International Journal of Applied Research and Sustainable Sciences (IJARSS)
Vol. 3 No. 12, 2025: 1007 - 1018

Comparative Analysis of Calcium Carbonate and Clay Based on Solution Specific Gravity for Core and Shell Separation in the Claybath Unit at PMKS PT. XYZ

Hariyanto[1], Gilbert Tua Beltsazar Sitorus[2], Dimas Frananta Simatupang[2*]
Politeknik Teknologi Kimia Industri, Medan, North Sumatera, Indonesia
Corresponding Author: Dimas Frananta Simatupang difratas@ptki.ac.id

ARTICLEINFO

Keywords: Claybath, Shell, Core, Calcium Carbonate, Clay, Specific Gravity, Core Losses, Oil Palm

Received : 22 October
Revised : 22 November
Accepted: 24 December

ABSTRACT

This study is the result of an analysis of the effect of the ratio of calcium carbonate ($CaCO_3$) and clay ($Al_2O_3.3SiO_2.2H_2O$) on the specific gravity of the solution and the effectiveness of the separation of palm kernel and shell in the Claybath unit at PMKS PT Sisirau. This separation is based on the principle of specific gravity difference, where the optimal solution medium has a specific gravity between 1.12-1.13 gr/mL. The research was conducted by varying the ratio of calcium carbonate and clay, measuring the specific gravity of the solution, and calculating the resulting core losses. The results showed that increasing the specific gravity of the solution significantly decreased the core losses. The negative linear regression correlation value of -0.9955 shows a very strong relationship between the increase in specific gravity and the decrease in losses. The optimal combination was obtained at a ratio of 5:5 (150 g calcium carbonate and 150 g clay) with a specific gravity of 1.133 g/mL and core losses of 3.23%, lower than the company's maximum standard of 3.50%. This analysis shows that the use of a combination of calcium carbonate and clay is effective and more economical as a separation medium in the Claybath unit process.

DOI: https://doi.org/10.59890/ijarss.v3i12.164
E – ISSN : 3026-0205
https://jpnmultitechpublisher.my.id/index.php/ijarss/index

INTRODUCTION

Oil palm plants can be processed into palm oil. This oil is called Crude Palm Oil (CPO). Several products are derived from palm oil, including cooking oil, margarine, cakes/biscuits, raw materials for other industries (oleochemicals), and materials for making biodiesel. Palm oil processing is one of the determining factors for the success of oil palm plantations. The main products obtained are crude palm oil or CPO (Crude Palm Oil), palm kernel oil or PKO (Palm Kernel Oil), fiber, shells, and empty palm fruit bunches. The process of processing fresh fruit bunches (FFB) into palm oil and palm kernel oil is divided into two stages: the main station and the supporting station. The main station functions as a fruit reception, sterilizer, stripper, digester, presser, clarifier, and seed and kernel separator. Meanwhile, the supporting station functions as a power plant, laboratory, water treatment plant, product storage facility, and workshop (Ulimaz et al., 2021).

The clay bath method is one of the most commonly used techniques in the kernel separation process. This technique utilizes the principle of the difference in specific gravity between the kernel and the shell, with the help of a media solution (Claybath) whose specific gravity is adjusted. The specific gravity of this solution is adjusted so that the lighter kernel will float, while the heavier shell will sink (Saputra et al., 2024).

Specific gravity (SG) is the ratio of the weight of an object to its volume. When the SG of the object is greater than the SG of the solution (sinks), the SG of the object is less than the SG of the solution (floats), and the SG of the object is equal to the SG of the solution (floats). This phenomenon is utilized in the process of separating palm kernel and shell using a separation medium consisting of a mixture of clay and water.

In general, calcium carbonate (CaCO3) is more widely used as a separating medium between palm kernel and shell, in addition to the specific gravity of the CaCO3 solution being close to that of the palm kernel shell. This results in the accumulation of CaCO3 in nature and has not been fully utilized. However, for economic reasons, calcium carbonate solution is not very profitable to use in the separation process. Therefore, various efforts have been made to find other materials that are more economical, inexpensive, and easily available, such as ash and clay. Several studies have shown that the use of clay solution can significantly improve the separation of kernels and shells. This is because clay can increase the specific gravity of the mixture (from 1 g/mL to 1.3 g/mL). Theoretically, the specific gravity value of this clay mixture is almost the same as the specific gravity value of calcium carbonate (Rio Fernandez et al., 2023).

