Department of Agriculture

PHILIPPINE COCONUT AUTHORITY

COCO-BIODIESEL

COCONUT METHYL ESTER (CME) AS PETRODIESEL QUALITY ENHANCER

By:

Engr. Roberto C. Ables

Biodiesel Program Officer/Project Leader

Background

- **For more than two decades, government and private institutions like DOST, ITDI, PCA, NPC, PNOC-ERDC and PCRDF had conducted research and development experiments on the fuel application of Coconut Methyl Ester (CME).**
- **The general objective of these experiments was to establish the viability of CME as a Petroleum Diesel Fuel (PDF) alternative or substitute fuel.**

COCONUT METHYL ESTER PHILIPPINE STUDIES

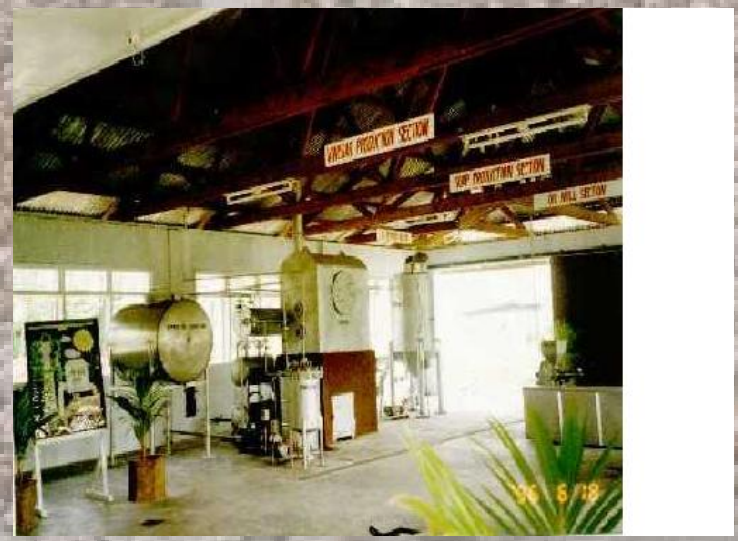
- 1983 : ITDI –NIST/DOST
- 1989 : Inter-Agency (DOST, PCA, NPC, PNOC-ERDC and ITDI)
- 1991: PCRDF
- 1991: Technology Transfer of Coconut Methyl Ester in Region XI (Dahitri Plantation)
- 1995: Evaluation of a claimed “cold process” transesterification technology at PCA Zamboanga Research Center

COCONUT METHYL ESTER PHILIPPINE STUDIES

- **Objective**: To establish the technical and economic viabilities of replacing/substituting petroleum diesel with CME
- **Methodology**: 100% of CME directly fed to diesel transport vehicles
- **Findings:** Technically viable to substitute Petroleum Diesel with CME, but not economically viable due to high cost of CNO.

Background

- When the price of Coconut Oil (CNO) increased, or when the price of PDF decreased to a level much lower than that of CNO, the promotion tended to be discontinued because of economic viability issues which failed to attract local and foreign investors.



Background

- However, when the Philippine Clean Air Act (RA 8749) was enacted in 1999, the law provided a window of opportunity for CME as a PDF quality-enhancing additive.
- Application now demonstrates a cost-effective solution in complying with the smoke emission specifications/standards of RA 8749.

RULE XXXII EMISSION CONTROL FOR IN-USE VEHICLE, Section 1. Emission Standards for In-Used Vehicle

For vehicles with compression-ignition engines, the following emission standard shall apply:

Table 17
Emission Standards for Vehicles with Compression-Ignition Engines (light absorption coefficient, m^{-1})*

	Naturally Aspirated	Turbo charged	1,000 m increase in elevation
Registered for the first time prior to December 31, 2002	2.5	3.5	4.5
Registered for the first time on or after January 1, 2003	1.2	2.2	3.2

*Using the free acceleration test

PCA BIODIESEL INITIATIVE

General Objective

To establish the viability of CME as a PDF quality enhancer for the reduction of air pollution, in line with RA 8749; for better engine performance; and for increased utilization of CNO in the domestic market.

- PCA-DA launched a Biodiesel Development Project in May 2001with issuance of DA Special Order no. 176, series of 2001.

- PCA set-up Coconut Biodiesel Pump Station at its Quezon City compound for Coconut Biodiesel promotional utilization and conduct of scientific validation testing and R&D activities.

Fifteen PCA vehicles were tested on their smoke emissions with 1% CME blend. No engine modifications were done.

The test results showed a reduction of around fifty percent (50%) on their smoke emissions.

SMOKE EMISSION TESTING OF PCA VEHICLE (MITSUBISHI L-200) ON JANUARY 10, 2002 BY DENR TECHNICIAN. CHECKING THE “k” OR OPACITY PRINTOUT DATA RESULTS

WHAT IS CME?

- CME is the acronym for Coconut Methyl Ester or Coco-Biodiesel. Biodiesel, on the other hand, is the international name for methyl ester when used as diesel fuel or enhancer.
- Biodiesel in other counties like the US, Germany and other Euro counties their biodiesel is a mixture of diesel fuel and ester derived either from corn, soya, sun flower, rapeseed oil. They use of 5% to 20% blend on their diesel fuel.

