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Liquid Desiccant-assisted Dehydration of Bio-based Oligomers

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ABSTRACT

We evaluate liquid desiccant–assisted coalescence to dehydrate bio-based oligomers and break water in oil emulsions under mild conditions. An experimental packed column contacted epoxidized oil with glycol in counter-current at moderate temperature and ambient pressure; moisture was measured by Karl Fischer; a thermodynamic model using cubic plus association assessed desiccant flow effects. The column operated under an apparent laminar regime to maintain film stability and encourage coalescence without disruptive turbulence. The system achieved specification moisture, and model trends agreed with experiments; laminar hydraulics promoted droplet growth and rapid gravitational separation; compared with vacuum drying, the approach delivered shorter drying duration and lower energy demand. Dehydration accelerated because glycol absorbs water, stabilizes film drainage, enlarges droplets on packing, and minimizes back mixing when flow is controlled. The approach enables continuous, economical dehydration of palm-based oligomers with simple operation, compatibility with downstream processes, and scalability for industrial production and reliability.

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1. INTRODUCTION

An emulsion is typically defined as a heterogeneous system comprising two immiscible liquid phases, most commonly involving water and oil (Bhikuning & Senda, 2020). A water-in-oil emulsion forms when water is dispersed as fine droplets within a continuous oil phase. These emulsions can occur spontaneously or be induced in various industrial processes, including oil production in mills, functionalization of vegetable oils, and their transformation into chemical derivatives. Breaking such emulsions is essential to ensure that downstream processes are free from moisture, which can negatively impact machinery and degrade product quality. Additionally, effective emulsion breaking enhances product throughput while reducing capital and operating costs, ultimately lowering overall production expenses.

In particular, water-in-oil emulsions pose a significant challenge in producing oligomers or their derivatives derived from renewable resources such as vegetable oil. Acid catalysts are commonly used to facilitate oxidation reactions, such as in the synthesis of bio-based polyols. However, after such reactions, a rigorous work-up process is required to remove residual impurities (including acid catalysts and water resulting from oxidizing agents like hydrogen peroxide) to prevent undesirable side reactions and adverse chemical properties in the final products.

A successful coalescing process generally involves three sequential steps. First, dispersed droplets must collide with and adhere to the coalescing medium. Second, multiple small droplets combine to form larger droplets. Third, the enlarged droplets separate from the continuous phase and settle under gravity. Several physicochemical factors influence this process, including interfacial tension, surface tension, fluid density, mass transfer between phases, viscosity, wetting properties, temperature, droplet size, and the presence of surface-active components.

As described in Equation (1), gravity acts as the main driving force for coalescence, with droplet diameter being the critical parameter. The settling velocity of a dispersed droplet (v_d) in a liquid-liquid dispersion is determined using the following Equation (1):

$$v_d = \frac{g \cdot |\Delta\rho| \cdot d^2}{18 \cdot \mu_c} \tag{1}$$

where g is the gravitational acceleration, $\Delta\rho$ is the density difference between the two liquid phases, d is the drop size diameter, and μc is the dynamic viscosity of the continuous phase. For smaller liquid droplets, the settling velocity is very low compared to the random motion imparted by the Brownian random motion. For example, water generated from the oxidation of triglyceride or monoglyceride may form very small water droplets and become well dispersed as a water-in-oil emulsion. Although such dispersions are thermodynamically unstable, they appear stable due to very low kinetic separation by gravity.

Liquid–liquid separators, such as coalescers, operate by promoting the coalescence of the discontinuous or polydivided phase within a mixture of immiscible liquids, thereby forming larger droplets that are more easily separated by gravity. The packing elements used in such systems may include random or structured packings, plates, membranes, sheets, or any combination thereof, often constructed in corrugated geometries to enhance contact efficiency. Various materials have been evaluated for their effectiveness as packing media in emulsion-breaking applications and their influence on dehydration performance. These include coalescing plates, synthetic fibers, a combination of water-retaining cellulose and water-coalescing fiberglass, and fluorinated halocarbons. However, to date, there are no known reports on the application of liquid desiccants in coalescer systems for dehydrating bio-based oligomers such as epoxidized palm oil.

In this study, we investigate the dehydration of bio-based oligomers using a liquid-desiccant-assisted coalescer operating under low Reynolds number conditions. Evaluating the process performance is crucial to reducing associated operating and capital expenditures. The ability to operate at mild temperatures and ambient pressure further enhances the adaptability and commercial viability of the proposed dehydration approach. This investigation specifically focuses on the use of monoethylene glycol (MEG) as the liquid desiccant due to its compatibility with downstream processes and its minimal impact on the final product quality of bio-based oligomers.

