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Article

Simulation model of carbon capture with MEA and the effect of temperature and duty on efficiency

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ABSTRACT

Humans continue to rely on fossil fuels to generate electricity. In other words, fossil fuels are the world's largest energy producers. Fossil fuels produce significant carbon dioxide, mostly in areas where humans live. Although the share of carbon dioxide produced in big cities is minimal compared to the carbon dioxide production of volcanoes, the production of carbon dioxide in big cities has destructive effects. Process Simulator is utilized to evaluate the effectiveness of their simulation model by subjecting it to various experimental conditions, including liquid loading, temperature, and CO_2 absorption (PPS). Comparing empirical and simulated mass transfer coefficients distinguishes this study from others. This procedure consists of two steps: Carbon dioxide (CO_2) absorption in a solvent produces highly concentrated CO_2 gas following solvent regeneration. A chemical adsorption process's scalability depends on accurate simulation models, typically validated using data from a pilot plant. With the aid of this study, a simulation model of a desorption column is constructed with ASPEN PLUS and 42% MEA validated. In addition, the effect of the weight percentage of 20-42 MEA in the inlet stream on the efficiency is investigated, and the influence of the MEA inlet temperature on system efficiency is examined. Then, the recommended temperature is confirmed based on the MEA's heat tolerance capacity of 303 Kelvin.

1. Introduction

Although low-cost variable renewables have emerged, coal and gas-fired power plants still account for nearly two-thirds of global electricity generation [1, 2]. Since the year 2000, this percentage has stayed pretty constant. As of now, fossil fuels are still used to generate most of the world's electricity [3]. As a result, the electricity sector is the largest emitter of carbon dioxide among all energy sources [4]. The global electricity sector is expected to meet the rising demand and provide a low-carbon future by increasing access to electricity in a world where end-use activities are increasingly electrified [5, 6]. Regardless of the rapid expansion of renewable energy generation, the sheer magnitude of current electricity sector emissions and the importance of electrification require countries to take immediate action to reduce their greenhouse gas emissions from electricity to meet these global climate goals [7]. Achieving long-term climate goals without large-scale carbon capture, utilization, and data storage devices in the oil and gas sector requires the virtual elimination of fossil power generation and, ultimately, the early retirement of gas-fired power generation. Carbon capture technologies are essential for providing dispatchable, low-carbon electricity to stranded assets under this scenario; by 2040, plants equipped with these technologies will generate 5% of global energy [8]. As you can see in Figure 1, carbon emissions are increasing worldwide. Figure 2 shows the world's carbon dioxide emissions for 2020. As illustrated in Figure 3, extensive research has been done on this issue worldwide. This Figure shows the keywords researched on this topic, which we will review in the next chapter.

2. Literature review

Researchers and scientists have focused on carbon absorption in the last ten years, mainly through simulation. In order to evaluate their simulation model, Pinto et al. [9] used the Process Simulator (PPS) to evaluate how well it predicted experimental liquid loading, temperature, and absorbed CO_2. The empirical and simulated mass transfer coefficients were compared, which sets this study apart from others [10]. Specifically, zeolite-based adsorbents were the focus of the research conducted by Rubira et al. [11]; an accurate numerical model of the dynamic performance of biomass-derived activated carbon in biogas treatment was developed.

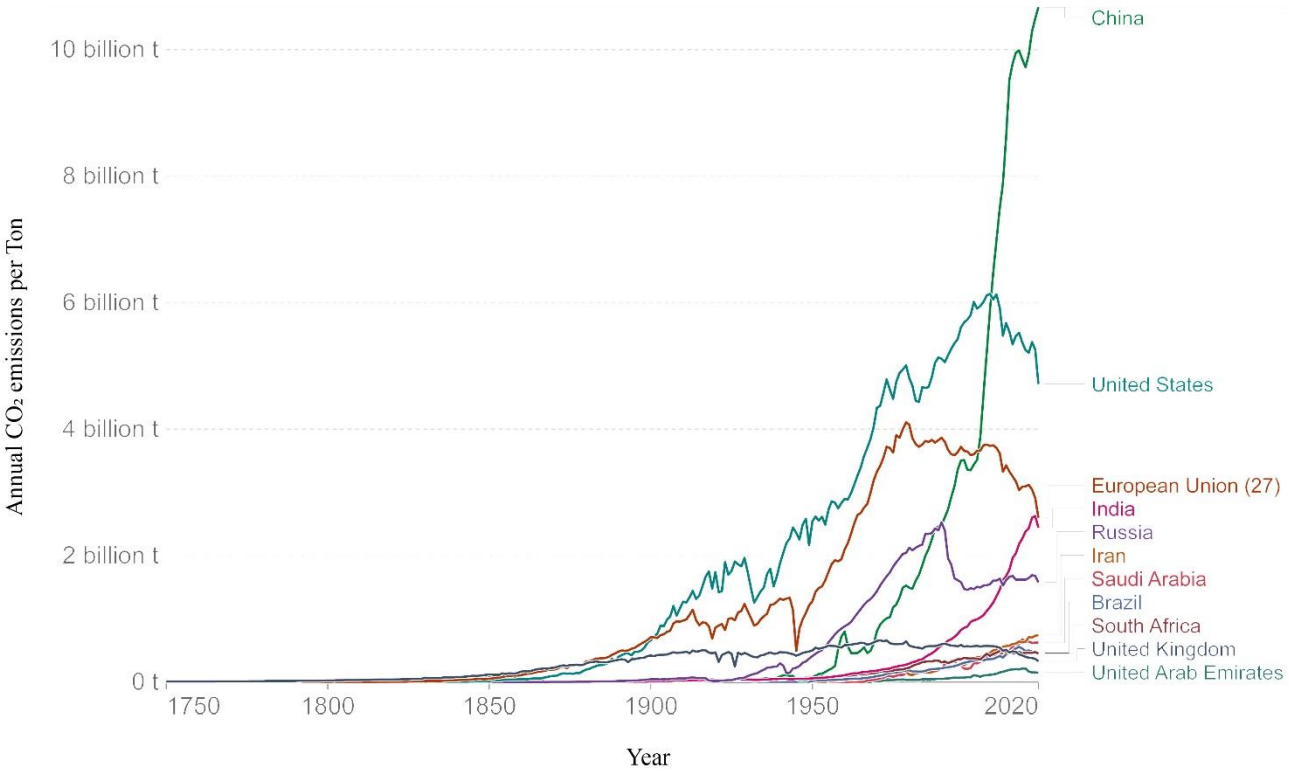

Figure 1. Annual carbon emissions in tons [1]