The Uniqueness of Coco-Biodiesel

CARBON CHAIN DISTRIBUTION OF PLANT OIL (% by Weight)

PLANT OIL	C8	C10	C12	C14	C16	C18	C20	C22
COCONUT	7	7	49	17	9	11	0	0
PALM KERNEL	3	5	49	17	8	18	0	0
PALM	0	0	0	4	40	58	0	0
CORN	0	0	0	1	10	89	0	0
SUNFLOWER	0	0	0	0	6	94	0	0
SOYBEAM	0	0	0	0	10	83	0	0
RAPESEED	0	0	0	0	3	42	55	0
MUSTARD	0	0	0	0	3	62	35	0

STUDIES OF COCONUT METHYL ESTER (CME) AS PETRODIESEL QUALITY ENHANCER

COCO-BIODIESEL

PHILIPPINE INITIATIVE

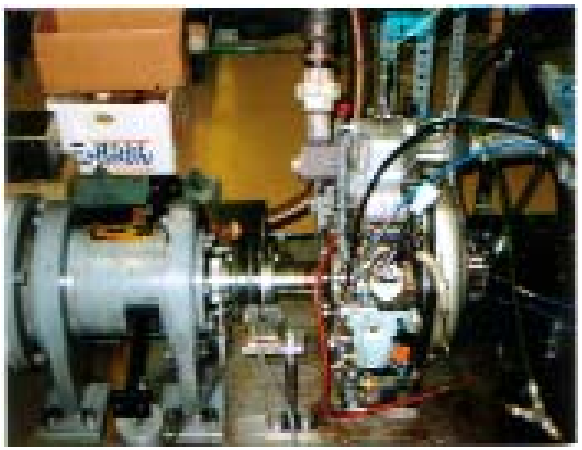
STUDY CONDUCTED AT THE NIHON UNIVERSITY, JAPAN

PROPONETS

- **Dr. Koji Yoshida (Nihon University)**
- **Prof. Rey P. Hizon (TUP)**
- **Prof. Felipe M. Argamosa (TUP)**
- **Engr. Carlos Zapanta (TUP)**
- **Mr. Masaharu Kubota (Nijon University)**

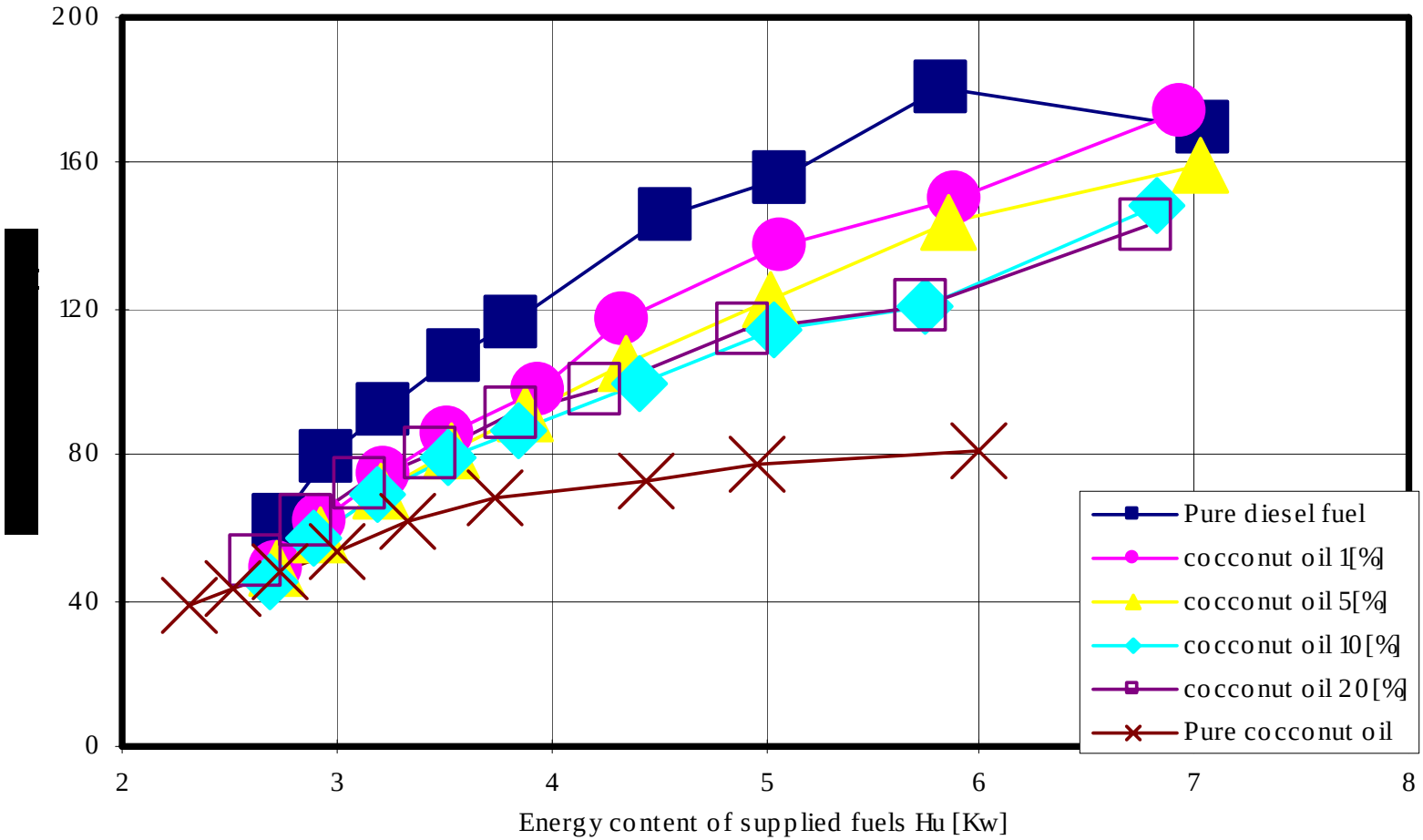
Sponsored by:
Japan Society for the Promotion of Science (JSPS)

