PROCESS SIMULATION USING ASPEN HYSYS

MSc in Petroleum Engineering **MFKOT710021**

COURSE DESCRIPTION

University of Miskolc
Faculty of Earth Science and Engineering
Petroleum and Natural Gas Institute
September 2020

Course Data Sheet

Course Title: Free elective Process Simulation Using ASPEN HYSYS **Instructor:** Dr. Zoltán TURZÓ associate professor László KIS, assistant lecturer	**Code:** MFKOT710021 **Responsible department/institute:** DPE/IPNG (OMTSZ/KFGI) **Course Element: Free Elective**
Position in curriculum* (which semester): 1 (4)	**Pre-requisites (if any):** no
No. of contact hours per week (lecture + seminar): 2+0	**Type of Assessment (examination / practical mark / other):** practical mark
Credits: 2	**Course:** full time

Course Description:

1. The Aspen HYSYS software package, its features, its applications, and the problems that can be solved.
2. Examination of elements suitable for production oil and natural gas: pipelines
3. Heat exchangers
4. Compressors
5. Expanders
6. Separators
7. Mixers
8. Production systems
9. Modeling of the technological sub-processes used to produce crude oil
10. Modeling of the technological sub-processes used to produce natural gas
11. Modeling of the technological sub-processes used during pipeline transport.
12. Evaluation of simulation results.
13. Structure of the cold separation technology model relating to the natural gas preparation, uploading, running and evaluation of data.
14. Compilation of documentation to solve the problem.

Competencies to evolve:
Knowledge: T1, T4, T5, T11
Ability: K1, K4, K5, K9, K10, K11
Attitude:
Autonomy and responsibility: F1, F3, F6, F7

Assessment and grading:
Students will be assessed with using the following elements.

Attendance:	5 %
Homework	10 %
Midterm exam	40 %
Final exam	45 %
Total	100%

Grading scale:

% value	Grade
90 -100%	5 (excellent)
80 – 89%	4 (good)
70 - 79%	3 (satisfactory)

	60 - 69% 2 (pass) 0 - 59% 1 (failed)

Compulsory or recommended literature resources:

- User Manuals of ASPEN HYSYS Software
- R. N. Maddox, D. J. Morgan: Gas Conditioning and Processing: Volume 4: Gas Treating and Sulfur Recovery, Campbell Petroleum Series, 2008
- F. S. Manning, R. E. Thompson: Oilfield Processing: volume Two: Crude Oil, PenWell, 1995.
- Gas Conditioning and Processing: Volume 2: Equipment Modules, Campbell Petroleum Series, 2013
- A. Bahadori: Natural Gas Processing: Technology and Engineering Design, Gulf Professional Publishing, 2014. ISBN 9780124202047

Course Schedule for 2020/21 school year

Date	Topic
2020.09.07.	The Aspen HYSYS software package, its features, its applications, and the problems that can be solved.
2020.09.14.	Examination of elements suitable for production oil and natural gas: pipelines
2020.09.21.	Heat exchangers
2020.09.28.	Compressors
2020.10.05.	Expanders
2020.10.12.	Separators, Mixers
2020.10.19.	Test writing.
2020.10.26.	Production systems
2020.11.02.	Modeling of the technological sub-processes used to produce crude oil
2020.11.09.	Modeling of the technological sub-processes used to produce natural gas
2020.11.16.	Modeling of the technological sub-processes used during pipeline transport.
2020.11.23.	Evaluation of simulation results.
2020.11.30.	Structure of the cold separation technology model relating to the natural gas preparation, uploading, running and evaluation of data. Compilation of documentation to solve the problem.
2020.12.07.	Test writing.

Test Example

HYSYS TEST (80 points)

Component	Mol %
Methane	0.7254
Propane	0.1231
n-Butane	0.0044
i-Butane	0.0029
Ethane	0.0321
i-Pentane	0.0049
n-Pentane	0.0071
n-Hexane	0.0024
n-Heptane	0.0009
n-Octane	0.0019
n-Nonane	0.0014
n-Decane	0.0286
H_2O	0.0021
H_2S	0.0011
CO_2	0.0496
Nitrogen	0.0098
Oxygen	0.0022
Mercury	0.0001

The given gas mixture flows in a 12 km long pipeline with 450 mm outer diameter and 425 mm inner diameter. The pipeline descends 20 m in the flow direction. The soil temperature is 8°C, the pipe is insulated with 4.2 cm thick fiberglass block. The pipe is buried at 1.3m in dry clay. The starting pressure is 24 bar, the starting temperature is 20°C and the mass flow rate is 50 t/d.

1. *Find the outlet gas pressure and temperature. (5p+5p)*

The pipeline is connected to a 3 phase separator.

2. *Find the mass flow rate of the 3 phases. (2p+2p+2p)*

Increase the pressure of the gaseous phase to 52 bar using a compressor with 90% adiabatic efficiency.

3. *Find the temperature of the compressed gas and the required power. (2p+2p)*

The compressed gas is fed to a heat exchanger's tube side. 50-50 mol% nitrogen and carbon-dioxide is fed to the shell side. Before the heat exchanger the nitrogen and carbon dioxide mixture is flowing in a 1.5 km long pipeline with 25 m elevation change in the flow direction. The outer diameter of the pipe is 252 mm and the wall thickness is 1.5 cm. The total heat loss is 4097.9 kcal/h. The initial pressure and temperature of the nitrogen and carbon-dioxide mixture is 6 bar and 8°C respectively. The mass flow rate is 125999 kg/d. The specified pressure drop is 0.5 bar for both sides of the heat exchanger. The overall heat transfer coefficient (UA) is 3500 kJ/°C h.

4. *Find the pressure and temperature of the cooling gas entering the heat exchanger. (5p+5p)*
5. *Find the temperature of the nitrogen and carbon-dioxide mixture and the HC gas mixture leaving the heat exchanger. (5p+5p)*

The HC gas mixture is transported in a three segmented pipeline. The elevation changes are -43.34 m, 1260 dm and 2300 cm in the segments. The length of the segments are 42650 m, 372599 m and 14329 m. The pipes have the same 4cm thick urethane foam insulation and are laid 1.7 m depth in 3°C wet sand.

6. *Find the minimal nominal diameter using Schedule 40 pipe. Find the endpoint pressure and temperature of the gas. (10p+5p)*
7. *Create a case study to find the relationship between the mass flow rate of the HC gas and the pressure of the HC gas after the three-segmented pipeline. Find the maximal throughoutput capacity that can be divided by 100. (5p+5p)*
8. *Create a case study to find the relationship between the mass flow rate of the cooling gas and the temperature of the cooled HC gas after the heat exchanger. Find required cooling gas mass flow rate to achieve 32°C HC gas temperature. (5p+5p)*
9. *Create a case study to find the relationship between the mass flow rate of the HC gas and the temperature of the HC gas at the endpoint. (5p)*

Examination review questions

The exam is a practical one with the task of creating a system in HYSYS such as in the test and answer the emerging questions.