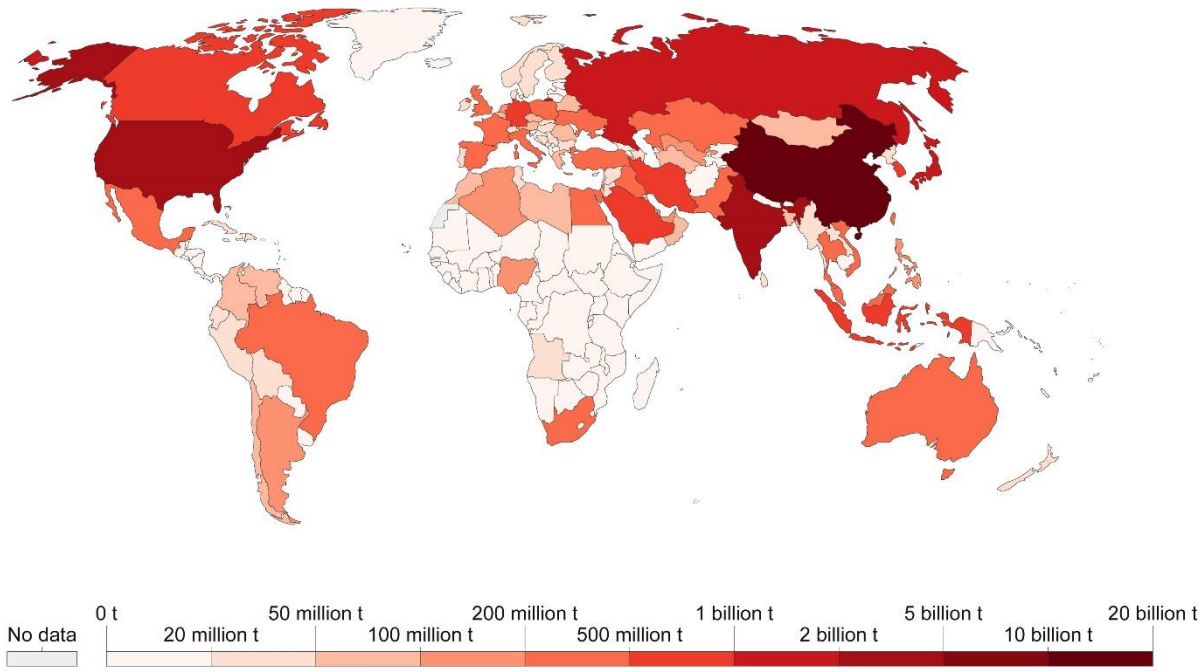

Figure 2. Carbon dioxide emissions for 2020 in the world [1]

