Exam IHE Transient Groundwater

Tuesday, Feb 4, 2020.

# Question 1

1. Explain what is meant by air-entry pressure, and how you interpret it in terms of groundwater.

The air entry pressure is the pressure required to blow air through a small soil sample. It corresponds to the suction head of the widest pores, and, therefore, the thickness of the capillary fringe.

1. What happens to the water level in a piezometer installed in a confined aquifer if suddenly a load equivalent to a pressure increase is placed on ground surface?

The water pressure increases by *LE* times . And the head in the piezometer goes up by

1. What happens to the water level in a piezometer if the barometer pressure suddenly change by an amount ?

The water level would go up like answered in the previous question, but because of the full barometer pressure pushing down on the water level in the piezometer, it actually goes down by .

1. Explain what causes the difference between the answers to questions 2. And 3.

It’s already explained in question 1.3

1. If a pressure transducer is fixed in a piezometer, below the water level at a given elevation, then what changes would it register in the two situations described in questions 2 and 3? (A pressure transducer measures and registers the absolute pressure, i.e. water + air).

A pressure transducer measuring absolute pressure will experience a pressure increases of in both cases.

# Question 2

Let the time-dependent change of head in a strip of land with width *𝐿* [m] between two ditches be caused by a sudden change of water level equal to *𝐴* [m] at the left ditch and equal to *𝐵* [m] at the right ditch. We know that this can be computed using the formula that is valid for a half-infinite aquifer (that is an aquifer for which *x*>0) bounded by surface water at *x*=0, if we apply superposition. The formula for the half-infinite aquifer is

In preparation of the superposition, a superposition scheme is drawn (see figure below), showing the strip of land in dark yellow and the first few of the infinite series of mirror ditches. The arrows indicate the direction and size of the change of head at all ditches.



1. Is this scheme correct? Explain why or why not that is the case.

The scheme is correct because around the left ditch all mirror ditches cancel out except so that at the left ditch, only het head change at the left ditch remains. The same is true for the right ditch.

The first term of formula for drainage of a strip of land in which the head is at *𝑡*=0

is uniform and equal to A [m] above the ditches on either side is given by

with

1. What does this equation tell you? What's happening here? What name would you give to *T* ? Also explain why.

The head between the diches has the shape of a cosine between and that declines exponentially with time. *T* can be named characteristic time because its scales the actual time.

1. What is the halftime of this drainage process? Explain, and show it mathematically.

A halftime of a process is the time in which some outcome of the process is halved. Halftimes are a characteristic of exponential decay.

Mathematically just say that , so

1. How would you compare the rate of drainage of a desert that is 500 km wide between surface -water boundaries and an arable field of 100 m wide between ditches, if both have the same aquifer properties?

The characteristic time is , therefore,

# Question 3

The simplified Theis solution for the drawdown due to a pumping well in a (un)confined aquifer reads

A pumping test was carried out with an extraction of . The drawdown was measured in 3 observation wells.

The figure shows the measured drawdown in the observation wells as a function of on logarithmic scale.

Answer the following questions

1. What is the transmissivity, explain and compute it.

The drawdown per log-cycle is about 0.55 m, which should equal

Therefore,

1. What is the storage coefficient, explain and compute it?

Extending the straight portion of the drawdown curve to gives . At this value, the argument of the logarithm must be 1, because then the computed drawdown is zero.

1. If you had only the drawdown in the well itself instead of in observation wells? What could you and what could you not determine, and why?

In that case we can always compute the transmissivity, but not the storage coefficient, because the drawdown in the well depends on other things like borehole skin and partial penetration of the screen, which are not known in general.

1. What is the radius of influence? Explain and show it mathematically.

That’s the radius at which the drawdown in the simplified Theis formula is zero, so that then the argument of the logarithm is zero. In fact this is what we used above to computed the storage coefficient, hence

