

PROVIDING VEGETABLE STEARIC ACID SUPER V 1895 S FROM HYDROGENATED OF CRUDE VEGETABLE STEARIC ACID HCV 1895 S WITH A SINGLE FRACTIONAL DISTILLATION COLUMN

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Abstract

In 2005 stearic acid V 1895 S is manufactured for 1st time in Indonesia base on the natural vegetable oil, Crude Palm Oil to apply Twin Rivers's demand. One of it specific quality (iodine value 0.15 g/100 g maximum) is very influence to the purifying steps, one of the steps is purifying of hydrogenated crude V 1895 S (HCV 1895 S) feed by a single column of fractional distillation to produce V 1895 S with the lowest possible of it iodine value, lower than the maximum value. The results of application and small adjustments of determination operating conditions of the single column priority based on the feed composition, product composition of V 1895 S and it pressure drop character are compared based on it quality standards. This is the method used in this research to provide V 1895 S and conducted in the plant scale of PT. XXX factory with production yield 88 - 89 % of 0.90mt HCV 1895 S, unsaturated content is lower than 0.15 g/100 g and higher than 98 % w/w C18 purity. In general the specific quality standards of V 1895 S can be met.

Keywords: quality standards, fractionation, composition, unsaturated content, adjustments

1. Introduction

Fatty acid of **V 1895 S** is meansuper fatty acidbased on **natural vegetable oils/fats** with stearic acid $C_{17}H_{35}COOH$ or C_{18} composition is minimum 95 % w/w. It has been never manufactured at all, although oleo chemical industry had been growth in Indonesia in the period 1989-2004. This fatty acid had been produced in America and Europe to consume for: one of the consumption as the raw material of the cosmetic manufacturing that have the lowest skin effect, for example to manufacture the **premium** shampoo **Pantene**. This stearic acid has very low unsaturated content. Since the beginning of the year 2005, South East Asia's begun to see as a V 1895 S producer. In October 2005 **Twin Rivers** as a **buyer** gave an idea, a standard quality that had to be followed and produce it according to the process sequences which were determined and do by PT. XXX alone (Figure 1), a company that had been exist in operation in oleo chemical industry, since the last of the year 1998. Quality of V 1895 S produced had to meet the quality standard which is shown in Table 2 below (settled by **Twin Rivers**). The same quality standard which was produced in America and Europe by the method was

different at all. This was because of the different raw material and the used technology.

In this research is used a natural vegetable oil, Crude Palm Oil (CPO) as raw material for the manufacturing and refining of stearic acid super V 1895 S as shown in Figure 1 below. Manufacturing and refining technique of CPO to produce stearic acid super V 1895 S (Figure 1) is so different compare to the general alternative manufacturing and refining technique of fatty acid in Figure 2 below [12]. Figure 2 is modified to be Figure 1 to produce V 1895 S to apply Twin Rivers's demand with the lowest possible it unsaturated content, as the first technique in the world. Refining of raw material on left side of Figure 1 and Figure 2 can be done by degumming only and/or combined together with bleaching and or deodorization process alternatively according to raw material used, product quality have to be met and equipment capability. Refining of fatty acid on the left side of the both figures can be proceed through distillation and/or combined with fractional distillation alternatively, again it's very depend on the

raw material specs, product quality have to be met and present equipment capability.

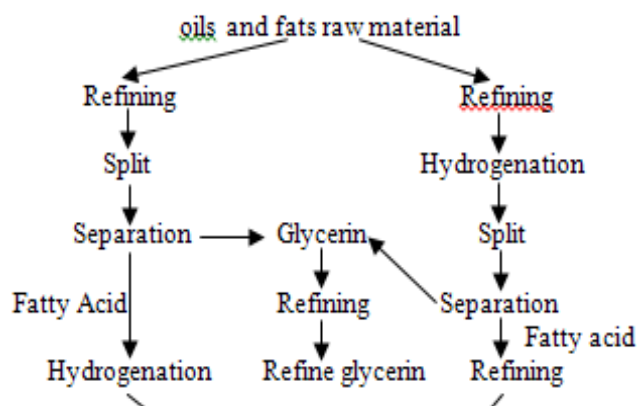
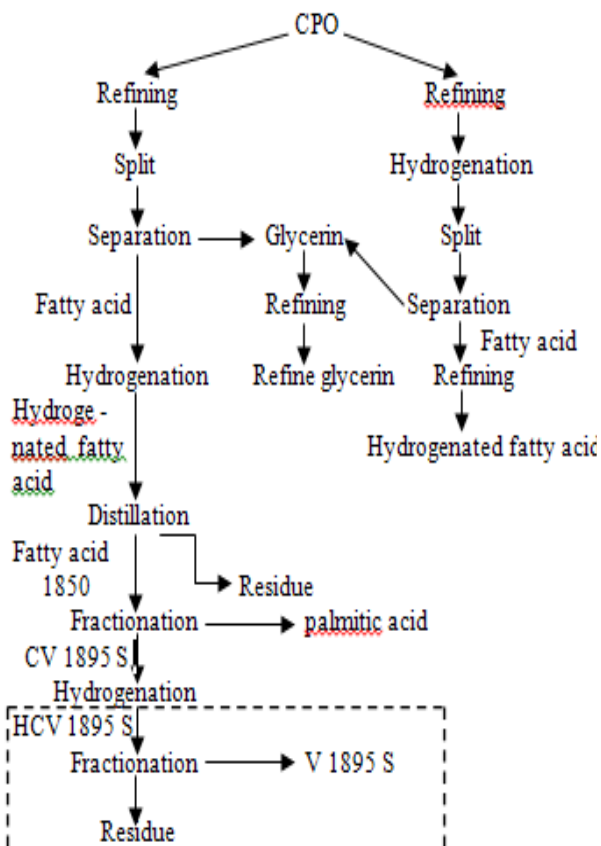


