# Mineral Oil Saturated Hydrocarbon in Crude Palm Oil-Current Status in Sime Darby Palm Oil Mills

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***Abstract*—A pilot study on Mineral Oil Saturated Hydrocarbon (MOSH) status in the Crude Palm Oil (CPO) was conducted. Two Sime Darby Plantation Palm Oil Mills located in East and West of Malaysia respectively were selected for this study. Samples of CPO from production oil and processing lines were collected from the palm oil mills for 6 consecutive weeks. CPO samples were taken from production oil line after vacuum dryer. Processing lines samples were taken at its processing points. All samples were collected by trained personnel. Samples were analyzed using test method based on ISO17780:2015 – Determination of Aliphatic Hydrocarbons in Vegetable Oils Hydrocarbon (as Mineral Oil Saturated Hydrocarbon). Results revealed that mineral oil hydrocarbon in HACCP certified palm oil mill is at the range of 10-17ppm while non-HACCP certified mill has an average 44.81ppm MOSH. In the processing lines, samples were taken from 3 points namely, samples at the vibrating screen, clarifier underflow and decanter light phase for both premium and standard CPO line. Highest MOSH found in clarifier underflow in standard CPO line at 55.53pm. In CPO comparison, premium CPO showed lower MOSH at 10.7ppm compared to standard CPO at 21.9ppm. There is no correlation between oil quality (FFA%) and MOSH level. In conclusion, HACCP certified mill showed lower MOSH even though the mill is producing standard CPO. Comparison between premium and standard CPO showed that premium CPO production oil has lower MOSH compared to standard CPO production oil as well as in the processing parameters as shown in samples taken from vibrating screen, clarifier underflow and decanter light phase.**

***Index Terms*—crude palm oil, mineral oil saturated hydrocarbon, palm oil mill, HACCP**

## I. Introduction

In 2008, sunflower oil contaminated with mineral oil hydrocarbons (MOH) from unknown origin was exported from Ukraine to the European Union (EU) Community [1]. In order to protect public health, the European Commission (EC) has imposed that sunflower oil imported into European Union Community shall not contain more than 50mg/kg (or ppm) mineral paraffin [2]. In 2012, The European Food Safety Authority (EFSA) published an opinion related to MOH [3]. In its opinion, EFSA found that MOH was present at different levels in nearly all foods. Following this, The Federation for European Oil and Proteinmeal Industry (FEDIOL, Belgium) has published a Code of Practice (CoP) in vegetable oils and fats supply chain in 2017 [4]. The FEDIOL CoP and its statement [5] related to mineral oil in vegetable oil and fats indicated that Hazard Analysis Critical Control Point (HACCP) system should have special consideration towards lubricants handling in crushing and refining plants which may accidentally come into contact with oils. In 1950s, mineral oil exposure was linked to wide-spread occurrence of granulomas in human tissues but did not trigger a thorough investigation [6]. MOH are separated in saturated species (MOSH) and compounds including at least one aromatic ring (MOAH). The genotoxicity of MOAH fraction depends on its composition [6]. MOAH of crude oil has genotoxic constituents [7]. As such, Sime Darby Plantation Bhd. through its research arm and sustainability operating unit has worked extensively to ensure that MOSH contamination in Crude Palm Oil (CPO) for food processing is adhering to the good governing. In this research, two palm oil mills were selected to pilot study on mineral oil hydrocarbon status in CPO produced by mills with different practices – HACCP compliance and soon to be HACCP compliance mill. Lab analyses done were on the determination of MOSH at this point of research.

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## II. Materials and Methods

### A. Materials

#### 1) Sample collection

In this pilot study, two palm oil mills were selected which are located in East (POM1) and West (POM2) of Malaysia. Palm Oil Mill 1 (POM1) is HACCP certified since November 2007. This mill is producing standard CPO only. Palm Oil Mill 2 (POM2) is to be HACCP certified by 2020. POM2 is currently producing standard CPO, Premium Quality (PQ) CPO and Special Quality



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(SQ) CPO based on its quality parameters such as Free Fatty Acid (FFA) percentage in CPO.

PQ and SQ CPO are also known as 'premium' CPO. These types of CPO only processed from superior standard crop which is known as crop A and do not include loose fruits in its processing. Loose fruits are palm oil fruit that detached from the fruit bunch. Loose fruits that are collected at the estate will be collected and processed separately from Crop A bunches to maintain the premium oil quality standards. Crop A is usually processed immediately upon reaching the Palm Oil Mill thus minimizing the post harvesting fruit quality deterioration. The difference between PQ and SQ oils is FFA % respectively at 1.2% and 1.5%. Standard CPO consists of normal condition CPO processing which include crop B (overnight palm fruit), and also include loose fruits during a production day. For PQ CPO, SQ CPO and standard CPO, samples were collected at production oil of the day after the vacuum dryer. This point of sampling was selected as it will explain the condition of the processing line which resembled the live post production before piped into storage tanks. Sampling works commenced on weekly basis up to 6 consecutive weeks. In order to relate the production oil with its significant processing line, samples from notable processing points were also collected. The points mentioned were from the vibrating screen where the fibrous material is screened from oil, the clarifier underflow and the decanter light phase. The person performing sampling has taken all necessary precautions to avoid contamination of the sample. The sample collection tools are free from mineral oil contamination [8]. All sampling was done by trained personnel.

