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The Density Value of Mixing Water and Cooking Oil Using an Emulsifier (Tween 20)

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ABSTRACT

Water and cooking oil are fluids that we often encounter in our daily lives and are often needed. Water is polar while cooking oil is non-polar, so in uniting the two fluids an emulsifier (Tween 20) is used to mix them. The aim of this research is to combine polar and non-polar fluids. Emulsifier (Tween 20) is used as a polysorbate surfactant (mixing agent) for the two fluids and can mix perfectly. The combined water and oil are mixed using a mixing stirrer with a speed of 100-200 rpm, a temperature of 70ºC, within 1 hour. To obtain a fluid density value by providing heating from 30ºC-90ºC, then inserting it into a 25 mL volumetric flask and weighing it. After mixing, a white hybrid fluid will be produced, and it will separate again when the fluid is at room temperature.
Keyword: Fluid, Water, Cooking Oil, Emulsifier, Mixing

ABSTRAK

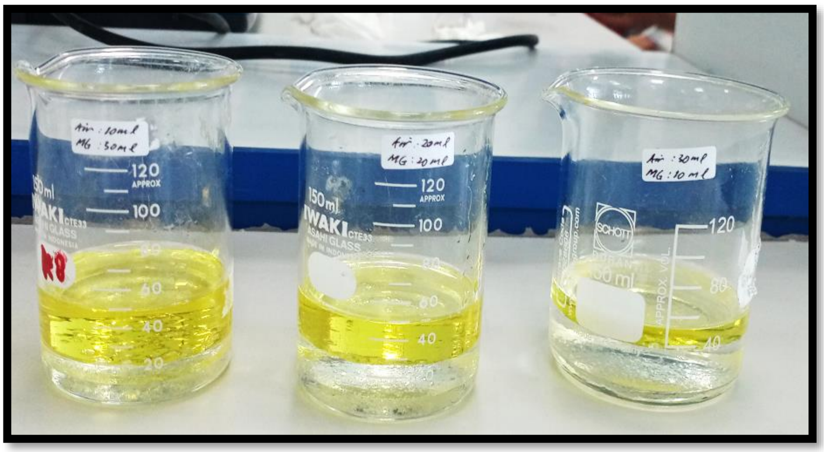
Air dan minyak goreng merupakan fluida yang sering temui oleh kita dikehidupan sehari-hari dan sering dibutuhkan. Air bersifat polar sedangkan minyak goreng bersifat nonpolar, sehingga dalam menyatukan kedua fluida tersebut menggunakan emulsifier (Tween 20) untuk mencampurkannya. Tujuan dari penelitian ini menggabungkan fluida polar dan nonpolar. Emulsifier (Tween 20) dipergunakan sebagai polysorbate Surfactant (bahan pencampur) kedua fluida tersebut dan dapat bercampur secara sempurna. Gabungan air dan minyak dicampurkan menggunakan mixing stirer dengan kecepatan 100-200 rpm, temperatur 70ºC, dalam waktu 1 jam. Untuk memperoleh nilai densitas fluida dngan memberikan pemasanan dari 30ºC-90ºC, kemudian memasukan kedalam labu volumetrik 25 mL dan menimbangnya. Setalah dilakukan pencampuran akan dihasilkan hybrid fluida berwarna putih, dan akan menjadi terpisah kembali saat fluida tersebut pada suhu ruang.
Keyword: Fluida, Air, Minyak Goreng, Emulsifier, Pencampuran

1. Introduction

The State of Indonesia has agrarian commodities that produce several plant, mining and marine products. Agricultural products from plant agriculture starting from vegetables, fruit, vegetable oil and so on, contribute to the development and fulfillment of consumption in the country and abroad. One of the big and excellent agricultural products, namely: oil palm plantations[1-5]. The produce of oil palm plantations in the form of fresh fruit bunches (FFB) will be processed into crude palm oil (CPO) in which the FFB is boiled, shelled, pressed, filtered, and purified in the clarification process [6-8]. The results of CPO will be processed back into cooking oil with a series of refining processes, bleaching deodorizing palm olein (RBDPO) [9-13].

Water is the main ingredient for living things to carry out the process of digestion, growth, and maintaining the body [14]. Water is an inseparable need for living things, such as for drinking, cleaning, cooking and so on[15].

