

Statistical interpretation of a groundwater flow and chemistry in the coastal underground LPG storage facility, Yosu, Korea

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1. Introduction

To monitor the hydrological stability during operation, a number of piezometers are installed in the area of underground storage caverns which have been excavated artificially for reserving LPG with great scale, and periodical measurements of groundwater level of these piezometers are being performed. This study, making the underground LPG storage facilities and their piezometers constructed in the vicinity of the Petrochemical Complex, Nakpo-Dong, Yosu, Korea an subject of research, is to investigate the hydrogeological and hydrogeochemical characteristics and natural impacts of the coastal aquifers caused by the cavern operation, using appropriate statistical methods.

2. Hydrogeology

In the study area, most of groundwater flows are through the aquifers which are mainly composed of Cretaceous volcanic rocks in the butane cavern area, and those of conglomerate and sandstones in the propane cavern area. Total 14 piezometers and monitoring wells are installed in the study area. Among those, 5 piezometers for measuring hydraulic head variation are around the butane cavern area, and 7 piezometers around the propane cavern area, and 2 monitoring wells for head measurement of water curtain tunnel are also installed. The overall head variations in all piezometers are -5.39~3.48 m of butane cavern area, and -26.08~-0.29 m of propane cavern area. The approximate hydraulic conductivities of the aquifers, measured by several hydropressure tests performed during cavern excavation, have the range from 9.0×10^{-7} to 2.6×10^{-5} cm/sec.

3. Results and discussion

As a result of the chemical analysis of groundwater samples, collected at 4 times since 1998, remarkably high sodium (167~27,700 mg/L) and chloride (1,005~15,368 mg/L) contents were observed at a butane cavern piezometer (TE 10), a propane cavern

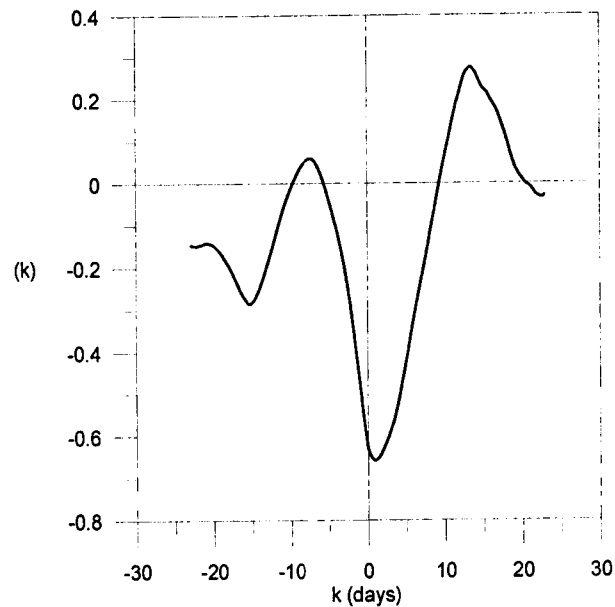
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piezometer (TE 8), and the seepage waters. Considering the fact that this higher ion contents showed conspicuous temporal variance, it could possibly suggest that some intrusion of high saline water into the aquifers is occurred in the study area.

The principal component analysis (PCA) was performed using 8 chemical ions as statistical variables, and its results revealed that the chemical characteristics of the piezometer samples in butane cavern were strongly dependent upon the nitrate contents, and those in propane showed reciprocal dependency between nitrate and bicarbonate contents.



Cross correlation trend between electrical conductivity and the groundwater level monitoring data at certain piezometer (TE 8)

Time series analyses in terms of cross correlation among the operation pressures of each caverns, groundwater level data of the piezometers, and electrical conductivity suggested that the groundwater levels of the piezometers adjacent to the propane caverns sensibly respond to the minute change of the cavern operation pressure, and their response time is expected to less than 1 day. Moreover, the cross correlation between the groundwater level and electrical conductivity monitoring data showed that gradational drawdown of water level could accompany the drastic increase of conductivity, and could implicate that an periodical inflow-outflow phenomenon of external high-saline water at the piezometer was occurred in terms of the change of the operation pressure at the propane cavern.