The development of efficient dehydration strategies for bio-based oils is critical in advancing sustainable chemical production and reducing dependence on petroleum-based feedstocks. Many reports regarding oil-related research have been well-documented (Lao *et al*., 2022; Ebulue, 2025; Ebulue & Ebulue, 2022). Specifically, bio-based oligomers, particularly those derived from vegetable oils such as palm oil, represent a renewable alternative for manufacturing polyols, polymers, and surfactants. However, their commercial viability hinges on achieving precise moisture control during processing. Excess water and residual catalysts can compromise product stability, hinder subsequent chemical conversions, and damage processing equipment. Therefore, research on improving emulsion-breaking and drying performance is essential not only for ensuring product quality but also for enabling scalable and environmentally friendly production. By optimizing dehydration techniques tailored for renewable oil-based materials, this study contributes to the broader goals of green chemistry and circular bioeconomy.

Therefore, this study aims to evaluate the performance of a liquid desiccant–assisted coalescer system for the dehydration of bio-based oligomers, particularly under low Reynolds number conditions. The novelty of this research lies in the integration of monoethylene glycol (MEG) as a liquid desiccant within a coalescer setup, which has not been previously reported for the treatment of epoxidized palm oil. By coupling experimental observations with thermodynamic modeling using the Cubic Plus Association (CPA) framework, this work provides new insights into the mechanisms of emulsion destabilization and moisture removal in renewable oil-based systems. The outcomes are expected to support the development of more energy-efficient and scalable dehydration technologies compatible with downstream processing requirements in oleochemical industries.

2. METHODS

2.1. Materials

Monoethylene glycol (AR grade) was obtained from Systerm (AR grade). Triethylene glycol was purchased from Isochem. Bio-based epoxidized oil was obtained from AOTD and MPOB, and their chemical composition is tabulated in **Table 1**.

Table 1. Typical composition in crude bio-based oligomer.

Component	Typical content, w/w %	CAS number	IUPAC name
Bio-based oligomers (epoxidized oil)	88 to 93 %	2443-39-2	Ethyl 9,10-epoxyoctadecanoate
Water	4 to 7 %	7732-18-5	Water
Acid (formic)	3 to 5 %	64-18-6	Methanoic acid

2.2. Water Content by Karl Fisher

The experimental water content in the oil was analyzed using ASTM D6304. 1 g of sample was weighed and introduced into a Karl Fischer 784 KFP Titrino coulometer. The moisture content was calculated using equation (2):

$$\text{Water mass, \%} = \frac{W_1}{10000 \times W_2} \tag{2}$$

where W_1 is the mass of water titrated (µg) and W_2 is the mass of the sample used (g).

2.3. Simulation of dehydration in ASPEN Plus

To understand the effect of glycol flow rate on the dehydration process, we developed a model to simulate the liquid desiccant-assisted dehydration in Aspen Plus V14. The selection of the thermodynamic property package is crucial as it provides the essential parameters required for binary interaction, which would affect the dehydration process. In general, there are two types of thermodynamic property packages called the equation of states and activity-based models. In this study, we adapted the equation of states model as it has been highly reliable in predicting properties of vast hydrocarbon fluids at a wide range of operating conditions, including high temperature and high pressure.

We used an equation of state thermodynamic model called cubic plus association (CPA), and its general equation is described in equation (3):

$$P = \frac{RT}{V_m - b} - \frac{a}{V_m(V_m + b)} - \frac{1}{2}\left(\frac{RT}{V_m}\right)\left(1 + \frac{1}{V_m}\frac{d\ln g}{d\left(\frac{1}{V_m}\right)}\right)\sum_i x_i \sum_{A_i}(1 - A_i) \tag{3}$$

where P is pressure, R is the universal gas constant, and V_m is molar volume. a and b are the volume constants. g is the fugacity coefficient, x is the mole fraction of species i in the mixture, and A is the binary interaction parameter.

The CPA model provides accurate calculations for water content, activity coefficients, and dew point temperature. CPA model has five pure compound parameters in its thermodynamic equation derived from vapor pressure and liquid density data (Kontogeorgis *et al.*,1996). Application of the CPA includes normal chain alcohols and water, and it demonstrated an accurate representation of vapor pressures and liquid densities for simulation. The earlier version of the glycol package was limited to triethylene glycol (TEG) and less accurate for MEG and diethylene glycol (DEG) applications; hence, it was not considered in this study.