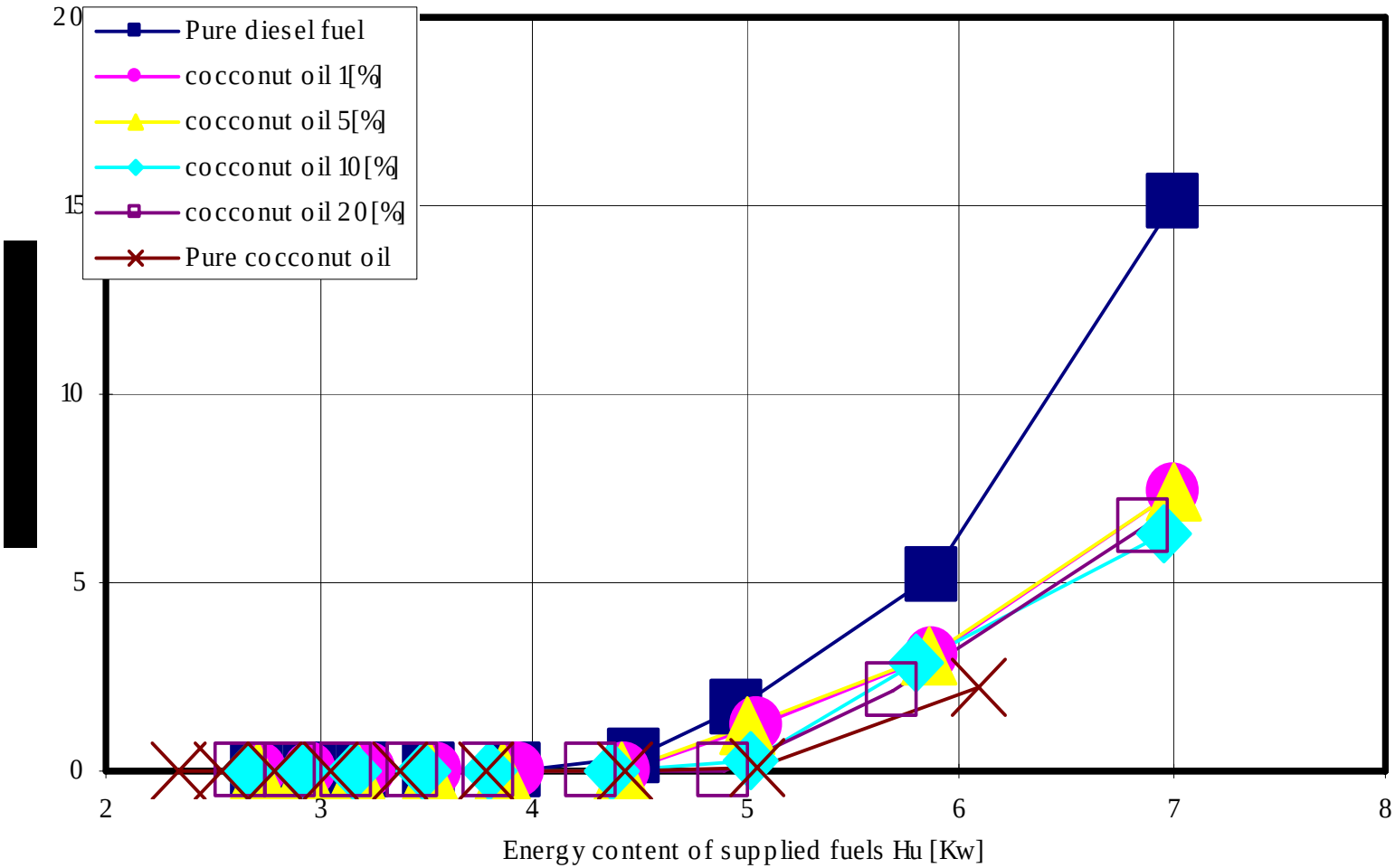
TUP – Technological University of the Philippines



- Determined the engine performance and emission of a single cylinder four stroke diesel engine (yanmar).
- Blends of 1%, 5%, 10% and 20% Coconut Methyl Ester to low sulfur diesel (Japan diesel 0.03% sulfur).
- Test results have shown that an average of 20% NOx reduction, and 70% reduction of of particulate matter.