In separating kernels and shells, palm oil mills generally use two systems, namely dry and wet separation systems. In the dry separation system, separation is carried out in a vertical column with the help of air suction, with the working principle being that lighter fractions will be sucked upwards and heavier fractions will fall downwards. The separation unit is called Light Tenera Dust Separation (LTDS). In the wet separation system, separation is carried out in a Claybath unit to separate small kernels, broken kernels, and large shells. Wet separation is performed so that small kernels, broken kernels, and large shells from the LTDS are cleaned again (Oksya Hikmawan, Marisa Naufa, 2020).

According to Spradley, analysis is an activity to find a pattern. In addition, analysis is a way of thinking related to systematic testing of something to determine the parts, the relationships between the parts, and their relationship to the whole (Kamu et al., 2014).

At PMKS PT. XYZ, separation between the shell and kernel is carried out in a clay bath. This separation can occur due to the difference in density between the shell, kernel, and solution. The separation can also occur with the help of a centrifugal pump. Palm kernel has a density of 1.06-1.09 g/ml, while the shell has a density of 1.25-1.45 g/ml. The separation between the shell and kernel can be effective if the solution has a density of around 1.12-1.13 g/ml with a maximum kernel loss standard of 3.50%. However, the amount of CaCO3 and soil needed to be added so that the solution has a specific gravity of 1.12-1.13 g/ml, causing the kernel to float in the solution and the shell to sink to the bottom, has not yet been determined. If the shells do not sink to the bottom, it will cause high impurity levels and result in losses for the factory because the kernel marketing process will be disrupted and buyers will no longer subscribe to the factory. Based on the above description, the author is interested in writing a journal with the title: Comparative Analysis of the Use of CaCO3 and Clay Based on the Specific Gravity of the Solution for the Separation of Kernels and Shells in the Claybath Unit at PMKS PT. XYZ in the Province of Nanggroe Aceh Darussalam. The efficiency of the separation will be determined and tested using a simple linear regression equation.

LITERATURE REVIEW

Oil Palm Processing Process

The process of processing fresh fruit bunches (FFB) into *Crude Palm Oil* (CPO) and *palm kernel* (PK) goes through many treatments and stages. The palm oil processing process is divided into several stages and stations, namely fruit *reception station*, *sterilizing station*, *threshing station*, *pressing station*, clarification station and *kernel recovery station*). There are various processes and stations used to turn fresh fruit bunches into crude *palm oil*, one of the most important processes in palm oil processing, namely at clarification *stations*. The purification process is an important process in separating crude oil, water and impurities. In this process, a lot of attention is paid to several important things such as temperature and the residence time of the materials in the tank (T&Eng, 2022).

Kernel Station

The kernel station is a station where palm kernel seeds are processed and *fibre press* from the press station. The press pulp that comes out of the press machine consists of fibers and nuts that will be separated to facilitate the next process. Fiber, which has a percentage of about 10 to 12% of processed FFB, will be transferred to the boiler unit into fuel, while *nuts* with a percentage of 12 to 16% of processed FFB will be broken using *a ripple mill* to remove palm *kernels*. Broadly speaking, the products produced from kernel stations are palm kernel

(*Kernel*), shell (*Shell*), fiber. The kernel of the palm is part of the palm fruit that has been separated from the pulp. The shape of the cocoa core is round, dense or slightly flat, dark brown. Palm kernel is the second most important thing after fruit pulp because palm kernel is the raw material for making palm kernel oil or *Crude Palm Kernel Oil (CPKO).* All products produced from *kernel* stations have their own economic value, so that companies can produce products according to predetermined quality standards. Palm kernel is a raw material to produce CPKO, which is one of the products from palm oil that is widely used in the cosmetics, pharmaceuticals and foodstuffs industries, etc. Press pulp from palm kernel is also still economically valuable, namely as a material for making animal feed. Meanwhile, palm shell and fiber are used as *boiler fuel* for the process of producing steam and power for the sustainability of the processing process in the factory. The processing process at *the kernel* station uses the laws of physics, including (1) The *fan suction* process, takes place on *fibre cyclone* and LTDS. The difference in specific gravity with the fluid medium (a mixture of calcium carbonate (CaCO3) with water), takes place in a *claybath*. The *centrifugal principle* and the difference in specific gravity, takes place in *a hydrocyclone,* (2) The process of reducing moisture content using hot air blowing, takes place in the *kernel of the silo.* The purpose of this processing is to separate the kernel from the shell and to prepare it to be processed in the palm kernel processing plant. This separation process is carried out by *centrifugal system*, suction, and drying.

