The use of biofuel and biomass for rural electrification and green house gas reduction

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Recent conditions of electricity in Cambodia

- About 25% of Cambodian has the electricity access
- The price of electricity in rural area is still high (0.2-0.75 USD/kWh)
- Nearly all electricity is produced from the combustion of fossil fuel
- The electricity from combustion is still important even in the year 2030

CO2 emission by sectors

CO2 emission from various sectors in Cambodia (2008)
in million tonnes

	Total CO2 emissions from fuel combustion	**Other energy industries**	**Manufacturing industries and construction**	**Transport**	**Of which road**	**Other sectors**	**Of which residential**
Cambodia	4.6	-	0.5	1.1	1.1	2.9	2.0
Indonesia	385.4	36.8	171.4	75.9	69.0	101.3	62.9
Thailand	229.5	16.3	100.1	51.2	50.7	61.8	22.9
Vietnam	103.0	-	51.7	25.5	23.2	25.8	17.8

Source (IEA)

CO2 emission for electricity and heat generation

g CO2/ kWh of electricity and heat generation

	1995	**2000**	**2005**	**2008**	**Average**
Cambodia	1816	1798	1205	1152	1160
Indonesia	552	596	694	726	726
Thailand	606	564	535	529	525
Vietnam	301	427	412	413	430
Japan	411	401	429	436	436

Source (IEA)

CO2 emission in Cambodia

CO2 in power generation

- ✓ High dependence in fossil fuel
- ✓ High CO2 /kWh electricity

Measures

- ✓ Using renewable energies (biofuels)
- ✓ Using the waste from agriculture(biomass)

Biofuels and biomass in ICE

- ✓ Neutral CO2 emission
- ✓ Energy security
- ✓ Renewable energy
- ✓ Improvement of local economics

Potential and use of biofuels

Potential feedstocks in Cambodia

Jatropha Curcas, Sugar Cane, Palm, Cassava, Rubber seed...

Cake

Waste charcoal

Fertilizer

Biogas

Oil

Generator

Biodiesel

ELECTRICITY

Buses and Trucks

Agricultural and mining machines

Off-grid community

Research phase I

Cake

Oil

Generator

ELECTRICITY

Off-grid community

Jatropha Curcas Oil

Jatropha Curcas Oil

- ✓ High viscosity
- ✓ High phosphorous contents

Measures

- ✓ High viscosity is reduced by heating (from cooling water)
- ✓ High phosphor is removed by de-phosphor process

Operations

Engine is started up by diesel fuel at first before using Jatropha Curcas oil and is switched to diesel fuel before shutting down