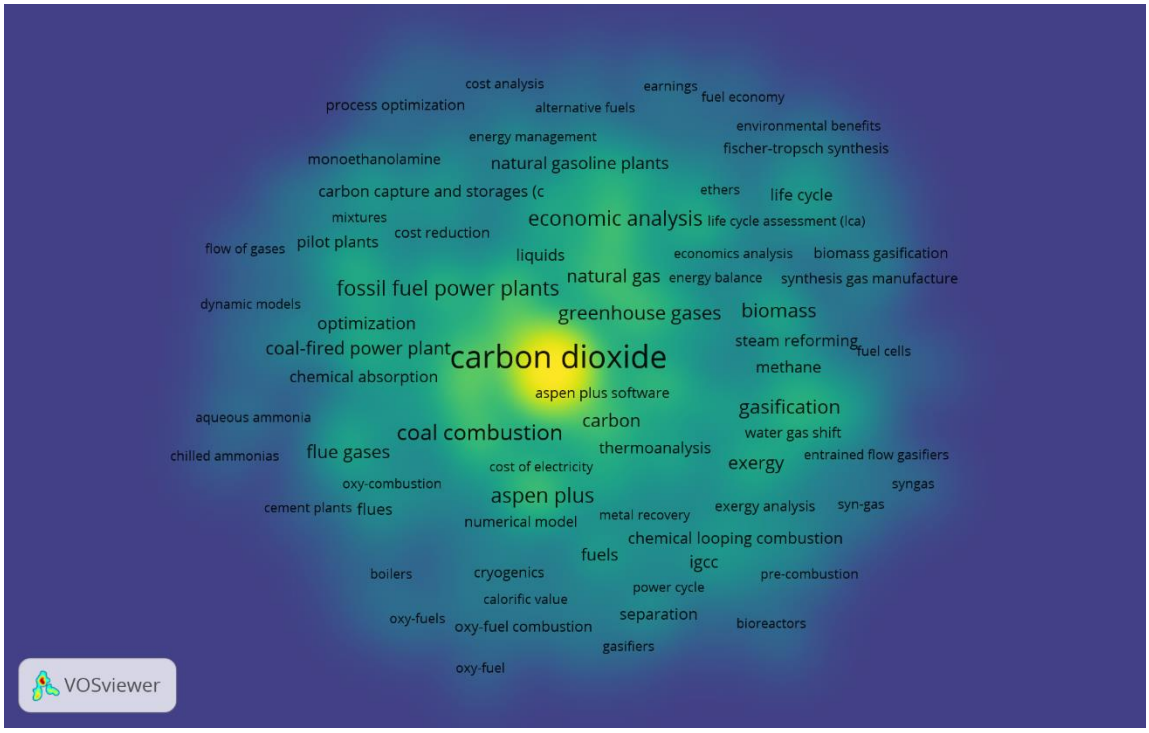

Figure 3. Research conducted in recent years in the field of carbon

The separation efficiency of a PSA process that generates biogas from biomass was measured using the mathematical model. In configurations with P/F ratios (molar flow ratios of CH_4 in the treatment and feed streams) between 0.67 and 1, at an absorption pressure of 3 bar, a single-stage, four-stage PSA can produce methane with a purity greater than 95% and a recovery of approximately 60%, according to a sensitivity analysis. The results of the thermodynamic analysis of a CO_2-negative gas production plant using zero-dimensional mathematical models were presented by Ziolkowski et al. [12]. Utilizing selective codes, the developed models of a new gas cycle predict key thermodynamic cycle parameters such as power output, efficiency, combustion composition, and exhaust temperature. Numerous researchers have extensively studied CO_2 absorption by amines; nevertheless, the majority of research has concentrated on the chemical reaction mechanism, mass transfer, and gas/liquid equilibrium, among other aspects of CO_2 absorption [13-15]. However, significant amounts of heat are required to regenerate the amine solvent used in CO_2 absorption. According to a typical range, an MW produced by a coal-fired power plant typically falls between 0.72 and 1.74 MW [13, 16]. Zhua et al. [17] modeled the CLC process in ASPEN Plus before validating it with experimental data from the combustion of three types of biomasses as fuel and hematite (Fe_2O_3) as oxygen carriers (OC). All three forms of biomass have been shown to have extraordinarily high carbon sequestration efficiency, with olive stone sequestration efficiencies approaching 100% and pine sawdust and almond shell sequestration efficiencies exceeding 100% at temperatures more than or equal to 950 °C. It has been reported that the solubility of CO_2 in an aqueous solution of 2-amino-2-methyl-1-propanol (AMP) and dimethylethanolamine (DMAE) is 30 percent higher, while the mixture's energy generation happened, and it is 20 percent lower [18].

Several piperazines (PZ)-who analyzed DETA-based systems and the energy generation of PZ-DETA-methanol aqueous solution were found to be 47% less than that of MEA's solution in the alkaline phase [8, 19]. Tarasova et al. [20] focused on membrane technologies deemed a viable alternative. This research aims to determine how existing commercial modules perform from an economical and practical standpoint, as well as whether there are feasible and practical membrane materials for post-combustion carbon dioxide separation. Future membrane technology may be suitable for treating fuel gas [21]. Still, issues remain to be resolved, such as membrane resistance to wet feed flow, fouling, and the long-term stability of the selective thin film [22].

Yang et al. [23] analyzed the biomass pyrolytic polygeneration system, the second new bioenergy technology, in terms of GHG emission intensity and reduction to assess the potential for bioenergy development accurately, considering the scenario where all biochar is returned to the field. In this case, the system's harmful carbon emissions at a pyrolysis temperature of 250 degrees Fahrenheit can be 22 times greater than its greenhouse gas emissions. Redick et al. [24] used Aspen Plus simulation to evaluate the new use of ejectors to increase external waste heat in the conventional carbon capture adsorption and desorption process. By promoting external waste heat, ejectors in this application aim to reduce the quantity of costly turbine steam required for solvent regeneration. Utilizing the solvent-rich stream to produce the secondary ejector stream does not affect energy consumption. Larson et al. [25] investigated a hydrogen generation unit for a thermal power plant and a combined power plant with carbon absorption based on chemical absorption. Lee et al. [26] investigated the carbon sequestration model in parametric research by identifying key process variables. Analyzing the solvent composition reveals that the ratio between MDEA and PZ is a crucial design

parameter for carbon adsorption efficiency and process energy demand. Sarodan et al. [27] reported that the discrepancy between the two models for the liquid and gas temperature profiles was sufficient (approximately ten degrees Celsius) to affect the transfer. Because the composition and flow rate of the outflow streams were nearly identical to what the RadFrac model predicted, the crime did not occur in the membrane contactor. Benito et al. [28] used the COSMO-based/Aspen methodology and the Aspen Economic Analyzer tool to determine the energy and solvent consumption and the capital and operating costs for nine different configurations. The most promising results for IL regeneration were obtained at 1 bar and high adsorption and regeneracy [29]. As the temperature difference between adsorption and regeneration increases, the operating and equipment costs associated with the vacuum and the service costs related to heat transfer increase in proportion.

Khalafullah et al. [30] employed an economic analysis of carbon absorption. While maintaining gasifier performance conditions, the sulfur content in synthesis gas, and the stoichiometric number in the methanol synthesis reactor, these four designs were compared in terms of energy consumption, economy, methanol production rate, and carbon emissions. The study also revealed that the conversion of coal to methanol using external hydrogen from an electrolysis plant to achieve higher production rates and lower CO_2 emissions is currently not cost-effective due to the high cost of H_2 [31]. Fermahini et al. [32] evaluated this innovative method's current status, investigated its potential and influence in the material screening field, and identified the obstacles preventing its widespread implementation. After a thorough discussion of data accessibility, model compatibility, and data reproducibility issues, new options for the field's future are proposed. Table 1 examines a variety of carbon absorption-related styles.