Cooking oil is currently a community need in the process of cooking and ripening food by heating [16-18]. The heating process uses a heat source (furnace, LPG gas, electric stove) as heat energy in the ripening process. Compounds formed due to the existence of electron bonds with each other in the binding elements [19]. These binding elements will join each other because the bonding elements have different electronegativity values. Compounds are divided into polar and non-polar [20-23]. Some characteristics of polar compounds, namely: can dissolve in water and other polar solvents, have positive (+) and negative (-) poles due to the uneven distribution of electrons [24]. Water and oil are materials needed by humans, but have different characteristics, where water is a polar material while cooking oil is a non-polar material [25-26]. The two fluids have different densities, so they can easily separate between the two [27]. In Figure 1.1 you can see the condition of the water and cooking oil being separated.



a. b. c.

Figure 1.1**.** Water & Cooking Oil Fluid Conditions, a) 30 mL Cooking Oil & 10 mL Water, b) 20 mL Cooking Oil & 20 mL Water, c) 10 mL Cooking Oil & 30 mL Water.

In research, it is necessary to combine the added materials in the form of emulsion surfactants to combine the two.

2. Methodology

2.1 Preparation

In the process of this research was carried out using water and cooking oil with a composition of 10 mL & 30 mL; 20 mL & 20 mL; 30 mL & 10 mL, 3 times repetition. The addition of emulsion in each test is 10 mL of tween 20 [28-29]. The mixing process used a magnetic stirrer at 2000 rpm (2 Mot), 70ºC, for 1 hour.

2.2 Density Testing

Density testing is carried out to determine the density of the fluid that has been mixed thoroughly from the two fluids (water & cooking oil) [30]. The fluid hybrid formed will be weighed using a 25 mL volumetric flask (picnometer). The mixed fluid is heated from 30ºC - 90ºC, put into a volumetric flask, and the total weight is weighed. The equation used to show density is [31] :

$$\rho = \frac{m}{V} \quad (1)$$

Where :
ρ = Fluid density [g/mL]
m = fluid mass [g]
V = Fluid volume [mL]

3. Discussion Result

3.1 Density

This test was carried out using 3 glass beakers with the composition of each glass beaker being 10:30:10; 20:20:10; and 310:10:10 (mL). The results of the density test carried out in mixing water, cooking oil, with this emulsifier can be seen in table 3.1.

Table 3.1. Sample Density Test Data 1

No Sample	Cooking Oil : Water : Emulsifier (mL)	Temperature (ºC)	Sample Mass + picno (gr)	Picno Mass (g)	Sample Mass (g)	Picno Volume (mL)	Density (g/ mL)
1	10:30:10	30	45.47	19.78	25.69	25	1.0276
		40	45.2	19.78	25.42	25	1.0168
		50	45.05	19.78	25.27	25	1.0108
		60	44.73	19.78	24.95	25	0.998
		70	44.39	19.78	24.61	25	0.9844
		80	44.35	19.78	24.57	25	0.9828
		90	44.54	19.78	24.76	25	0.9904
	20:20:10	30	46.93	23.38	23.55	25	0.942
		40	46.98	23.38	23.6	25	0.944
		50	46.65	23.38	23.27	25	0.9308
		60	46.55	23.38	23.17	25	0.9268
		70	46.48	23.38	23.1	25	0.924
		80	46.23	23.38	22.85	25	0.914
		90	46.31	23.38	22.93	25	0.9172
	30:10:10	30	44.54	21.55	22.99	25	0.9196
		40	44.48	21.55	22.93	25	0.9172
		50	44.32	21.55	22.77	25	0.9108
		60	44.2	21.55	22.65	25	0.906
		70	43.85	21.55	22.3	25	0.892
		80	43.82	21.55	22.27	25	0.8908
		90	43.67	21.55	22.12	25	0.8848

