UNIVERSITY OF MISKOLC
FACULTY OF
EARTH AND ENVIRONMENTAL
SCIENCE AND ENGINEERING

OILFIELD HYDROGEOLOGY

Environmental Engineer MSc mesterszak

2023/24 I. félév
2023/24 I. Semester

TANTÁRGYI KOMMUNIKÁCIÓS DOSSZIÉ

Miskolci Egyetem/University of Miskolc
Műszaki Föld- és Környezettudományi Kar/Faculty of Earth and Environmental Sciences and Engineering
Víz- és Környezetgazdálkodás Intézet/Institute of Water Resources and Environmental Management

Tartalomjegyzék

1. Tantárgyleírás, tárgyjegyző, óraszám, kreditérték

Course Title: Oilfield hydrogeology	**Credits: 3**
Type (lec. / sem. / lab. / consult.) and Number of Contact Hours per Week: **lec. 2, sem. 1**	
Neptun code: MFKHT730014	
Type of Assessment(exam. / pr. mark. / other):**exam** During the semester one written test and 5 exercises are given. The former is responsible for the 30% of the mark, while the latter ones contribute to the 70% of that. **Grading limits:** > 90%: excellent, 75-89 %: good, 65-74%: satisfactory, 51-64%: pass, < 50%: unsatisfactory.	
Position in Curriculum (which semester): **third**	
Pre-requisites *(if any)*:	
Course Description:	

Acquired store of learning:

Study goals:The students will be familiar with the main concepts of modern hydrogeology as well as petroleum or oilfield hydrogeology. The students will review the migration and accumulation theories and will understand the hydrogeologic indicators of petroleum reservoirs. The students will be able to apply hydrogeology in regional petroleum and gas exploration projects. The course makes the students understand the presence and place of hydrocarbon-pools.

Course content:The main properties and quality aspects of groundwater. Classification of groundwater resources. Storage and hydraulic properties. Darcy-law, flow and seepage equations. Temperature properties under the surface. Shallow and deep groundwater. Flow systems under the surface. Groundwater as a geologic agent. Determination of hydraulic conductivity. Transport processes in groundwater. Basics of well hydraulics. Group of wells. Pumping tests and their interpretation. Complex interpretation of groundwater data. Evaluation and interpretation of subsurface hydrodynamic data of extended regions. Hydraulics and hydrodynamics of petroleum entrapment and occurrences. Characterization of groundwater flow systems. P(z) profiles, fluid-potential maps, hydraulic cross-sections. Hydrogeothermal conditions. Over-pressured aquifers.UVZ methods. Entrapment potential.

Education method: Lectures with powerpoint slides, practises in the laboratory.

Competencies to evolve:

T1 – Behatóan ismeri a kutatáshoz és a tudományos munkához szükséges, műszaki és természettudományi területen alkalmazható problémamegoldó technikákat.

T4 – Részleteiben is ismeri a kőolaj- és földgáz nyersanyagtelepek felkutatására alkalmas geológiai és geofizikai módszereket.

T5 – Rendelkezik a kőolaj- és földgáz nyersanyagtelepek felkutatásához szükséges mélyreható földtani, geofizikai és természettudományos ismeretekkel.

T6 – Jól megalapozott ismeretekkel rendelkezik a kőolaj- és földgázvagyonok feltárásának módszereiről.

T9 – Átfogó ismeretekkel rendelkezik a kőolaj- és földgáz vagyonok kitermelésére alkalmas módszerekről.

T12 – Birtokában van a tudományos kutatómunkában (beleértve a PhD képzéstbe történő belépést) való részvételhez szükséges ismereteknek.

K2 – Képes korszerű ismeretszerzési és adatgyűjtési módszerek alkalmazására.

K4 – Képes a szénhidrogénkutatási komplex tervezési és kivitelezési munkák irányítására és projekt menedzseri feladatok ellátása, illetve azokban való részvételre.
K6 – Képes a szénhidrogéntároló földtani szerkezetek földtani és geofizikai viszonyainak elemzésére, szakszerű kutatására és a kitermelés tervezésére, kutatási-műszaki üzemi terveinek elkészítésére, a kutatás műszaki lebonyolítására és ennek ellenőrzésére, valamint a (záró) jelentések elkészítésére és véleményezésére
K7 – Képes a szénhidrogénkutató felszíni és fúrási geofizikai kutatások tervezésére, a mérések végrehajtására, és irányítására, a mérési adatok feldolgozására, kiértékelésére és földtani-geofizikai elemzésére, valamint ezeknek a tevékenységeknek a véleményezésére
K9 – Képes a szénhidrogén termelés során (tervezés, beruházás, üzemeltetés, bezárás) felmerülő földtani-geofizikai jellegű problémák megoldásában való közreműködésre és a megoldási lehetőségek elemzésére.
K10 – Képes a kutatási és termelési adatok feldolgozására és geoinformatikai adatbázisokba (rendszerekbe) való szervezésére.
A1 – Nyitott és fogékony, aktív a műszaki földtudományi mérnöki szakterületeken zajló szakmai és technológiai módszertani fejlesztés (pl. új geofizikai mérési eljárások módszerek, geokémiai elemzési módszerek, földtani modellezés) megismerésére, elfogadására fejlesztésükben való közreműködésére.