CPA combines the Soave-Redlich-Kwong (SRK) equation of states with an association term similar to the Statistical Association Fluid theory (SAFT) models for better handling mixtures with hydrogen-bonding compounds. In the absence of hydrogen bonding compounds, CPA is reduced to SRK. Furthermore, the CPA package is capable of describing complex vapor-liquid-liquid equilibrium (VLLE) applications for mixtures with hydrocarbons, non-hydrocarbons like carbon dioxide, hydrogen sulfide, and nitrogen, and polar or associating chemicals such as water, alcohols, glycols, esters, and organic acids. Hence, this ability to model complex systems involving typical dehydration components makes CPA the ideal package for modeling dehydration. The binary interaction parameters for the CPA model were used without modification in Aspen Plus V14.

Figure 1 describes a process flow diagram illustrating dehydration involving the addition of liquid desiccant and a packed column called a coalescer, where water droplets in the bio-based oligomer (methyl 9,10-epoxystreate) were immediately attracted to liquid desiccant and coalesced along the packing material. A less dense, dried bio-based oligomer was removed at the top of the coalescer. Meanwhile, denser, richer liquid desiccant was removed at the bottom of the coalescer. A case study was employed to examine the effect of glycol flow rate on the dehydration process.

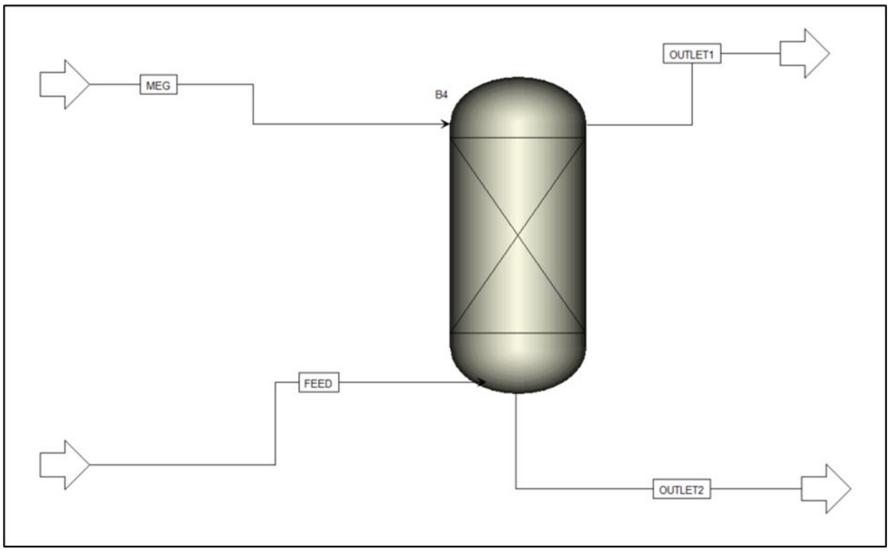

Figure 1. Flowsheet in ASPEN Plus V14 exhibiting a liquid-liquid separator equipped with a glycol stream acting as a liquid dessicant and dehydrating the oil feed.

2.4. Experimental Coalescer

A small-scale system was constructed and tested to demonstrate the effectiveness of the emulsion-breaking and dehydration system. The coalescer column technology had an effective 25 mm inner diameter and 1,500 mm length and used a 25 mm diameter Sulzer DX packed column. Wet oligomers from processed oil were supplied to the system at a constant 10 kg/h, and the glycol flow rate was varied between 0 and 50 kg/h. Bio-based oligomer was contacted with glycol in a counter-current arrangement at a constant temperature of 70 °C and ambient pressure (1 bar).

Materials of construction for packing or coalescing media are materials having useful surface tension with a working surface tension for droplets to coalesce. As critical surface tension is somewhat difficult to predict for a mixture complex containing various chemical elements, part of the coalescer works by increasing droplet diameter and accelerating settling by gravity. Materials with a water-coalescing property may be used, including steel, copper, zinc, tin, alloy, fiberglass, aluminum, or any of these combinations. Glass, in particular, has been widely adopted as a packing material in a coalescer. In this study, however, we found that glass is an ineffective packing material as it contains oxygen elements and may interact with the epoxide or carboxyl group of oligomers and promote back-mixing. Alternatively, plastic packing material has been proven in some application areas for high molecular weight oligomers. In addition, packing geometry can take many forms where structured packing with an axis angle to fluid flow axis (β) is usually fixed between 30 and 60°. The condition of fluid flow in the packing shall be under apparent laminar flow with little to no back-mixing.

