JAMA
JAPAN AUTOMOBILE MANUFACTURERS ASSOCIATION, INC.

Items to be considered in establishing to Guidelines of High-FAME Blends

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Japan Automobile Manufacturers Association
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1. Introduction

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- In the 1st APEC WS, the AAF recommendation was proposed to be used as a base specification for a discussion toward high FAME blends (up to B20) guidelines in APEC countries.
- AAF recommendation is established focusing on the market conditions in East-South Asian regions. However, it may not be suitable in the other APEC counties.
- There are several restrictions and conditions in the AAF recommendation in order to be utilized high FAME blends securely and safely. Because automobile manufacturers do not want to see any issues or problems on vehicles in the market.
- It is very important to recognize real world conditions of each country in APEC region and it may need to set the conditions or restrictions in the guideline.

2. Conditions to be Considered

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- Emission Requirements
- Climate Conditions
- Feed Stock
- Base Diesel Fuel

2-1. Emission Requirements (1/2)

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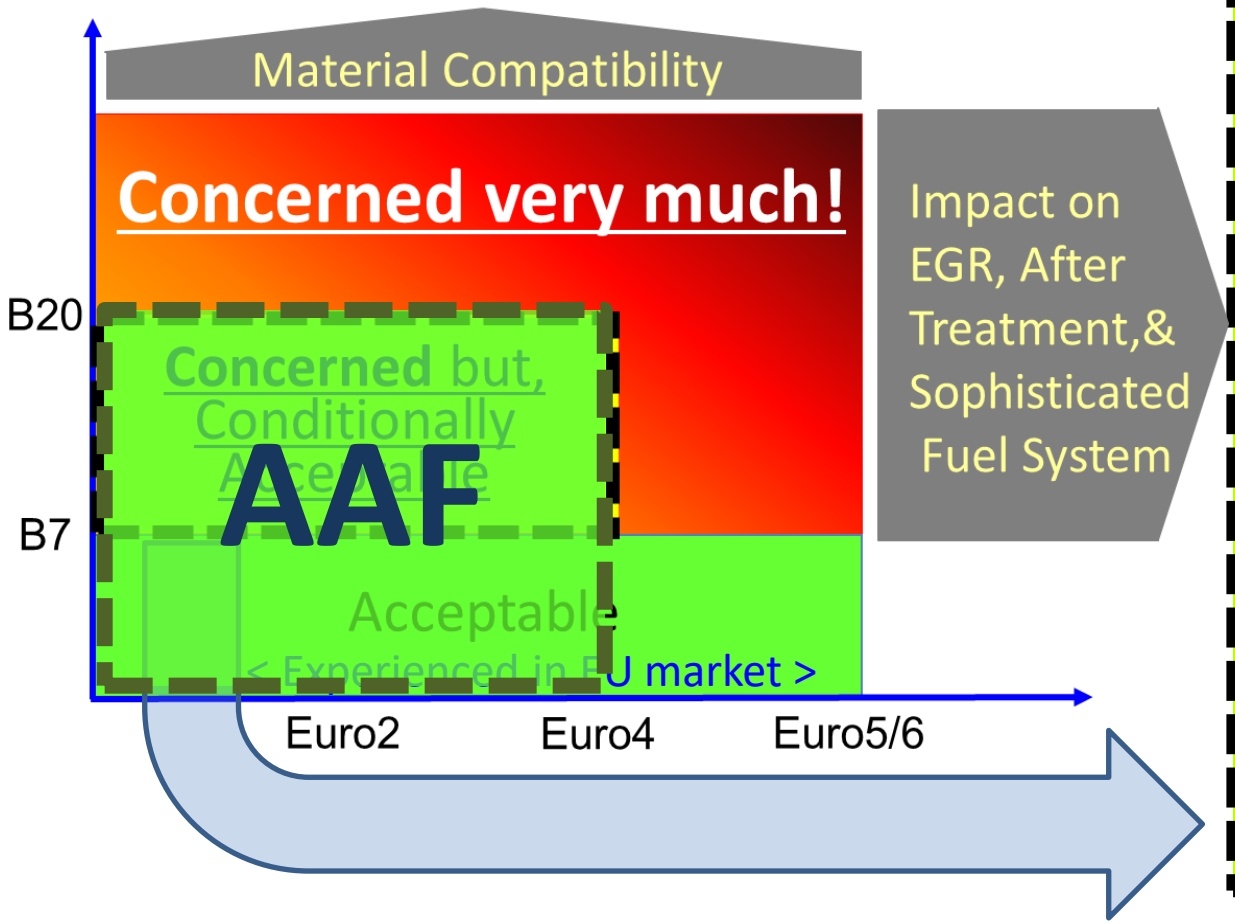
✓ **AAF recommendation is specified the use of up to B20 in the regions implemented Euro 2/3/4 regulations.**



Conditions

"Presupposed Conditions"

- Warm/Hot Climate
- PME
- Up to Euro4/IV emission requirement

"Recommendations"

Measures for….

- Oxidation Stability
- Precipitate
- Solubility

2-1. Emission Requirements (2/2)

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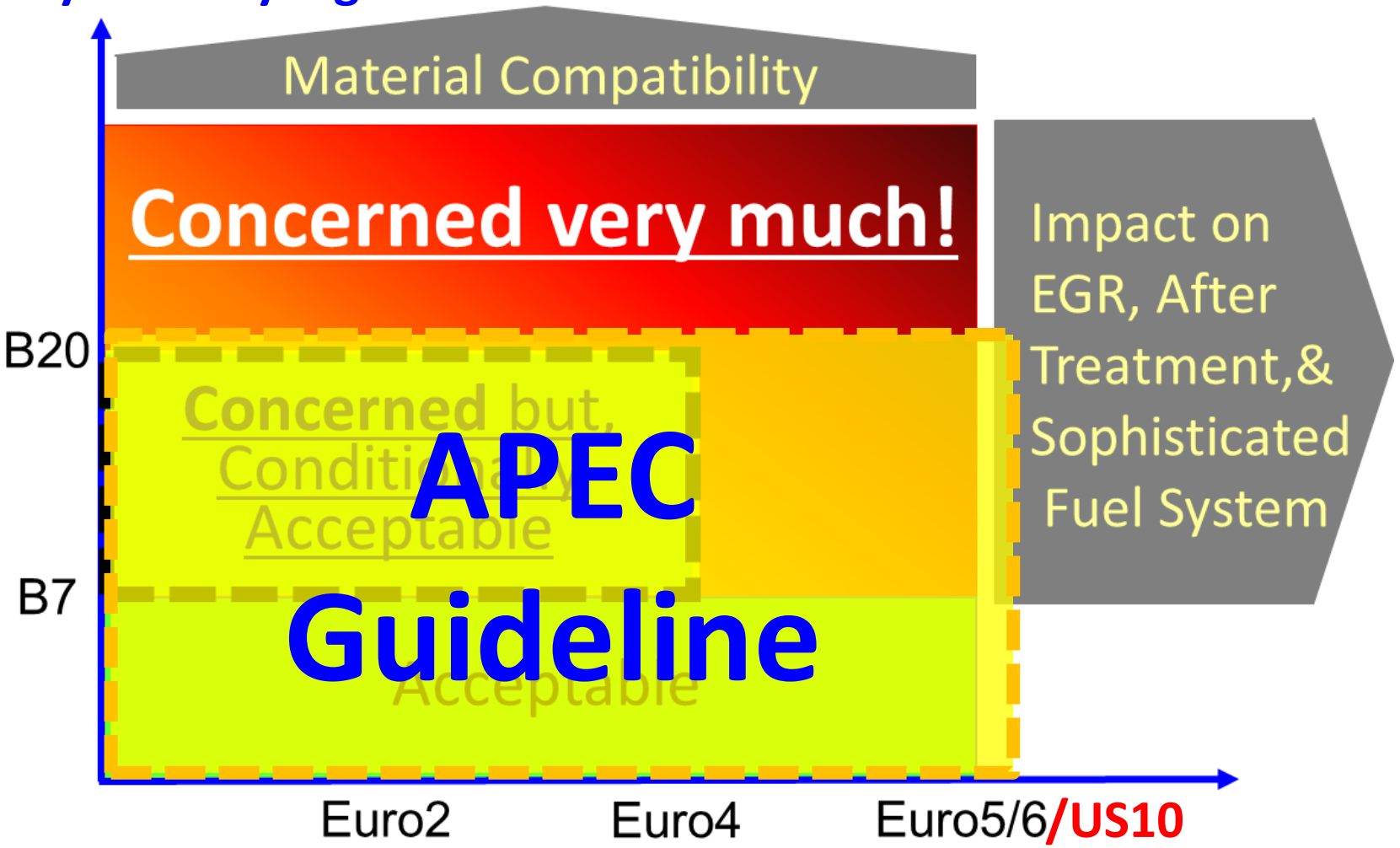
✓ **For vehicles compliant to more stringent emission regulations, need to consider the impact on sophisticated emission control systems by high FAME blends.**