The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**:

- David Daming, 2002: Introduction to Hydrogeology, McGraw-Hill Higher Education.
- Charles R. Fits, 2002: Groundwater Science. Academic Press, pp. 1-450.
- S. E. Ingebritsen, W. E. Sanford, 1998: Groundwater in Geologic Processes. CabridgeUniversity Press.
- Eric. C. Dahlberg, 1982: Applied Hydrodynamics in Petroleum Exploration, ISBN: 0-387-97880-1, Springer-Verlag.
- Willis D. Weight, 2004: Manual of Applied Field Hydrogeology, McGraw-Hill Professional Engineering.

Responsible Instructor(*name, position, scientific degree):*

Péter Szűcs Dr., professor, DSc

2. TANTÁRGYTEMATIKA

Oilfield hidrogeology.
Tantárgytematika (ÜTEMTERV)
Aktuális tanév őszi félév
Petroleum Geoengineering mesterszak MSc, 1. félév, törzs tárgy

Hét		Előadás
1.	09.14	Most important facts, issues and relations in hydrogeology.
2.	09.21	Comprehensive examples related to groundwater resources.
3.	09.28	Groundwater basins. Groundwater flow systems.
4.	10.05	Sustainability issues. Artificial groundwater recharge
5.	10.12	The groundwater management challenges related to transboundary aquifers all over the world.
6.	10.19	Hydrogeology of the Carphatian Basin – interesting phenomena from a special hydrogeological laboratory.
7.	10.26	*No class (by Rector's Decision)*
8.	11.02	*No class (by Rector's Decision)*
9.	11.09	Isotope hydrogeology. The application of stable and radioactive environmental isotopes in hydrogeological interpretations. Hydrogeological case-study in a volcanic environment.
10.	11.16	Special interpretation methods in well hydraulics Groundwater and surface water interaction. Relationship between surface and groundwater resources.
11.	11.23	Karst hydrogeology, Groundwater modeling of karst systems
12.	11.30	Chemical hydrogeology. Transport processes. Chemical components in groundwater. Hydro-geochemistry.
13.	12.07	Recharge estimation of groundwater systems.
14.	12.14	Petroleum hydrogeology

3) MINTA ZÁRTHELYI

Oilfield hidrogeology c. tárgy zárthelyi dolgozat

MSC Hydrogeology practice
(TEST 1)

Sieve diameter (mm)	Remained (g)	Remained (%)	All remained (%)	All fallen through (%)
16	40			
8	60			
6,3	260			
4	132			
2	300			
1	406			
0,5	284			
0,25	100			
0,125	40			
0,06	366			
Sum:	**1988**	**100**		

1. After a sieve analysis, we got the results seen in the table. Calculate the rest of the table, and draw the particle size distribution curve. (5 points) Give the inequality coefficient (U) and the significant particle size (d_m) values, and name the sample. (4 points)

2. Give the following definitions:
   Hydrological equation (1p.):

   Hydraulic conductivity (sign + unit!) (2 p.):

   Porosity (sign + unit) (2 p.):

   Geothermal gradient (sign + unit) (2 p.):

3. Please give the methods for defining hydraulic conductivity! Please write down the measurement steps of the <u>laboratory method</u> used at practice! Give the two equation which is for the two interpretation method! (6 p.)

4. What does the axes of the two coordinate systems represent, in type curve fitting of Theis method? What kind of scale are used on the axes? (3 p.)

5. Consider an in-ground pool with impermeable walls and compacted clay lining on the bottom. The surface area of the pool is 20 m^3. The water level in the pool is at -0.5 m, while the groundwater level is at -3.0 m. The soil around the pool is composed of coarse sand. The clay lining is of 0.6 m width and its hydraulic conductivity is 2e-7 m/s. Calculate the rate of water loss from the pool, give it in m^3/day! (6 p.)

6. What are the major aquifer parameters which are determined using pumping tests? (3p.)

Miskolc, 8. Dec. 2016.

Teachers: Csaba Ilyés, Zsombor Fekete

Time available: 60 minutes, maximum points: 34 (0-19=failed; 20-31=pass; 32-34=excellent)
(60%<failed; 60-93%=pass; 94%>excellent)

MSC Hydrogeology practice
(TEST 1)
SOLUTION

Sieve diameter (mm)	Remained (g)	Remained (%)	All remained (%)	All fallen through (%)
16	40	2,01	2,01	97,99
8	60	3,02	5,03	94,97
6,3	260	13,08	18,11	81,89
4	132	6,64	24,75	75,25
2	300	15,09	39,84	60,16
1	406	20,42	60,26	39,74
0,5	284	14,29	74,55	25,45
0,25	100	5,03	79,58	20,42
0,125	40	2,01	81,59	18,41
0,06	366	18,41	100,00	0,00
Sum:	**1988**	**100**	**-**	**-**