*2) Chemicals*

All chemicals used were either of analytical or chromatographic grades purchased from Merck (Darmstadt, Germany) or Fischer Scientific (Loughborough, UK).

### *B. Methods*

*1) Free fatty acid analysis*

Free Fatty Acid (FFA) composition was determined based on the AOCS Official Method Ca5a-40 [9]. The oil (1.0g) is dissolved in an isopropanol solution which was titrated with sodium hydroxide (NaOH). The FFA content was calculated as palmitic acid percentage.

*2) Mineral Oil Saturated Hydrocarbons (MOSH) analysis*

The determination of MOSH is performed by Gas Chromatography with Flame Ionization Detector (GC-FID). A 15m long; 0.32mm internal diameter; 0.1µm film thickness of capillary column with 95% dimethyl: 5% diphenyl polysiloxane are equipped in this analysis. This method is based on the international standard method (ISO) 17780:2015 [8]. As a principle of this method, the saturated hydrocarbon is isolated by liquid chromatography on silica gel impregnated wilh silver nitrate and determined by capillary gas chromatography with flame ionization detection using *n*-octadecane as internal standard. From the chromatogram, the area attributed to mineral oil is calculated by subtracting sharp peaks due to naturally occurred hydrocarbons from the total area including the unresolved complex mixture (UCM) [10].

## III. Results and Discussion

### *A. HACCP Certified Mill vs non-HACCP Certified Mill*

Standard oil obtained from POM1 (HACCP certified since 2007) in 6 consecutive weeks showed lower MOSH at the average of 12.7ppm (Table I) as compared to POM2 (non-HACCP certified) at the average of 44.8ppm. POM1's MOH level at this point is ~74% below the required minimum amount of mineral paraffin level (<50ppm) imposed to sunflower oil imported into the EU [2]. HACCP system that incorporated Good Manufacturing Practice (GMP) specifically in handling of lubricants in POM1 might explained the controlled level of MOSH in their standard oil. This is in lined with Fediol CoP [5] statements that HACCP system should have special consideration towards lubricants handling in vegetable oil plants.

TABLE I. Mineral Oil Saturated Hydrocarbon (MOSH) Level in HACCP Certified and non-HACCP Certified Palm Oil Mill

| Week 1 | MOSH (ppm) | |
|---|---|---|
| | POM1 (HACCP certified mill CPO) | POM2 (Non-HACCP certified mill CPO) |
| 1 | 10.35 | 38.02 |
| 2 | 10.77 | 21.45 |
| 3 | 11.85 | 15.07 |
| 4 | 12.26 | 62.62 |
| 5 | 14.51 | 23.93 |
| 6 | 16.58 | 107.79 |
| Average | 12.72 | 44.81 |

### *B. Premium CPO vs Standard CPO*

Sime Darby Palm Oil Mills are producing premium (PQ & SQ) CPO and standard CPO. Sampling exercise for production oil were segregated into these 2 categories, premium CPO and standard CPO. In palm oil milling, crude oil is extracted by using screw press. The extracted oil that containing oil and fibrous material is then diluted with hot water in order to enhance its fluidity and reduce its viscosity. Reducing its viscosity is crucial for oil recovery during oil clarification process. Prior to the clarification process, the Diluted Crude Oil (DCO) will go through vibrating screen to remove carried over fibrous material, this oily fibrous material will be restreamed to the screw press in order to recover back the oil. In clarification process, oil is recovered through gravitational separation by using vertical clarifier. The clarification happens as oil flows to the top and sludge flows to the bottom. The oil will be skimmed to the Pure Oil Tank and subsequently will undergo purification and dried in vacuum condition to become production oil. Samples from the processing line were taken from the screened fibrous material of vibrating screen at the Pressing Station, clarifier underflow and decanter light

phase at Clarification Station. These points of sampling are ought to be significant to the latter production of the day operation (Fig. 1). Samples were taken for 6 consecutive weeks.

