Study on Contaminant Transportation of a Typical Chemical Industry Park Based on GMS Software

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Abstract: The groundwater solute transport model can effectively simulated the transport path, the transport scope, and the concentration of contaminant which can provide quantitative data for groundwater pollution repair and groundwater resource management. In this study, we selected biological modern technology research base of Shandong province as research objective and simulated the pollution characteristic of typicalcontaminant cis-1, 3-dichloropropene under different operating conditions by using GMS software.

1 Introduction

Water is not only a very valuable natural resource, but also important for maintaining the stability and balance of the entire ecosystem[1-2]. With the development of society economy, the trend of groundwater pollution has becoming more and more serious[3-5]. Numerical simulation method is an important means of groundwater resources research. It is used to predict the development trend of groundwater pollution, select the best prevention and control measures, and make sustainable use of groundwater resources[6-10].

The study area is located in the southern part of the Ciyao town which is in the eastern part of Ningyang County, Tai'an City, Shandong Province. There is a Shandong Province biological high-tech industry base in the study area. While the enterprises are developing, the groundwater resourcesare polluted. So it is urgent to prevent and govern groundwater pollution.

2 Summary of Hydrogeology

The exposure strata of the study area is dominated by the strata of theQuaternary alluvial. The eastern and southern areas are mainly exposed to the strata of the Yanling Formation in the Taishan Rock Group and the limestone strata of the Cambrian Ordovician. In the study area, there are mainly Yishan fault and Wensi fault whosedirectionsare north-south and east-west. The faults in the study area are mainly small faults, and most of them are covered by Quaternary strata. The study area is located in the intersection of low mountains, hills and Dawenhe alluvial plains. The groundwater is dominated by shallow dives and deep fractured karst water, followed by weathered fissure water.

3 Model Establishment and Solution

3.1. Numerical Model

This simulation uses the MODFLOW and MT3D modules of the GMS software. MODFLOW module is used to simulate groundwater's seepage, and MT3D module is used to simulate groundwater's solute transport.

3.2. Divisions of Hydrogeological Parameter

The hydrogeological parameters and rainfall infiltration coefficients are shown in the following table:

Tab 1 The shallow aquifer hydrogeological parameters partition table

Number	Horizontal conductivity（m/d）	Vertical conductivity（m/d）	Effective porosity
1	18.00	0.05	0.30
2	6.00	0.40	0.30
3	8.00	0.20	0.30
4	4.00	0.30	0.30

Tab 2 The deep aquifer hydrogeological parameters partition table

Number	Horizontal conductivity（m/d）	Vertical conductivity（m/d）	Effective porosity
1	5.00	0.03	0.25
2	6.00	0.40	0.25
3	7.00	0.40	0.25

Tab 3 The precipitation recharge coefficient partition table

Numer	precipitation recharge coefficient
1	0.25
2	0.24
3	0.29

3.3. Processing of Source and Sink Items

Rainfall infiltration, irrigation backflow and extraction are given by the Recharge module. The river is processed by the River module and the Drain module. The other source and sink items are processed into mining wells or recharge wells and calculated by the Well module in the model.

3.4. Correction of Model

The parameters of the model are identified and validated by using the water level in December 2012 as the reference. The simulated flow pattern of the model is the same as the measured flow field (Fig. 1). So the model can be used to forecast the groundwater level.

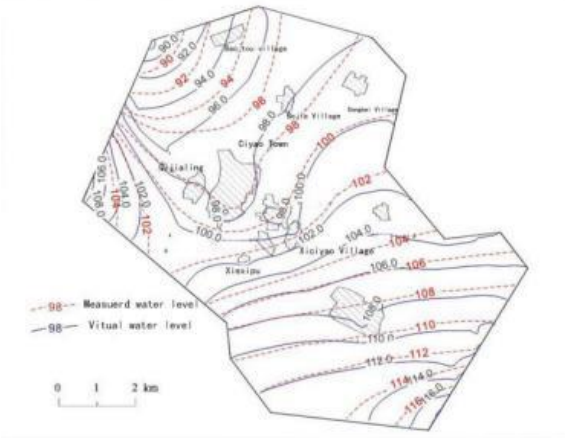

Fig 1 The fitting chart of deepaquifer flow field

4 Analysis of Simulation Results of Pollutant's Transport

In this simulation, cis-1, 3-dichloropropene produced in the production process was used to simulate the migration of pollutants in the aquifer and the potential impact on the aquifers.

4.1. Migration Characteristics of Pollutants in Normal Conditions

According to the relevant data of the EIA report, it is assumed that the amount of sewage leakage is 40 m^3/d, the concentration of dichloropropene in sewage is 24 mg/L, and the simulated pollution threshold is 0.1 mg/L.