Calcium Carbonate

Calcium carbonate is a compound that has the molecular formula CaCO3, calcium carbonate compounds obtained from extinguishing lime suspensions in water and gases. This compound is the simplest mineral that does not contain silicon and is the largest commercial source of calcium compound manufacturing. Calcium carbonate is also an *inorganic* mineral that is known to be commercially available at low prices. (Veronika & Rohmawati, 2022). The use of $CaCO_3$ in the process of separation of cores and shells is essential, as this material is able to maintain the specific gravity stability of the solution in *the Claybath*. However, the effectiveness of $CaCO_3$ has a certain limit, where the solution can become saturated after a certain interval of time. This saturation leads to a decrease in the solution's ability to optimally separate the kernel and shell, which risks increasing the kernel *loss rate*. Therefore, the management of solution saturation time intervals is an important factor in maintaining the efficiency of the separation process (Saputra et al., 2024).

Clay

Clay/Hydrosilicate Alumina is a silica-based skeletal mineral particle that is less than four micrometers in diameter. Clay has the chemical formula Al2O3.3SiO2.2H2O. Clay is formed from the weathering process of silica rocks by carbonic acid and is partly produced from geothermal activity. Clay serves to facilitate the separation of cores and shells based on *Specific Gravity.* In addition, clay also serves to increase the specific weight of water from 1 kg/m3 to 1.3 kg/m3. The floating kernel will be lifted with a small wheel while the shell uses a long wheel. The shell will enter the *Shell Bin* using *a blower* while the kernel from *Claybath* will enter the *Kernel silo* (Oksya Hikmawan, Marisa Naufa, 2020).

Table 1. Chemical Element Composition in Clay / Alumina Hydrosilicate

No.	Elements/Compounds	Percentage (%)
1	Silica (SiO_2)	75,40
2	Kalsium Oksida (CaO)	0,70
3	Magnesium Oksida (MgO)	0,71
4	Besi Oksida (Fe_2O_3)	0,01
5	Aluminium Karbonat (Al_2O_3)	14.10

(Source: Chemistry Laboratory of FMIPA USU; 2011)

Specific Gravity

Specific gravity is the ratio of the weight of a volume of material at a temperature to the weight of water with the same volume at that temperature. Specific gravity, BJ, is the ratio of an object's weight to its volume. BJ can be used for a variety of things, such as: determining the purity of a substance, recognizing the state of the substance, and demonstrating the sensitivity of the solution. If an object with a certain BJ is put into a solution that has a certain BJ as well, then it will experience several possibilities, such as: sinking, floating, and floating. These three phenomena occur due to the difference in BJ between objects and solutions. When BJ objects > BJ solution (sink), BJ objects < BJ solution (floating), and BJ objects = BJ solutions (floating). This phenomenon is used in the process of separating oil palm kernels and shells using a mixture of clay and water separation media.

Several studies related to the separation of cores and shells in *claybath* units in palm oil mills explain the need for calcium carbonate used. Rizki (2016) researched the determination of the amount of calcium carbonate (caco3) use in the process of separating *kernels* and shells in *claybath* units at PKS PT. Tales Inti Sawit – Deli Serdang. In the *Claybath unit*, it shows that at a specific gravity of 1.12 gr/ml, the percentage *of kernel* losses is 1.95% and the percentage of impurities in *the kernel* is 5.90%. This value still meets the standards determined by the factory, namely the percentage of *kernels* that have a shell < 2% and the percentage of dirt on the *kernel* < 6%. Based on the calculation results, the amount of use of Calcium Carbonate (CaCO3) to maintain the specific gravity of the CaCO3 solution at 1.12 gr/ml with an operating time of 9 hours is 771.42 kg with the addition of 1800 liters of water. Meanwhile, Juwita (2025) also examined the calculation of the mass balance in the process of separating kernels with shells in *the claybath* unit at PTPN IV PKS Sawit Sebrang and concluded that the amount of CaCO3 solution needed in the process of separating *the kernel* with the shell in *the claybath* unit is 1500 kg/hour with an average amount of *kernel losses* which was obtained by 0.62%. However, in this follow-up study, development was carried out on the use of comparative variations of calcium carbonate and clay to separate the core and shell in *the claybath unit.*

METHODOLOGY

This research was conducted at PMKS PT. XYZ Nanggroe Province Aceh Darussalam. The tools and materials used in this study include: 1000 ml measuring cup, cup mixer rod, bucket, digital analytical balance, hydrometer, strainer, oven, clay, calcium carbonate, samples from feeding claybath and water. Calcium carbonate and clay solutions are made with a wide variety of concentration variations based on the difference in the amount of calcium carbonate and clay used, and dispersed in 1000 mL of water.

