INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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Coupled thermomechnical effect on the swell pressure and reactive transport through compacted bentonite

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SHORT ABSTRACT

Deep geological disposal has been considered as one of the best ways to handle higher-level nuclear wastes. The compacted bentonite or sand bentonite blocks are used as a buffer material in the deep geological repository (DGR) for the safe disposal of high-level nuclear waste (HLW) due to its favorable physicochemical and hydro-mechanical properties. Buffer surrounding the waste canister experiences variation in the temperature for a long duration of time. Such thermal effects are induced when high-temperature waste canister comes in contact with buffer and due to seasonal temperature change resulting from a heat source in the ground. The temperature from the waste canister can go initially as high as 250°C and probably reduce to ambient temperature upon the decay of the waste material. This long duration temperature variation induces a thermal loading on the bentonite buffer, affecting its index, physicochemical and hydro-mechanical properties. The hyper alkaline pore fluid is generated when the fluids from the host rock infiltrate through the cement/concrete layer, which is constructed as a bulkhead or in the vaults or to support the access of galleries between a buffer and the host rock. The unbalanced conditions generated inside the deep geological repository can force the steel canister to corrode. The swelling behaviour of the bentonite under such hyper alkaline environment as well as the effect of thermal history is essential to study for the stable performance of the buffer during its long-term operations. Even the temperature variation, probably because of continuous heat emitting canister (initially-150°C to 250°C) and geothermal gradient, affect its performance, there would be bentonite iron interface reactions due to the corrosion of steel canister, which might cause reactive transport through the compacted bentonite buffer. The generated fluids (leachate produced due to canister corrosion or a hyper alkaline solution from the other side) may cause reactions due to the presence of exchangeable cations inside the bentonite and cause the reactive transport, which could ultimately affect the purpose of bentonite as a buffer material.

The bentonite buffer is expected to exhibit stable performance in the presence of such unstable thermal and chemical flux. The main focus of this study was divided in to four phases. Initially the thermal treatment was given to powdered bentonite samples and tasted for its index and physicochemical properties. In the second phase the thermal history was given to compacted bentonite samples and tested for its swell pressure saturated by distilled water and hyperalkaline cement water. In the third phase the thermal history was given to compacted bentonite with addition of corrosion products and tested for its swell pressure saturated by distilled water and hyperalkaline cement water. In the last phase the compacted bentonite samples were checked against the reactive transport through it by creating thermal gradient.