APPARATUS USED IN CONDUCT OF STUDY ON CME/PDF UTILIZATION


200
160
120
80
40
0
2
3
4
5
6
7
8
Energy content of supplied fuels Hu [Kw]
Pure diesel fuel
cocconut oil 1[%]
cocconut oil 5[%]
cocconut oil 10[%]
cocconut oil 20[%]
Pure cocconut oil


Pure diesel fuel
cocconut oil 1[%]
cocconut oil 5[%]
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cocconut oil 20[%]
Pure cocconut oil
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Energy content of supplied fuels Hu [Kw]

COCONUT BIODIESEL PROJECT

IN COOPERATION WITH

PHILIPPINE COCONUT AUTHORITY

DEPARTMENT OF ENERGY (DOE)

TECHNOLOGICAL UNIVERSITY OF THE PHILIPPINES (TUP)

METRO MANILA DEVELOPMENT AUTHORITY (MMDA)

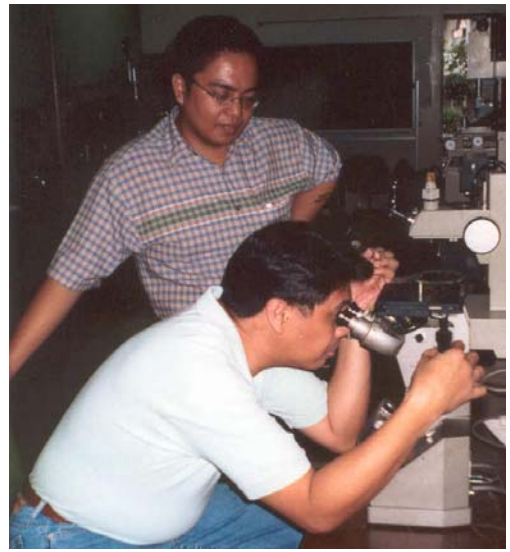
PROJECT TITLE

- **UTILIZATION OF COCONUT METHYL ESTER (CME) AS PETROLEUM DIESEL FUEL (PDF) QUALITY ENHANCER PILOT R&D PROJECT**

- Project Leader: **ROBERTO C. ABLES**
  Philippine Coconut Authority
- Study Leaders:
  - Chemical Aspects — **RICARDO S. INFANTE**
    Department of Energy
  - Mechanical Eng'g. Aspects — **FELIPE M. ARGAMOSA**
    Tech. University of the Phils.
  - Consumer/Market Aspects — **REY CRISANTO P. HIZON**
    Tech. University of the Phils.

General Objective

- To establish the viable utilization of CME as a PDF quality enhancer for the reduction of air pollution, in line with the 1999 Clean Air Act; and for better engine performance



Professor Rey P. Hizon looking at the surface of the profile of the new injection nozzle

Engr. Robert C. Ables looking at the surface of the profile of the new injection nozzle

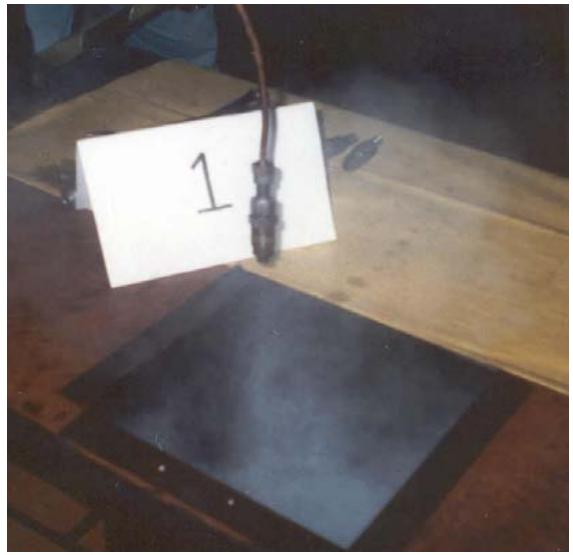
Mechanical Aspects

- Conducted baseline data analysis on the test vehicle used.
- Conducted City and country road run test and free acceleration smoke emission test.
- Conducted top overhauled inspection on the test vehicle after 5,000 and 20,000 km on-road test.

Professor Loreto G. Aguila preparing the Profile Projector equipment to measure the injection nozzle tiny parts.

