Transactions of the Korean Nuclear Society Autumn Meeting
Jeju, Korea, October 21-22, 2010

Analysis of Tracer Test at NPP site

Seung Gyu Hyun[* a,b], Nam. C. Woo[b], Jae soo Jeon[c], Sobeom Jin[a], Kilseong Kim[d]
[a]*Korea Institute of Nuclear Safety, 34 Gwahak-ro, Yuseong-ku, Daejeon.,Korea*
[b] *Yonsei University, 262 Seongsanno, Seodaemun-gu, Seoul, Korea*
[c] *NexGeo, 16-15 Garakbon dong, Songpa-gu, Seoul, Korea*
[d]*Institute of Environmental Resource Research, Munyeonno 2, Jeju-si, Korea*

[*]*Corresponding author: mgodo@kins.re.kr*

1. Introduction

If radioactive materials that are contained in Nuclear Power Plants(hereafter as NPPs) are discharged by way of both direct and indirect pathways, they could have significant impact on the public and the environment in the region.[1)]

Groundwater, one of the potential pathways of the radioactive materials discharged from the NPPs site, flows slower than the surface water and subsequently, the pollution of groundwater by the discharged radioactive materials could have an impact for a much longer period.

For the construction and operation of NPPs, therefore, the applicant's safety analysis report is required to describe the characteristics of potential contamination and transport pathways in the groundwater environment, the coefficients of dispersion, groundwater velocities, travel times, hydraulic gradients, hydraulic conductivities, porosities, etc. These parameters should be demonstrated with representativeness and confidence. Thereafter the dose assessment should be performed considering the pathway and input data and using the reasonable model.[2), 3)]

This paper describes results from the tracer test performed near the Radioactive Waste Storage Tank of Shinkori unit 2, and the implications for the future improvement of site safety analysis.

2. Methodology

The study site is located in coastal regions between Jangan-eup, Busan and Seosaeng-myun, Ulsan.

One injection well and three monitoring wells were installed for the tracer(Figure 1). Total depths of injection well(PW-2) and each monitoring well(PM2-1, 2-2, 2-3) were -16.1m EL, -10.8m EL, -11.5m EL, -11.4m EL, respectively.

NaCl solution was used as a conservative tracer in the tests and initial electric conductivity(hereafter EC) of injection solute was 5,130 ㎲/㎝.

Injection depth of tracer was -0.1 m EL and monitoring device(CTD-diver) was installed at -2.3m EL for PM2-1, -2.3m EL for PM2-2 and -3.3m and -4.3m EL for PM2-3, respectively, considering the open joint in each monitoring well. Device was set up to record the EC, temperature and water level every 10 minutes. Tracer solution had been injected as 2.73 L/min for 1,910 minutes in the 1st period, and after 1,910 minutes the injection rate changed to 0.84 L/min for 2,885 minutes. Tracer test were carried out about 7 days(10,300 minutes)

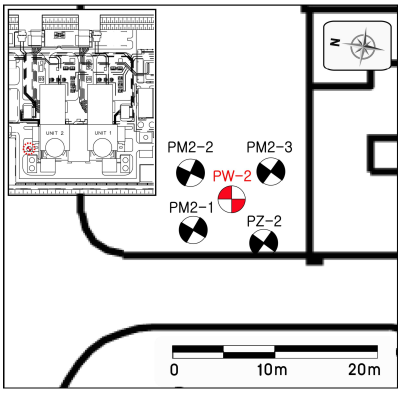

Figure 1 The well array in the study site

3. Results and Discussion

3.1 Monitoring result

Figure 2 shows the variation of the EC and water level of PM2-3 recorded at -4.3m EL. Initial response of EC was observed at about 570 minutes and its maximum at about 1,840 minutes with 2,360 ㎲/㎝.

During the experiment, abrupt drop of EC were observed between 1,870 and 2,840 minutes. This phenomenon was attributed to the mixing of groundwater occurred in the process of groundwater sampling.