2-2. Climate Conditions

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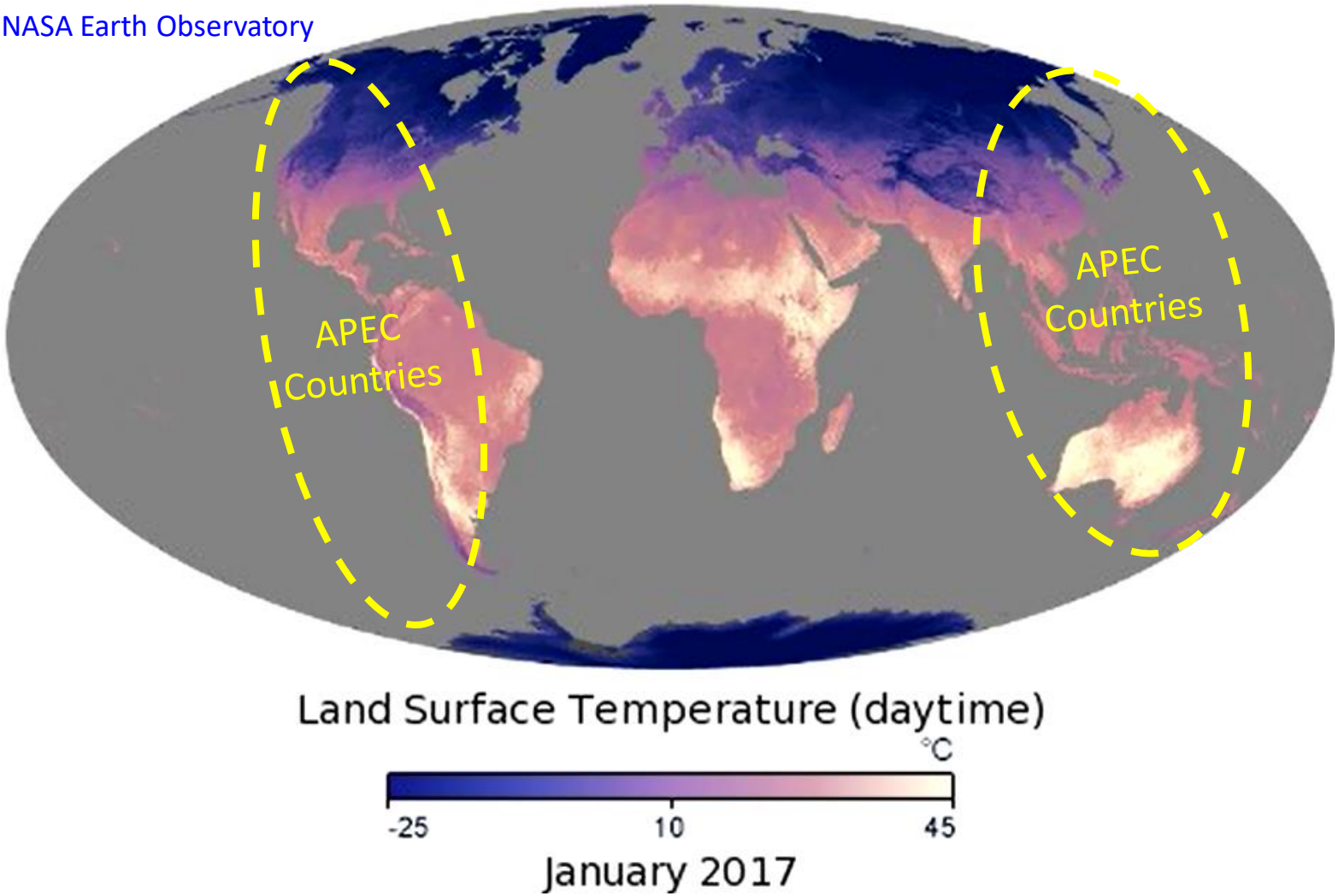
- ✓ **Variation in ambient temperature is large in APEC countries.**
- ✓ **Ambient temperature would be an important factor to determine characteristics of FAME blends in the real world.**

Source: NASA Earth Observatory



2-3. Feed Stock (1/2)

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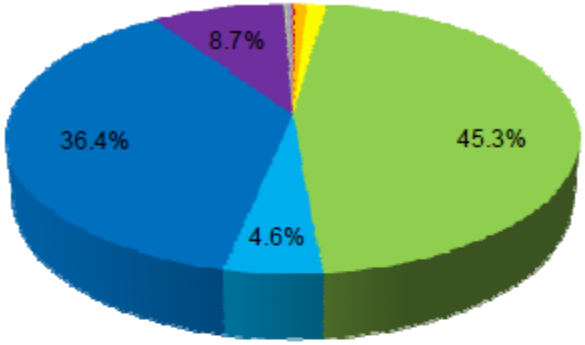
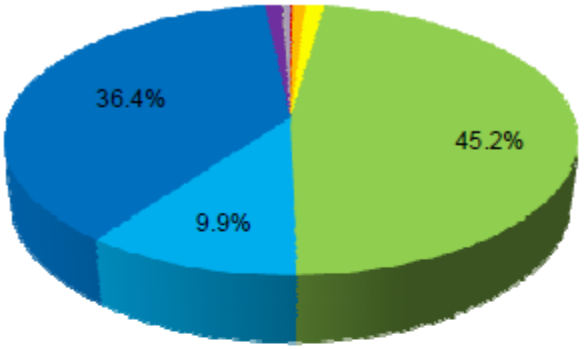
- ✓ **Composition of FAME is vary depending on feed stock.**
- ✓ **Amount of saturated ME and polyunsaturated ME are key components to determine characteristics of FAME.**

Composition of various biodiesel feedstocks

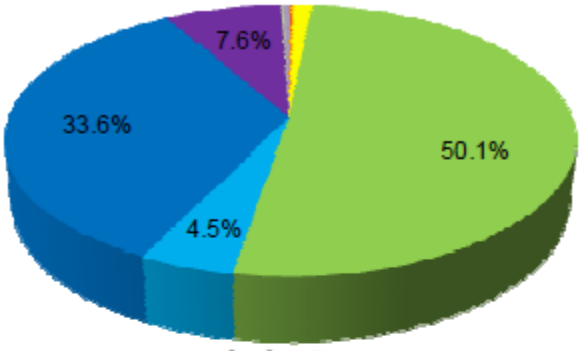
Source：JAMA/JARI report



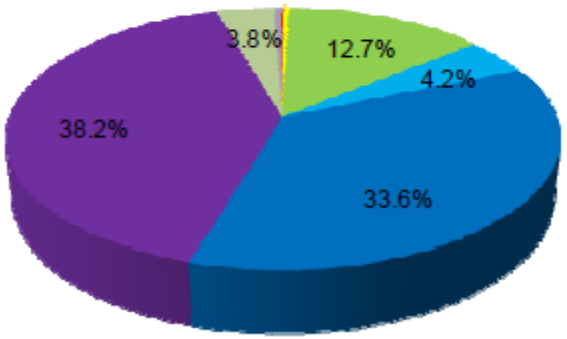
PME: Thailand



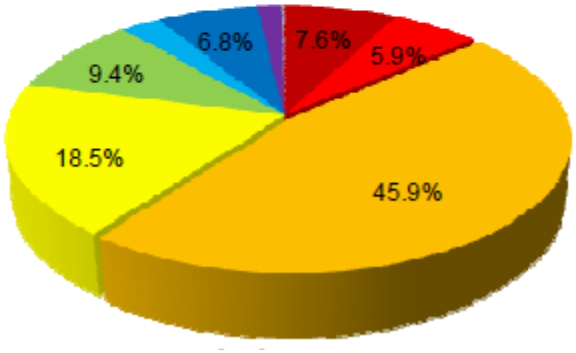
PME (H-FAME): Thailand



PME: Indonesia



SME: USA



CME: Philippines

2-3. Feed Stock (2/2)