7. After a sieve analysis, we got the results seen in the table. Calculate the rest of the table, and draw the particle size distribution curve. (5 points) Give the inequality coefficient (U) and the significant particle size (d_m) values, and name the sample. (4 points)

8. Give the following definitions:
Hydrological equation (1p.): *Inflows = Outflows± Changes in stored Water (ΔS)*

Hydraulic conductivity (sign + unit!) (2 p.): *Sign: - K (internationally), k (in Hungary), „velocity" dimension [m/d]. It characterise also the rock and the fluid, which flows through it pores*

Porosity (sign + unit) (2 p.): *The ratio of the pore volume and the whole volume, n = Vpore/Vwhole*

Geothermal gradient (sign + unit) (2 p.): *is the rate of increasing temperature with respect to increasing depth in the Earth's interior. Earth average is 3°C /100 m. In Hungary 5-7 °C /100 m*

9. Please give the methods for defining hydraulic conductivity! Please write down the measurement steps of the laboratory method used at practice! Give the two equation which is for the two interpretation method! (6 p.)

Field methods, laboratory method, calculation methods.
Sample is fitted into the measurement tube, and water is flown through it. In fixed wall method, we measure the differences in water levels through time.
k=2.3(f*l)/F*(1/ΔT)*lg(h0/hi)*
k=2.3(f*l)/F*ctg(alfa)*

10. What does the axes of the two coordinate systems represent, in type curve fitting of Theis method? What kind of scale are used on the axes? (3 p.)

Axis x= time [s]
Axis y=depression [m]
Logarithmic scale

11. Consider an in-ground pool with impermeable walls and compacted clay lining on the bottom. The surface area of the pool is 20 m^3. The water level in the pool is at -0.5 m, while the groundwater level is at -3.0 m. The soil around the pool is composed of coarse sand. The clay lining is of 0.6 m width and its hydraulic conductivity is 2e-7 m/s. Calculate the rate of water loss from the pool, give it in m^3/day! (6 p.)

12. What are the major aquifer parameters which are determined using pumping tests? (3p.)

Transmissivity, Storage coefficient, hydraulic conductivity

Miskolc, 8. Dec. 2016.

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Time available: 60 minutes, maximum points: 34 (0-19=failed; 20-31=pass; 32-34=excellent)
(60%<failed; 60-93%=pass; 94%>excellent)

4) VIZSGA TÉTELSOR

Oilfield hidrogeology C. TÁRGY
TÉTELSOR

1. What is the definition of the aquifer? What are the principal aquifer rock types? Please give examples for the values of hydraulic conductivity in case of different rock types. What is the definition of the storage coefficient?
2. What is hydrogeology? Please describe the Darcy-equation and its components. What are the elements of hydrologic cycle? Please describe the global hydrological (water budget) equation.
3. What is the definition of groundwater basin? Please describe the Hubert's model and the Toth's flow model. Please describe the local, medium and regional flows in a basin. Please describe the Ghyben-Hetrzberg equation in case of sea water intrusion. How can this phenomenon jeopardize drinking water supply in coastal regions?
4. Please describe the main steps of the Theis pumping test evaluation. Please give the main equations with the well function. What is the meaning of recovery data in well hydraulics? Why can experts prefer field data to laboratory data concerning the hydraulic conductivity.
5. Please describe the evolution of the safe yield concept. What are the most important groundwater management tools? What kinds of aspects have the term of sustainability?
6. How does artificial recharge work in reality? Which regions can be suitable for this method? What are the main technical solutions for implementing the artificial recharge? What is the advantage of conjunctive water use?
7. What is the importance of transboundary aquifers? Which is the more preferable position in case of water management? Downstream side or upstream side? What is the situation in Hungary concerning the internationally shared aquifers? How can groundwater flow simulations help the decision makers?
8. Drinking, mineral, medicinal and thermal water resources and their utilization from aquifers. Please give the basic definitions. How can geothermal gradient and heat flow be defined? What is the relationship between hydrogeology and geothermal energy utilization?
9. Please describe the main properties, features and aspects of karst aquifers? What is epikarst? What kinds of methods are existing in karst investigations? What is a tracing experiment? Please give information about hydrograph analysis. Classify hydrograph analytical methods. What are the main features of a hydrograph peak? What is the Maillet formula? What is recession coefficient? Which aquifer parameters influence recession coefficient?
10. What are the main steps of the comprehensive water management focusing on water status? Please describe the concepts of the Water Framework Directive. Why is the Danube watershed so special?
11. Please describe the isotope hydrology techniques in groundwater investigation. Please give the most important radioactive and stable isotopes in hydrogeology. What are the methods for groundwater age determination?
12. How can you estimate the groundwater recharge with environmental isotopes in the unsaturated and the saturated zone? What kind of interaction can exist between groundwater and surface water?

5. EGYÉB KÖVETELMÉNYEK

A zárthelyi dolgozat írása és a vizsga közben a mobiltelefon használata tilos!