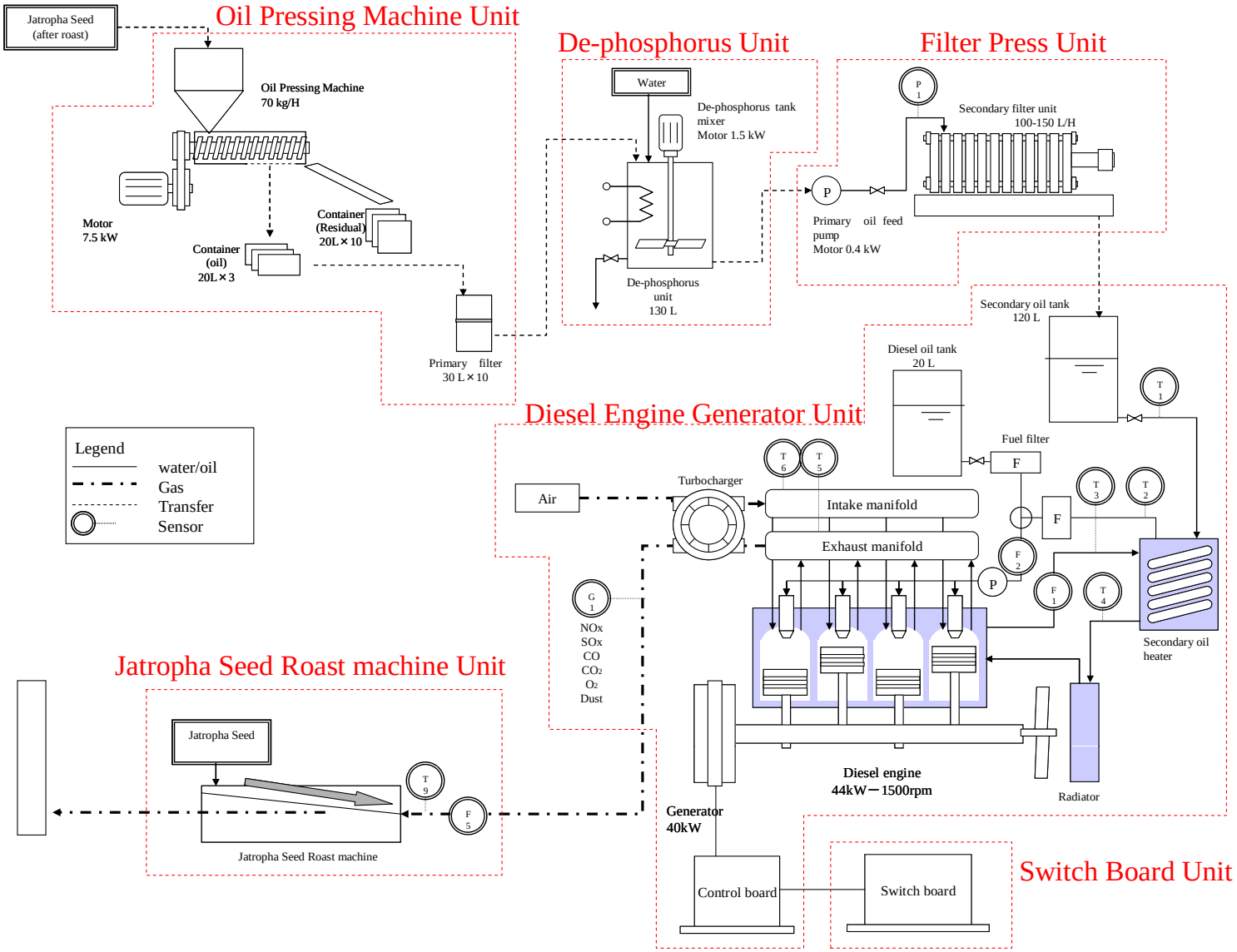
Objectives and contents

❖ To improve the quality of Jatropha Curcas oil by various processes

❖To confirm the use straight Jatropha Curcas oil in generator by durability tests

Long term durability test within 300 hours with constant load 20 kW to investigate the engine exhaust gas emission, sprays and engine components