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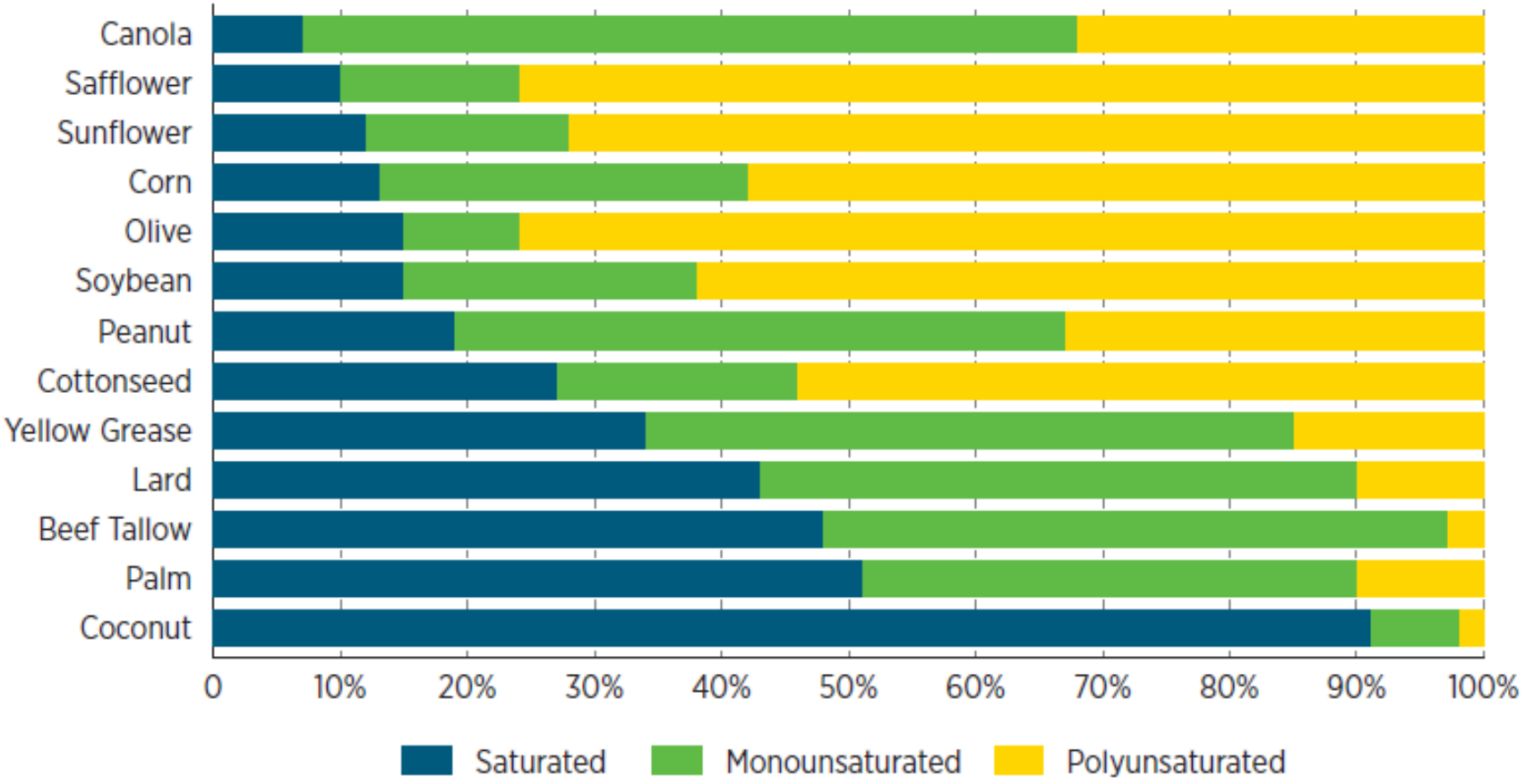
✓ **Various feedstocks are utilized in APEC countries depending on its circumstances.**

Difference in composition by biodiesel feedstocks

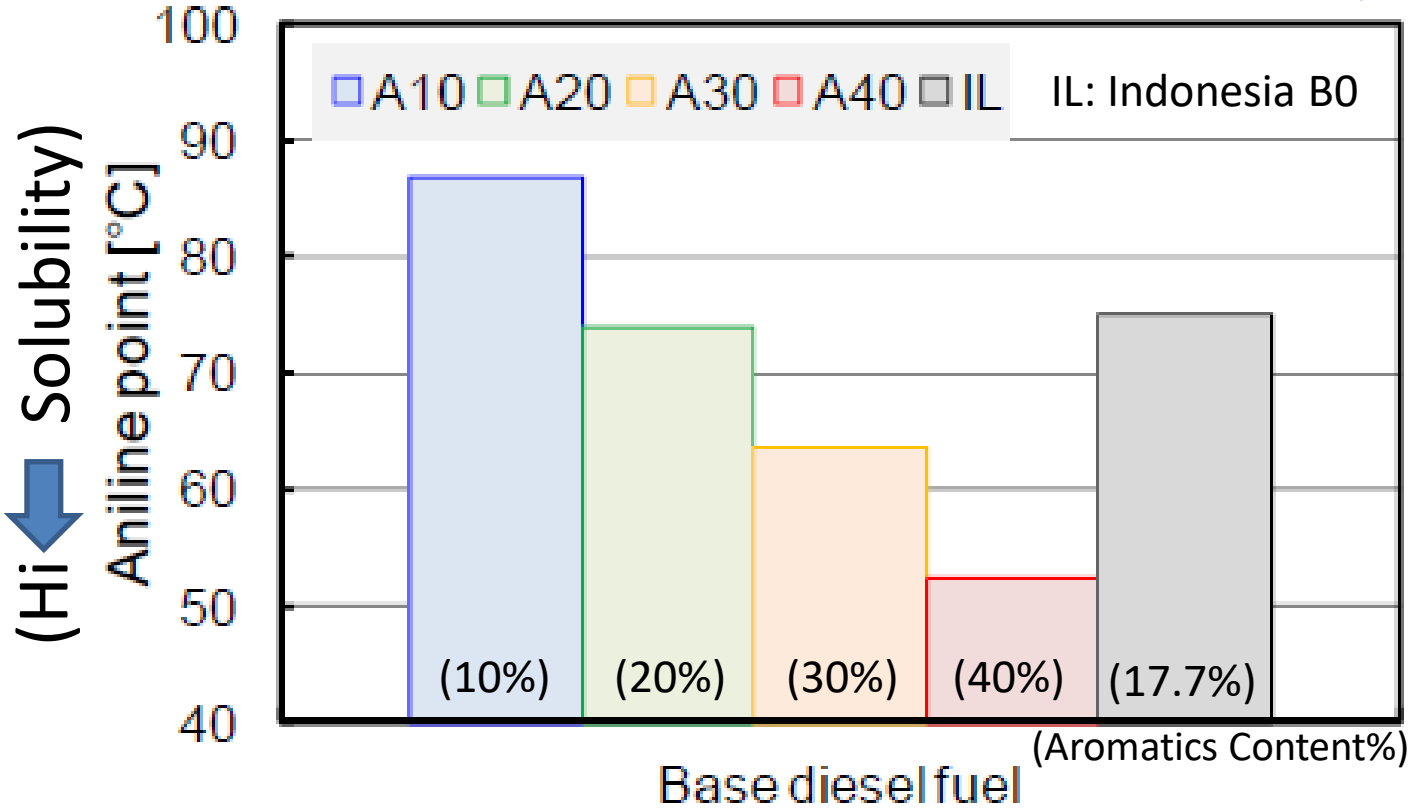


Source：US DOE Biodiesel Handling and Use Guide (5th Edition)