Figure 2. General alternative of fatty acid refining steps

Palm oil is one of the source of stearic acid (C₁₇H₃₄COOH) or C₁₈ also as a source of unsaturated fatty acid oleic acid (C₁₇H₃₃COOH) or C₁₈₋₁ and linoleic acid (C₁₇H₃₂COOH) or C₁₈₋₂ that could be hydrogenated to be stearic acid as also stated by [7][10][15] till the total amount of C₁₈ is **around** 50 % w/w. See the raw material quality CPO that used in this study. The fatty acid distillate which is obtained of splittedCPO is called fatty acid 1850[7]. Crude Palm Oil has the highest C₁₈ content than the others natural vegetable oils such as: crude palm kernel oil and coconut oil. This's the reason the raw material CPO is used in this research.

Table 1. The specific quality of CPO to provide V 1895 S

Raw material	AV	SV	H2O	C12	C14	C16	C18	C18-1	C18-2	C20	Unk
CPO	2.6	201.2	0.29	0.1	1.1	43.5	4.4	39.4	10.3	0.4	0.8

source: Flora Sawita Chemindo, 2005

Note: AV = acid value; SV = saponification value; Unk = unknown component/material

Refining steps that are started from CPO refinery till distillation step in Figure 1 above are intended to separate the impurities of CPO (gum, trace metals), reduce of ; pigments, odors, short carbon chain of C6 till C14 fatty acid (as the experience CPO contain trace C6-10 in the light end product of distillation process),

Fractional distillation

In this manuscript is discussed priority the results of this study in the end step of the refining Hydrogenated Crude V 1895 S (HCV 1895 S) to produce stearic acid super V 1895 S through a single fractional distillation column in Figure 3 which is equipped a packed of structured packing and falling film reboiler [6]. The using this column will be obtained the better saving of

aldehydes, ketones, iodine value (through hydrogenation and distillation) to provide of fatty acid feed quality (HCV 1895 S in Table 2 below) that refined in the end step, in a single fractional distillation column (Figure 1). Each step affect to the each others, agreed also by the researcher [8].

energy consumption, equipment, operating cost, flexible and product quality compared to the using of two fractional distillation columns that utilized trays and live steam (Figure 4) [13]. This technology in Figure 4 was mostly used in Indonesia since 1989, in oleo chemical industries.

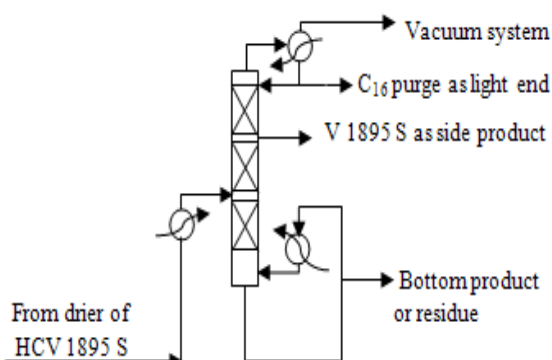


Figure 3. The refining of HCV 1895 S by a single fractional distillation column

Please compare this new technology in Figure 3 above with the old one in Figure 4 below. Refining of blended fatty acid that content of at least two main fatty acid components was usually used two fractionation columns. The 1st column is used to separate light end and 2nd column is used to separate the top product with bottom product. Light end contain any substances or impurities which have the lower boiling point than boiling point of the main product in 2nd column (the side or bottom product). The bottom product has the higher boiling point than the boiling point of the side product in the same column. Separation of the light end in 1st column and bottom product in 2nd column affect much better to the main products quality.

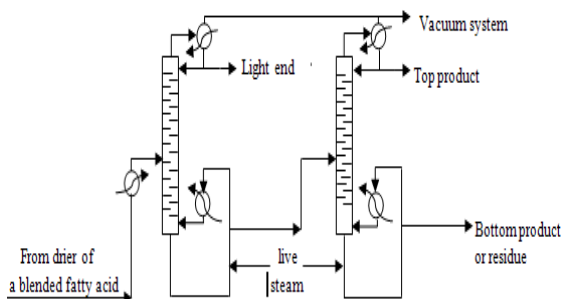


Figure 4. The refining of blended fatty acid through 2 fractionation columns

Table 3. Quality of feed HCV 1895 S

Material (%)	C14	C16	C18	C18-1	C20	Unk	Remarks	Quality status	Status
HCV 1895 S	-	0,76	98,06	0,23	0,92	0,23	C18-1 > 0,15	off specs	Feed

Source : Flora Sawita Chemindo, 2005

Unsaturated content of HCV 1895 S is higher than the maximum standard (see Table 3 above), because of it value is over than 0.15 %. So it has to be reduced till meet the standard. Reduction of C₁₈₋₁ amount in C₁₈ is also decrease of arachidic acid (C₂₀) composition and the others impurities that have the same or higher than

Vacuum pressure fractional distillation is applied in this study as done for distillation because of fatty acid included unsaturated bond inside are so sensitive for oxidation [13][14] (which is so influence into the bed of fatty acid color and odor). This is also according to the researchers [1-3][9]. Unsaturated bond in fatty acid is more sensitive. If unsaturated bond is higher in fatty acid, it's easier to oxidize [10]. Prevention of fatty acid oxidation means to prevent the increment of fatty acid iodine value or unsaturated content, colors and odors. It means also control closely fatty acid quality which is made. In this research was V 1895 S quality. A researcher explained in his dissertation: reduction of bottom temperature of column can reduce stearic acid iodine value or unsaturated content or vice versa [18].