Oil production and engine setup



Experimental apparatus

Screw oil pressing machine

De-Phosphorus machine

Press filtering machine

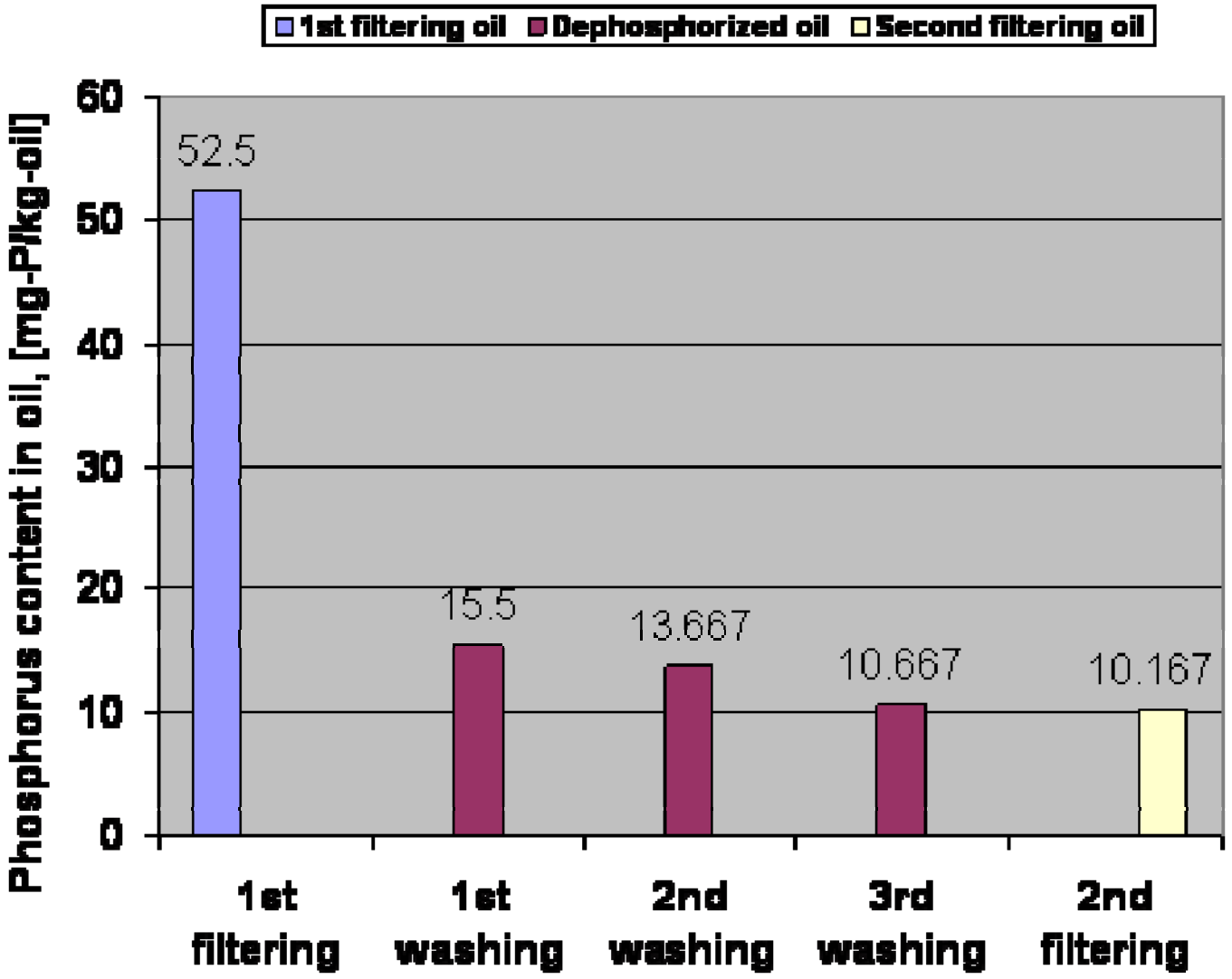
Generation sets

Result and discussion

Engine exhaust gas emission

Fuel type	CO, [ppm]	NOx, [ppm]	CO2, [%]	O2, [%]	Exhaust gas temperature, [ºC]
Light oil	225	499	5.54	14.32	250
DJO	425.9	425.2	6.0	13.3	289

