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Production Feasibility Evaluation of Engineering Scale Bentonite-Graphite Buffer Blocks

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1. Introduction

Buffer blocks play a crucial role as primary components of engineered barrier system within deep geological repository, aimed at enhancing the stability of high-level radioactive waste (HLW) disposal. Among various requirements, buffer materials must exhibit thermal performance to dissipate the heat generated from HLW into the surrounding rock [1]. Consequently, ongoing research efforts focus on developing buffer blocks with increased thermal conductivity through the addition of additives such as sand, graphite, and SiC [2]. Additionally, assessing the producibility of engineering-scale buffer blocks is crucial to address challenges that may not arise during laboratory-scale production [3, 4]. This study aims to evaluate the production feasibility of engineering-scale bentonite-graphite (B-G) buffer blocks.

2. Materials & Methods

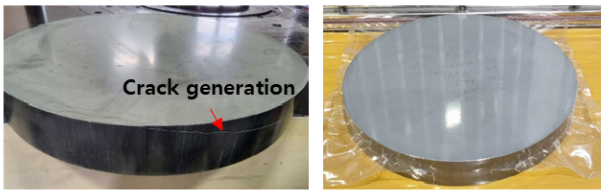
In this study, Ca-type KJ-II bentonite and graphite powder (<20 μm) was used. The mass ratio of these two materials was set at bentonite 97% and graphite 3% based on dry weight. The mixing device, illustrated in Fig. 1, involved charging samples weighing 50~60 kg into the device, with the screw rotation rate set at 15 rotations per minute. Mixing times of 0.5 hours and 2 hours were examined. Engineering-scale buffer blocks with a diameter of 407mm were manufactured using a 2000-ton press machine. The evaluation of buffer block production feasibility was based on the presence or absence of visible cracks on the block surface.

(a) (b)

Fig. 1. Agitating apparatus for mixing bentonite and graphite: (a) Before mixing; (b) After mixing

3. Results

Evaluation of engineering-scale buffer material production feasibility based on the mixing time of bentonite and graphite revealed that materials mixed for 0.5 hours resulted in cracks on the side of the block (Fig. 2(a)). In contrast, blocks produced after 2 hours of mixing showed no cracks on their surfaces (Fig. 2(b)). Graphite, with its hydrophobicity and weak interlayer bonding due to van der Waals forces, may lead to crack formation when locally aggregated under the pressure applied during buffer block production. Hence, it is inferred that mixing bentonite and graphite for more than 2 hours with the agitating apparatus and conditions utilized in this study is necessary for uniform mixing and successful B-G buffer block production.



(a) (b)

Fig. 2. Evaluation results of B-G buffer block production feasibility according to mixing time: (a) 0.5 hour; (b) 2 hours

4. Conclusions

The evaluation of engineering-scale B-G buffer block production feasibility highlighted the importance of sufficient mixing time to prevent crack formation on the block surface. Adequate mixing of bentonite and additives is crucial for successful buffer block production.

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