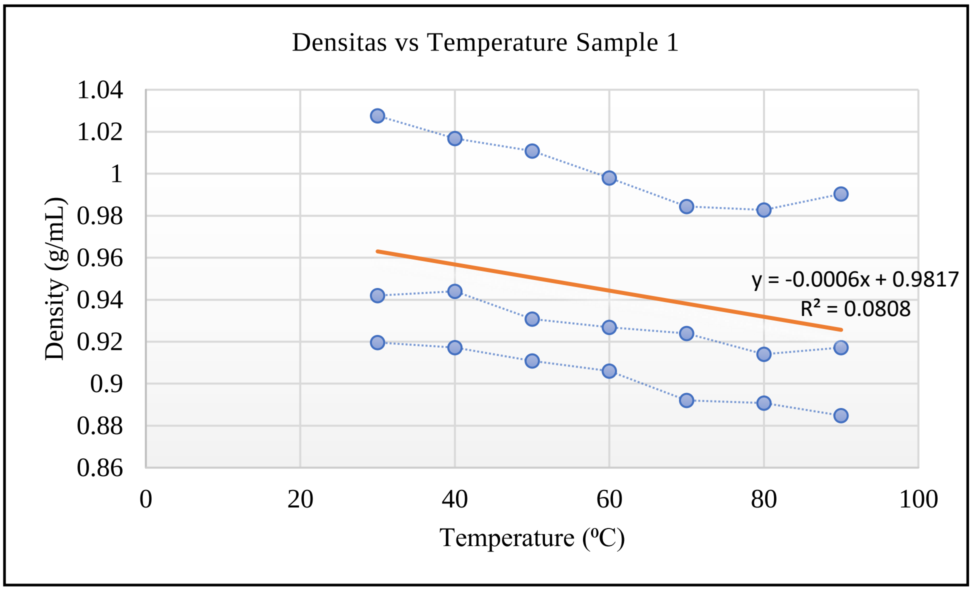


Figure 3.1 Graph of Density vs Temperature in Sample 1

Figure 3.1 shows that different compositions and different temperatures will give different values. At a composition of 10:30:10 mL (cooking oil : water : emulsifier) it can be seen that the density is still above 1 g/mL at a temperature of 30ºC-60ºC. This shows that the mixture still contains a lot of water, where the density of water is 1 g/mL. After giving the addition of a temperature of 70ºC-90ºC the fluid mixture will be lower. At compositions 20:20:10 ml and 30:10:10 mL, there has been a decrease in density starting from 30ºC-90ºC

indicating that these compositions match the density of cooking oil. According to Sahasrabudhe et al 2017, the higher the temperature, the lower the fluid density value [32].
Then the researchers repeated the second sample with the same composition and the same treatment (using a magnetic stirrer for mixing, temperature 70ºC for 1 hour). The results of mixing the fluid are then tested for density which can be seen in table 3.2.

Table 3.2. Sample Density Test Data 2

No Sample	Cooking Oil : Water : Emulsifier (ml)	Temperature (ºC)	Sample Mass + picno (g)	Picno Mass (g)	Sample Mass (g)	Picno Volume (mL)	Density (g/mL)
2	10:30:10	30	43.58	19.72	23.86	25	0.9544
		40	43.21	19.72	23.49	25	0.9396
		50	43.15	19.72	23.43	25	0.9372
		60	42.69	19.72	22.97	25	0.9188
		70	42.35	19.72	22.63	25	0.9052
		80	42. 25	19.72	22.53	25	0.9012
		90	42,38	19.72	22.66	25	0.9064
	20:20:10	30	46.76	21.55	25.21	25	1.0084
		40	46.67	21.55	25.12	25	1.0048
		50	46.36	21.55	24.81	25	0.9924
		60	46.02	21.55	24.47	25	0.9788
		70	45.97	21.55	24.42	25	0.9768
		80	45.81	21.55	24.26	25	0.9704
		90	45.67	21.55	24,12	25	0.9648
	30:10:10	30	45.03	19.786	25.244	25	1.00976
		40	44.62	19.786	24.834	25	0.99336
		50	44.22	19.786	24.434	25	0.97736
		60	44.2	19.786	24.414	25	0.97656
		70	44.02	19.786	24.234	25	0.96936
		80	43.5	19.786	23.714	25	0.94856
		90	43.48	19.786	23.694	25	0.94776