Table 1. CO_2 removal in MEA solutions review [33]

Desorbed validation parameters	Pilot plant data	Modeling type	Framework	Source
Temperature; Loading; Regeneration energy	1 pilot plant (39 runs)	ASPEN PLUS	ENRTL	[34]
Reboiler duty; CO_2 concentration; Temperature	1 pilot plant (19 runs)	ASPEN PLUS	ENRTL	[35]
CO_2 desorbed; Reflux flow rate; Loading	2 Pilot Plants	MATLAB	NA	[36]
Reboiler duty	NA	Aspen Plus Aspen Hysys	ENRTL	[37]
Loading; Desorbed CO_2; Solvent flow rate	1 Pilot Plant	K-Spice + InfoChem + CO2SIM	InfoChem	[38]
Reboiler duty; CO_2 loading	2 pilot plants	ASPEN PLUS v7.3	NA	[39]
Reboiler temperature	1 pilot plant	Dymola + Modelica + Optimica	NA	[40]
Heat of regeneration; Temperature; CO_2 loading	1 Pilot Plant (2 runs)	In-House	ENRTL	[41]
Temperature; Vapour composition	1 pilot plant (1 run from [25])	ASPEN PLUS v8.0	ENRTL-RK	[42]
Temperature; Reboiler duty	1 pilot plant (5 runs)	Aspen Hysys	ENRTL	[43]
Lean temperature; CO_2 concentration on the top of the stripper; Flow rate	1 pilot plant with variation of operation parameters	Dynamic, Mathamatical (NLARX) model + Simulink	NA	[44]
Loading; Reboiler duty	1 pilot plant with variation of operation parameters	ASPEN PLUS+ dCAPCO$_2$ MATLAB+ dCAPCO$_2$	UNIQUAC UNIQUAC + GM enhancement factor model	[16, 45, 46]
Temperature; Loading	1 pilot plant	ASPEN PLUS+ ASPEN PLUS DYNAMICS + ASPEN PLUS GUI + FORTRAN	ENRTL	[47]
NA	1 pilot plant [25]	Aspen Custom Modeller	ENRTL	[48]

Modifying the flow rate and temperature of the incoming flow to the towers and the pinch system reduces energy consumption, which is essential in light of the industry four revolution and the global energy transition. This study has optimized and suggested a novel system by combining Aspen Plus 11 and Python with machine learning. By systematizing with the assistance of a neural network, a plan with maximum efficiency and minimum cost has been demonstrated, thereby contributing to the concept of carbon-free cities. Numerous recent publications have addressed this topic, making it significant.

3. Methodology

3.1 System description

The diagram appropriately depicts an experiment including an absorption and desorption column, heat exchange between the two columns, and the recycling of water and amine [49]. The operating settings of this procedure were intended to be as near to real-world situations as feasible. Where simulation-required data was missing, acceptable approximations were made for the missing information [50]. In the system of Figure 4, it is extinguished in the first tower of the absorption system using MEA, and in the second tower, MEA is recycled and returned to the system. The materials used in this system are listed in Table 2. Table 3 was compiled with the aid of the references listed in Table 1 and adjusted to correspond with the system under investigation. After utilizing Python and an optimization system, what must raise the inlet temperature of the first tower must be preheated with energy from anaerobic digesters to boost its efficiency. Because the absorption process is facilitated, the tower's speed improves when the food entering the system has a greater energy level. For the simulation of various efficiencies, solvent concentration and CO_2 loading are considered.

The solvent content ranges from 25 to 40 (wt/wt%), and the lean loading ranges from 0.15 to 0.30 (mol CO_2/mole MEA) for CO_2 removal efficiencies between 70 and 95 (mol%). Analyzing CO_2 removal operations with coal, gas fuel, or a digester system involves the same simulations.

The mixed flow model is chosen in each of the three absorption simulation models involving coal, gas, and digester fuel. Aspen Plus Basic Model provides access to four alternative flow models. The mixed-flow model is proposed in the publications due to the high CO_2 content of the composition [53].

Table 2. Components used in the carbon absorption system

ID	Type	Name	Formula
MEA	Conventional	MONOETHANOLAMINE	C_2H_7NO
H_2O	Conventional	WATER	H_2O
CO_2	Conventional	CARBON-DIOXIDE	CO_2
H_3O^+	Conventional	H3O+	H_3O^+
OH-	Conventional	OH-	OH^-
HCO_3^-	Conventional	HCO3-	HCO_3^-
CO_3^{-2}	Conventional	CO3--	CO_3^{-2}
$MEAH^+$	Conventional	MEA+	$C_2H_8NO^+$
$MEACOO^-$	Conventional	MEACOO-	$C_3H_6NO^{3-}$
N_2	Conventional	NITROGEN	N_2
O_2	Conventional	OXYGEN	O_2
CO	Conventional	CARBON-MONOXIDE	CO
H_2	Conventional	HYDROGEN	H_2
H_2S	Conventional	HYDROGEN-SULFIDE	H_2S
HS^-	Conventional	HS-	HS^-
S^{-2}	Conventional	S--	S^{-2}
CH_4	Conventional	METHANE	CH^4
C_2H_6	Conventional	ETHANE	C_2H_6
C_3H_8	Conventional	PROPANE	C_3H_8

Table 3. Incoming flows to the system and its thermodynamic conditions [51, 52]

Stream	Flue gas	Lean amine	Flue gas	Lean amine
Temperature (k)	299.15	322.15	326.92	332.57
Molar flow (mol/s)	0.14	1.04	52.33	214.55
CO_2 (mol frac)	0.191	0	0.12	0.0263
MEA (mol frac)	0	0.055	0	0.102
H_2O (mol frac)	0.1	0.945	0.12	0.8717
N_2 (mol frac)	0.709	0	0.76	0
Pressure (kPa)	103.15	103.15	106.391	101.325