Table 2. Composition of calcium carbonate and clay with a wide variety of variations

Comparison	**Weight of calcium carbonate (grams)**	**Weight of clay (g)**	**Water volume (g)**	**Sample (g)**
1:9	30	270	1000	100
1:4	60	240	1000	100
3:7	90	210	1000	100
2:3	120	180	1000	100
1:1	150	150	1000	100

Calcium carbonate was weighed using a digital scale to obtain 30 grams, and clay was weighed to obtain 270 grams, then placed in a bucket. 1000 ml of water was added to the bucket. The solution was stirred for 5 minutes until homogeneous. A hydrometer was placed in a measuring cup containing the solution, then the specific gravity of the solution was tested. A sample of 100 grams of feeding Claybath was added to the solution. The solution was stirred for a few moments. The sample from the feeding Claybath is filtered using a simple filtration process. The result of the filtration is washed using running water. The sample is dried in an oven at a temperature of 105°C for 10 minutes. The core, shell, and whole seeds are separated, then weighed and the results are recorded. The same procedure was carried out with calcium carbonate weights of 60 g, 90 g, 120 g, and 150 g and clay weights of 240 g, 210 g, 180 g, and 150 g. The study was repeated three times, and the data presented are the average values.

The data analysis technique used in completing this study was a quantitative inferential approach described descriptively. Based on the data from the analysis of the effect of calcium carbonate and clay use on the separation of the core and shell, a simple regression analysis was performed using statistical theory, namely the simple linear regression line approach.

RESEARCH RESULT

Effect of the addition of calcium carbonate and clay on the specific gravity of the solution

The effect of adding calcium carbonate and clay to the specific gravity of the solution was carried out by varying the weight of calcium carbonate and clay, starting from a ratio of (1:9) with the addition of 30 grams of calcium carbonate and 270 grams of clay, (1:4) 60 grams of calcium carbonate and 240 grams of clay, (3:7) 90 grams of calcium carbonate and 210 grams of clay, (2:3) 120 grams of calcium carbonate and 180 grams of clay, (1:1) 150 gr of calcium carbonate and 150 gr of clay.

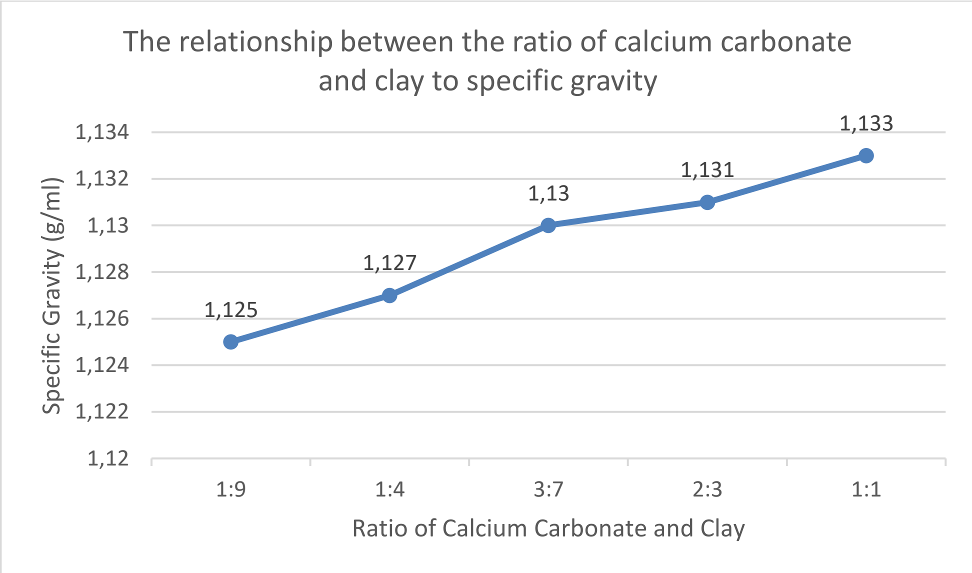

Figure 1 Graph of the effect of calcium carbonate and clay composition on the specific gravity of the solution

From Figure 1, it is known that the relationship between the amount of calcium carbonate and the added clay is directly proportional to the specific gravity of the resulting solution. It is known that the more calcium carbonate and clay compositions are added, the more the specific gravity of the solution will be. Calcium carbonate is more effective in increasing specific gravity compared to clay because calcium carbonate has the ability to increase particle density higher than clay.