Fractional distillation is shown in Figure 3 above is intended to reduce unsaturated content of stearic acid C₁₈. Separation of oleic acid C₁₈₋₁ in the residue of single fractional distillation column will reduce oleic acid (C₁₈₋₁) content in stearic acid C₁₈ as a side product. It means the lower color and odors in stearic acid C₁₈ or V 1895 S. Reduction of fatty acid iodine value, color and odors is not only can be done by hydrogenation priority, but can be done also through fractional distillation process to achieve the lower point. How it can be done?

Table 2. Quality standard of stearic acid super V 1895 S

1	Fatty acid composition, (% w/w)	Quality range
	< C14	0,5 maximum
	C16	10.0 maximum
	C16-1	-
	C17	-
	C18	90.0 minimum
	C18-1	-
	C18-2	-
	C20	0,44 maximum
	C20-1	-
2	Total unsaturated, % w/w	0,15 maximum

Source : Flora Sawita Chemindo, 2005

stearic acid C₁₈ boiling point which is so positive influence to the V 1895 S iodine value, unsaturated content, color and odors, to be lower. This will be influence to the lower production yield of V 1895 S absolutely, but hopefully with the better quality V 1895

S than HCV 1895 S will be achieved. The above question is answered.

Operating conditions of single fractional distillation column has to be determined and predict carefully before by Roul't's Law [5][16]. Oleic acid content C_{18-1} had to be a main consideration in this study. It is so sensitive to the oxidation and heating. Increment of unsaturated content or iodine value should be protected, should be lower in V 1895 S. The prediction of the single fractional distillation column operating conditions is done base on the capacity and column characters (the pressure drop on the top, bottom and feed tray location of the column), feed composition HCV 1895 S, product composition of V 1895 S and residue product composition is predicted. Actual application of this prediction will change a little bit depend on the actual product quality is made. The

2. Method

Semi trial and error method is used in this research. Operating conditions are determined, predict first and apply to meet V 1895 S specs. The changing is done according to the actual results V 1895 S is obtained, based on it quality standard (priority it composition,

changing have to be predicted and make better compared to the quality standard. The understanding of fractional distillation, physical and chemical properties of the substance, experience in this process and filling heart have the big contribution to do the changing of the operating conditions [11]. The operating conditions are determined and predict 1st for 80% production yield of V 1895 S according to the specs of V 1895 S composition to get *in specs* and the higher reflux rate in the single column, according to C_{18-1} properties that so sensitive to the oxidation and heating. The high reflux rate has to be made as it value is achieved on the actual 80% production yield of V 1895 S or higher, that's limited by V 1895 S composition, unsaturated content, color are achieved on the actual operating conditions are applied, to get the higher yield. What are the suitable conditions?

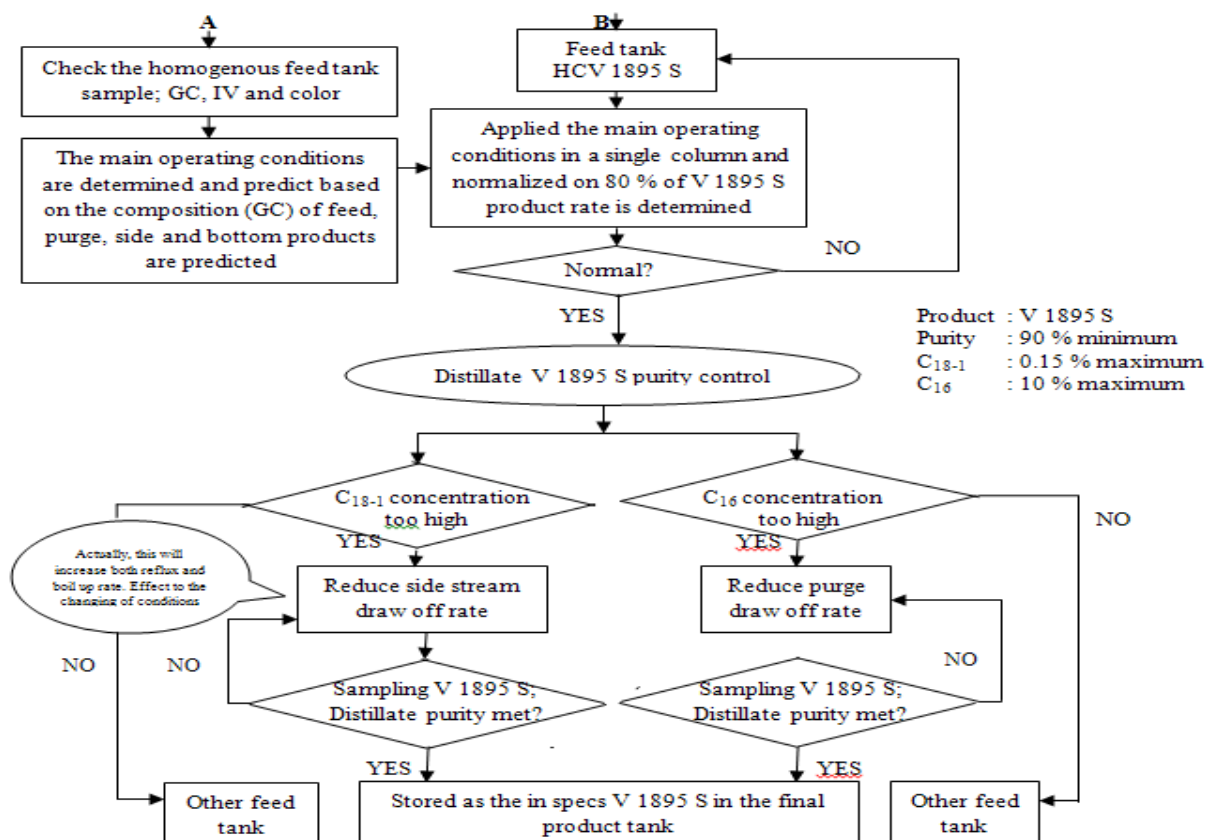


Figure 5. Fractionators' control chart to achieve operating conditions and quality V 1895 S as it standard