3. RESULTS AND DISCUSSION

3.1. Approach to emulsion breaking

Numerous production processes of oligomers depend on the separation step and removal of aqueous acidic or caustic-containing materials to make them commercially acceptable products. Various fractions of oligomers are subject to aqueous acidic or caustic-containing materials. For example, homogeneous acid catalysts are used in epoxidation and alcoholysis, which is undesirable in oligomers. Typically, a combination of water and salts is used to remove residual acid catalysts. Removal of both aqueous acidic and aqueous caustic phases has been increasingly difficult due to the marginal difference in interfacial tension of the phases involved and the additional processing time required.

It is crucial to couple the packing with different unit operations, such as a desiccator, to achieve a higher degree of separation and subsequently affect the dehydration level obtained, and take advantage of coalesced water. In general, there are solid-form desiccants and liquid desiccants. Application of desiccant increases process flow rate and stabilizes film-breaking of emulsion in the packing. Solid-form desiccant works by adsorbing water-like molecules, such as clay, molecular sieve, silica gel, or any combination of them. Liquid desiccant such as MEG, DEG, and TEG works by absorbing water-like molecules. Regeneration of such desiccants is widely established at industry-wide levels and further enhances the economic aspect of such a dehydration process.

Primary emulsion takes place when droplets exceed 10 µm in size, and separation is accelerated as the discontinuous phase coalesces and settles under gravity, forming a heterogeneous layer. On the other hand, the addition of surface-active material and rigorous agitation typically resulted in a secondary emulsion. Secondary emulsion occurs when the droplets, generally, are smaller than 10 µm, where separation is mitigated with fewer discontinuous phase coalescence; hence, settling by gravity to form a heterogeneous layer is increasingly difficult.

The interfacial tension between dispersed water and the continuous phase of the oligomer can generally be reduced by adding surface-active materials such as acid catalysts and surfactants. These materials are used to accelerate the functionalization of the organic layer and subsequent cleaning.

3.2. Effect of liquid-desiccant flow rate

The stability of water-in-oil emulsion is affected by the water-to-oil density ratios, as predicted in Equation (1). The absorption of water content in bio-based oligomers was implemented using glycol (**Figure 1**). A combination of geometry and construction material is vital to ensure accelerated dehydration without droplet break-up at the outlet. Controlling the coalescer at an optimum flow rate primarily depends on the selection of packing and wetted material inside the column. Accordingly, the flow rate in apparent laminar is highly imperative to develop adequate drop contact time and sustain film thickness below h_{crit}. Specifically, for the dehydration of oil/oligomer, excessive flow rate will destabilize column operation and collapse any coalescence process.

Final water content in the bio-based oligomers must be lower than 0.1 % w/w as stated in the internal product specification. Hence, we found that we were able to achieve the specification by using both glycol and a coalescer. Rapid dehydration began at a very low glycol flow rate, as shown in **Figure 2**. As the glycol flow rate approached unity with bio-based oligomer at 10 kg/h, the water content in the oil dropped to 0.15 % w/w. Water content became lower than 0.1 % w/w when the glycol flow rate doubled that of the bio-based oligomer flow rate. A higher glycol flow rate minimized the water content and was lower than 0.05 % w/w at a glycol flow rate of 50 kg/h. The water content reduction trend exhibits similar behavior in the model and experimental observations, indicating a decent function of CPA as a thermodynamic property package.

One major limitation in this study was that the experimental work was carried out at ambient pressure; hence, we can’t validate the CPA model at higher pressure, as it may drift far from the current estimation. Further work at higher pressure is required to test and validate the CPA model at higher pressure.