It can be seen from the simulation results(Fig.2) that the organic pollutants in the aquifer migrate northward. The organic pollutantsshift to the direction of Huayang pesticide factory 5 years later and it began to shift to the direction of Ciyao town 20 years later. The farthest distance of pollutants can be 1770m 20 years later and the maximum impact area will be $9.2\times10^5 m^2$.

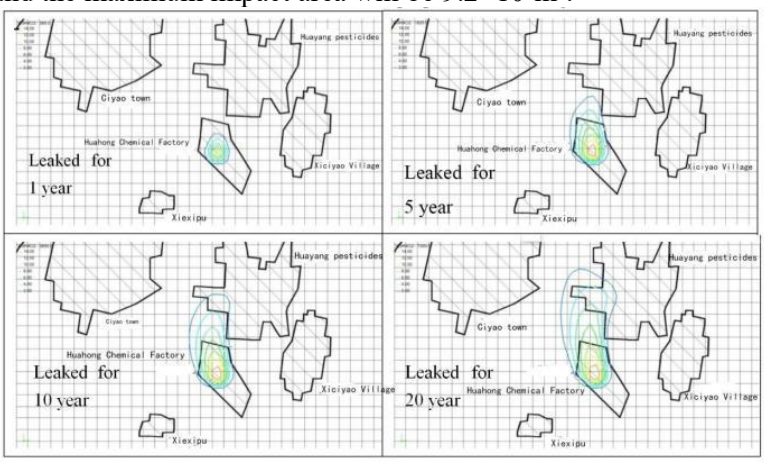

Fig 2 Cis-1, 3-dichloropropeneconcentration contour map

4.2. Characteristics of Pollutant Migration under Extreme Conditions

It assumed that the leakage of the high concentrations of dichloropropene (97%) is 5t and the critical value of the pollution is 0.1mg/L. From the simulation results, it can be seen that the aquifer suffered a certain degree of pollution(Fig.3). After the accident, the concentration can reach 33.4mg/L and the pollution area is 1.1×10^5 m^2 after 1year. The maximum distance is 1600m after 20 years. The concentration of contaminants is gradually reduced to less than 1 mg/L. The largest contaminated area appears in the first 20 years. The pollution area is 5.1×10^5 m^2 and the maximum concentration is about 1mg/L.

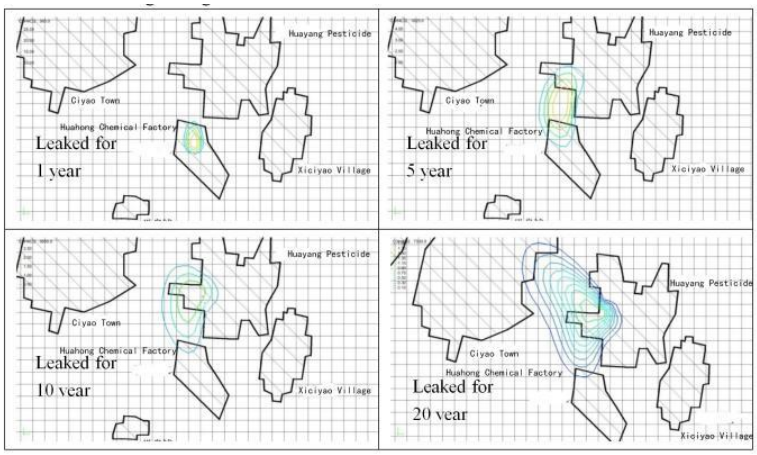

Fig 3 Cis-1, 3-dichloropropeneconcentration contour map

5 Conclusion

(1) With the time going by, the pollutant flows roughly along the direction of the water flow and causes a certain degree of pollution to the aquifer;

(2) The migration range is an oval-shaped contaminated area which the leakage point is the center of the circle and the main flow direction is the long axis. The concentration of pollutants in the center of the leak is the largest and the concentration of pollutants is decreasing when the distance is far from the center;

(3) Under different working conditions, the cis-1, 3-dichloropropene can separately transport 1770m and 1600m and the greatest affected area can separately reach $9.2\times10^5m^2$ and $5.1\times10^5m^2$ after 20 years.

(4) The transport of pollutants in aquifers is greatly influenced by human factors. Artificial exploitation of groundwater can change the hydraulic characteristics of groundwater and affect the transport path and pollution range of pollutants;

(5) In the chemical park, it is important to pay special attention to the management of pollutants, make anti-seepage measures, and manage and monitore the research area and the surrounding area's groundwater resources.

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