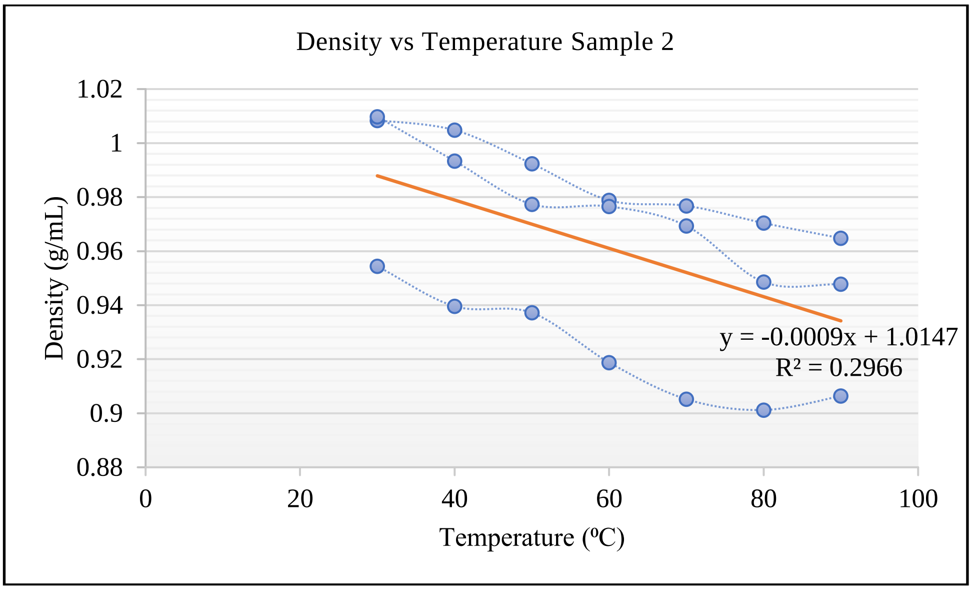


Figure 3.2 Graph of Density vs Temperature in Sample 2

Figure 3.2 shows that the graphs for compositions 10:30:10 mL, 20:20:10 mL and 30:10:10 mL are almost entirely below 1 g/mL, this shows that mixing is getting better and leading to mass. the type of cooking oil, which is below 1 g/mL. the statement that high temperatures will decrease the value of the fluid density in oil [32]. Then the mixing process was carried out on sample 3, where the mixing treatment, temperature and time used were the same. The results of the density test on sample 3 can be seen in table 3 below.

Table 3.2 Sample Density Test Data 3

No Sample	Cooking Oil : Water : Emulsifier (mL)	Temperature (ºC)	Sample Mass + picno (g)	Picno Mass (g)	Sample Mass (g)	Picno Volume (mL)	Density (g/mL)
3	10:30:10	30	46.01	23.38	22.63	25	0.9052
		40	46.73	23.38	23.35	25	0.934
		50	46.49	23.38	23.11	25	0.9244
		60	45.61	23.38	22.23	25	0.8892
		70	45.56	23.38	22.18	25	0.8872
		80	45.21	23.38	21.83	25	0.8732
		90	45.17	23.38	21.79	25	0.8716
	20:20:10	30	44.28	19.8	24.48	25	0.9792
		40	44.21	19.8	24.41	25	0.9764
		50	44.05	19.8	24.25	25	0.97
		60	43.64	19.8	23.84	25	0.9536
		70	43.45	19.8	23.65	25	0.946
		80	43.34	19.8	23.54	25	0.9416
		90	43.09	19.8	23.29	25	0.9316
	30:10:10	30	48.03	23.44	24.59	25	0.9836
		40	47.91	23.44	24.47	25	0.9788
		50	47.77	23.44	24.33	25	0.9732
		60	47.32	23.44	23.88	25	0.9552
		70	47.27	23.44	23.83	25	0.9532
		80	47.16	23.44	23.72	25	0.9488
		90	47.08	23.44	23.64	25	0.9456