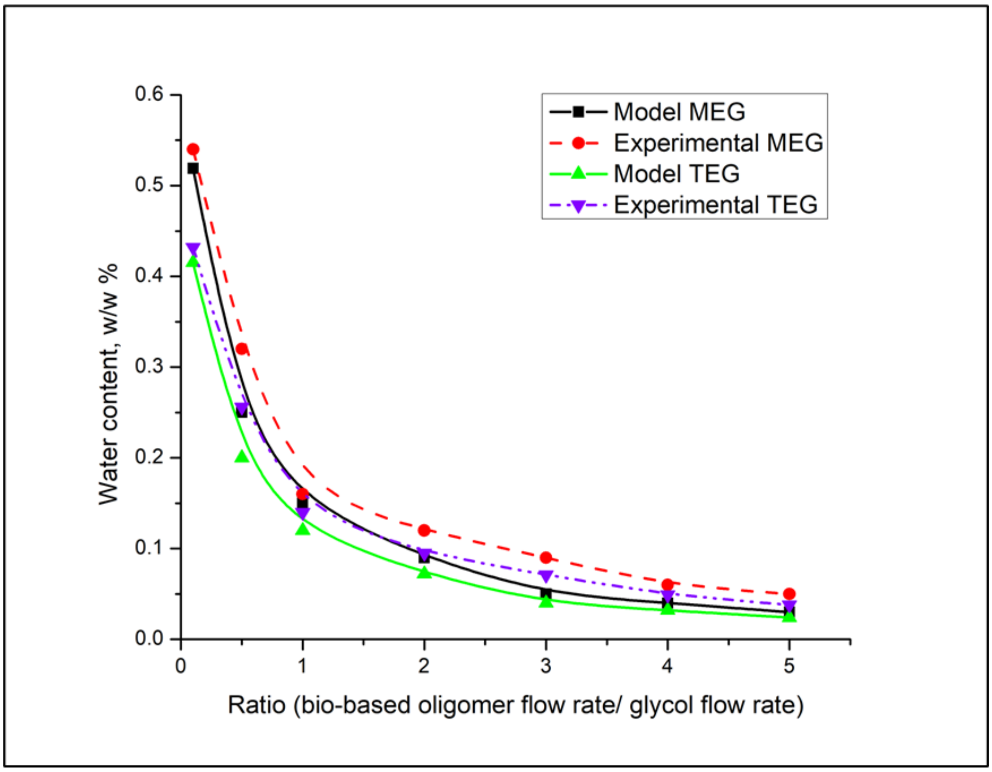

Figure 2. Reduction in water content at increasing glycol flow rate based on experimental bio-based oligomer and model as simulated in ASPEN Plus using CPA property method. Higher glycol flow rate reduces the water content in the oil-rich outlet (outlet 1).

3.3. Hydraulic of packed column

To understand the physical relationship between glycol flow rate and dehydration of bio-based oligomers, we checked for Reynolds numbers, superficial velocity, and phase density at various glycol flow rates. Dimensionless Reynolds number (*Re*) characterizes the flow regime based on the characteristic length of geometry, average velocity, and fluid properties. In this study, Reynolds number (Re) for two-phase flow was expressed in Equation (4):

$$Re = \frac{p_c V_c d_h}{\mu_c} \tag{4}$$

where p_c is the density of the continuous phase, μ_c is the dynamic viscosity, and V_c is the mean velocity of the continuous phase. For a narrow distance of the plate pack, mixture density (ρ_m) was obtained from laboratory data. V represents the fluid velocity, and h is the distance between plates. The glycol flow rate varied between 0 and 50 kg/h, which included laminar and transition to turbulent flow regimes. Separation efficiency was determined based on the amount of water content in the outlet oil.

Typically, the transition to turbulence occurs between Re = 2,000 to 10,000. Lower Reynolds number mitigated the effect of mixing and promoted water droplets to coalesce and form larger droplets, as indicated by increasing and stable density at a higher glycol flow rate (**Figure 3**). Furthermore, a lower Reynolds number allows a longer time for water droplets to coalesce and form larger droplets. Larger water droplets catalyzed rapid dehydration. When Re was below 500, no eddy current was observed, and no back-mixing was observed in both experimental and flow analysis in the simulation. Effective water removal increased substantially with correct hydraulic control in the coalescer. In **Figure 3**, we exclusively displayed the velocity changes during coalescence at different glycol flow rates. The velocity is at its lowest at the highest glycol flow rate. A lower Reynolds number was obtained by increasing the glycol flow rate to the coalescer (**Figure 3**). Gradual changes in the superficial velocity of the glycol phase agreed with the experimental (**Figure 2**). As the velocity of water droplets in the bio-based oligomer reduced with increasing glycol flow rate, it energized the coalescing effect, formed a larger droplet diameter, and accelerated the settling velocity as predicted in equation (1). At a relatively low glycol flow rate (< 1 kg/h), the emulsion is relatively stable, and the water content in the oil-rich phase is relatively high. However, as the glycol flow rate increases, the droplet deforms and is attracted to the water-rich phase. Once the water droplet escaped from the oil-rich phase, the oil-rich phase was recovered and dried. It can be deduced that the emulsion instability due to growing water droplets and thin oil phases cannot prevent the interface breakup and instantaneous film drainage. As a consequence, the oil becomes dehydrated. These results agreed well with the others (Munir & Wu, 2024). In addition, it is clear from **Figure 3** that the oil-rich phase becomes more stable as the glycol flow rate passes unity (10 kg/h) and during coalescence, where the calculated density of the oil-rich phase has become stable. It is known that density calculation in modeling is greatly affected by the multiphase flow (Kontogeorgis *et al*., 2006).

