SIMULATION PROGRAM SKILLS FOR CHEMICAL ENGINEERING GRADUATES

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Abstract
In a competitive job market, new chemical engineering graduates are tasked with enhancing their skills beyond the theoretical knowledge acquired in academia, focusing on areas such as process management and software proficiency. This need arises not only due to competition with coworkers, but also with experienced professionals from various fields. The objective of this study is How to Skill Simulation Programs for Chemical Engineering Graduates. Using a literature review methodology, this study explored the importance of software skills, specifically in Aspen HYSYS, Matlab, and AutoCAD P&ID, for chemical engineering graduates. The results underscore the importance of chemical engineering curricula to include software training, enhancing students' hard skills in parallel with soft skills development. This approach not only aligns with the evolving demands of the chemical industry, but also equips graduates with a competitive advantage in the job market. The discussion further illustrates the broader implications of software proficiency for new graduates, demonstrating the correlation between technical skill acquisition and job readiness. Therefore, this study advocates a balanced emphasis on soft and hard skills in chemical engineering education, proposing that such an integrated approach is essential for the holistic development of future professionals in the field.

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A. INTRODUCTION

In facing job competition, a fresh graduate of chemical engineering must complete his skills according to the field of work related to chemical engineering, such as process management (which requires skills in calculating process flow). Job competition occurs not only between fresh graduates but also with workers who are experienced in their field or not in their field. A fresh graduate is someone who has just graduated from school or college and has no experience in the world of work. The transcripts and knowledge obtained in college are not enough to guarantee their ability to get a profession easily. Therefore, fresh graduates need to develop skills and other special expertise to have a greater chance of getting a job.

Seeing the developments in the world of work, the role of soft skills and hard skills has a very important role because both of these are able to influence the performance and success of a worker (Rasid & Tewal, 2018; Rumira et al., 2023). Companies generally offer jobs with more consideration of the role of soft skills and hard skills. Both must be owned by each prospective employee to complement each other, and graduates must be able to adapt to changes that will occur in the work environment.

Soft skills are skills related to other people (interpersonal skills) and the ability to manage themselves (intrapersonal skills) (Widiastuti et al., 2014). Communication skills, motivation, leadership, self-marketing, and teamwork are included in the interpersonal skills needed for workers and opportunities to open jobs (entrepreneurship) (Rahmatunissa et al., 2020; Widiastuti et al., 2014). Meanwhile, intrapersonal skills are related to the ability to understand oneself and easily adapt to circumstances (Suhartono & Machmuddah, 2020). Emotional intelligence, responsibility, creative thinking, and ethics are related to the ability to manage oneself (De Campos et al., 2020).

Hard skills are the mastery of science, technology, and technical skills related to the field of science, as well as for chemical engineering graduates. These skills are required for specific jobs. An example is an engineer with mastery of machining skills or a programmer focusing on programming skills in a particular language (Ratnasari & Thiyarara, 2020). Soft skills and hard skills will encourage prospective graduates to prepare themselves for work and be ready to compete in the professional world of work. Soft skills are very important in a job, but hard skills are also needed to facilitate job completion. Researcher (Pratama et al., 2018) suggested that the hard skills most often required in job vacancies for engineers are skills in using software, quality improving, and production controlling and analyzing, with achievements of 28.57, 15.13, and 10.08%, respectively. Generally, software skills are listed in every job vacancy, and most expect prospective employees to be able to operate at least Microsoft Office software.

Skills using software that must be possessed by chemical engineering graduates to be applied in the world of work, namely being able to run process simulator software, heat exchanger design simulator, computational fluid dynamics, numerical algorithms, and design and modeling, The skills to use the software are not only obtained while studying in lectures, but students can also be optimized through their participation in training and workshops. Therefore, the purpose of this article review is to find out the use of software or simulation programs and apply them to one of the studies in the field of chemical engineering—the chemical industry. Case studies or problems in the field can be resolved by applying the software and correlated through theoretical mathematical equations. The software that will be reviewed in this review is Aspen HYSYS, Matlab, and AutoCAD P&ID (Piping and Instrumentation Diagrams).

B. RESEARCH METHOD

The method used in making this article is the literature study method. The steps taken are collecting library data, reading and recording, and analytically processing data regarding software skills needed by chemical engineering graduates to keep pace with the rapid advancement of technology in the industrial sector. The software is Aspen Hysys, Matlab, and AutoCAD P&ID. The data analysis technique used in this article is content analysis. The data analysis begins by analyzing a relevant article about the software used by chemical engineering graduates. The author analyzes an article starting with reading the abstract section of each previous study, then notes the parts that are relevant to the topic of software skills needed by chemical engineering undergraduates.