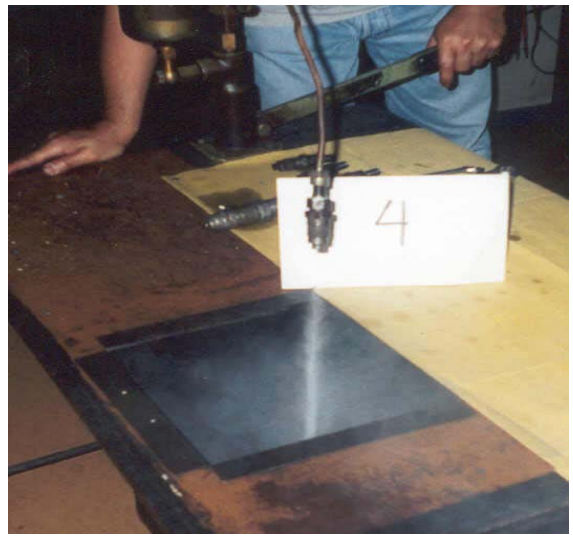
Professor Felipe M. Argamosa looking for a better position of the injection nozzle part

Full view of injection nozzle pin projected by the profile projector equipment



Spay pattern testing on injection nozzle 1 of SDN 982 vehicle

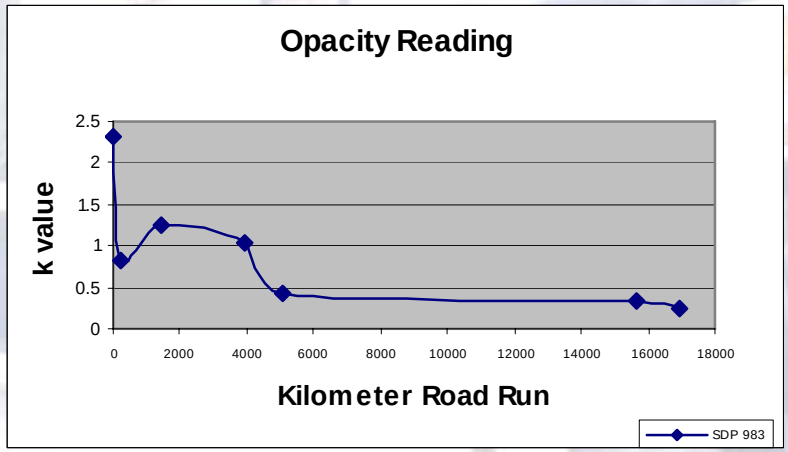
Nozzle injector parts on the profile projector

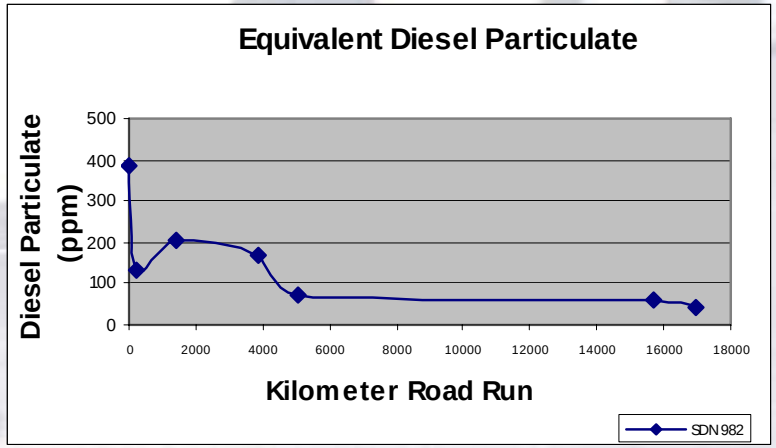


Spay pattern testing on injection nozzle 4 of SDN 982 vehicle

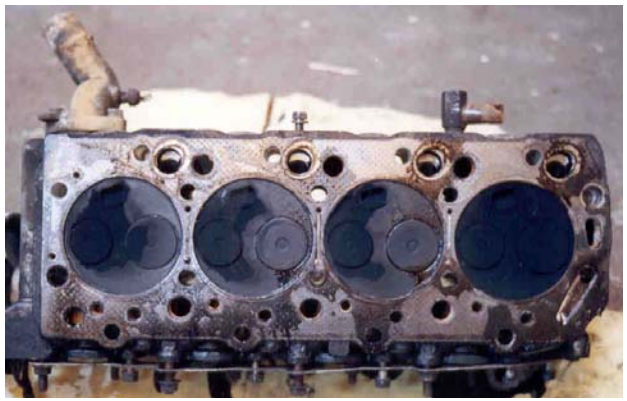
REDUCTION OF SMOKE EMISSION AFTER USING 1% OF CME INTO PETRODIESEL AND HEALTH ADDED VALUES

Road Run Kilometer (km)	Opacity or "k" Reading (m^{-1})	Equivalent Diesel Particulate (PPM)	Remarks/ Fuel used
0	4.18	696.67	CB-02, w/o proper maintenance
0	2.32	386.67	PDF/Replace defected injection nozzle
200	0.81	135.00	CB-01
1,400	1.24	206.67	CB-01
3,900	1.03	171.67	CB-01/ Cleaned the tailed pipe before testing
5,033	0.43	71.67	CB-01/ Cleaned the tailed pipe before testing
15,663	0.35	58.33	CB-01
16,928	0.24	40.00	CB-01





