

Environmental Contamination Recovery System Utilizing Soil Freezing and Jetting

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Abstract : This paper discusses a new environmental contamination recovery system, which enables positive clean up of contaminated soil in a relatively short time. The system integrates the soil freezing with the jetting technologies widely used in the construction industry. The soil freezing gathers the contaminants at a point on the phenomenon that impurities are excluded from water solution when it freezes. The two-phase jet consisting of water and nitrogen gas washes contaminants off soil particles then enhances the formation of frozen soil barrier. Thus, the contaminants are not only enclosed in the frozen soil barrier but easily collected and recovered.

Features :

The system

- enables in-situ decontamination of the soil in a large area.
- dispenses with excavation to remove soil for further handling.
- causes no secondary pollution.
- collects contaminant in solution for flexible handling.

Principle : Ice grows only in pure water excluding impurities in the solution on a certain condition. In order to concentrate the contaminant, the system utilizes this phenomenon, the concentration effect by freezing. The contaminated solvent in the pore water can primarily be targeted for the purification, but contaminants sticking to soil particles could also be treated by two-phase jet washing contaminants off the soil. The two-phase jet of water and the nitrogen gas is also used for scattering ice in the soil, for more effective freezing.

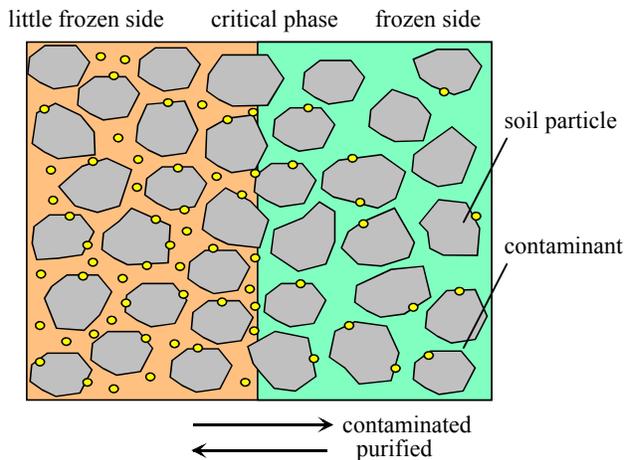


Fig.1 Concentration Effect by Freezing

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Authors prepare a soil improvement system, capable of creating a column of 5 meters in diameter with jet grouting method for larger area of contamination with some modification. The concentrate of contaminated solution is gradually collected and recovered correspondent to the growth of soil barrier.

Sequence :

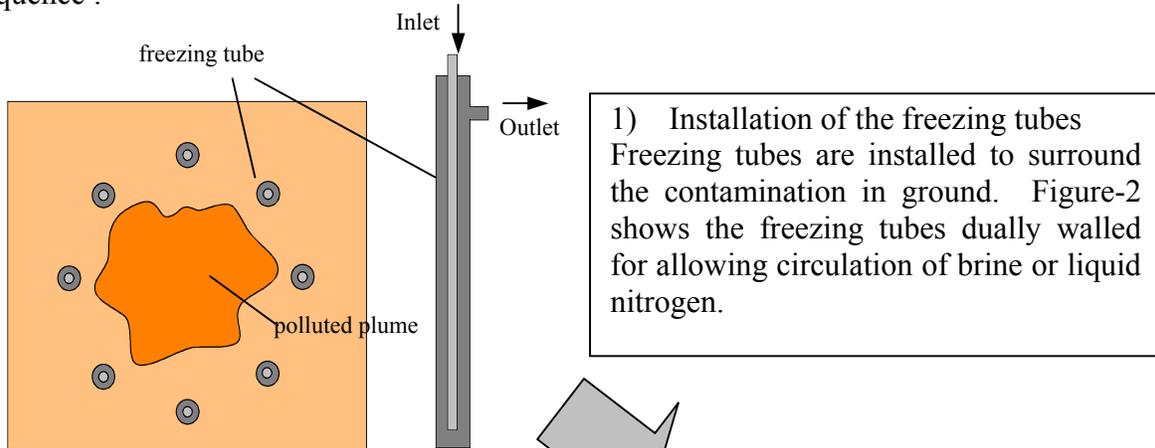


Fig.2 Installation of Freezing Tube

2) Discharging of two-phase jet
When frozen soil barrier is formed, two-phase jet of water and nitrogen gas is discharged to wash contaminants off the soil as well as to scatter ice in the ground.

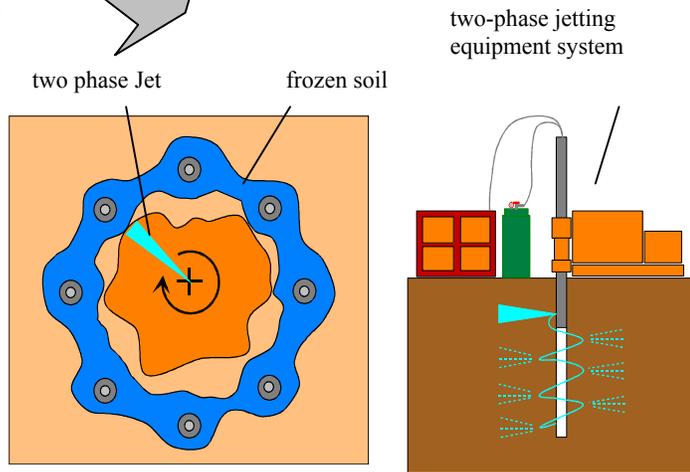


Fig.3 Ejecting and Churning by Two-phase jet

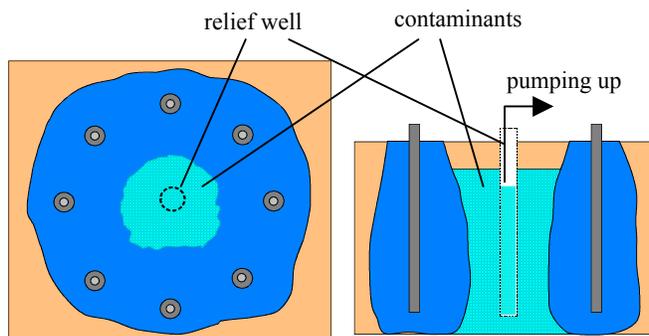


Fig.4 Recovery of Polluted Material

3) Collection of contaminants
Unfrozen underground water containing contaminants gradually moves towards the center and begins to concentrate with the growth of the barrier. Contaminants can be recovered to the surface from the well set at the center of the barrier in the ground. Warm water is circulated and thaws the barriers at the end of the work.

Fundamental examination :

1) Concentration effect by freezing

Authors examined the concentration effect by freezing in regard to Pb,Cd,Cr and oil in water and soil. Freezing pipe in the center of tank freezes the water and the soil. The quantity of contaminations in frozen area is compared with that in unfrozen area. As a result, concentration effect by freezing was confirmed in regard to Pb,Cd,Cr in water.



Fig.5 Examination system



Fig.6 Contaminants in water



Fig.7 Contaminants in soil

2) Two-phase jetting

Using test tools, two-phase jet consisting of water and nitrogen gas was jetted in air. The pressure of nitrogen gas bottle (0.7~0.8Mpa) was used as the jetting force. As a result, ice was discharged from jetting tool.

Future Development : It is of vital importance to grasp the degree of the concentration of contaminants in the soil and that of the decontamination of polluted material stuck to soil particles by two-phase jetting.

A test of so called the concentration effect by freezing in a sandy soil is currently being verified in the laboratory. Besides, the development of a two-phase jetting tool, which functions under an extremely low temperature, is also launched for further practical use.