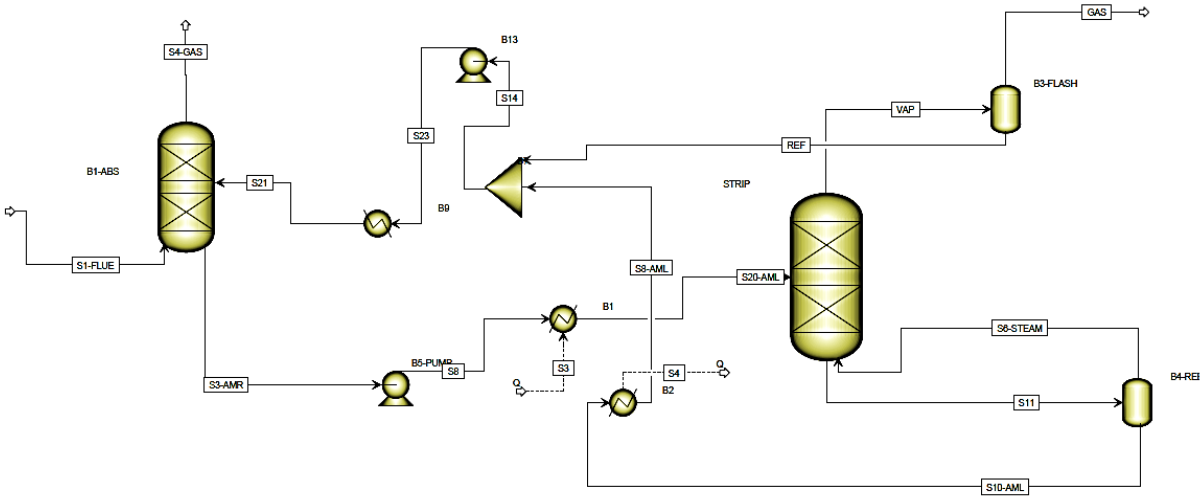

Figure 4. MEA simulation flowsheet in Aspen Plus

Table 4 and Table 5 illustrate the chemical reactions occurring in this system. The electrolyte solution is represented by the CHEMISTRY model with ID = MEA. Two REACTION versions, Absorber (used in the absorber, 303-353 K) and Stripper (used in the stripper, 353-393 K), have been manufactured. In the Absorber/Stripper, it is assumed that all reactions, except for CO_2 with OH^- and CO_2 with MEA, are in chemical equilibrium [54].

Table 4. Chemical reactions of the MEA section

Type of reaction	Reaction
Equilibrium	$MEAH^+ + H_2O \leftrightarrow MEA + H_3O^+$
Equilibrium	$MEACOO^- + H_2O \leftrightarrow MEA + HCO_3^-$
Equilibrium	$2H_2O \leftrightarrow H_3O^+ + OH^-$
Equilibrium	$CO_2 + 2H_2O \leftrightarrow HCO_3^- + H_3O^+$
Equilibrium	$HCO_3^- + H_2O \leftrightarrow CO_3^{2-} + H_3O^+$
Equilibrium	$H_2S + H_2O \leftrightarrow HS^- + H_3O^+$
Equilibrium	$HS^- + H_2O \leftrightarrow S^{-2} + H_3O^+$

Table 5. Reactions of the Absorber/Stripper section

Type of reaction	Reaction
Equilibrium	$MEAH^+ + H_2O \leftrightarrow MEA + H_3O^+$
Equilibrium	$2H_2O \leftrightarrow H_3O^+ + OH^-$
Equilibrium	$HCO_3^- + H_2O \leftrightarrow CO_3^{2-} + H_3O^+$
Equilibrium	$H_2O + HS^- \leftrightarrow S^{2-} + H_3O^+$
Equilibrium	$H_2O + HS^- \leftrightarrow S^{2-} + H_3O^+$
Kinetic	$CO_2 + OH^- \rightarrow HCO_3^-$
Kinetic	$HCO_3^- \rightarrow CO_2 + OH^-$
Kinetic	$MEA + CO_2 + H_2O \rightarrow MEACOO^- + H_3O^+$
Kinetic	$MEACOO^- + H_3O^+ \rightarrow MEA + H_2O + CO_2$

3.2 Model description

This method involves both liquid and gaseous phases. CO_2 is present alongside nitrogen, oxygen, and water vapor in the first stage. Depending on the circumstances, the flue gas may contain additional pollutants, such as H_2S [55]. Low morphometric efficiency levels suggest that the process conditions are far from phase equilibrium. For this reason, the so-called rate-based method is the most common technique for the reactive removal of CO_2 adsorption with MEA. This method can take mass transfer restrictions resulting from chemical reactions into account, selecting the rate-based mode to characterize both the absorber and stripper. The rate-based approach is based on Lewis and Whitman's two-film hypothesis. The rate-dependent portion of absorption is represented graphically in Figure 5.