3. Results and Discussions

This step is intended to separate stearic acid (C_{18}) super or V 1895 S and fatty acid residue C_{18-20} of the feed HCV 1895 S to reduce unsaturated content of V 1895 S. There is no light end draw off in this study because of color (not shown here), C_{16} and C_{18} of HCV 1895 S is

in specs. The final quality of V 1895 S is shown in Table 4 below. The off specs one V 1895 S in the final storage tank is caused of by production yield increment over than 87 % (see Table 5 and Figure 7 below).

Table 4. Unsaturated content of HCV 1895 S and V 1895 S (%w/w)

Material	C14	C16	C18	C18-1	C20	Unk	Remarks	Quality status	Status
HCV 1895 S	-	0,76	98,06	0,23	0,92	0,23	C18-1 > 0,15	C18-1, C20 are off specs	Feed
V 1895 S	0,09	1,12	98,08	0,19	0,30	0,42	C18-1 > 0,15	C18-1 is off specs	Product

Source : Flora Sawita Chemindo, 2005

The results of this research show that *unsaturated* content in this step came down to be average of **0.19** % (based on Twin River's analysis) or iodine value of V 1895 S came down to be average of **0.12 gr I2/100 g**. Comparison of unsaturated content C18-1 of HCV 1895 S and V 1895 S can be seen in Table 4 above. Actual color of V 1895 S is in specs, but not shown in Table 4 above, discussion is centered to the unsaturated

content **which is off specs**. See in Table 3 and Table 4 above.

The operating conditions are determined and predict, can be seen in Figure 6 below. This prediction is made base on the fatty acid composition only. Please, compare this one with the actual operating conditions in Table 6, in discussion 3.3.

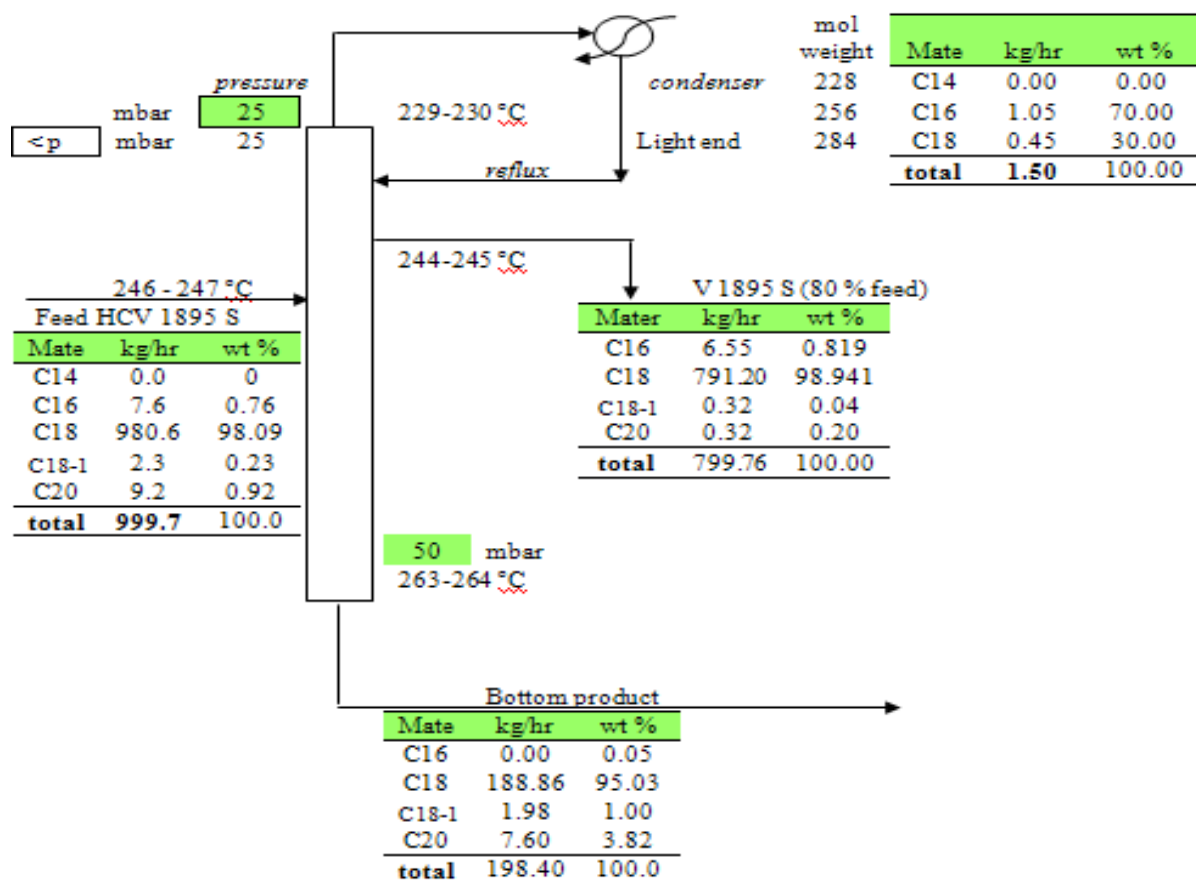


Figure 6. The operating conditions design for the providing of HCV 1895 S by a single fractional distillation column