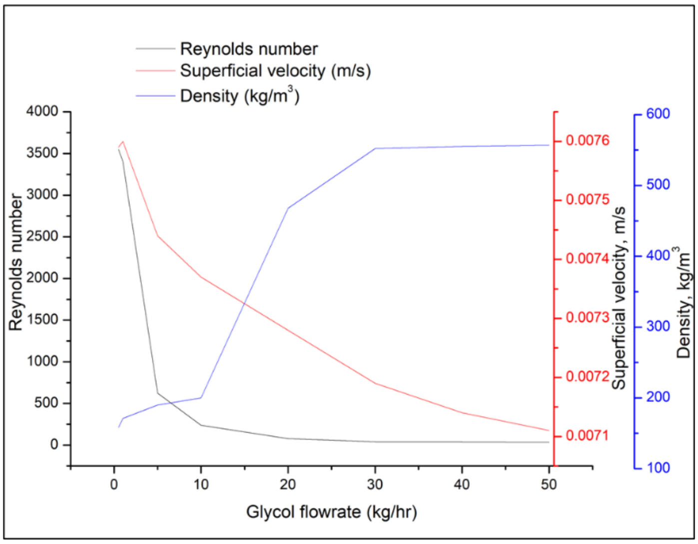

Figure 3. Changes in Reynolds number, superficial velocity, and phase density for oil-like phase at different glycol flow rates using CPA property method. Higher glycol flow rate reinforced the flow behavior towards the laminar regime and stabilized the phase density.

The extent of dehydration is limited by mass transport between continuous and dispersed phases. As such, it is paramount to optimize the column hydraulic, which controls the concurrent liquid movement. Such coalescence requires precise hydraulic control to provide a drop contact time higher than film drainage time and to maintain a distance between drops below a critical distance. In this study, packed material was utilized, and the result is a sufficiently large superficial velocity of the liquid load called Q_{load}, which ranges from 0.5 $kg/s/m^2$ to 14 $kg/s/m^2$. Higher Q_{load} allows higher capacity of mass transfer to occur using smaller-sized equipment. In addition, a minimum pressure drop across the column is determined to be between 0.1 to 10 mbar/m, suggesting an economical process for the dehydration step.

3.4. Separation efficiency and composition profile

As shown in **Figure 1**, the oil and glycol mixture entered the coalescer, and their mixture had to follow the fluid path directed by the coalescing plates. The fluid mixture had accelerated separation at the middle of the coalescer as it passed a series of coalescer elements. The momentum of the fluid mixture between oil and glycol enhanced the mass transfer through coalescing elements. Once the mixture arrived at the end of each coalescer element, the fluid mixture disengaged due to the density difference, and the newly formed two-layer fluids were disallowed from re-mixing. Herein, the combined use of coalescing elements and glycol as a liquid desiccant indicated that the separation process was accelerated.

Figure 4 exhibited composition changes along the coalescer stages. We elucidated the effects of glycol flow rate on the chemical composition profile along the coalescer. **Figure 4** illustrates the profile of chemical composition at different locations or stages. We started from the top of the coalescer (stage, *N* = 0) as shown in **Figure 4**. At this low stage, it is found that EPO dominated the mixture composition. We also observed that both water and formic acid content, as well as MEG, were close to negligible. Insets in **Figure 4** exhibited the effect of a higher glycol flow rate. We observed that the water and formic acid content (water-like) diminished at stage *N* = 6, and the effect got stronger with a higher glycol flow rate, as shown in Fig. 4 (inset). Higher glycol flow rates give lower water content and are more favorable for dehydration performance in the dehydration process. The bottom of the coalescer (*N* = 10) was dominated by water-like compounds suspended in glycol (rich glycol). The separation of dehydrated oil and rich glycol was based on density difference, where glycol density is usually higher than oil.