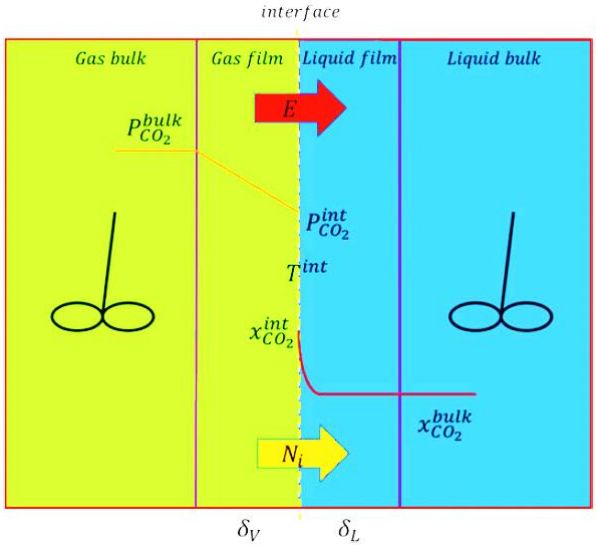

Figure 5. The rate-based segment to attract

The mole fraction of CO_2 in the adsorbent corresponds to the profiles of the two films in Figure 5. Due to the absence of gas-phase reactivity, the shape is linear. Once a liquid absorbs CO_2, it interacts rapidly with MEA. This explains the significant nonlinearity of liquid film. In the RadFrac model - a rate-based method for determining the individual resistivities of each phase film - various variables are available to represent these distinct behaviors of the two films. Since there is no interaction in the gas phase, who specifically selected the Film option, only the material's resistance to diffusion is evaluated in this instance. Due to rapid reactions, the liquid film must be discretized, and numerous parameters must be modified to represent the profile slope accurately. The Discrxn option was activated to account for the diffusion resistance, the presence of reactions, and the discretization of the liquid film. The reaction condition factor (RDC) is a variable between 0 and 1 that specifies the weight of the interface and mass chemicals and the temperature when calculating the reaction rate within a film. When the reactions in the film are extremely rapid, such as CO_2 adsorption with MEA, the bulk conditions should be given greater weight when calculating the reaction rate. Then, substantial RCF must be established. Contrary to the thermodynamic model, CO_2 absorption is a non-equilibrium process. At each step of the adsorbent, the vapor and liquid phases are in equilibrium. This model necessitates the determination of the number of moles of CO_2, H_2O, and MEA in the vapor and liquid phases at a given temperature. The thermodynamic model predicts the formation of ions and polar molecules during the process. Ions are nonvolatile and only soluble in the liquid phase, whereas only CO_2, H_2O, and MEA are present in the gas phase. The CO_2 absorption process is non-equilibrium. In the rate-based model, reaction rates are faster but not in equilibrium. The rate and kinetics of the reaction between CO_2 and MEA depend on the temperature and composition of the reactants. In the rate-based model, the

RATEFRAC mode of Aspen Plus is used to simulate the absorber and stripper column [56]. The absorber and stripper's exhaust gases are part of the MEA. In addition, a small amount of MEA is damaged throughout the process. Before the recycled stream enters the absorber, MEA components are added to compensate for these losses. Atmospheric pressure and temperature are used when adding the solvent. The blower is given to pay for the pressure loss caused by the humidifier by increasing the flue gas pressure. As the humidifier's gas comes into contact with the water, the pressure decreases. Additionally, absorption is enhanced by force. The pump is utilized to increase the pressure of the rich amine to migrate to the center of the stripper column. Since the stripper is typically a tall column, more intense pressure is required to lift the abundant amine. Additionally, the heater's anxiety decreases, necessitating the addition of force to compensate for the loss of rich amine.

4. Validation

The simulation was done in this system from the Garcia et al. [57] system, and the MEA liquid density parameter at 298.15 K was used for confirmation. Table 6 shows a numerical comparison between the Garcia et al. model and the outputs of this process. In Table 6, the error of each data is placed according to the reference; the error is acceptable.

5. Results

As mentioned before, past studies on heat loss have been investigated. However, the use of pinch technology is not mentioned. Since digesters have high heat output and if the input to the absorption tower has more energy, the system's performance increases, placing a digester system next to a carbon absorption system and a desalination system can reduce waste (Figure 6). Power can help up to 20%.

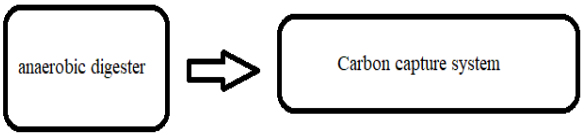

Figure 6. Creation of energy absorption system from digesters in crane absorption system

In Figure 7 (a) 25w/w%, (b) 30w/w%, (c) 35w/w%, and (d) 42w/w% in digester gases, symbols refer to efficiency: blue 95%, red 90%, green 85%, and yellow 70%. Figure 7 shows that the necessary energy of the steam boiler reduces with increasing solvent load until it reaches a minimum. However, beyond a specific threshold of loading value, the boiler duty began to climb once more. Optimal is the point that produces the least amount of boiler energy. To achieve the desired efficiency in carbon dioxide removal, the inlet solvent flow is changed. In each of the four instances, the lowest reboiler duty is observed for MEA concentrations between 25% and 42%. 70% of its effectiveness has been demonstrated. When the efficiency of CO_2 removal increases, so does the reboiler load. Figure 7 (d), which depicts a concentration of 42% MEA, has the lowest reboiler duty according to the data. To optimize the process, minimizing the solvent flow rate and the boiler load required is essential. Figure 8 depicts the solvent flow rate for the MEA loading model. As the removal efficiency increases, so does the needed solvent flow rate.

