Novel Emplacement Device for a Very Deep Borehole Disposal

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1. Introduction

There is a worldwide attempt of HLW disposal into a very deep borehole of around 3~5 km depth with the advancement of an underground excavation technology recently. As it goes into deeper underground, the rock becomes more uniform and flawless. And then the underground water circulation system at 3~5 km depth is almost disconnected with near groundwater circulation system. Therefore the possibility of radionuclides escape into a surface eco-system can be minimized when a very deep borehole disposal is adopted. Moreover the canister integrity is less important in this very deep borehole disposal system unlike a general geologic disposal system at 500 m.

In the deep borehole disposal procedures, one SNF (Spent Nuclear Fuel) assembly is stored in one disposal canister (D30~40cm, H4.7~5.0m), and approximately 10~40 disposal canisters are connected axially, which parade length can leach to around 200m in maximum. The connected canister parade is lowered through a very deep borehole (D40~50cm) by emplacement devices. Therefore the connections between canisters and canister to lowering joint are very important for the safe operation of it. The well-known connection method between canisters is Threaded Coupled Connection method [1], in which releasing of the connection is almost impossible after thread fastening in the borehole. The Threaded Coupled Connection is widely used for the connection of drilling pipes in the oil industries. A J-Slot Joint method [2] is another well-known method for the connection of a top canister in the parade and drilling pipe, in which the connection can be released by the breaking a fixing pin by pressing it with a drilling pipe when it arrives at the borehole bottom. But when the retrieval of emplaced canisters is required, the J-slot Joint of emplacement must be changed to a new J-slot Joint of retrieval at outside. In this research, novel emplacement device is designed to perform combined actions of releasing and retrieval. The novel emplacement device can release a canister parade onto a borehole bottom and then retrieve it again without any joint change. Therefore this novel device does not need to come back to surface for the joint change. It is sure that the emplacement by the suggested device is more convenient and time saving than before.

2. Methods and Results

The novel joint device has several hooks to seize the wedge on top of a canister parade. In Fig. 1, the cross sectional structure is illustrated. The joint device can be equipped to a drilling pipe end or tension cable in a disposal process

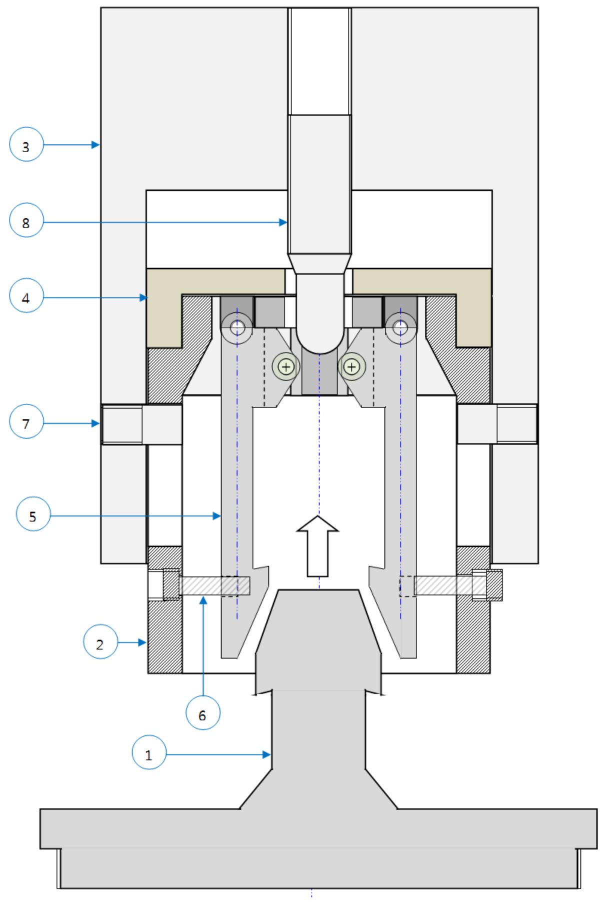
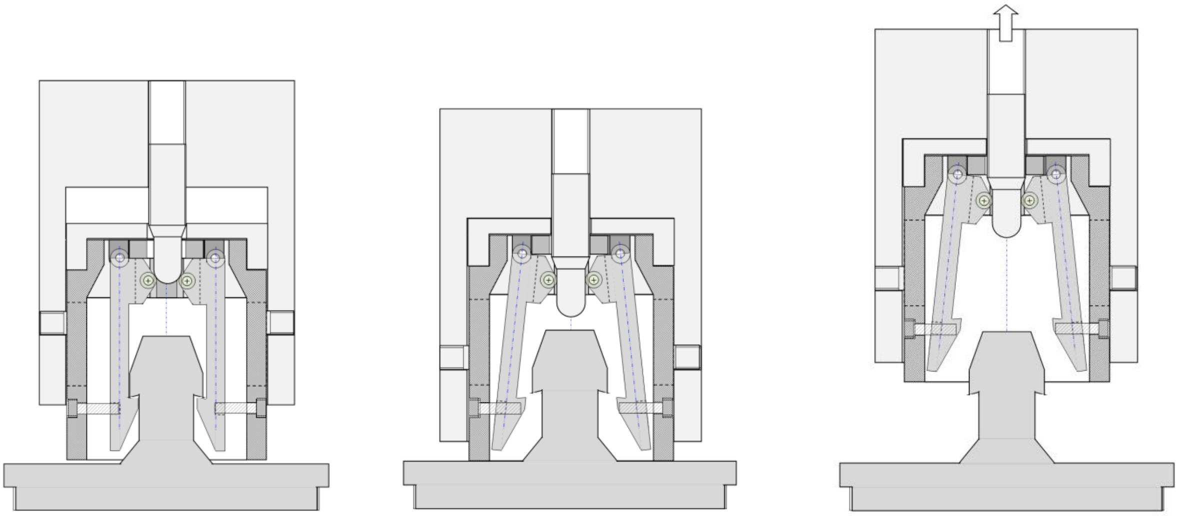