Determination of Total Core Losses

To find out the percentage of total core losses, it can be calculated with the following formula:

% Total core = % Core in whole kernel + % Sunken core .... (1)

Then the results are as shown in Table 3 below:

Table 3 Data on the calculation of core losses with variations in specific gravity

Comparison	**Weight of calcium carbonate (gr)**	**Weight of clay (g)**	**Specific gravity (g/ml)**	**Core losses (%)**
1:9	30	270	1,125	5,28
1:4	60	240	1,127	4,58
3:7	90	210	1,130	3,93

2:3	120	180	1,131	3,73
1:1	150	150	1,133	3,23

Determination of Simple Linear Regression

In general, the forms of linear regression equations are:

$$y = \alpha + bx \text{.................}(2)$$

Description :

y = Dependent variable (tied variable)

a = Constant (value of y when x = 0)

b = Coefficient (positive or negative influence)

x = Independent variable

In this study, the specific gravity of the solution with different concentrations was estimated as an independent variable while the core *losses* were estimated as a dependent variable. After calculating the percentage of core *losses*, the results are obtained and made into the tabulation table as follows:

Table 4 Data on linear regression analysis between specific gravity to core losses

No	Specific gravity (g/ml) (X)	Core losses (%) (Y)	X^2	Y^2	XY
1	1,125	5,28	1,27	27,88	5,94
2	1,127	4,58	1,27	20,98	5,16
3	1,130	3,93	1,28	15,44	4,44
4	1,131	3,73	1,28	13,91	4,22
5	1,133	3,23	1,28	10,43	3,66
Σ	5,6460	20,7500	6,3755	88,6455	23,4208

The calculation process is carried out using *the Microsoft Excel* application to get accurate calculation results. When *plotting* between specific gravity and *core losses* is carried out , the regression equation can be determined.

Based on the results of calculations in *Microsoft Excel, the* results of regression equations and correlation coefficient values (R2) were obtained. The results of the regression equation calculation using *Microsoft Excel* can be seen in the following graph.

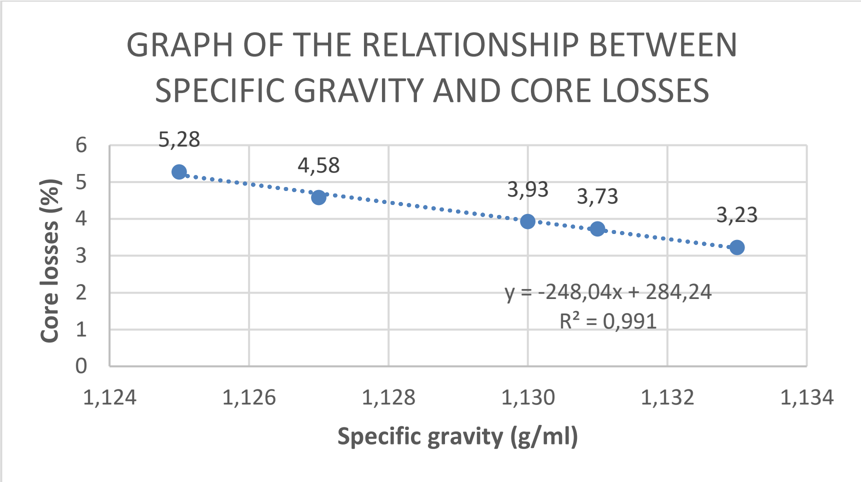

Figure 2 Plotting between Density vs Core Losses to obtain a linear regression equation

The linear regression equation between the specific gravity of calcium carbonate ($CaCO_3$) solution and clay ($Al_2O_3.3SiO_2.2H_2O$) solution against core losses is y = 284.24 – 248.04X. Based on this equation, it can be seen that the value of b is negative, indicating that the greater the specific gravity value, the lower or smaller the core losses will be. After that, the statistical test conducted in this study was a correlation test between the specific gravity of the solution and core losses. The test was conducted to determine the relationship between the specific gravity of the solution and core losses. The correlation value between variable X (specific gravity of the solution) and variable Y (core losses) is -0.9955, which indicates that the relationship between the specific gravity of the solution and core losses is very strong. Then there is a coefficient of determination value obtained or R^2 of 0.9910, which means that the percentage of the specific gravity of calcium carbonate ($CaCO_3$) and clay ($Al_2O_3.3SiO_2.2H_2O$) solutions contributes significantly, namely 99.10% to core losses. Meanwhile, the remaining (±0.90%) is caused by other variables or factors.