C. RESULTS AND DISCUSSION

Reviewing a number of articles provides results related to the software skills needed by chemical engineering graduates. The review process is carried out by searching for relevant theories and literature reviews from various sources. Software in chemical engineering consists of several kinds, including Microsoft Visio, AutoCAD P&ID, Aspen HYSIS, Matlab, Scilab, and others. The software is differentiated based on its function. Microsoft Visio and AutoCAD P&ID can be used to describe the flowsheet of a chemical process. While Aspen HYSIS can be used to simulate a process, Matlab and Scilab can be used to solve mathematical models related to chemical engineering operations.

Aspen HYSYS, Matlab, and Autocad P&ID were applied to a problem related to heat exchangers. The problem aims to calculate the outlet temperature on the shell side. A shell and tube heat exchanger is used to cool hot water entering through the tube side. The mass flow rate is 0.03 kg/s to cool the water from 80 to 30^{o}C. The cold water on the shell side has a mass flow rate of 0.06 kg/s with 20^{o}C as the entry temperature.

Aspen HYSIS

Aspen HYSYS is a simulator for several series of processes related to engineering, especially chemical engineering. Chemical engineering students at Universitas Singaperbangsa Karawang have a final project, which is a chemical plant design (Sutardi et al., 2020). This software can be used as a process simulation to calculate mass balance, energy balance, and several other equipment specifications. In general, chemical engineers are involved in two types of tasks: process design and the new simulation of an existing process. A simulation can be run in the presence of adequate data. The step is to modify a process or optimization by continuing in the direction of existing analyses (Haydary, 2018).

Simulation of a process circuit in Aspen HYSYS includes the selection of chemical components, thermodynamic equations (fluid packages), and determination of operating conditions (in the form of flow rate, pressure, and temperature). Aspen HYSYS provides >1500 thermodynamic component lists (hydrocarbon, non-hydrocarbon, petrochemical, and chemical fluid groups) and 34 fluid packages (A. D. K. Wibowo & Yoshi, 2021). The selection of fluid packages in Aspen HYSYS depends on the selected component list. The Peng-Robinson fluid package is used for hydrocarbon groups such as methane, ethane, propane, and so on. Another example is the Non-Random Two Liquid (NRTL) fluid package, which is used for the vegetable oil-based biodiesel manufacturing process. This biodiesel production process uses a component list consisting of methanol, water, oleic acid, glycerol, and methyl oleate (Dimawarnita et al., 2021; Fadhillah & Sari, 2023; Naulina et al., 2023). In addition to the component list and fluid package, there are five types of reactions, including conversion, equilibrium, heterogeneous catalytic, kinetic, and simple rate (Ayun et al., 2023; Brenner et al., 2001; Sinaga et al., 2023) or distillation tower (Fitriah & Sari, 2023; Miledhiya & Sari, 2024; Sari et al., 2021; Wibowo et al., 2022). These reactions can be applied to the reactor tools available in Aspen HYSYS. The tools used for simulation in Aspen HYSYS are available on the Simulation menu in the form of a model palette, which is divided into 8 groups (dynamics & control, external model, heat transfer, manipulator, piping & hydraulics, pressure changer, reactor, separator).

The component list used to complete the heat exchanger case study is water with the NBS-steam fluid package. The heat exchanger is a shell and tube type that is in the heat transfer group in the Aspen HYSYS model pallet. Figure 1 presents the process flow in the shell and tube heat exchanger to reduce the temperature of hot water entering through the tube side with the cooling medium in the form of cold water (entering through the shell side).

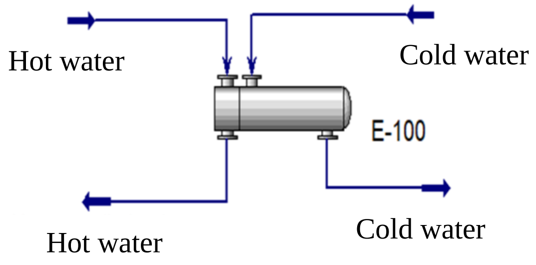

Figure 1. Process flow on the shell and tube heat exchanger

Operating conditions such as mass flow rate, temperature, and pressure are entered into the worksheet. Unit input is also adjusted. As presented in Figure 2, there is an output temperature value for cold water on the shell side of 45.01°C. In addition to being used to simulate heat exchangers, Aspen HYSYS is applied to simulate distillation columns, as done (Joao & Silva, 2016) by organizing training involving chemical engineering students. Other applications of this software in the industrial world are simulating acid gas sweetening with DEA (diethanolamine), atmospheric crude towers, sour water strippers, propylene/propane splitters, ethanol plants, synthesis gas production, and the petroleum industry (Ambar et al., 2012).