2-4. Base Diesel Fuel

- ✓ **Properties of base diesel are vary and would effect to characteristics of FAME blends.**
- ✓ **Aniline point (Solubility) is changed by content of aromatics in diesel fuels.**

Source：JAMA/JARI report



Aromatics content in Base Diesel >>> A10: 10%, A20: 20%, A30:30%, A40: 40%

3. Properties/Specifications

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These items have to be considered as well……

- **Oxidation Stability**
- **Mono-glyceride Content**
- **Cold Properties: CP/CFPP/FBT**
- **Metallic Content**
- **Others - Uncontrollable Properties**

3-1. Oxidation Stability (1/4)

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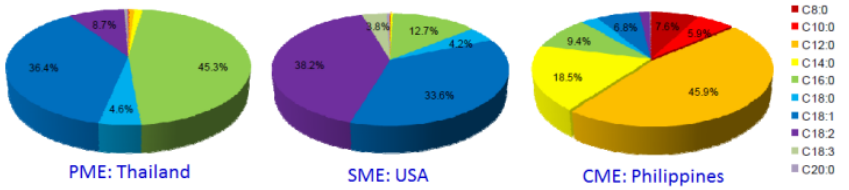
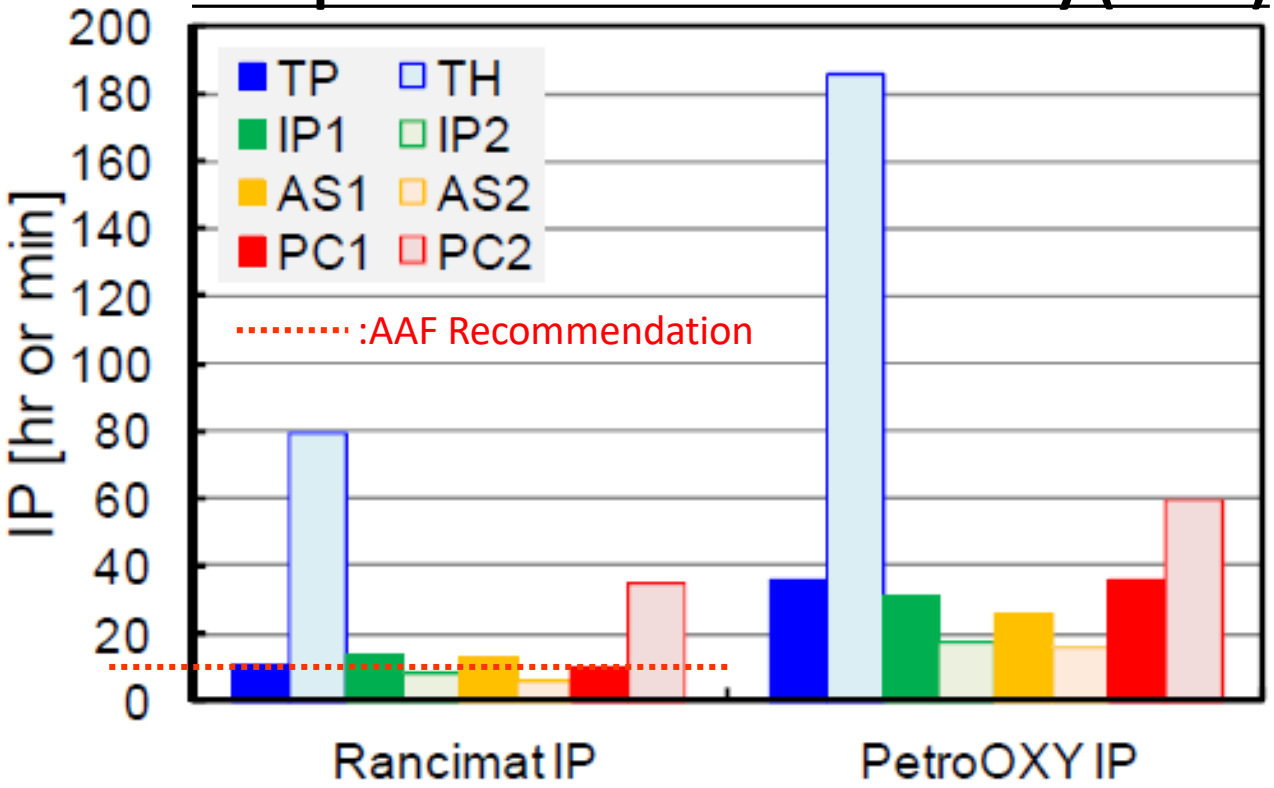
- ✓ **OS is vary based on distribution of composition in feed stocks.**
- ✓ **Generally, feed stocks having polyunsaturated ME are poor in OS.**



Source：*JAMA/JARI report*

Comparison in Oxidation Stability (B100)



	Source	F/Stock	Remarks
TP	Thailand	Palm	PME
TH	Thailand	Palm	H-FAME
IP1	Indonesia	Palm	PME
IP2	Indonesia	Palm	PME
AS1	USA	Soybean	SME
AS2	USA	Soybean	SME
PC1	Philippines	Coconut	CME
PC2	Philippines	Coconut	CME

3-1. Oxidation Stability (2/4)

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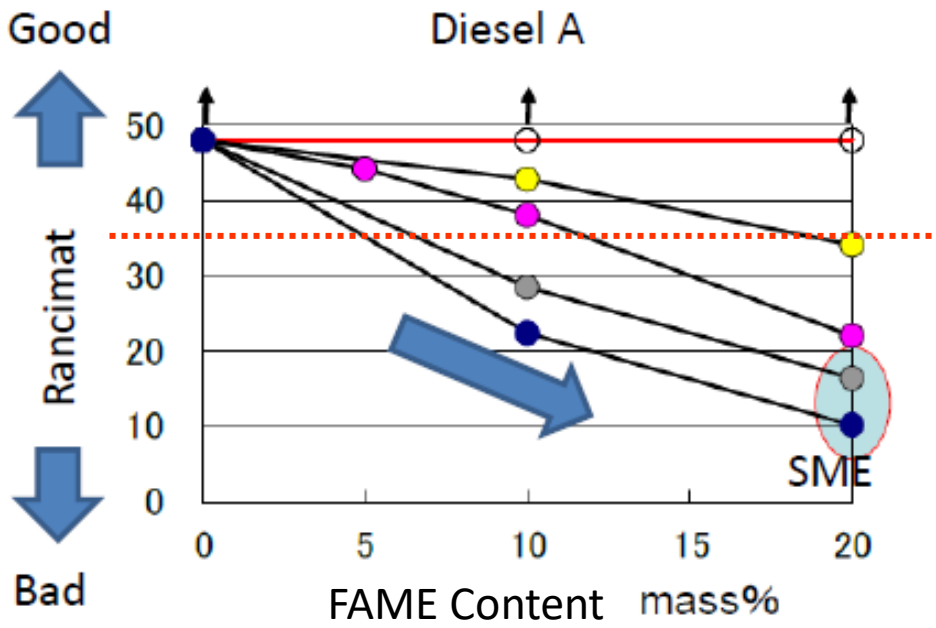
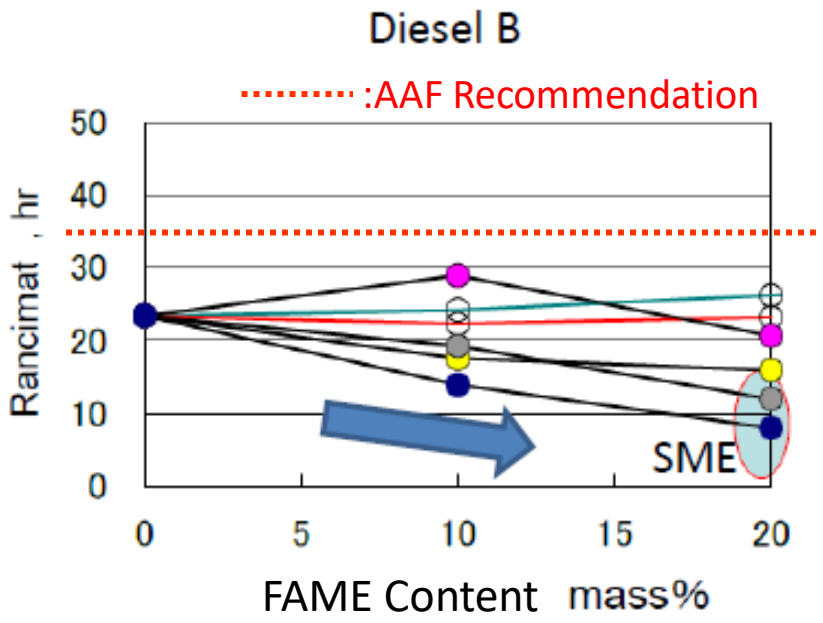
- ✓ **Oxidation stability of FAME blends is getting worse when FAME content is increased.**
- ✓ **Polyunsaturated ME is increased by increasing in FAME content.**