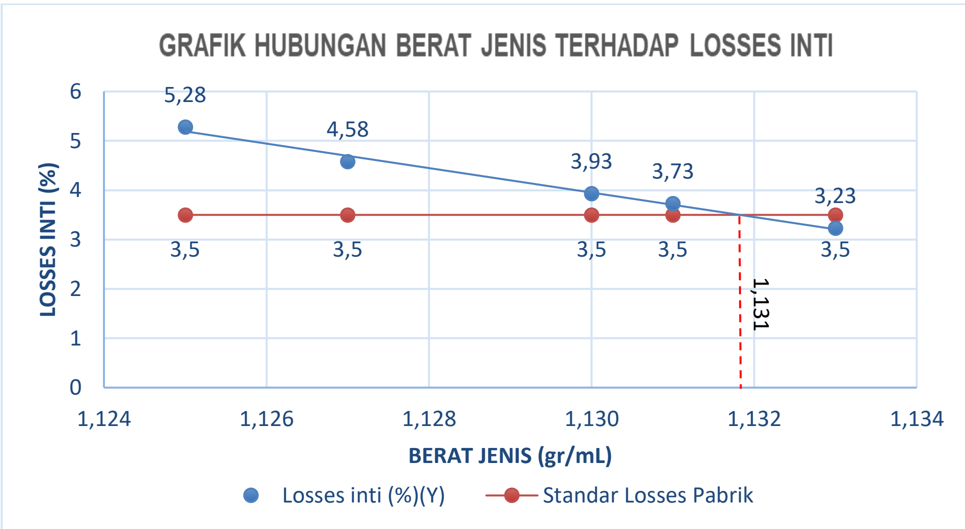

Figure 3 Graph of the relationship of specific gravity to core losses to obtain optimal specific gravity

DISCUSSION

The process of separating the core and shell is based on differences in specific gravity. If a mixture of shells and cores is placed in a solution with a specific gravity between that of the shells and cores, those with a specific gravity lower than that of the solution will float to the top, while those with a specific gravity higher than that of the solution will sink to the bottom of the cone.

In this study, a mixture of calcium carbonate (CaCO3) and clay (Al2O3.3SiO2.2H2O) was used, which had become a solution with a specific gravity of 1.125-1.133 g/ml. Palm kernel has a specific gravity of 1.06-1.09 g/ml, while the shell has a specific gravity of 1.25-1.45 g/ml. The separation between the shell and the kernel can be effective if the solution has a specific gravity of around 1.12-1.13 g/ml. As can be seen in Figure 4.2, from several data variations, the one with the lowest kernel losses is the 5:5 variation with a CaCO3 weight of 150 g and a clay weight of 150 g with a specific gravity of 1.133 g/ml and a kernel loss value of 3.23%. However, when calculating the theoretical specific gravity or the specific gravity used to obtain a standard core loss of 3.50% in the separation of the core and shell, it is 1.132 g/ml. Therefore, it can be hypothesized that there is no significant difference between the specific gravity in the study and the theoretical specific gravity.

The percentage of core losses in this study is 3.23%. When compared to the standard losses stipulated by the factory, which is 3.50%. The difference between the research % losses and the factory standard is due to several factors, such as the density of the solution not being appropriate, the separation medium not being optimal, and sedimentation occurring where the separation medium settles at the bottom. This occurs because the stirring process causes the separation medium to be less homogeneous, meaning that if the stirring is not intense enough, the calcium carbonate and clay particles (separation medium) tend to settle at the bottom. This percentage of losses must be determined so as not to cause losses to the company. If there are many kernel losses and impurities are missed, the company will suffer losses because many kernels are wasted, which leads to reduced production and reduced income. The addition of CaCO3 should be as efficient and effective as possible so that not too much impurity is missed, thereby preventing buyers from being disappointed or suffering losses due to many shells being mixed into the production kernels. This also minimizes kernel losses so that the company does not suffer losses due to many kernels being mixed into the shells that will be channeled into boiler fuel, and it can maintain the specific gravity of the calcium carbonate solution at 1. 12 (Abdikarso et al., 2024).