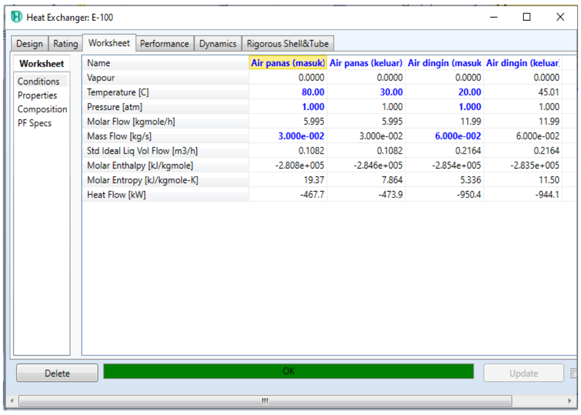

Figure 2. Worksheet on shell and tube heat exchangers

Matlab

Matlab is software used for solving mathematical modeling problems. It is used to develop mathematical algorithms, data visualization, data analysis, and calculation languages (Guangpu & Yuchun, 2012). The use of Matlab is favored in matrix operations and multivariable iteration processes with ODE (Ordinary Differential Equation) simulation models (Darmowijoyo, 2011; Li & Huang, 2016; Sari, 2018, 2021; Sari et al., 2019).

The previous Aspen HYSYS discussion was related to heat exchanger equipment, and this problem was also solved using mathematical equations through Matlab software. The comparison of the results is the point of application. In solving the problem, first calculate the heat capacity - Cp value for water, referring to (Yaws, 1999, 2015). The mathematical equation to calculate the Cp value using Matlab is presented in Figure 3. The result is the average Cp value for hot and cold water, 4.1683 and 4.1995 kJ/kg.°C, respectively.

After calculating the Cp value, the cold water output temperature value can be calculated by finding the Q - calorific value of hot water. The result obtained is 6.2524 kJ/s. Referring to the concept of heat balance, Q in hot water is equivalent to Q in cold water, so the value of the cold water output temperature is 44.8138°C. Figure 4 presents the value of heat and temperature on one side of the fluid.

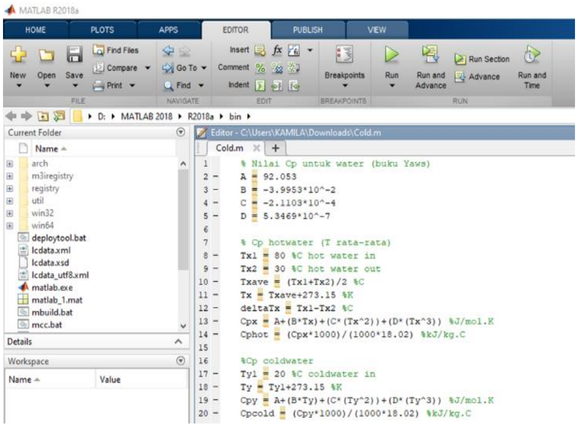

Figure 3. Calculation of the heat capacity value of a material

After calculating the Cp value, the cold water output temperature value can be calculated by finding the Q - calorific value of hot water. The result obtained is 6.2524 kJ/s. Referring to the concept of heat balance, Q in hot water is equivalent to Q in cold water, so the value of the cold water output temperature is 44.8138°C. Figure 4 presents the value of heat and temperature on one side of the fluid.

Skills using Matlab are helpful for solving mathematical equations for students. Researcher (Li & Huang, 2016) did Matlab skills training with the subject of chemical engineering students at Villanova University provided increased knowledge on the application of process modeling and control. The results indicated significant improvement after the training. Another example is the application of estimating the kinetic parameters of a reaction model in a batch reactor (Molina et al., 2019) or studying psychometric graphs (Gupta & Patel, 2017).

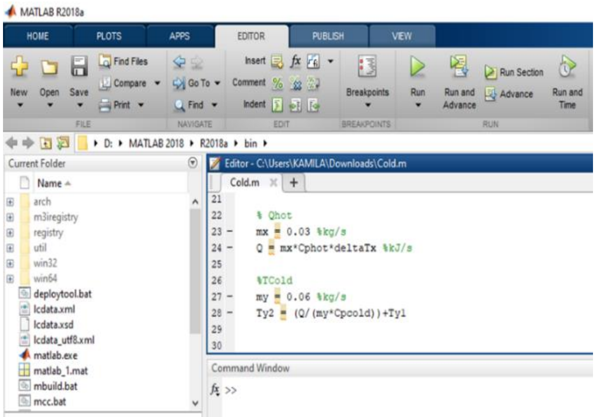

Figure 4. Calculation of the calorific and temperature value of a fluid

AutoCAD P&ID

AutoCAD P&ID is one of the computer-aided design (CAD) software programs specializing in chemical engineering that is used in designing the process flowsheet of a factory. P&ID software describes a process system flow scheme in the field regarding process equipment, piping systems, electrical systems, and control systems (Tukiman et al., 2012). The symbols represent the equipment installed in a plant, such as fluid input points, pipelines, control, and measurement instruments (Rahul et al., 2019). P&ID also displays a flow diagram design of a process that is more detailed than Process Flow Diagram (PFD) regarding symbol information in the form of instrument equipment, sensors, indicators, and control valves (Putra et al., 2018).