	SME	RME	PME	WME	HBD	FTD
Rancimat IP in B100 ⇨	1.9	6.4	5.0	4.3	>48	31.3

Source：*JATOP*

3-1. Oxidation Stability (3/4)

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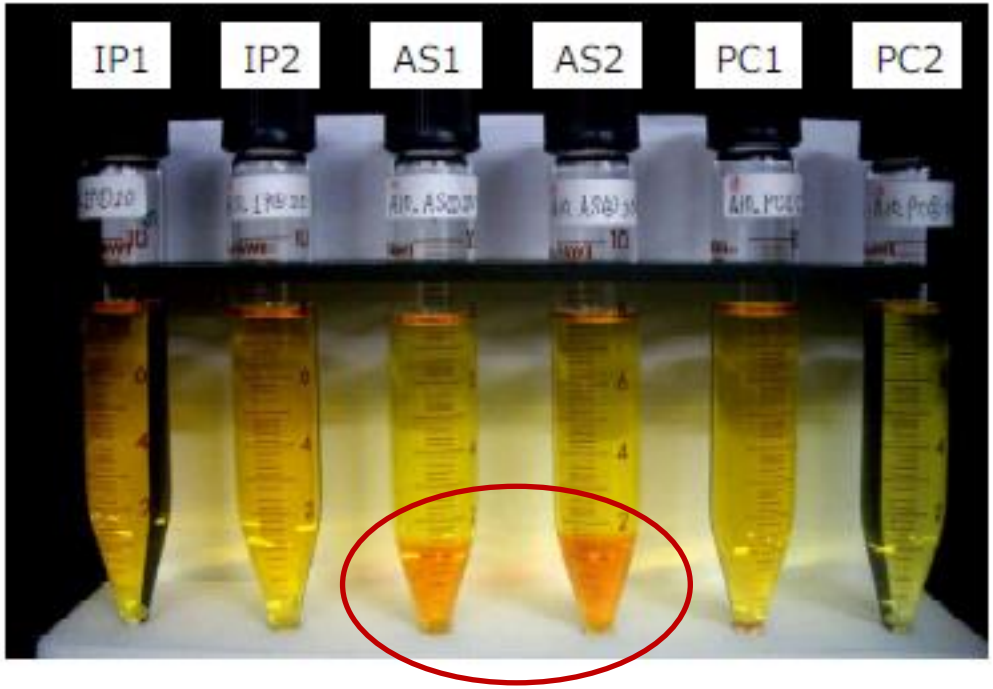
✓ **FAME containing much polyunsaturated ME will be deteriorated very much and generate polymers (sediment).**

Source：*JAMA/JARI report*



	Source	F/Stock	Remarks
IP1	Indonesia	Palm	PME
IP2	Indonesia	Palm	PME
AS1	USA	Soybean	SME
AS2	USA	Soybean	SME
PC1	Philippines	Coconut	CME
PC2	Philippines	Coconut	CME

Conditions for Deterioration:
@ 130 Celsius, for 20 hrs

3-1. Oxidation Stability (4/4)

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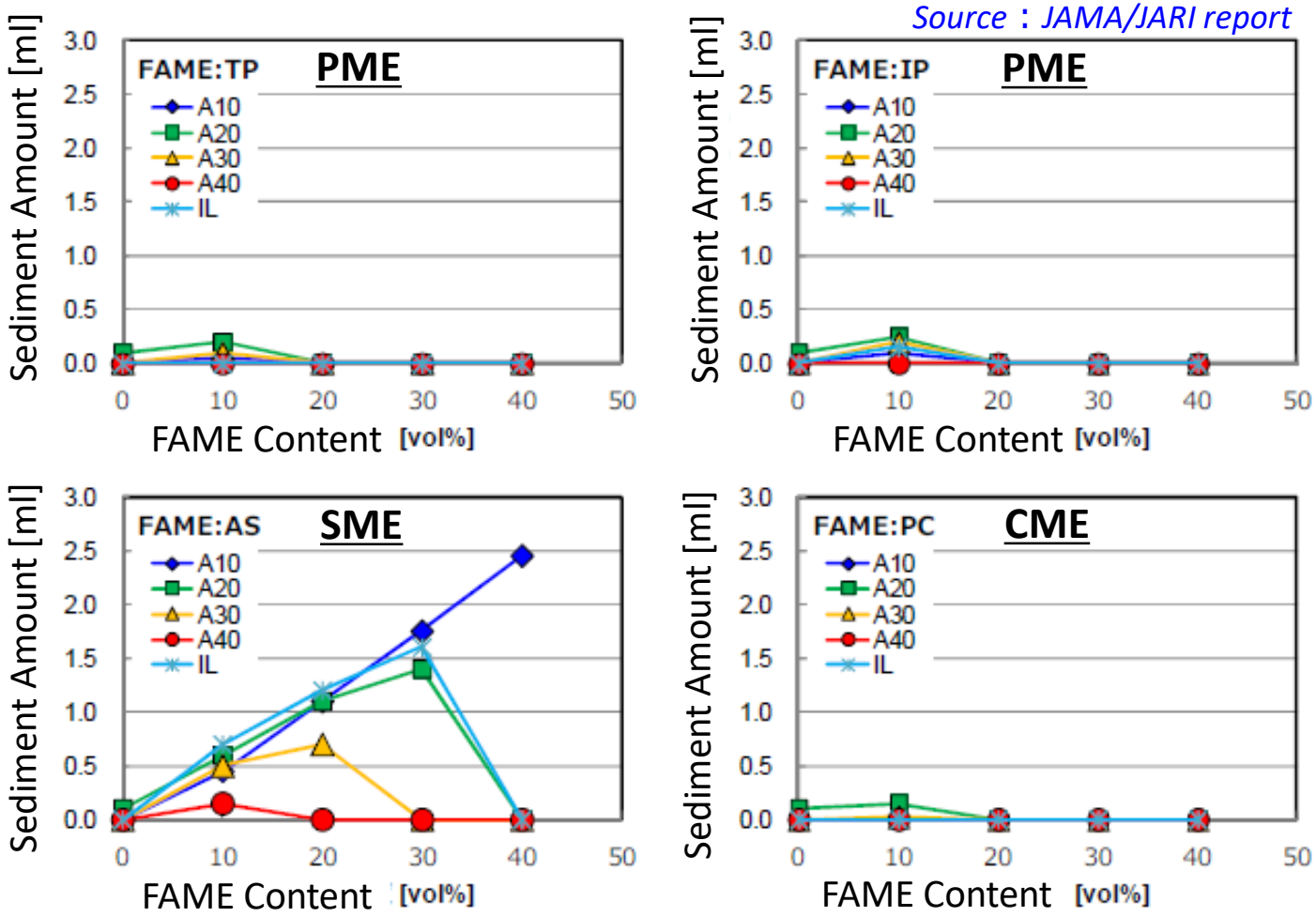
- ✓ **Trend in sediment generation is different by feedstock.**
- ✓ **Aromatics content in diesel effects on sediment generation.**