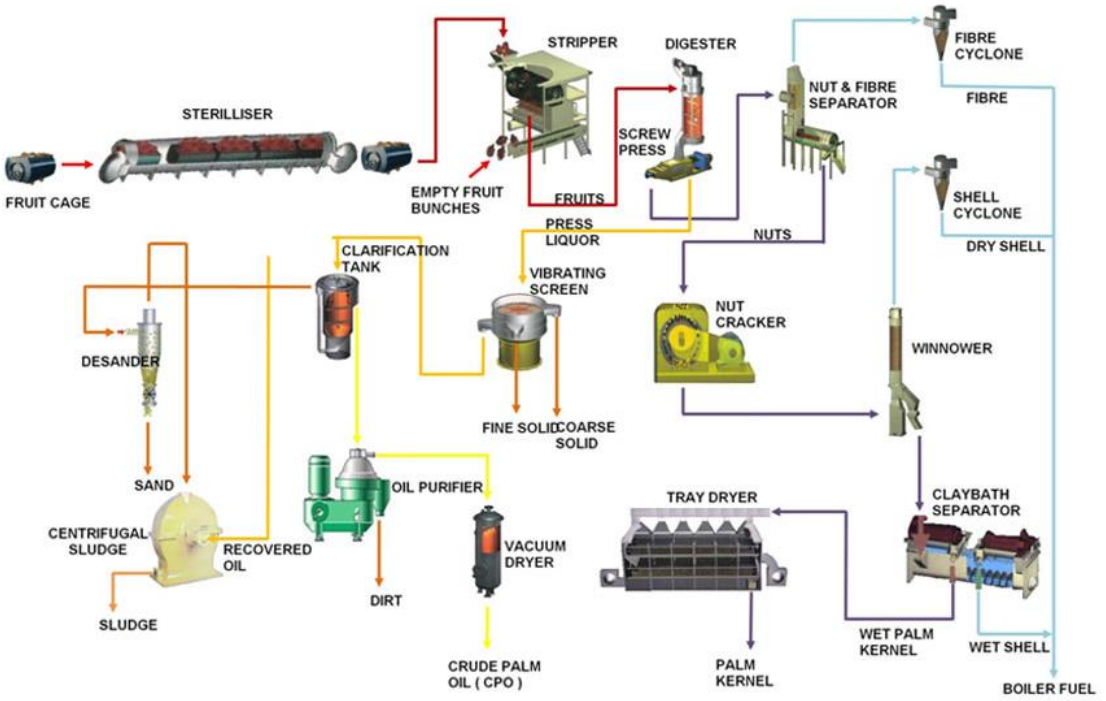


Figure 1. General palm oil milling process.

Result (Table II) showed that premium CPO has lower MOSH level (10.67ppm) compared to standard CPO (21.85ppm). Samples from vibrating screen has 15.61ppm MOSH in premium CPO line and 25.81ppm in standard CPO line. Clarifier underflow in premium CPO line has 9.07ppm MOSH and 55.53ppm in standard CPO line respectively. Finally, decanter light phase 17.4ppm in premium CPO line and 37.4ppm in standard CPO line. This result showed that better handling during mill processing with good governing of GMP during production day helps in lowering MOSH level in the production oil.

TABLE II. MINERAL OIL SATURATED HYDROCARBON (MOSH) LEVEL IN DIFFERENT PROCESSING LINE IN PREMIUM AND STANDARD CPO

| | Premium CPO processing line | Standard CPO processing line |
|---|---|---|
| CPO | 10.67 | 21.85 |
| Vibrating screen | 15.61 | 25.81 |
| Clarifier underflow | 9.07 | 55.53 |
| Light phase | 17.4 | 37.4 |

### C. Correlation FFA vs MOH

FFA% is one of the key parameters in determining CPO quality [11], [12]. At initial stage of this research, we believe that FFA% in CPO may have correlation towards MOSH content in the oil with regards to the palm fruit quality and condition during palm oil processing. For this correlation study, samples were taken randomly for 6 consecutive weeks from other Sime Darby Plantation palm oil mills in Malaysia (9 mills from East and West Malaysia). Samples were PQ Oil, SQ Oil and standard oil. MOSH and FFA analysis were carried out and based from the result (Fig. 2) we have confirmed that there is no correlation ($p<0.05$) between MOSH and FFA (Fig. 2). Therefore, we concluded that CPO quality is not an indicator to MOSH content in the oil.

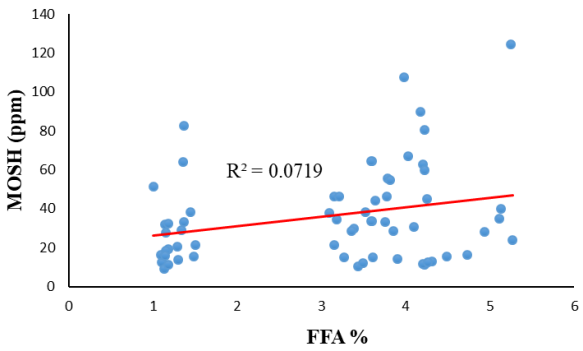


Figure 2. Correlation between MOSH (ppm) level and FFA, % value.

## IV. CONCLUSION

HACCP certified mill demonstrated lower MOSH in the production oil by 71% in average even though producing standard CPO compared to non-HACCP certified mill. This interesting fact showed that good control measures in HACCP system incorporated with Good Manufacturing Practice (GMP) good governance might benefited in controlling MOSH level in the CPO which is needed to be further investigated. Nevertheless, premium CPO showed lower MOSH level in the production of oil compared to standard CPO samples.

The study also concluded that there is no significant correlation between FFA, and MOSH level.

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