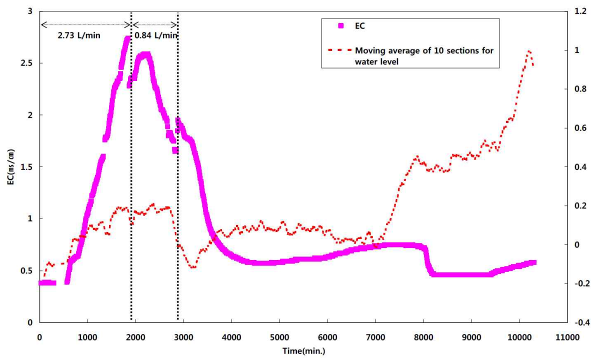

Figure 2 Result of EC and water level(moving average of 10 section) monitored at -4.3 m EL of PM2-3

During the 1st injection period, water level rose simultaneously with the start of injection, became stable between 0.1154 and 0.2854m EL from 1,570 to 2,750 minutes and then after, declined to -0.165m EL at 3,150 minutes. During the second injection period starting from 1,910 minutes, water level was increased and stabilized between 0.005 and 0.215m EL from 3,860 to 6,050 minutes.

Abnormal water-level rise was observed after 6,907 minutes. During the test period, no precipitation occurred and the rise appeared not to be a daily fluctuation by tidal effects. Consequently, this rise was interpreted as the result of the shutdown of the dewatering pump that is installed around the building and operated automatically to maintain the groundwater level.

3.2 Instantaneous test in 1D groundwater flow system

If a pollutant is injected instantaneously into the 1D uniform flow system, the maximum concentration (C_{max}) of a pollutant occurs at t_{Rmax}. The test result was analyzed using the Sauty equation[4].

Since the observed data from 3,170 to 3,760 minutes showed undistributed changes in the tests, these data were used to fit into the model(Figure 3).

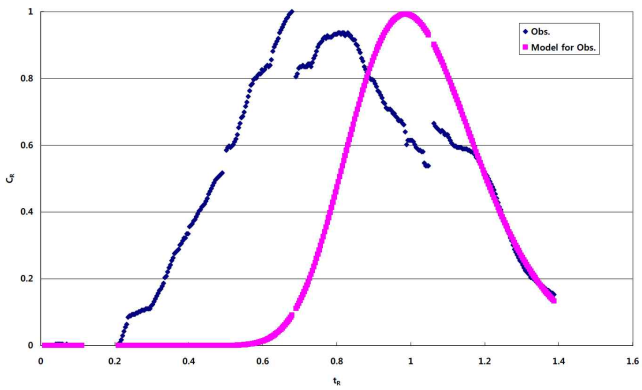

Figure 3 Result of fitting between data and model for analysis range

Results of the analysis shows that the linear mean velocity($\bar{v}_x$) is 2.55m/day, the dispersion coefficient(D_l) is 0.18 m^2/day, and the initial response time is 1,310 minutes(t_R=0.48). The effective porosity of media of study aquifer is 9.98E-4 obtained using the natural hydraulic gradient(0.094) and the conductivity(2.71E-2 m/day).

4. Implication

Groundwater is one of the main pathways of the radioactive materials discharged from the NPP site, and thus, we cannot overemphasize the significance of understanding the groundwater system of the site. This study shows one of the approaches to quantify the characteristics of the subsurface materials. Since the facility is operated with various safety control measures such as automatic dewatering pump, the test results should be carefully interpreted with the on-site conditions. For example, the test results from this study might be affected by the dewatering pump resulting in fast groundwater movement while in operation. When it's stopped, water flows become deterred and water level inclines. Therefore, it is suggested that at the NPP sites, facility operations that could affect the groundwater should be fully considered in the future tracer tests.

REFERENCES

[1] IAEA, "Dispersion of Radioactive Material in Air and Water and Consideration of Population Distribution in Site Evaluation for Nuclear Power Plants", Safety Guide No. NS-G-3.2, 2002.

[2] Notice of MEST No. 2009-37(MEST.reactor.006) "Standard Format and Content of Radiation Environmental Report for Nuclear Power Utilization Facilities"

[3] Notice of MEST No. 2009-37(MEST.reactor.030) "Technical Standards for Investigation and Evaluation of Hydrological and Oceanographic Characteristics of Nuclear Reactor Facility Sites"

[4] Sauty J-P. An analysis of hydrodispersive transfer in aquifers. Water Resour Res 1980;16:145– 58.