To solve this, AutoCAD P&ID software in its application can only describe a process flow as presented in Figure 5 below. Figure 5 provides a description that presents the process flowsheet of a shell- and tube-type heat exchanger. To create a shell and tube heat exchanger drawing in AutoCAD P&ID, learners can use the tool palette equipment presented in Figure 6 below.

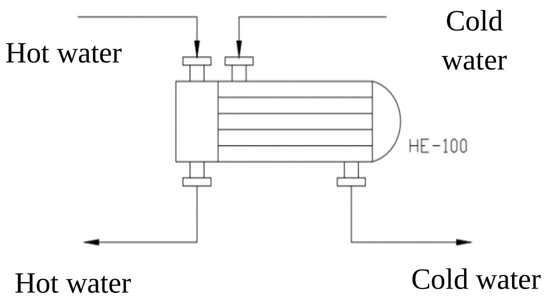

Figure 5. Process flow in shell and tube heat exchanger equipment

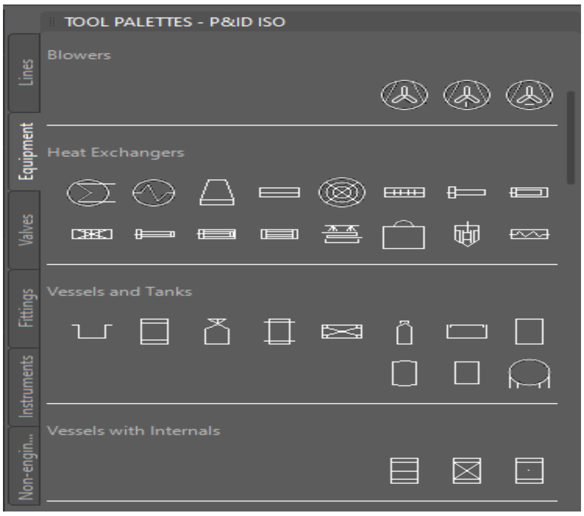

Figure 6. Tool palettes - P&ID ISO

The tool palette shown in Figure 6. uses ISO standards and can also design your own heat exchanger as desired using the draw menu bar in the autoCAD P&ID software, add lines to the tool palette lines, or, via command text, type "lead" as inflow and outflow. AutoCAD P&ID software is widely applied in various manufacturing industries, including oil and gas, cement plants, paper mills, and chemical plants, as software for drawing. P&ID is also often used by chemical engineering students to assist in preparing the final project of chemical plant design by describing the flow of chemical processes, including process tool symbols, tool codes, and flow.

Skills using AutoCAD P&ID software can be developed by attending training. Such as the AutoCAD P&ID software training conducted by chemical engineering students at Singaperbangsa University in Karawang with the aim of increasing the knowledge needed when preparing the final project of plant design and improving the hard skills of each student to be able to compete in the industrial world (Ulfa et al., 2020). Therefore, chemical engineering graduates who have the skills to use this software have a great opportunity to get a job in the industrial world.

The implementation of the software above is an illustration or reference to step into the world of work where the software becomes a basic skill for a fresh graduate of chemical engineering or someone who wants to enter the world of chemical industry work (Sijabat et al., 2024). For example, factory A uses the Heat Transfer Research Inc., HTRI application, which is an application for designing heat exchangers, especially shell and tube or air-cooled types, which can basically be learned in the Aspen HYSYS application as a reference (Fitria et al., 2022; Kamil & Sari, 2023; Ni'mah et al., 2023). In the case of workers in the chemical industry, it is necessary to prioritize the basis of operating an application to support the learning of skills to a higher level. The reference to learning support can be exemplified as someone learns a way to design a heat exchanger that initially uses a basic application, then, after mastering the basics, continues to use the Aspen HYSYS and HTRI applications.

D. CONCLUSION

A chemical engineering graduate is encouraged to have software skills to support a career in the world of work. Software skills include not only operating Microsoft Office but also being supported by other software such as Aspen HYSYS, Matlab, AutoCAD P&ID, and Scilab. The software is useful in applying the scientific theory that has been obtained during the education period. Software becomes a means of theoretical investigation related to problems in the process industry. Theoretical skills and data processing techniques can support these software skills. Software skills can be obtained through various trainings, simulation books, simulation videos, and workshops.

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