Table 6. MEA density data of Garcia et al. [57]and Error with experimental data

Density, kg/m 3	CO2 Loading, mol CO2/mol MEA	Num MEA 10wt%	Garcia MEA 10w t%	Error 10wt%	Num MEA 20w t%	Garcia MEA 20w t%	Error 20wt%	Num MEA 30w t%	Garcia MEA 30w t%	Error 30wt%	Num MEA 40w t%	Garcia MEA 40w t%	Error 40wt%
1,000.00	0.10	940.68	941.41	0.72	975.02	975.41	0.39	1,003.01	1,003.73	0.72	1,030.79	1,031.14	0.3539378
1,020.00	0.15	950.98	952.06	1.08	985.23	986.03	0.80	1,016.06	1,016.55	0.49	1,042.61	1,043.52	0.9080777
1,040.00	0.20	961.87	963.47	1.60	995.52	995.79	0.28	1,027.20	1,028.01	0.81	1,055.05	1,055.84	0.7931697
1,060.00	0.25	970.05	970.92	0.87	1,005.22	1,005.38	0.16	1,039.29	1,040.61	1.32	1,065.29	1,065.03	0.2545581
1,080.00	0.30	980.20	980.91	0.70	1,015.02	1,015.65	0.63	1,052.66	1,054.05	1.39	1,078.14	1,078.60	0.4618489
1,100.00	0.32	991.71	992.59	0.88	1,026.83	1,027.59	0.76	1,063.00	1,063.34	0.34	1,089.94	1,091.39	1.4505165
1,120.00	0.33	1,000.48	1,001.16	0.68	1,036.21	1,036.56	0.35	1,077.15	1,077.90	0.76	1,101.96	1,102.28	0.3256421
1,140.00	0.35	1,010.68	1,012.19	1.51	1,046.33	1,047.16	0.83	1,088.22	1,088.74	0.52	1,115.00	1,115.50	0.495645186
1,160.00	0.40	1,021.02	1,022.25	1.23	1,055.94	1,056.74	0.80	1,100.64	1,101.52	0.89	1,125.38	1,125.90	0.514161245
1,180.00	0.45	1,031.72	1,032.72	1.00	1,066.83	1,067.09	0.26	1,112.52	1,112.67	0.15	1,137.41	1,137.81	0.397722193
1,200.00	0.50	1,041.88	1,043.86	1.98	1,076.15	1,077.08	0.93	1,123.69	1,124.32	0.63	1,150.58	1,151.36	0.779891838