Source：JAMA/JARI report



Aromatics content in Base Diesel >>> A10: 10%, A20: 20%, A30:30%, A40: 40%

3-2. Mono-glyceride Content (1/5)

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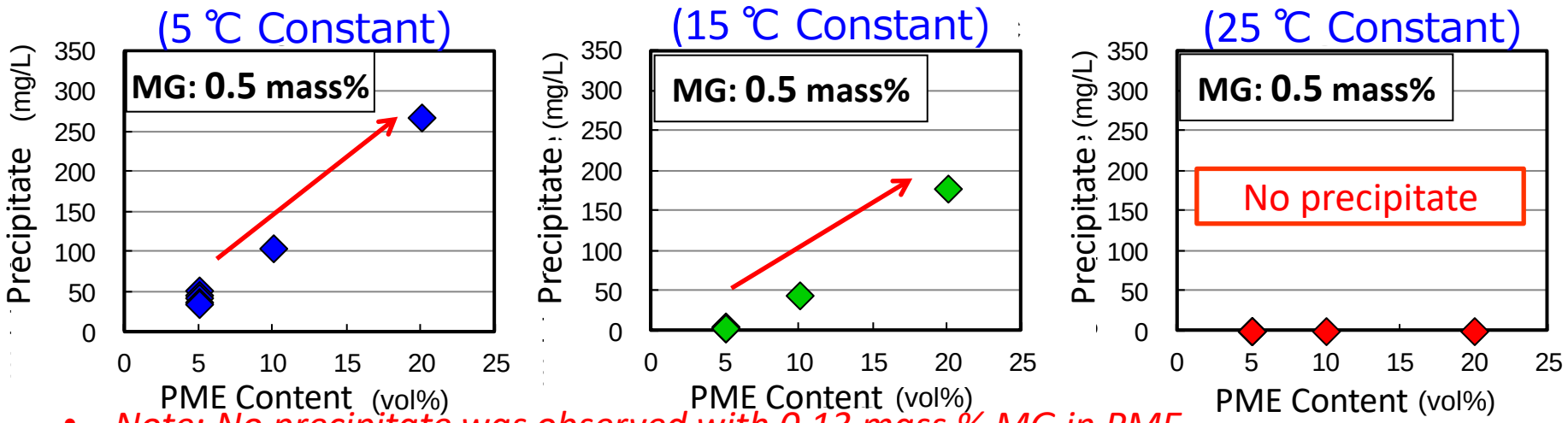
- ✓ **MG in FAME turns to solid from liquid at below room temperature.**
- ✓ **MG Content in B100 has to be specified in considering to the lowest temperature in the real world.**

Source：JAMA/JARI report



- *Note: No precipitate was observed with 0.13 mass % MG in PME.*

3-2. Mono-glyceride Content (2/5)

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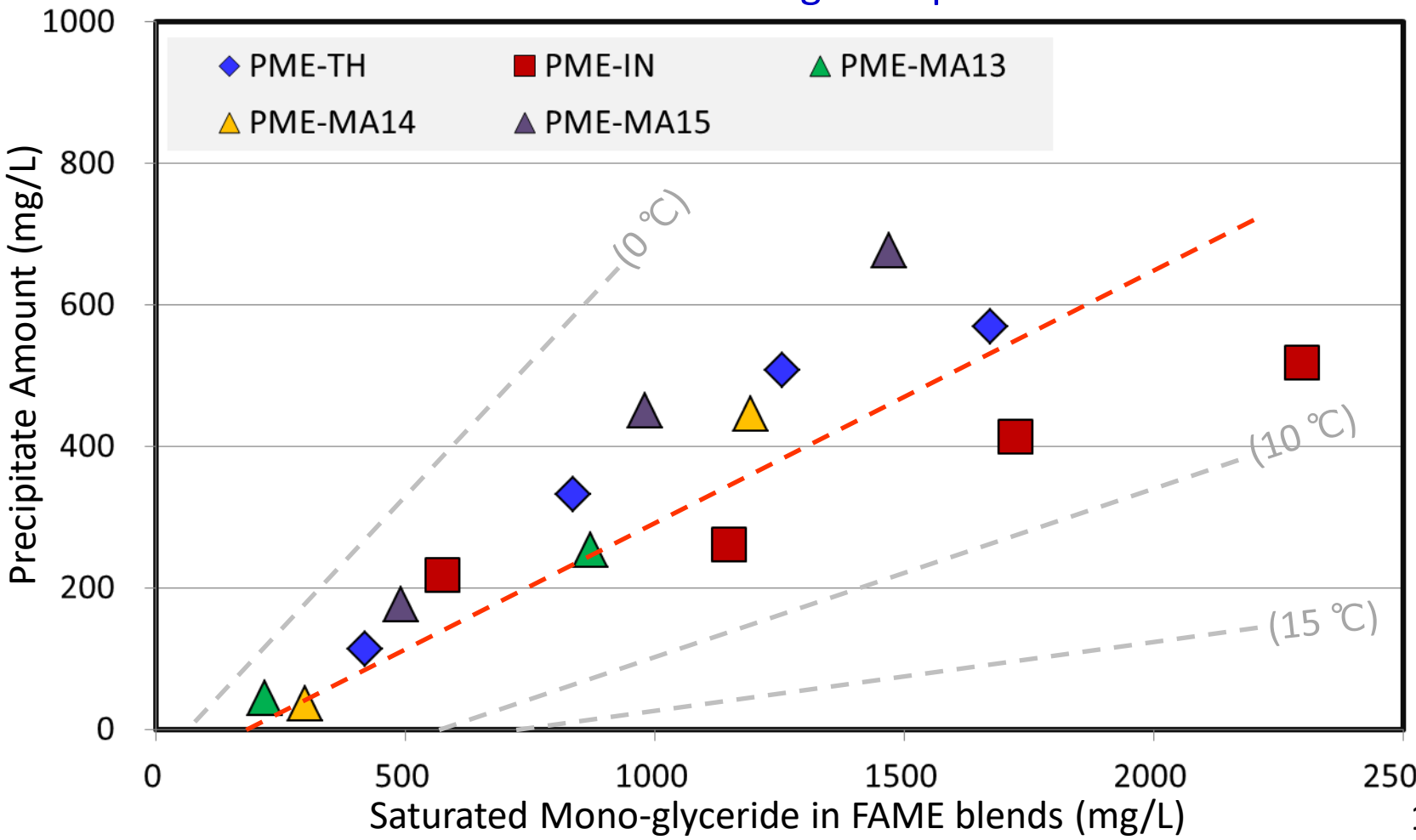
- ✓ **Tendency is similar regardless source of PME.**
- ✓ **Different trend would be seen with different temperature.**

Source：*JAMA/JARI report*

Storage Temp: 5℃ const. for 2 weeks



3-2. Mono-glyceride Content (3/5)