EFFECTS OF CME ON THE ENGINE



After using 1% CME

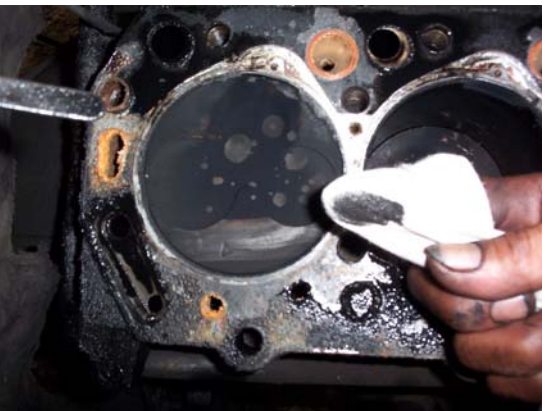
After using 1% CME

After 5,000 km road run using 1% CME

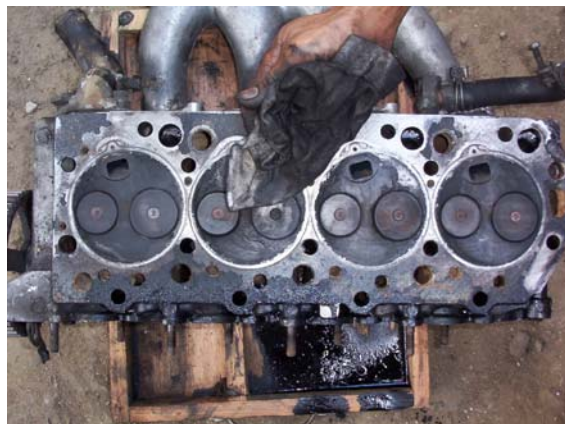
After using 1% CME

EFFECTS OF CME ON THE ENGINE

After More than 20,000 kilometers



Engine Top Overhauled of
Test vehicle SDN 982
(January 2004)



COST BENEFITS USING CME

- Average increase of more than 17% kilometers for every liter of diesel consumed.

- Translates into savings of P 0.916 to P 2.85 for every liter of diesel fuel.

PHILIPPINE COCONUT BIODIESEL PRODUCT STANDARD

- The specification for CME (B_{100}) prepared by the DOE's Technical Committee on Petroleum Products and Additives (TCPPA), had been adopted as Philippine National Standard (PNS) by the Bureau of Product Standards on May 2003.
- It has come up with conclusive inter-laboratory fuel tests (wherein the petroleum laboratories participated) that 1%, 2%, and 5% CME-Petrodiesel Blends (by volume basis) still conform to the Philippine National Standards for Diesel Fuel.

Chemical and Physical Requirements

Property	Units	Limits	Test Method
Flash Point, Pensky Martens	ºC, Min	100	PNS 613 / ASTM D 93
Water & Sediments	% vol. max	0.050	PNS 707 / ASTM D 2709
Kinematic viscosity @ 40 ºC	mm^2/s	2.0 – 4.5	PNS 407 / ASTM D 445
Sulfated ash	% mass max.	0.020	PNS 2025 / ASTM D 874
Sulfur	@ mass max.	0.050	PNS 54 / ASTM D 2622 PNS 1685 / ASTM D 5453 PNS 505 / ASTM D 4294 PNS 502 / ASTM D 1266
Copper strip corrosion 3 hrs. @ 50ºC, max.	rating	No. 3	PNS 379 / ASTM D 130
Cetane number, min.		42[a]	PNS 653 / ASTM D 613
Cloud point	ºC, max.	report	PNS 706 / ASTM D 2500
Carbon residue, 100% sample	% mass, Max.	0.050	PNS 708 / ASTM D 4530
Acid number	mg KOH, max.	0.50	PNS 2024 / ASTM D 664 PNS 2026 / ASTM D 974
Free glycerin	% mass, max.	0.02[a]	PNS 2022 / AOCS Ea 6-51 (1989)
Total glycerin	% mass, max.	0.24[a]	PNS 2023 / AOCS Ca14-56 (1997)
Phosphorus	% mass, max.	0.001	PNS 2028 / ASTM D 4951
Distillation AET 90% recoverd	ºC, max.	360	

[a] Transition standard

Critical Key Points on CME Fuel Quality

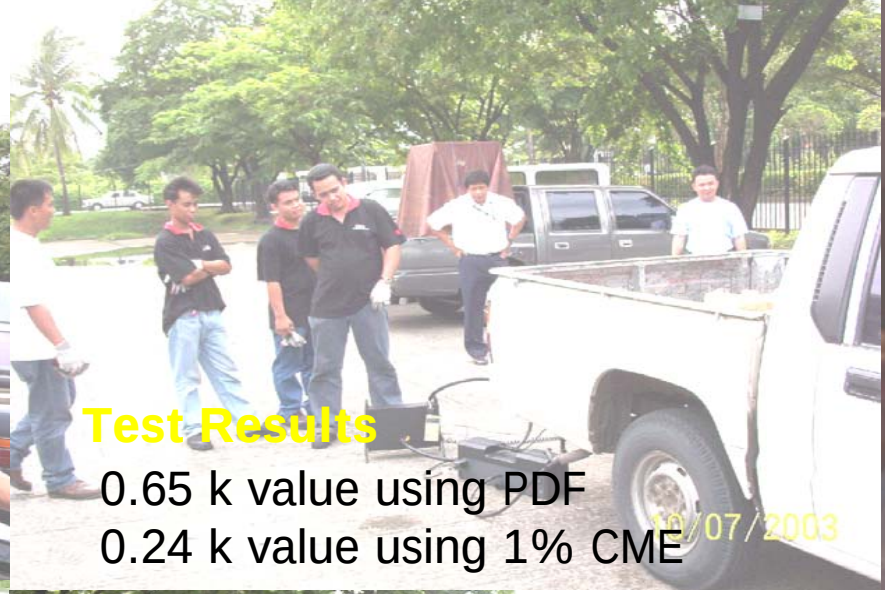
- ***CME Flash Point*** limit is to ensure the removal of excess methanol used during manufacturing process. Small amount of residual methanol reduce the flash point. Methanol can also affect fuel pumps, seals, elastomers and can result poor combustion.
- ***Sulfated Ash*** test ensures the removal of manufacturing catalysts, high level of catalysts in the fuel can result in injector deposits or filter plugging.
- ***Acid numbers*** higher than the set limit may shown with fuel system deposits, and reduced the life fuel pumps and filters.
- ***Free and Total glycerin number*** measure the complete conversion oils into ester products. If these numbers are too high, fuel gumming and engine fouling will occur.