3.1. How to minimize unsaturated content in V1895 S?

Based on Table 5 and Figure 7 below no doubt at all that C18 purity is over than 95 %, although V 1895 S production yield are (80.0 - 95.0 %). This is caused by C16 feed is lower than 1 % (Table 4 above). If C16 amount in the feed HCV 1895 S is kept as is in V 1895 S feed and **no light end draw off** total reflux in this system/study, C18 purity will not be lower than 90 % w/w. This also affects to the bigger C16

concentration in V 1895 S that can minimize unsaturated (C18-1) content in V 1895 S, the other components too, C20 and unknown (Unk) (in Table 5). The higher S production yield of V 1895 affects to the smaller C16 content and the higher C20 and unknown relatively. It affects to the off-specs unsaturated content in V 1895 S. It can't be allowed. Please, see also both figures, Figure 7 and Figure 8 below.

Table 5. Effect of fractionation production yield into unsaturated content of V 1895 S

Sample -i	C14	C16	C18	C18-1	C20	Unk	IV	Reflux rate, mt/h	Production yield (%)	Remarks
1	0,02	3,67	96,00	0,0	0,0	0,0	0,09	1.5-1.6	80,0	In specs
2	-	0,35	99,43	0,04	0,02	0,16	0,11	1.2-1.3	87,0	In specs
3	-	1,15	97,58	0,36	0,23	0,68	-	0.9-1.0	93,0	Off specs
4	0,39	1,21	97,27	0,38	0,27	0,48	0,12	0.8-0.9	95,0	Off specs

Source : Flora Sawita Chemindo. 2005

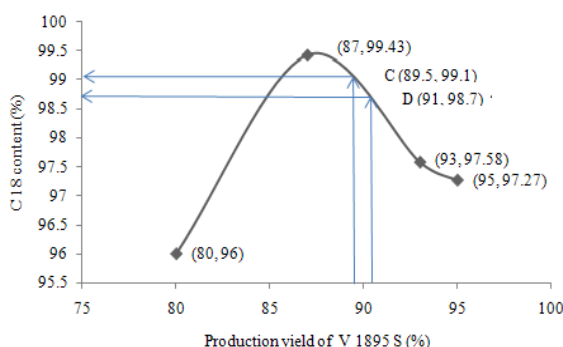


Figure 7. The influence of V 1895 S production yield on C18 purity in V 1895 S

Separation of amount C18 into fatty acid residue (see Figure 5 above) affects to the lower amount of V 1895 S. Reduction of the production yield of V 1895 S. This is caused by C16 amount ratio to the total amount of side product V 1895 S is bigger. Finally, although without light end draw off, color of V 1895 S met the quality standard (not shown in discussion). So the decision not to draw off light end is the exact consideration in the beginning of this study, one technique to minimize the unsaturated content or not reach 0.15 %. The ratio can be changed depending on the changing of V 1895 S production yield. So in this study, reduction of V 1895 S production yield is also another technique to control or reduce unsaturated (C18-1) content as it specs (see Figure 8).

The influence of the reduction of V 1895 S production yield on C18-1 content in V 1895 S and reflux rate in Figure 7 can be used as evidence to support to state; reduction of V 1895 S production yield will reduce unsaturated content in the main product. Reduction of V 1895 S production yield is caused by the increasing of reflux rate which reduced the BT of fractionation column (in Figure 9 at discussion 3.4). The same thing that had been done by a researcher to reduce stearic acid iodine value or unsaturated content in stearic acid distillate; by reducing BT of distillation column [18]. The reduction of BT affects to the reduction of evaporation rate of unsaturated content, reduce it amount into V 1895 S, of course also the other components. This is according to the distillation principles [5][11][17].

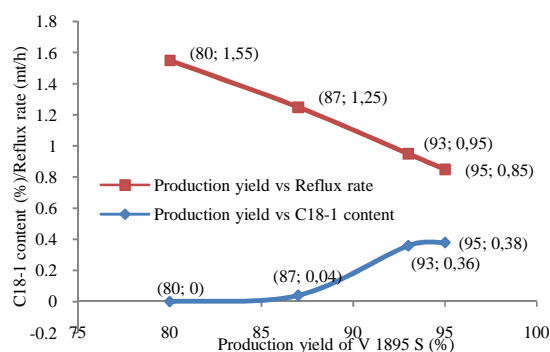


Figure 8. The influence of V 1895 S production yield on C18-1 content in V 1895 S and reflux rate

3.2. Prediction versus actual V 1895 S production yield

Reduction of V 1895S unsaturated content was done in this study. The production yield of V 1895 S is tried first 80 % as the design and prediction of the operating conditions (Figure 5 above). *Reflux rate* is also made so very high in the beginning, on the interval 1500 – 1600 kg/hr. This reflux rate is intended to suppress the evaporation rate of *unsaturated* component as low as possible because of the *boiling point* of unsaturated fatty acid C_{18-1} is lower than C_{18} boiling point [16]. This reflux rate is made also because of the amount of C_{18-1} in the feed HCV 1895 S is so small (0.23 % in Table 4 above), also the other components (Table 4). On the lower reflux rate, it's more difficult to be separated of C_{18} into the bottom product or residue (Figure 5 above). Of course the amount of C_{18} will be bigger in the residue. It's a risk of a high reflux rate. The feed rate is tried first on 1.000 kg/hr. These predictions are made according to the experience in the fatty acid distillation and fractionation in the previous.