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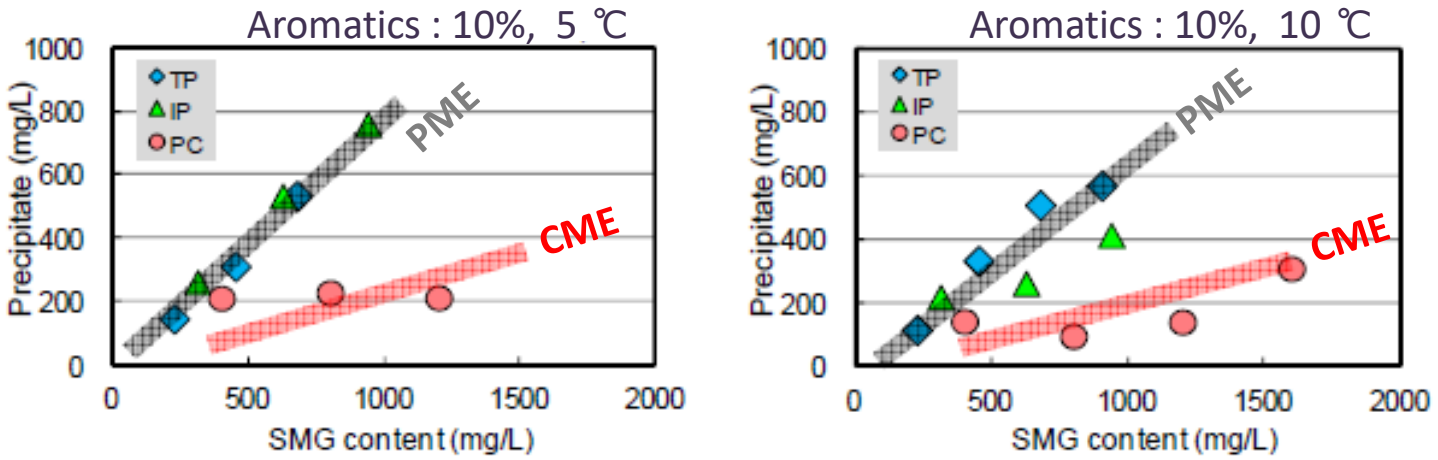
✓ **Tendencies in precipitate amount are different by feed stock.**

Source：JAMA/JARI report

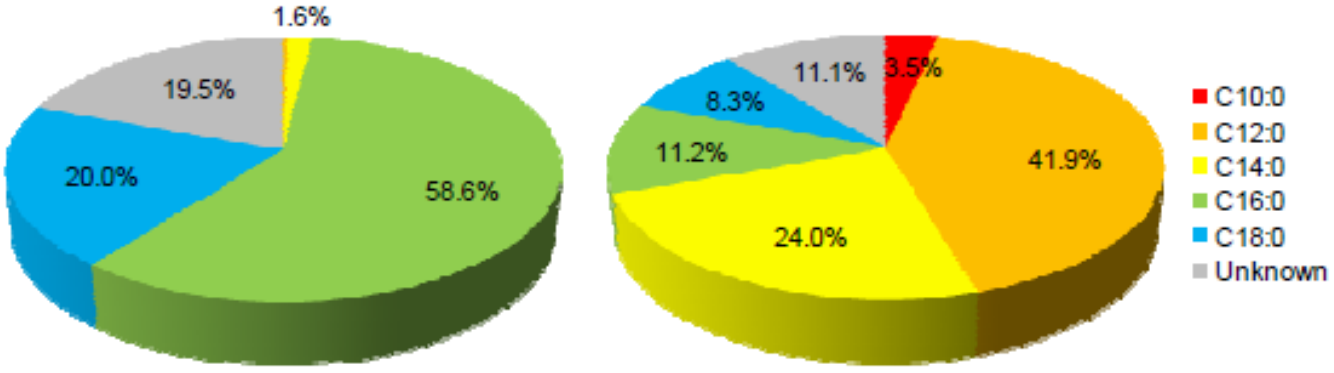
Trends in Precipitate by Feed Stock



Source：JAMA/JARI report

Distribution of SMG in Precipitate

Aromatics : 10%



B20 PME @ 5 ℃

B20 CME @ 5 ℃

3-2. Mono-glyceride Content (4/5)

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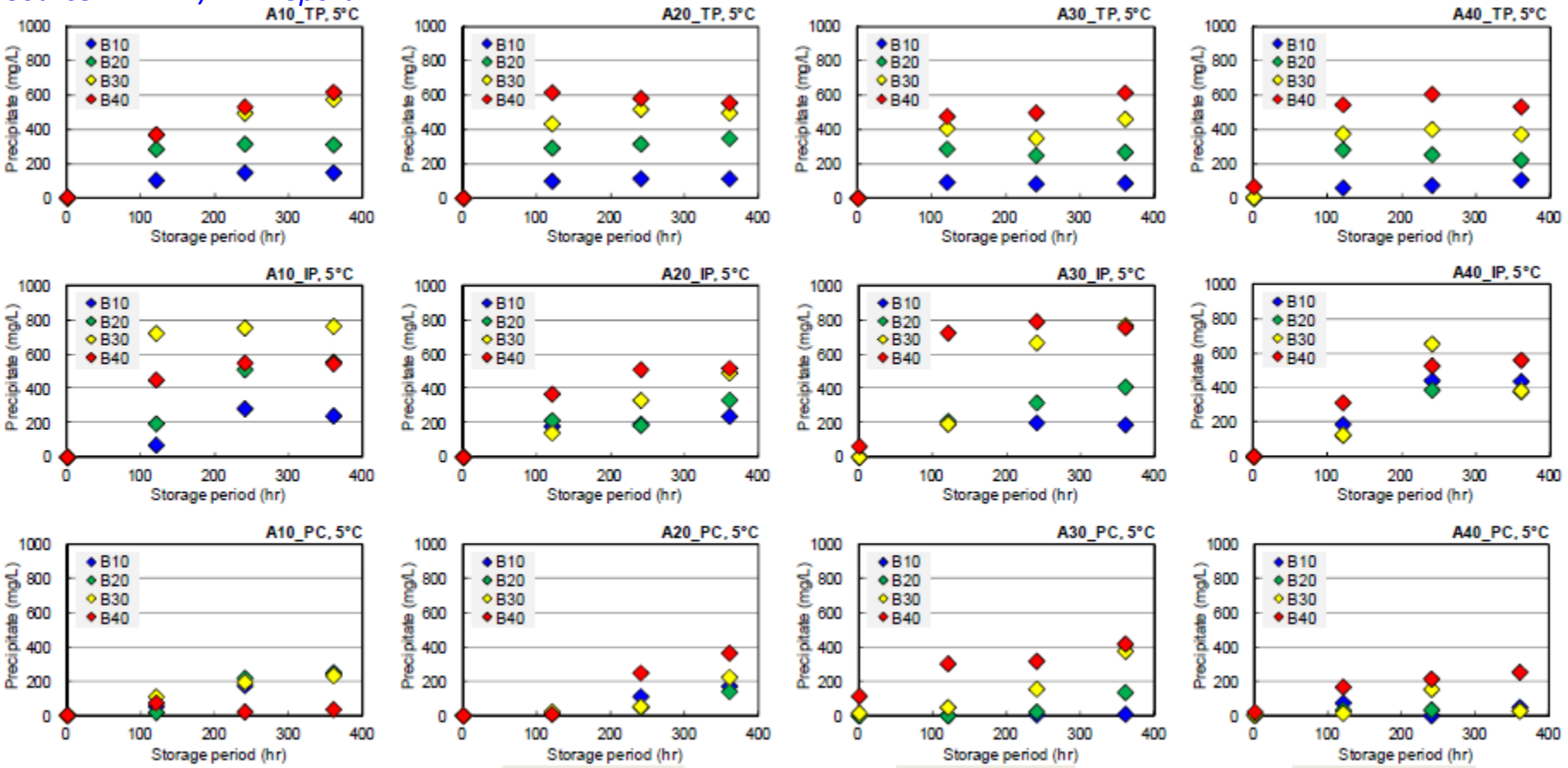
✓ **Properties of base diesel would effect on characteristics in FAME blends because of its variation of solubility.**

Source：JAMA/JARI report



Aromatics content in Base Diesel >>> A10: 10%, A20: 20%, A30:30%, A40: 40%

3-2. Mono-glyceride Content (5/5)