CONCLUSIONS AND RECOMMENDATIONS

From the results of linear regression calculations and correlation coefficients between variable X (specific gravity of the solution) and variable Y (core losses), it was found that the correlation coefficient of –0.9955 indicates a negative linear relationship, which means that it is inversely proportional and very strong. The effect of adding calcium carbonate (CaCO3) and clay (Al2O3.3SiO2.2H2O) on core losses in the core and shell separation process in the Claybath unit is that the greater the specific gravity of the solution, the lower or smaller the core losses will be. The coefficient of determination or R2 obtained is 0.9910, which means that the percentage of the specific gravity of the calcium carbonate (CaCO3) and clay (Al2O3.3SiO2.2H2O) solution contributes significantly, namely 99.10%, to core losses. Meanwhile, the remaining (±0.90%) is caused by several factors, such as the specific gravity of the solution not being suitable, the separation medium being less than optimal, and sedimentation occurring where the separation medium settles at the bottom, which occurs because the stirring process causes the separation medium to be less homogeneous. It can be concluded from several data variations that the most optimal mixture ratio is 1:1 with a weight of calcium carbonate (CaCO3) of 150 g and clay (Al2O3.3SiO2. $2H_2O$) 150 g, resulting in a solution density of 1.133 g/ml and core losses of 3.23%, which is lower than the company's maximum standard limit of 3.50%.

REFERENCES

Abdikarso, L., Ramadhan, P., Aziz, A., & Pratama, A. N. (2024). *Optimalisasi Claybath Pada Pabrik Kelapa Sawit Menggunakan Flow Meter Coriolis dan Auto Reverse Flow Rinsing Optimizing Claybath in Palm Oil Mills Using Coriolis Flow Meters and Auto Reverse Flow Rinsing*. *17*(2), 76–83.

Ismiasih, I., & Afroda, H. (2023). Faktor Penentu Produksi Kelapa Sawit Rakyat Di Provinsi Riau. *Jurnal Penelitian Pertanian Terapan*, *23*(2), 211–218. https://doi.org/10.25181/jppt.v23i2.2726

Kamu, S. N., Pati, A., & Sampe, S. (2014). *Silva Nita Kamu , 2020 . Analysis of Public Services in the Langowan Utara District , Minahasa Regency . (Under the supervision of Dr . Drs . Agustinus B . Pati , M . Si as the Chairman of the Commission , Stefanus Sampe , Ph . D . as the member)*. 55–71.

Oksya Hikmawan, Marisa Naufa, N. A. (2020). Jurnal Teknik dan Teknologi Jurnal Teknik dan Teknologi. *Pengaruh Penambahan Tanah Liat Pada Pemisahan Inti Dan Cangkang Sawit Effect*, *15*(30).

Rio Fernandez, B., Evencus Hutajulu, P., Sylviana Pratikha, R., & Imanuael Tarigan, N. (2023). The Effect of Specific Gravity of Clay (Aluminium Hydrosilicate) on Kernel Losses at Claybath Station`s. *Jurnal Rekayasa, Teknologi Proses Dan Sains Kimia (REPROKIMIA)*, *2*(2), 9–17. https://akses.ptki.ac.id/jurnal/index.php/reprokimia/article/view/125

Saputra, W. A., Dharmawati, N. D., & Purwoto, H. (2024). *Analisa Penggunaan Kalsium Karbonat (CaCO 3) dan Kehilangan Kernel pada Proses Pemisahan Kernel di Claybath*. *2*.

Ulimaz, A., Nuryati, N., Ningsih, Y., & Hidayah, S. N. (2021). Analisis Oil Losses Pada Proses Pengolahan Minyak Inti Kelapa Sawit Di Pt. Xyz Dengan Metode Seven Tools. *Jurnal Teknologi Agro-Industri*, *8*(2), 124–134. https://doi.org/10.34128/jtai.v8i2.144

Veronika, A. O., & Rohmawati, L. (2022). Sintesis CaCO3 dari Dolomit Bangkalan dengan Metode Leaching. *Sains Dan Matematika*, *7*(1), 39–42. https://doi.org/10.26740/sainsmat.v7n1.p39-42