The production yield of V 1895 S is then increased slowly (as shown in Table 5 above) after fractional distillation conditions were stable for 80.0 % production yield. This simulation is done for knowing the influence of the increment of V 1895 S on the increment of unsaturated content in V 1895 S. The results within Table 5 proved the prediction above. See also Figure 8 below. The higher possible production yield can be achieved but at the same time unsaturated content is closer to the maximum point of unsaturated content and finally of specs on 91 %, 93 % and 95 % production yield (Table 5 above and Figure 8 below). The in specs one of V 1895 S should be made in this research. How many percent the maximum production yield has to be achieved? How many percent the safest production yield? It has to be met. The trend in this Figure 9 can be used to predict the suitable production yield of V 1895 S to provide

The iodine value and unsaturated content of V 1895 S (in Table 5 above) came up to be higher. This is cause of unsaturated component is evaporated more together with V 1895 S as the impact of the increment of V 1895 S production yield and/or decreasing of reflux rate (see Figure 8 above). The composition of C20 is bigger also, caused of the same reasons. This is according to the distillation principles [5][11][17].

3.3. Actual versus predicted operating conditions

The reduction of V 1895 S production yield mean the top temperature of the fractionation column is adjusted lower. This temperature could be determined and predict practically by Roult's Law but have to be clarified actually through this research. The predicted

The off specs one stearic acid V 1895 S in Table 5 above is sent back the other feed tank as described in Figure 5 above to avoid the higher unsaturated content in the same feed tank and in the next V 1895 S will be produced. Based on data in this table, it is so clear the influence of the higher production yield V 1895 S to the higher it unsaturated content. See Figure 8 below.

Based on this figure, V 1895 S production yield is predicted 89.5 % to achieve 0.15 % **unsaturated content** in V 1895 S (point A). So the safest production yield should be under 89.5 %. Based on this **prediction** V 1895 S production yield should be adjusted to be lower than 89.5 % (see Figure 9 below). It could be 88 % or 89 %. Why it can be happened? It has to be considered strongly the unsaturated content should be achieved first lower than 0.15 %. It is very important to meet the specs first. If the production yield is kept constantly as is (89.5 %), there is a big possibility that V 1895 S will be off specs.

Beside this reason the stability of this process is considered strongly. It is not guaranteed all the instrumentations have the straight line response, according to the experience it's normally has the small fluctuate on the same amplitude.

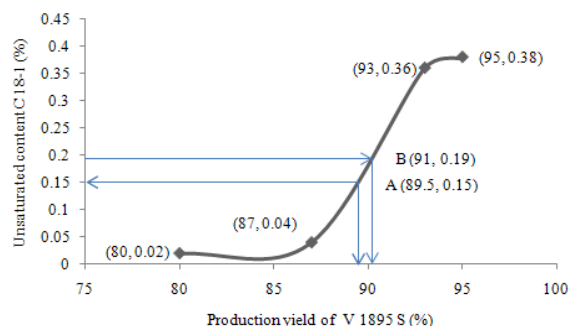


Figure 9. The influence of V 1895 S production yield on unsaturated content in V 1895 S

The **actual average production yield** is achieved **85.0 %**. Why is it different? The production yields in Table 5 are not straight since the increment is done. It is done slowly, step by step. It so logic the actual production yield is lower than the predicted one.

one is used as a main guide and very important to conduct this research. This prediction was limited by unsaturated content or double bond of C_{18-1} in the quality standard. If the consideration was based only of C_{18} purity (see Table 3 above), V 1895 S can be draw

off 98 % or it production yield 98 % as it composition in the feed but actually unsaturated content is off specs when it production yield achieved 93 % and 95 %. So it must be lower because of limited by unsaturated content in the quality standard. It's mean also the actual operating conditions are different with the predicted operating conditions. See Table 6 until Table 9 below.

The average conditions for the production yields 80 %, 87 % and 93 % (Table 6) were the average of the

simulation data on the same yields from Table 7 below. The data for 93 % and 95 % production yield didn't take more because of the conditions were up set already.

The average conditions for the production yields 88 %, 89 % in Table 10 were the average of the simulation data on the same yields from Table 11 below.

Table 6. The actual operating conditions to produce V 1895 S of 1st test

Production yield (%)	TP, mbar	TT, °C	SPTT, °C	FT, °C	BT, °C	RR, mt/h	BP, mbar	Remarks
80.0	19.3	232.8	244.4	237.4	266.6	1.1-1.2	50-54	C8-1 < 0.15 %
87.0	25.8	214.5	243.6	236.8	268.0	1.09-1.1	50-52	C8-1 < 0.15 %
93.0	27.2	203.8	245.1	238.9	274.0	0.85-0.9	50-51	C8-1 > 0.15 %
95.0	25.5	204.5	244.5	238.9	273.8	0.78-0.83	50.0	C8-1 > 0.15 %

Source: *Flora Sawita Chemindo, 2005*

Notes: TP = top pressure; TT = top temperature; SPTT = side product tray temperature; FT = feed temperature; BT = bottom temperature; RR = reflux rate; BP = bottom pressure

Table 7. The actual simulation of the operating conditions to produce V 1895 S of 1st test