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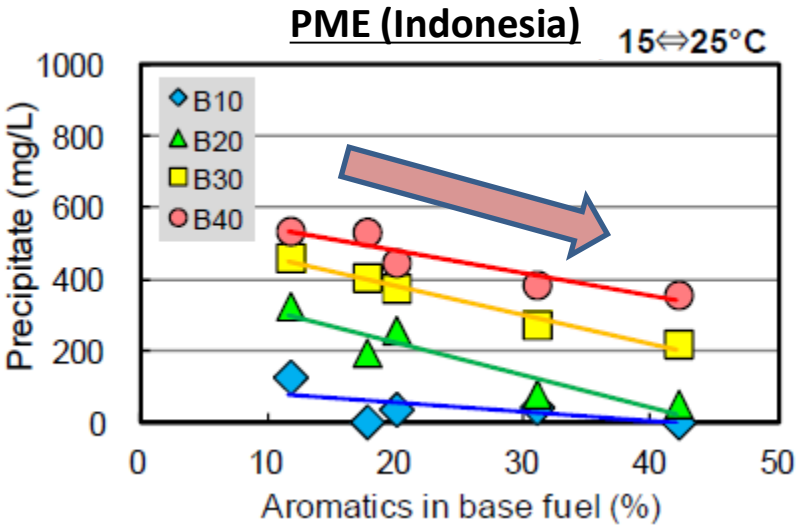
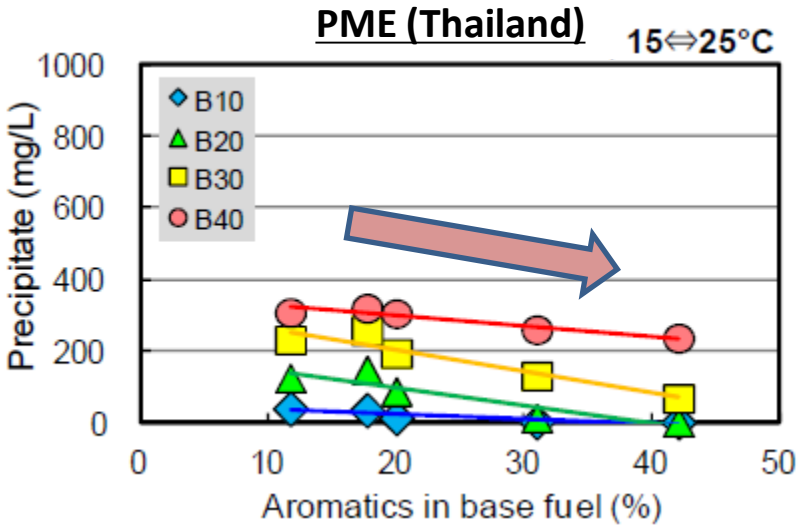
✓ **Higher amount of precipitate was generated when base diesel contained lower aromatics was used.**

Source：*JAMA/JARI report*



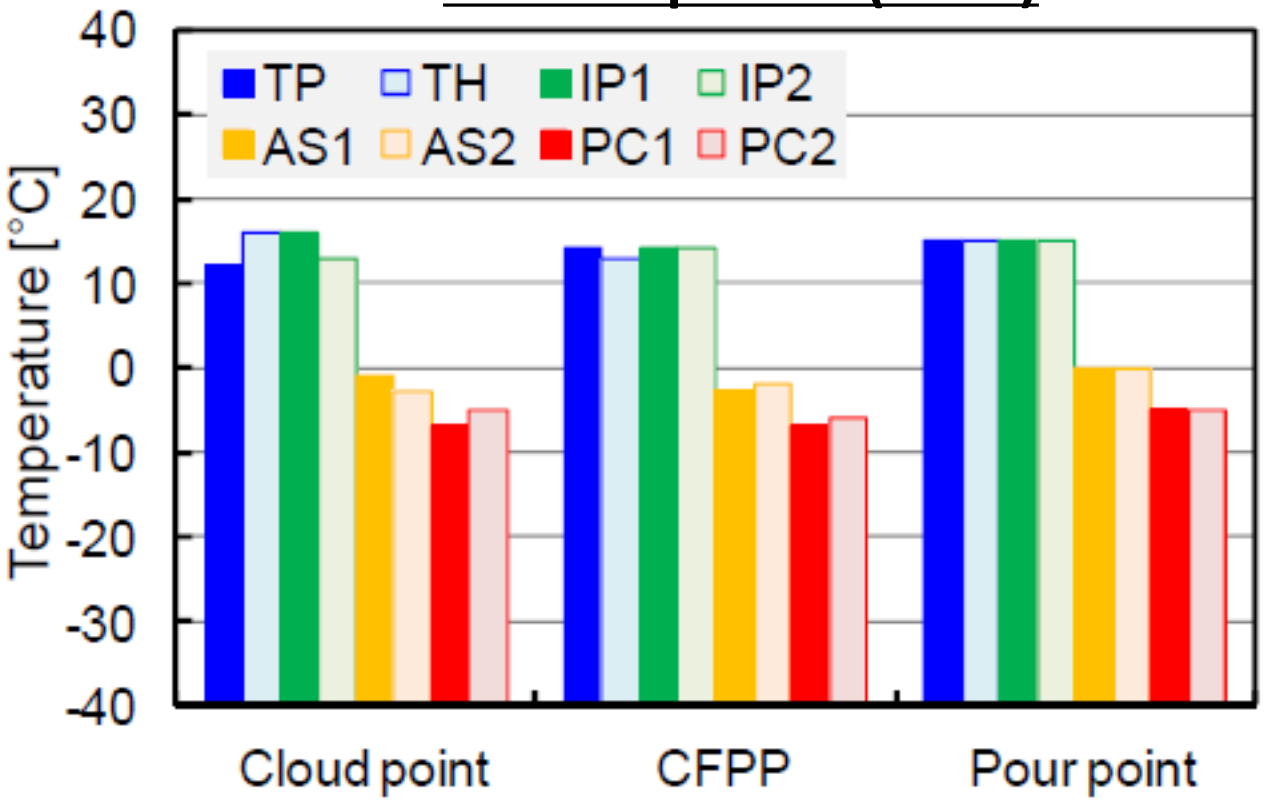


3-3. Cold Properties

- ✓ **Cold propertied such as CP, CFPP, and PP have to be specified in the guidelines of FAME Blends.**
- ✓ **The lowest temperature in some APEC countries would be below freezing point.**

Source：JAMA/JARI report

Cold Properties (B100)



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AS2	USA	Soybean	SME
PC1	Philippines	Coconut	CME
PC2	Philippines	Coconut	CME

3-4. Metallic Content

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- ✓ Metallic content in FAME would become a source of ash in DPF.
- ✓ Accumulation of ash in DPF would be accelerated by FAME blends containing high metallic components.
- ✓ Generally, left over metallic components used in the production process of B100, are containing in FAME.
- ✓ Key metallic components need to be specified in B100 standard would be Ca, Zn, P, Mg, Fe, and so forth.

4. Others – Uncontrollable Properties

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- ✓ There are some uncontrollable properties in FAME and in FAME blends which may impact on engine/vehicle operations.
- ✓ Typical properties to be considered are distillation and heating value (LHV).

Source：#1 APEC Work Shop

☐ Further Concerns - Expected Impacts (3/3)

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✓ High FAME blends would be expected to impact on newly employed systems and components.

Key Characteristics	Factor	Expected Impacts
Distillation < High Boiling Point >	• Unburned FAME in Exhaust	• Fouling, clogging EGR system components • Clogging DOC, DPF • Oil dilution by FAME (by DPF regeneration) - Drop of engine oil pressure
LHV < Low Calories >	• Lower Exh. Gas Temperature	• Drop of DPF regeneration performance • Decline in emission conversion rate
Oxidation Stability	• Oxidized Degradation	• Sludge formed in engine oil • Injector deposits - In-cylinder injector - Exhaust pipe injector (for DPF regeneration)

4. Summary – What to do next

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- ✓ **Need to recognize circumstances including restrictions in FQ by law (i.e. LCFS in Calif.) of real world in in all APEC countries.**
- ✓ **Need to think about specification for important properties both in B100 and BXX based on the all circumstances in APEC countries.**

➢ **Priority (Proposal)**

Priority	B100	BXX
1	Ester Content	FAME Content
2	Oxidation Stability	Oxidation Stability
3	Mono-glyceride	Water Content
4	Metallic components	CP/CFPP/PP/FBT
5	Water Content	

……. and more!!

Thank you very much for your attention

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