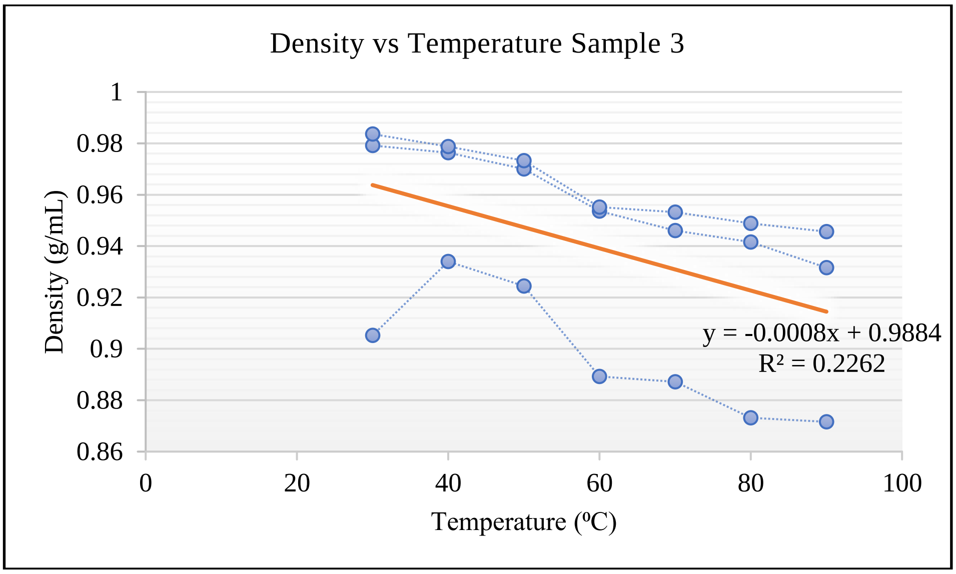


Figure 3.3 Graph of Density vs Temperature in Sample 3

Figure 3.3 shows that all of the mixed compositions of the three samples are below 1 gr/ml and are close to cooking oil fluids. This indicates that the composition will have almost the same properties and shape as cooking oil [27]. In oils derived from canola, corn, olive, peanut, and soybeans will also experience a low density value when given heating [32].

3.2 Density Comparison

From the results of the density test that has been carried out, the researchers made a comparison of the same composition in the samples. Each composition of 10:30:10 mL will be compared to samples 1,2,3, this is done to find out how much influence and density values occur. In Figure 5, you can see a graph of the 10:30:10 composition in samples 1,2,3.

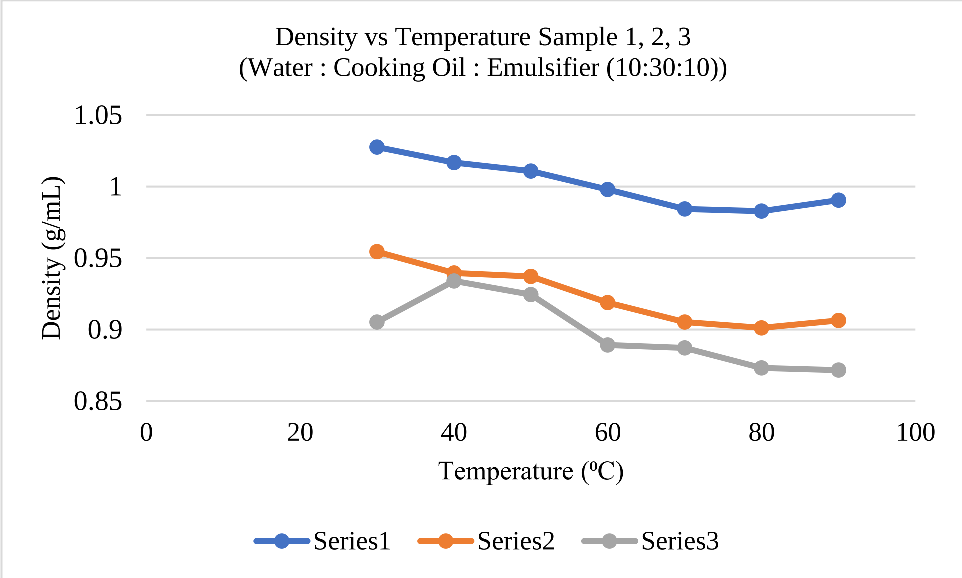


Figure 3.4 Graph of Density vs Temperature Composition 10:30:10 in Samples 1,2,3

In Figure 3.4, the sample 1 graph for this composition shows that the density value is still partially above 1 gr/ml. This shows that the content of this sample is close to the water fluid which is at 1 g/mL. Whereas in samples 2 & 3 it was below 1 g/mL, this indicates that this sample resembles a like cooking oil content.