Fig. 1. Cross-sectional illustration of a novel joint device; 1. Wedge on top of a canister parade, 2. Hook box, 3. Joint device body, 4. Piston head of hook box, 5. Hook, 6. Hook spring, 7.Sliding joint bar, 8. Pushing bar.

The joint device can go down through a borehole seizing the wedge on top of canister parade. And after arriving at the bottom, their separation occurs by just settling down and lifting up the joint device. The attractive merit of this device is that it can recombine with the canister parade by placing the device again onto the settled canister parade. This recombining can be achieved by adopting a sliding hook box, which vertical motion is limited by the very moment vacuuming of the space above the piston head of a hook box. When the device lifting is faster than the hook box dropping down, the wedge is released, and when it is slower, the wedge is seized by hooks again, because the hooks are closed when the hook box is at down position in the joint device. Now more precise explanation is presented with a Fig. 2 as followings.



Action I-Locking the Wedge   Action II-Unlocking the Wedge   Action III-Separation

Fig. 2. Three major states of a novel joint device.

Action I: The wedge (3) on top of a canister parade is locked by several hooks (5) in the joint device when it comes down through a borehole.

Action II: When it arrives at the borehole bottom, the pushing bar(8) fixed in the joint device start to push the hook pivots in the hook box(2), which result in the opening of the hooks(5).

Action III: By a swift lifting up of the joint device, the wedge separation can be possible since the pushing bar (8) is still pushing the hook pivot. The piston head (4) is close to the inner ceiling surface of the joint device because it needs a sometime for the sliding down.

Recombining: If the speed of a lifting up is enough slow for the piston head (5) to slide down, the hooks are seizing the wedge again as shown in Action I.

The speed of a lifting up for the separation can be controlled by the length of pushing bar. With a longer pushing bar, the speed for the separation can be slower.

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3. Conclusions

The novel joint device suggested in this paper can accommodate a canister emplacement and retrieval in the borehole disposal process. The joint can be lowered by bound to a drilling pipe, or high tension cable along 3~5 km distance. This novel device can cope with an accidental event easily without any joint head change. When canisters are damaged or stuck on the borehole wall during their descending, the canisters in trouble can be retrieved simply by the control of a lifting speed. It is certain that this novel device can attribute the technical advance of the very deep borehole disposal of HLW.

REFERENCES

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[2] Tim Harrison, "Very deep borehole Deutag''s opinion on boring, canister emplacement and retrievability", SKB R-00-35, May 2000.