ACTUAL DEMONSTRATIONS ON THE USED OF CME AND EFFECTS ON SMOKE EMISSION

Test Results

1.075 “k” using PDF
0.356 ‘k” using 1% CME

MEETING WITH THE VARIOUS GOVERNMENT AND PRIVATE AGENCIES AND ACTUAL DEMONSTRATION ON THE USE OF CME AS PDF FUEL ENHANCER CONDUCTED AT THE PHILIPPINE COCONUT AUTHORITY, JUNE 24, 2003

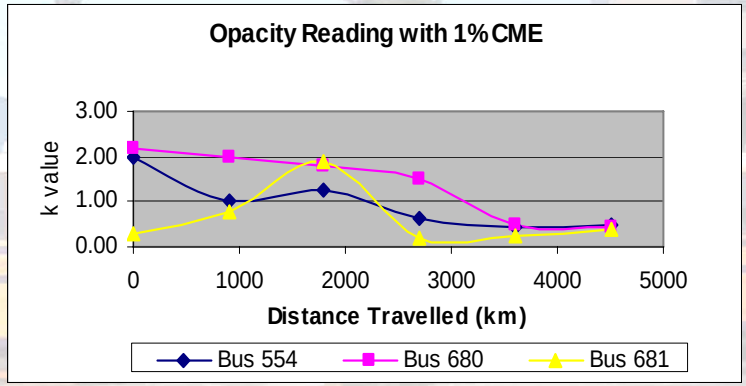


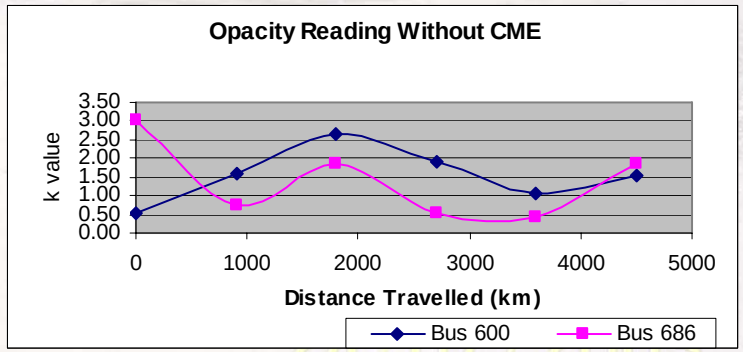
PARTICIPATION AT THE LEAGUE OF CORPORATE FOUNDATION CELEBRATION AND ACTUAL DEMONSTRATION ON THE USE OF CME AS PDF FUEL ENHANCER CONDUCTED AT PICC PARKING AREA WITH BANTAY USOK AND PETRON ON JULY 9-10, 2003

CBL activities

California Buses Opacity Test Results

Date	Trial	k value with 1% CME			Road Run Kilometer (km)	K value Without CME	
		554	680	681		600	686
		NXT 938	NYK 570	NYR 246		NYE 650	NXZ 780
24-Jul-03	1	1.98	2.16	0.28	0	0.54	3.03
31-Jul-03	2	1.02	1.97	0.79	900	1.60	0.74
7-Aug-03	3	1.25	1.79	1.89	1800	2.65	1.86
14-Aug-03	4	0.61	1.48	0.19	2700	1.90	0.51
21-Aug-03	5	0.42	0.49	0.26	3600	1.05	0.43
28-Aug-03	6	0.49	0.44	0.39	4500	1.53	1.88