Production yield (%)	TP, mbar	TT, °C	SPTT, °C	FT, °C	BT, °C	RR, mt/h	BP, mbar	Remarks
80.0	19.3	232.8	244.4	237.4	266.6	1.1-1.2	50-54	C8-1 < 0.15 %
80.0	19.5	233.0	244.2	237.6	267.0	1.1-1.2	51-54	C8-1 < 0.15 %
80.0	19.1	232.6	244.6	237.2	266.2	1.1-1.19	49-54	C8-1 < 0.15 %
87.0	25.8	214.5	243.6	236.8	268.0	1.09-1.1	50-52	C8-1 < 0.15 %
87.0	25.6	214.7	244.0	237.0	268.4	1.08-1.11	51-52	C8-1 < 0.15 %
87.0	26.0	214.3	243.2	236.6	267.6	1.09-1.1	49-52	C8-1 < 0.15 %
93.0	27.2	203.8	245.1	238.9	274.1	0.84-0.9	50-51	C8-1 > 0.15 %
93.0	27.25	203.7	244.9	238.9	273.9	0.86-0.89	50-51	C8-1 > 0.15 %
95.0	25.5	204.5	244.5	238.9	273.8	0.78-0.83	50-51	C8-1 > 0.15 %

Source: *Flora Sawita Chemindo, 2005*

Note: TP = top pressure; TT = top temperature; SPTT = side product tray temperature; FT = feed temperature; BT = bottom temperature; RR = reflux rate; BP = bottom pressure

The actual operating conditions on 80.0 % production yield has a small different than the predicted one (see Figure 5). The actual suitable prediction of production yield was 89.5 % (discussion 3.2 above). It's so different also than the prediction was done only base on the C18 composition in the feed. Feed temperature can't be reached because of the limitation Oil Thermal Heater system capacity (on 850-900 kgs/hour feed rate), to conduct heating in a heater and a reboiler of fractionation column.

Reducing of TT and SPTT trends that almost constant are according to the simulation of Roul't's Law (not shown here) [5]. SPTT trend as is due to C18 concentration is almost constant around 98 % on the same pressure 27 mbar. Reducing of TT is due to increasing C16 or reducing C18 composition in the

total reflux of light end on the same pressure, around 25 mbar, as affect of V 1895 S **production yield increment or decreasing of total reflux** into the column. This increment is cause of reducing C16 composition in V 1895 S that is added major from light end and also C18 composition increment that is added major from bottom product. This increment is also cause of the increment of BT that is effect to the higher C18 evaporation so it composition is higher at the production yield 87 % (see Figure 8 in the next discussion 3.4). Increment of production yield (priority 93 % and 95 %) is cause of the increment of BT that is so effect to the higher content of C18-1, C20 and unknown components, unsaturated content is off specs (0.36 and 0.38 %). This is also so affect to the lower C18 content in V 1895 S. That is why both the last 2 actual operating conditions in Table 6 can't be applied

on the next test, but the higher yield should be pointed as shown as discussion 3.2, based on Figure 7. The production yield 88 and 89 % are met graphically and

the operating conditions have to be predicted by Roul't's Law, next has to be tested actually, and compared how precise it.

Table 8. The predicted operating conditions to produce V 1895 S of 1st test

Production yield (%)	TP, mbar	TT, °C	SPTT, °C	FT, °C	BT, °C	RR, mt/h	BP, mbar	Remarks
88.0	23.36	217-218	244-245	246-247	263-264	1.08-1.09+	50*	C8-1= 0.12 % < 0.15 % (base on Figure 9 of 1st test)
89.0	23.36	217-218	244-245	246-247	263-264	1.01-1.04+	50*	C8-1= 0.14 % < 0.15 %, (base on Figure 9 of 1st test)

Note: TP = top pressure; TT = top temperature; SPTT = side product tray temperature; FT = feed temperature; BT = bottom temperature ; RR = reflux rate ; BP = bottom pressure ; * base on the highest actual vacuum pressure

Table 9. The predicted of V 1895 S quality on 1st test

Sample -i	C16	C18	C18-1	C20	Unk	IV	Reflux rate, mt/h	Production yield (%)	Remarks
1	0.74	98.80	0,05	0,20	0.21*	-	1.08-1.09+	88,0	In specs
2	0,76	98.67	0,06	0,22	0.30*	-	1.01-1.04+	89,0	In specs

Table 10. The actual operating conditions to produce V 1895 S of 2nd test

Production yield (%)	TP, mbar	TT, °C	SPTT, °C	FT, °C	BT, °C	RR, mt/h	BP, mbar	Remarks
88.0	25.8	214.5	243.6	236.9	268.2	1.09-1.15	50-52	C8-1= 0 < 0.15 % (base on Table 12)
89.0	23.2	229.5	242.7	242.5	265.5	1.03-1.1	50-52	C8-1= 0.02 < 0.15 %, (base on Table 12)

Source: *Flora Sawita Chemindo, 2005*

Note: TP = top pressure ; TT = top temperature; SPTT = side product tray temperature ; FT = feed temperature; BT = bottom temperature; RR = reflux rate ; BP = bottom pressure

Table 11. The actual simulation of the operating conditions to produce V 1895 S of 2nd test

Production yield (%)	TP, mbar	TT, °C	SPTT, °C	FT, °C	BT, °C	RR, mt/h	BP, mbar	Remarks
88.0	25.8	214.5	243.6	236.9	268.2	1.09-1.15	50-52	C8-1= 0 < 0.15 %
88.0	26.0	214.8	244.0	237.0	268.5	1.09-1.16	51-53	C8-1= 0 < 0.15 %
88.0	26.2	214.2	243.8	236.8	267.9	1.09-1.14	49-51	C8-1= 0 < 0.15 %
89.0	23.2	229.5	242.7	242.5	265.5	1.03-1.1	50-52	C8-1= 0.02 < 0.15 %,
89.0	23.3	228.9	242.5	242.3	265.8	1.03-1.1	50-51	C8-1= 0.02 < 0.15 %
89.0	23.1	230.1	242.9	242.7	265.3	1.03-1.1	50-53	C8-1= 0.02 < 0.15 %,

