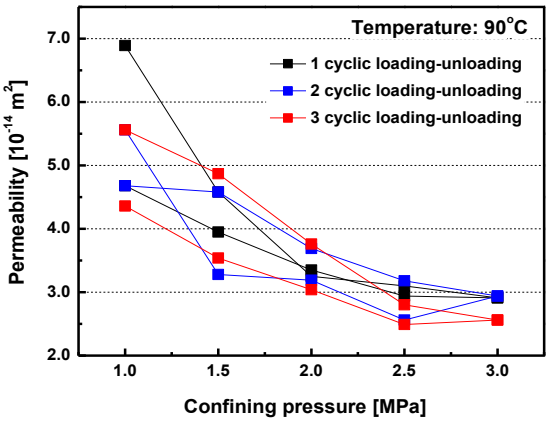

Fig.5 The permeability in triple repetitions of loading and unloading process. temperature of 90°C

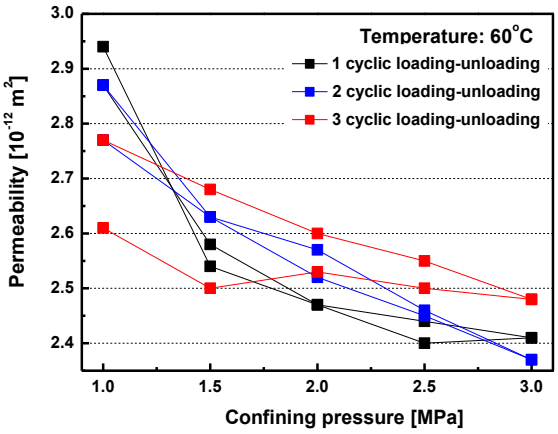

Fig.4 The permeability in triple repetitions of loading and unloading process. temperature of 60°C

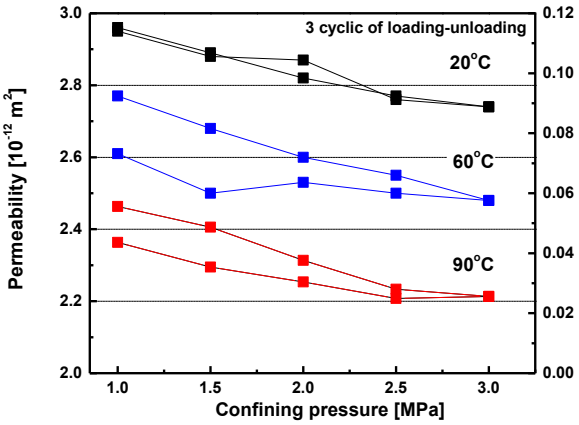

Fig.6 Comparison result of the permeability in three temperature (left axis 20°C,60°C, right axis 90°C)

4. CONCLUSIONS

This research conducted a series of experiments under constant confining pressure. We did loading and unloading of confining pressure three times, reversible phenomenon could be seen and elastic deformation was confirmed in this process. Then, permeability is sensible to reduce as increasing the temperature. The thermal influence makes the surface of fracture dilated and narrow the fracture aperture. Especially in 90°C, 2 order magnitude could be seen in this result. In the long term we recovered the temperature to 20°C, permeability has an irreversible performance from the short term 20°C, plastic deformation could happen on the interface of fracture, pressure solution on the contacting asperities maybe enlarge the contact area and the mineral dissolution also cannot be negative. Furthermore, chemical analysis should be checked in the future.

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