What has been done

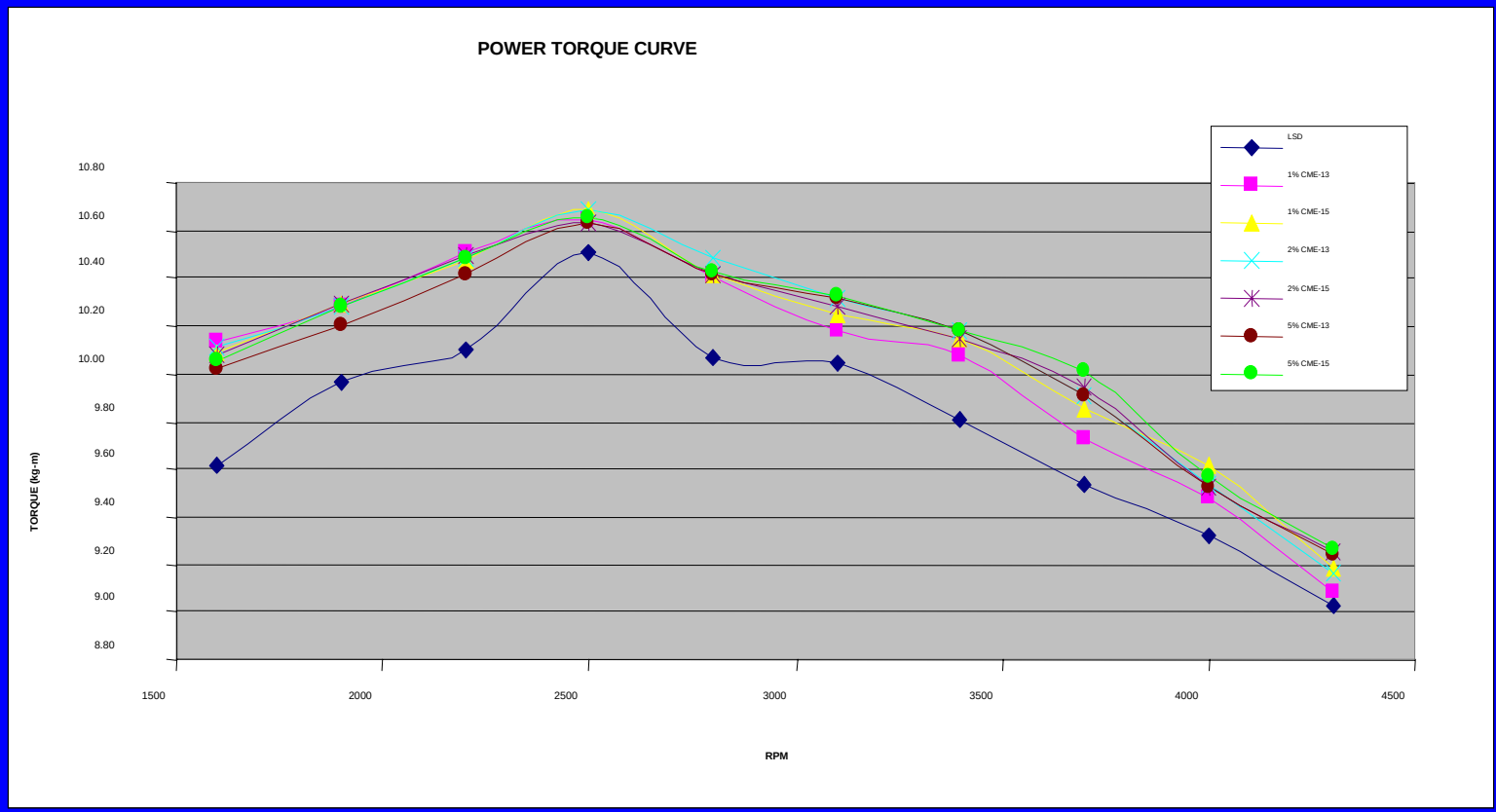
Conducted Validation Test on Engine Performance & Emission

- **Engine Performance**
  - **Increase in power output by 1% - 3%**

Dynamometer tests with a C-190 Isuzu engine

Undertaken by the Interagency and multi-sectoral cooperation

Dynamometer Test Results



Torque curve increase between 2.5% to 3.2% for CME blends as compared to Low Sulfur Diesel (LSD)

Launching of Coco-Biodiesel Program by Pres. Arroyo

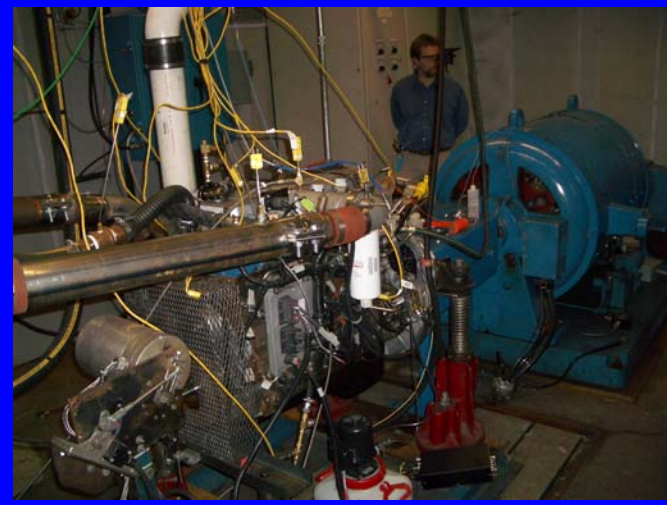
April 21, 2004
In San Pablo City

"Clean and healthy environment is for the Good of All and should therefore be the Concern of All…

Let us act Now, …
for Tomorrow may just be too late

Let us go for Clean Fuels…
Go for Coco-Biodiesel *"*

Thank you



for your time and attention