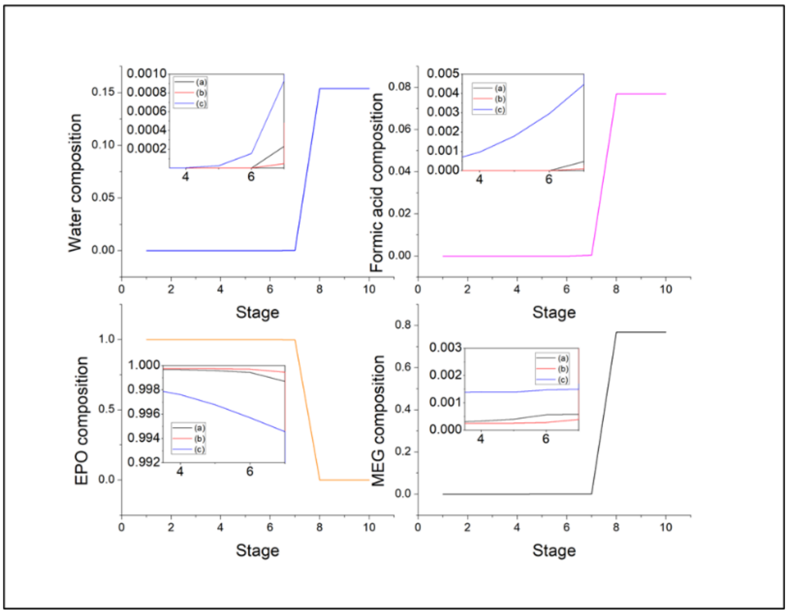

Figure 4. Chemical composition (weight basis) as a function of stages of coalescer as modeled in ASPEN Plus V14 using CPA property method. Insets show the zoomed part of each figure, where (a) glycol flow rate is 10 kg/h, (b) glycol flow rate is 30 kg/h, and (c) glycol flow rate is 1 kg/h.

Table 2 indicates the overall mass balance for the modeled coalescer. Outlet 1 represents an oil-rich phase consisting of dehydrated oil and a few traces of glycol. Good recovery of oil was indicated by the absence of traces of oil at Outlet 2, which represents a water-like (rich glycol) phase.

Table 2. Materials stream results for wet feed and glycol ratio at unity.

Stream name	Feed	MEG	Outlet 1 (oil-rich)	Outlet 2 (water-rich)
Liquid fraction	1	1	1	1
Temperature, K	343.15	343.15	343.15	343.15
Pressure, kPa	100	100	100	100
Total mass flow, kg/hr	10	10	7.0018	12.9982
Components				
Water	2.0000	0.0000	0.0000	2.0000
Formic acid	1.0000	0.0000	0.0000	1.0000
MEG	0.0000	10.0000	0.0018	9.9982
Bio-based oligomer	7.0000	0.0000	7.0000	0.0000

3.5. Economic Evaluation of Coalescer

A study was carried out to compare the effectiveness of the dehydration process between the coalescer and vacuum drying. Conventionally, wet oligomers have been dried by using a vacuum pump at the laboratory and pilot plant levels for batch processes. As the operational margin increases, it is challenged by incremental energy cost; it is vital that alternate drying technology be explored. Typically, a coalescer is used to dry natural gas in the oil and gas sector. It offers continuous process capability and has a higher initial capital cost compared to vacuum pump technology.

To understand the economic viability of coalescer as a drying technology for wet oligomers, we studied the effectiveness and associated cost of drying wet bio-based oligomers derived from triglyceride. A sample of 1 kg of wet bio-based oligomers was used for each coalescer and vacuum drying. **Table 3** shows the comparison between these drying technologies, including process duration, capital expenditure, and operational expenditure associated with applying each drying technology. We found that liquid dessicant (glycol)-assisted dehydration using a coalescer offers a shorter duration to achieve lower water content below, i.e., 0.1 % w/w in bio-based oligomers. It offers about 83% faster drying duration and 76% saving in prolonged energy consumption required to run the drying process. This indicates that the coalescer is a prominent alternative to drying by vacuum pump technology and provides better economic value for continuous production.

Table 3. Comparison for different drying technologies for wet oligomer and engineering parameters.

Drying technology	Duration required to reduce the water content to 0.1 wt% (Karl-Fisher) (h)	Process	Capital expenditure (RM)	Energy consumption (kWh)
Coalescer	1	Continuous	50,000	1.44
Vacuum pump	6	Batch	30,000	5.97

Figure 5 shows the capability of the coalescer to emulsion-break wet oligomer and immediately form 2 phases, namely dried oil (oil-rich phase) and water layer (water-rich

phase). The emulsion-breaking process allows better drying performance in a shorter duration. The consistency in using a coalescer to dry wet oligomer is exhibited in **Figure 6**, where the coalescer shows a stable level of moisture in dried oil. This is especially important for a continuous process that might be subjected to fluctuation in process parameters.