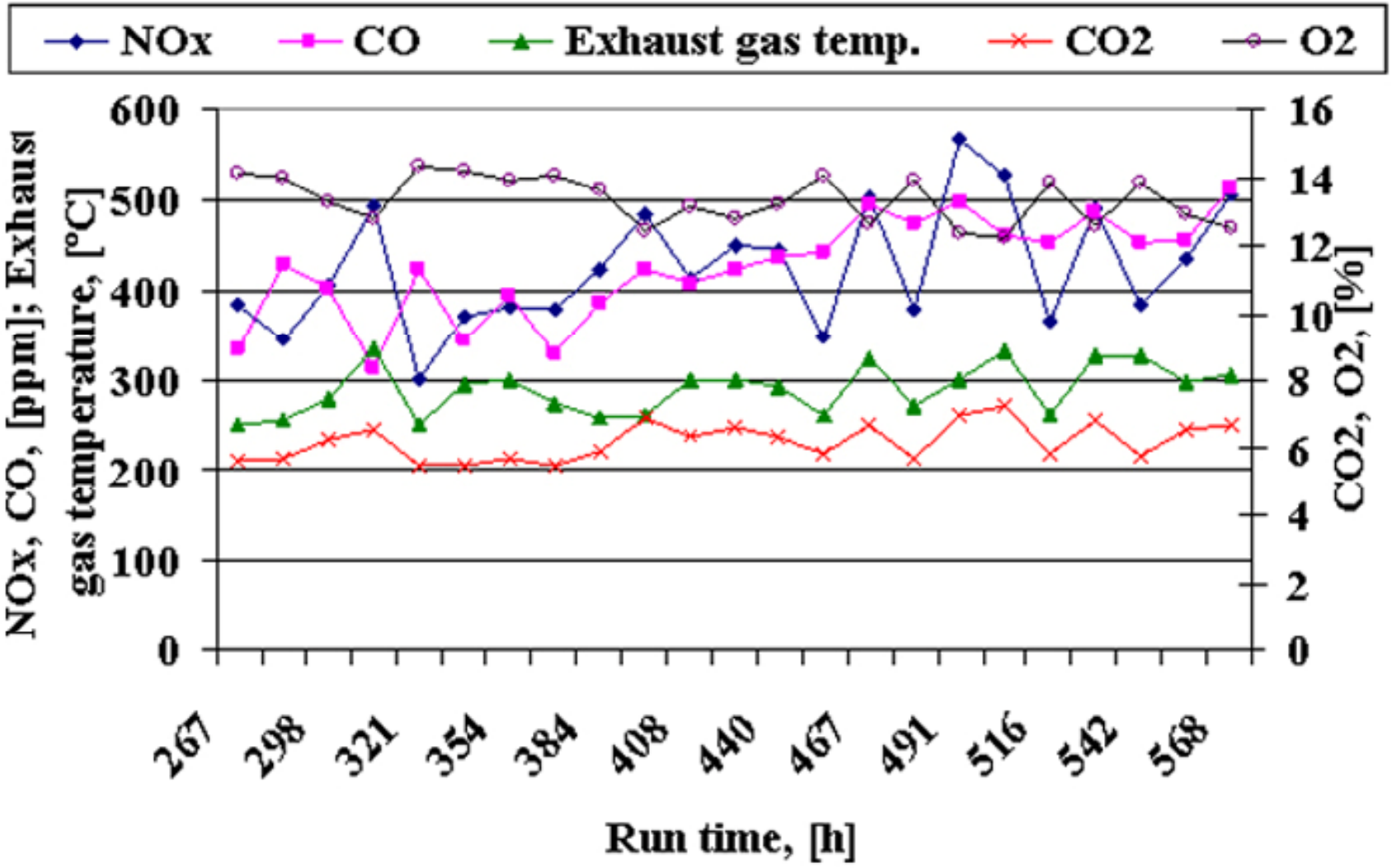
Result and discussion



Phosphor content is 10 ppm (EN14021, phosphor ≤10ppm)

Result and discussion

Engine exhaust gas emission in long term test



Result and discussion

Engine overhaul

Result and discussion

Overhaul consideration

- Engine was operated smoothly during 300 hours durability test
- The gums were found around injector nozzles in small quantity
- Injection spray check was in good condition
- Engine inner components were in normal conditions

Conclusions

- Limit of phosphorus content in DJO is 10 ppm
- DJO viscosity can be reduced by cooling water
- High injection pressure improved the combustion
- The value of exhaust gas emission are comparable for both fuel, except
- The concentration of CO is high for DJO but it is still less than limit by the standard (500 ppm)
- Phorbol ester is not detected in exhaust gas;
- Confirmation that we can generate diesel engine by 100% of Jatropha oil.

Future research

❖ As straight Jatropha Curcas oil can be used, the combination of gas from the gasification of Jatropha Cake and Rice Husk (research phase II) will be investigated.

❖ The success from the use of Jatropha Oil and Gas can be combined with solar energy for serving the electricity in rural area (research phase III)

❖ The expansion by the use of biofuel to the transportation and agricultural machinery will be applied (research phase IV)

Development consideration

- Jatropha Curcas can be planted in deforestation area
- Map of bio-energy plant and food plant should be created
- Energy and policy maker should provide some incentives, training and awareness about bio-energy to the farmer and investors

Further scope

- Cambodia should be able to use biodiesel and bioethanol at least 10% in 2020 and 20% in 2030, respectively, in total oil consumption
- Cambodia should promote the use of public/mass transport can reduce the oil consumption and exhaust gas emission especially CO2

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Thank you very much
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