Source; *Flora Sawita Chemindo, 2005*

Note: TP = top pressure; TT = top temperature; SPTT = side product tray temperature; FT = feed temperature; BT = bottom temperature; RR = reflux rate ; BP = bottom pressure

Table 12. The actual V 1895 S quality of 2nd test

Sample -i	C16	C18	C18-1	C20	Unk	IV	Reflux rate, mt/h	Production yield (%)	Remarks
1	1.03	98.49	0,00	0,00	0,48	-	1.09-1.15	88,0	In specs
2	0,79	98.97	0,02	0,02	0,20	0,11	1.03-1.1	89,0	In specs

3.4. Mechanism of the changing of the main temperature in the manufacturing of V 1895 S

The changing of the top, side product tray and bottom temperature versus reflux rate in the single fractionation column (in this research) can be seen in

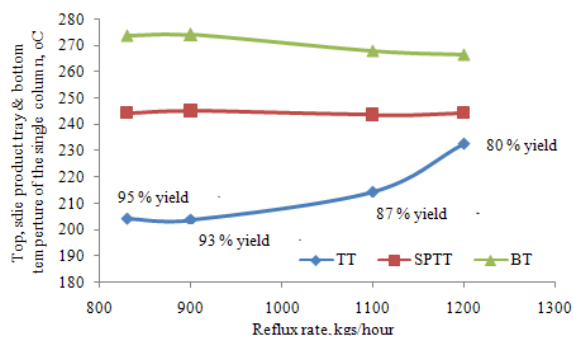


Figure 10. Mechanism of the changing of the main temperature to produce V 1895 S in a single fractionation column

4. Conclusions

Unsaturated content of V 1895 S is higher than 0.15 % due to the production yield of V 1895 S is higher than 90 %.

Based on the actual operating conditions to meet the safest unsaturated content (lower than 0.15 %) in V 1895 S finally is found graphically on 89.5 % V 1895 S production yield. Practically is found 88 - 89 % V 1895 S production yield. The light end has to be total reflux and unsaturated content of V 1895 S is controlled by the adjustment of V 1895 S production yield on the found practical or actual operating conditions

4. Suggestions

It's suggested strongly to improve the OTHS capacity to get the higher FT/capacity and V 1895 S production yield. The increment of FT will be cause of the RR increment that can reduce the lower unsaturated content.

Figure 10 below. The changing temperature above happen while total reflux of light end

in the single fractionation column as Figure 3 above. Reducing of reflux rate or increment of the production yield V 1895 S is cause of the top temperature (TT) decreasing, relatively no changing of the side product tray temperature (SPTT) and the bottom temperature (BT) increment of the single column, on the same heating in the reboiler.

This mechanism is so different with the temperature mechanism of **fatty acid blended** fractional distillation as Figure 4 above. According to the experience practically, the total reflux of light end is cause of TT and BT decreasing in 1st column and the increment of production yield distillate product in 2nd column is cause of TT and BT increment in 2nd column on the same heating in the reboiler. This is according also to the reference [11].

The actual operating conditions are found at TP (23.2 – 25.8 mbar), TT (214.5 - 229.5 °C), SPTT (242.7 – 243.6 °C), FT (236.9 – 242.7 °C), BT (265.5 – 268.2°C), RR (1.03 – 1.15 mt/hour), BP (50 – 52 mbar) and feed rate 850 – 900 kg/hour. It is found base on the predicted operating conditions at TP (23.36 mbar), TT (217 – 218 °C), SPTT (244 -245 °C), FT (246 - 247°C), BT (263 -264°C), RR (1.01 – 1.09 mt/hour), BP (50 mbar) and feed rate 850 – 900 kg/hour.

Feed temperature is actually found lower than the predicted one because of the limitation of the oil thermal heater system (OTHS) capacity.

It's suggested strongly to improve vacuum system capacity so it can be achieved 3 -5 mbar TP in of the single column to improve the total performance of the single column for this special product. The highest vacuum pressure 2 mbar is also stated by [9] to get the better results of fractionation/distillation products.

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Biographies



Muhammad Yusuf. Ritonga was born in Sipirok, Tapsel, North Sumatera province, Indonesia, on August 19, 1962. He studied and graduate in North Sumatera University since S1 degree till obtaining his doctor.

He had being a lecture since 1989 in Chemical Engineering Department, North Sumatera University. He has 20 years of special field experiences on oleo chemical industry since 1989 in troubleshooting, design, control, start up, commissioning; oils and fats pretreatment and splitting, glycerin purification, fatty acid dry fractionation, hydrogenation, distillation and fractionation. His experiences related also to PT. Aribhawana Utama (now called PT. Eco Green as a Fatty

Alcohol and Glycerin Plant) and PT. Flora Sawita Chemindo (as Fatty Acid and Glycerin Plant). He had been done many researches relate to oleo chemical industry ; fatty acid and glycerin products diversification and modification and design and modification of operating condition of the specific process in oleo chemical industry, on the plant scale. He also released many manuscripts on the various science and technical journals relate to fatty acid and glycerin in the terms splitting of various natural oils and fats, hydrogenation, distillation, fractionation and dry fractionation of various fatty acid base on various natural oils and fats. He is the author of book *Distillasi Praktis*. He planned to release two books (had being edited till now on) ; "*Practical Distillation Principles*" and "*Hydrolysis Oils and Fats in Oleo Chemical Industry*".