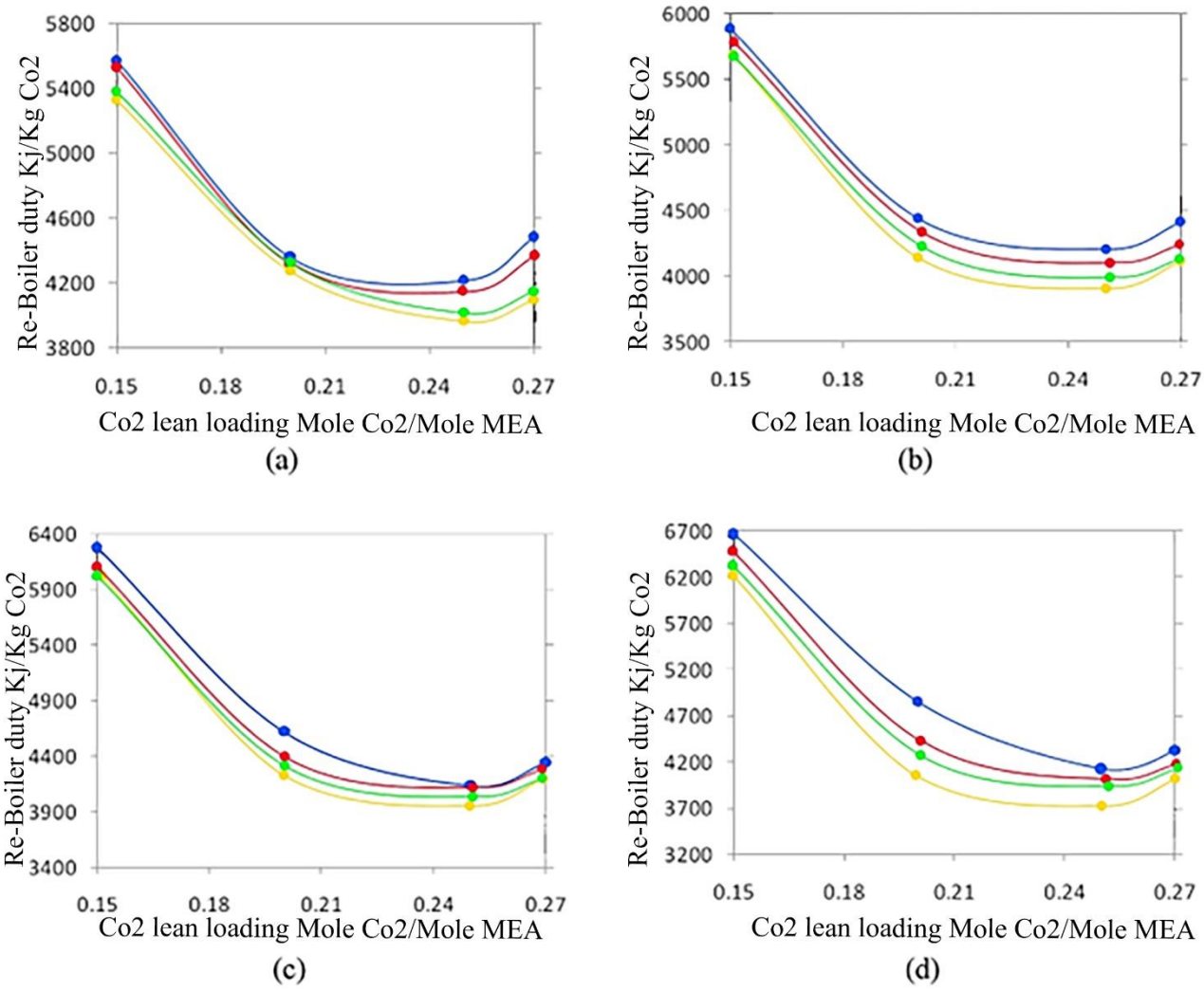

Figure 7. Variation of boiler load with CO2 input at various MEA concentrations

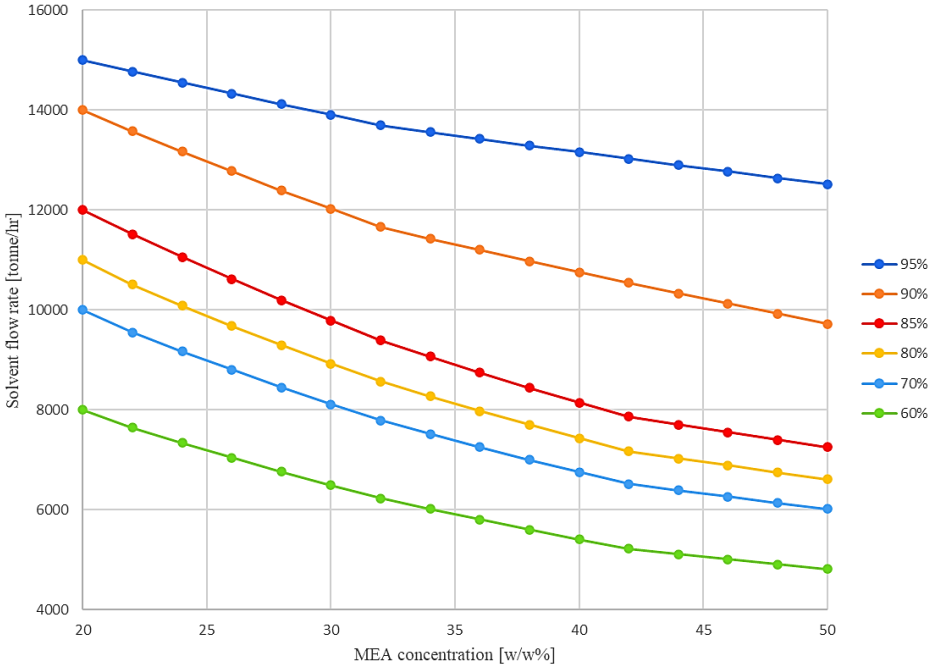

Figure 8. Changes in solvent flow rate with MEA concentration during CO_2 loading of 0.27

At all models of removal efficiency, the lowest solvent required is specified for a 42% MEA concentration. However, it is considered that increasing amine concentration has corrosive effects on all sectors. This can be mitigated by incorporating a tiny amount of corrosion inhibitors into the solvent stream. The CO_2 removal process is unaffected by the presence of these inhibitors. As seen in Figure 9, as the input temperature to the system rises, the energy input to the absorption tower must also rise, and the process becomes more efficient. However, what should be noted is that the temperature increase should not harm the MEA; thus, it is preferable to raise the temperature to 303 degrees Kelvin and stop there. As you can see in Figure 10, a partial increase in the different moles of the MEA input can increase the efficiency, but due to the sensitivity of the MEA and the equipment to the temperature, it is necessary that the temperature does not exceed 303 degrees Kelvin.

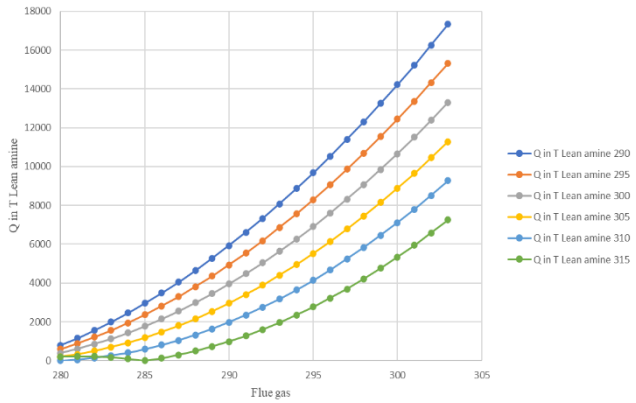

Figure 9. Energy consumption in the absorption tower in different moles of MEA

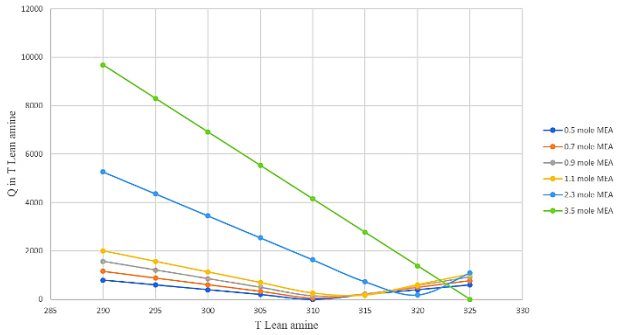

Figure 10. Energy consumption in the absorption tower in different moles of MEA

6. Conclusion

The thermal energy required in the absorption and disposal process is the most critical factor to consider when optimizing the absorption process since it influences total thermal efficiency. Using the ASPEN PLUS software, this study provided experimental data from four separate sections containing 42% MEA by weight. 303 Kelvin is the proposed temperature setting. Based on experimental data measured with 42 wt% MEA, the flow model, and modifications to the discretization of the film, the existing ASPEN model was modified to define packing. The simulated model is 9 percent more efficient than previous models of a similar kind. Necessary for generating a simulation-based estimate of the experimental heat loss for each campaign. The results also reveal that the heat loss is independent of the flow rate and duty of the welding machine but depends on the pilot and insulation level. The paper's conclusion illustrates how the ASPEN PLUS simulation tool can simulate CO_2 regeneration in an adsorption process based on 42 wt% MEA if correlation values for the solvent are specified.

Ethical issue

The authors are aware of and comply with best practices in publication ethics, specifically concerning authorship (avoidance of guest authorship), dual submission, manipulation of figures, competing interests, and compliance with policies on research ethics. The authors adhere to publication requirements that the submitted work is original and has not been published elsewhere in any language.

Data availability statement

Datasets analyzed during the current study are available and can be given following a reasonable request from the corresponding author.

Conflict of interest

The authors declare no potential conflict of interest.

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