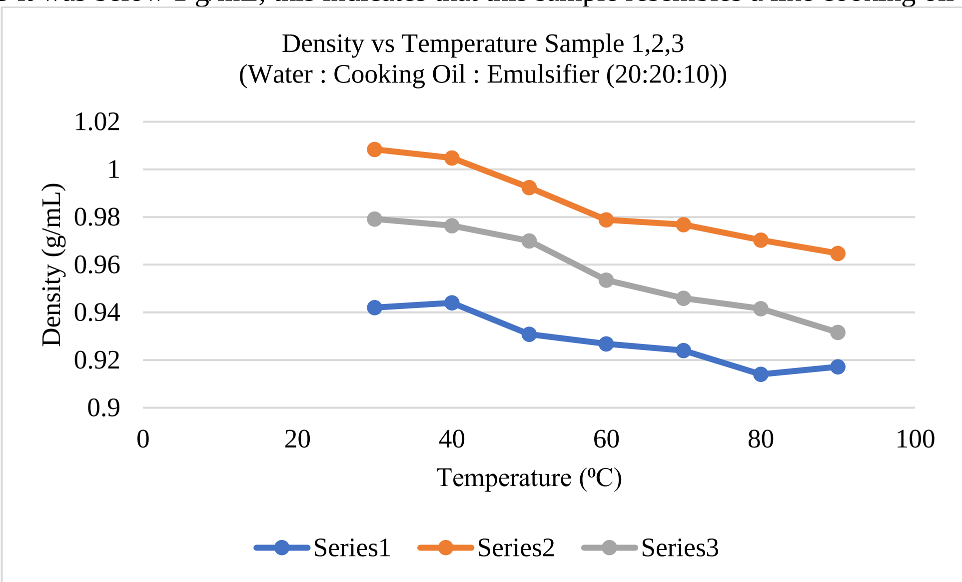


Figure 3.5**.** Graph of Density vs. Composition Temperature 20:20:10 in Samples 1,2,3

Figure 3.5 shows that sample 1 is still above 1 g/mL. For samples 2 & 3, all of them show a value below 1 g/mL, where this fluid is almost like a cooking oil.

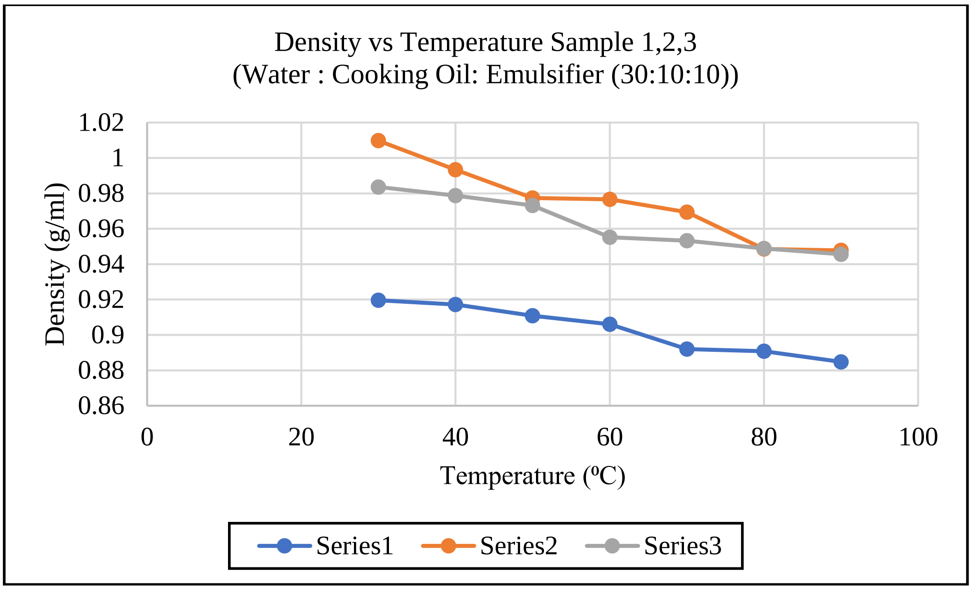


Figure 3.6. Graph of Density vs. Temperature Composition 30:10:10 in Samples 1,2,3

In Figure 3.6, almost all samples 1, 2, and 3 are below 1 g/mL, which almost resembles the condition of cooking oil in general. Where cooking oil in general has a density value in the condition of 1 g/mL [27].

4. Conclusion

Based on the research conducted, it can be concluded that the density value of mixing cooking oil, water, and emulsifier (Tween 20) is generally below 1 gr/ml, which shows almost similar conditions to cooking oil. Cooking oil has the ability to absorb and release heat faster and can be used in the cooling & heating industry.

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