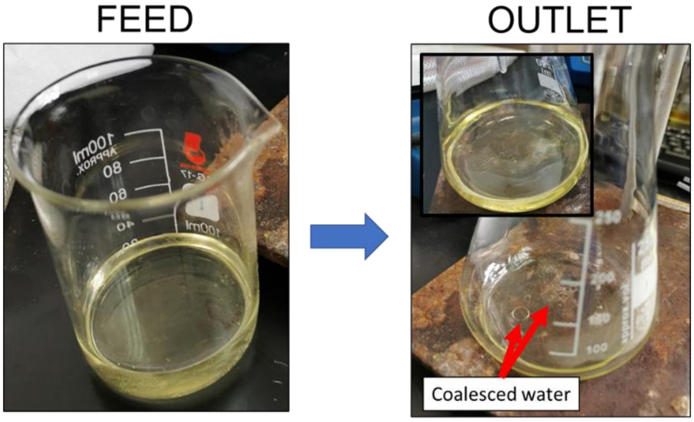

Figure 5. Transformation of 1-phase wet oil (Feed) into 2 phases (dried oil (oil-rich) and coalesced water (water-rich) phases) using a laboratory coalescer (length = 0.5 meter). Several large-diameter coalesced water droplets formed immediately upon exiting the coalescer. The feed contained wet oligomer with a moisture level of 3.4 wt%. The dried oil (oil-rich phase) at the outlet had a moisture level of 0.10 wt%. All moisture content was determined using the Karl-Fisher method (ASTM D6304).

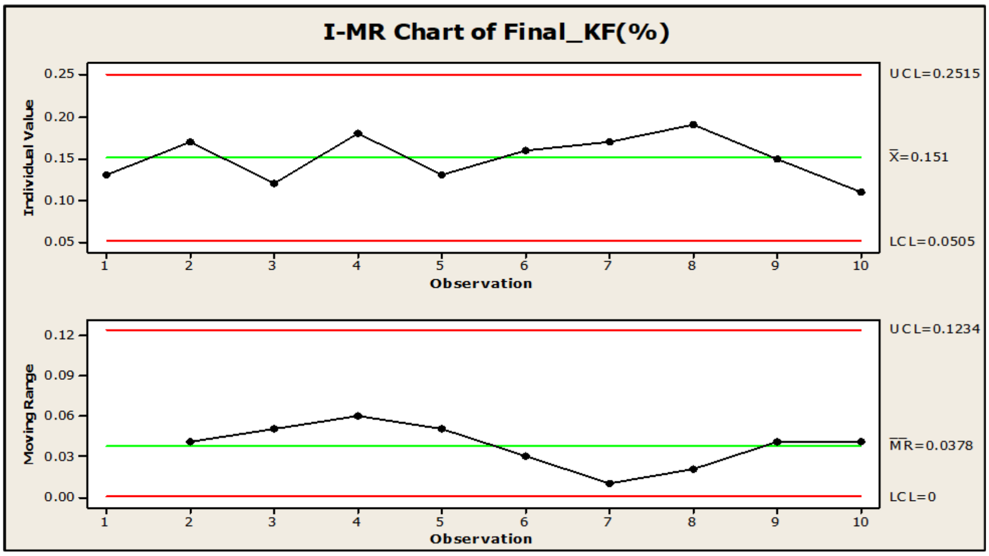

Figure 6. Reproducibility study for drying wet functionalized oil using a laboratory coalescer. The dried oil had moisture averaged at 0.15 wt%. I-MR chart of the dried oil shows excellent control of the moisture of dried oil, indicating the viability of such process for further study.

4. CONCLUSION

The application of liquid desiccant-assisted dehydration for bio-based oligomers offers industrial and commercial advantages, as it is based on the unsteady thermodynamic behavior of emulsions. This method effectively reduces separation time for processed oligomers and removes detrimental contaminants such as water and acid catalysts. The liquid desiccant contributed to rapid dehydration efficiency by reducing mixture viscosity, stabilizing emulsion-breaking, and mitigating detrimental back-mixing and undesired dispersion. These attributes underscore its high applicability and economic value in industrial processing.

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6. AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. Authors confirmed that the paper was free of plagiarism.

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