USQ Combustion Meeting
26 Nov 2012

Burning Characteristics of Coconut Oil In Micro-combustor

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ISTP-23 The 23rd International Symposium on Transport Phenomena
THE UNIVERSITY OF AUCKLAND, NEW ZEALAND | 19-22 NOVEMBER 2012

PRESENTATION OUTLINE

- INTRODUCTION
  - POTENTIAL
  - PROBLEM
  - OBJECTIVE
- EXPERIMEN
- RESULTS AND DISCUSSION
- CONCLUSION

COCONUT OIL POTENTIAL

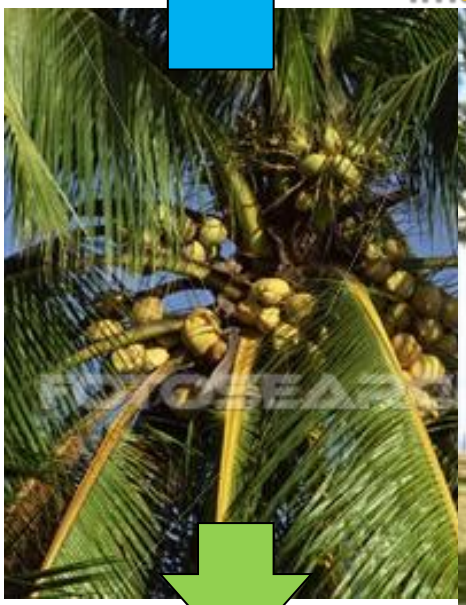
- Indonesia coastline length = 95,000 Km covered by coconut trees

http://www.fotosearch.com/photos-images/coconut-palm-tree.htm

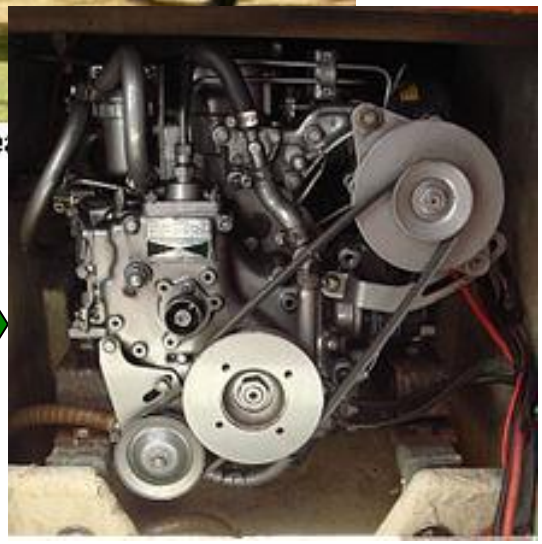
Zerro net CO2 emission

O_2

http://www.fotosearch.com/photos-images/coconut-palm-tree.htm



CO_2

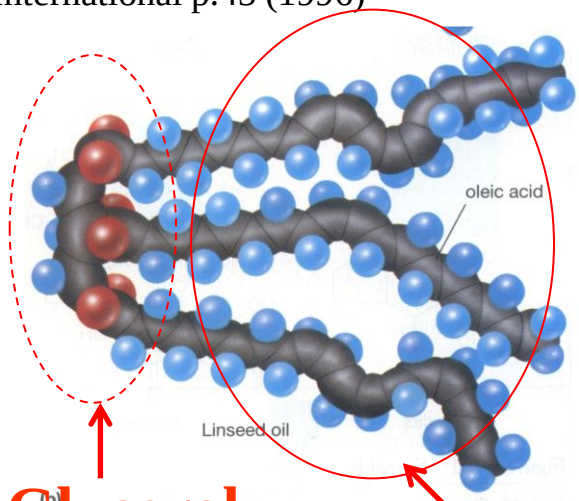


CO_2

http://en.wikipedia.org/wiki/Diesel_engine

COCONUT OIL

Audesirk T. and Audesirk G. Biology, Life on Earth, 4th ed. Prentice Hall International p.45 (1996)



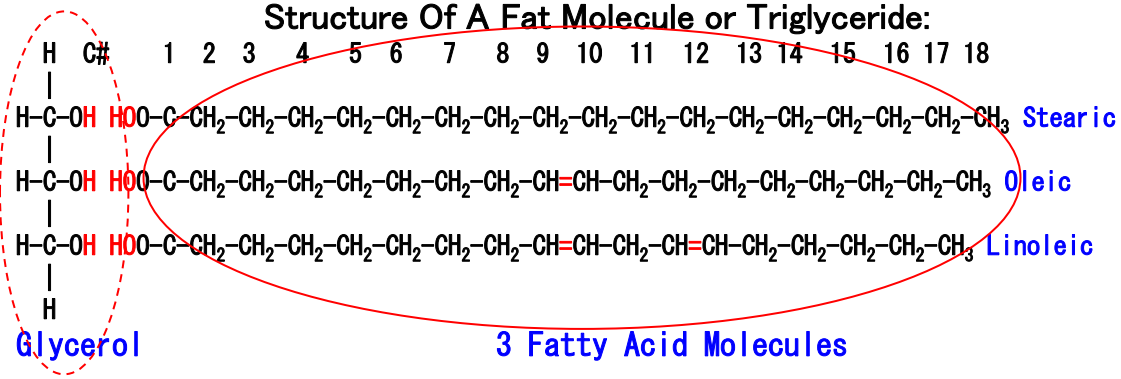
Glycerol

Fatty acid molecules

Wardana I.N.G., *Fuel*, **89**, 2010, 659-664

Fatty Acid Structure (wt.%)	C Number: Dbl Bond Number	Vegetable Oil		
		Sunflower	**Coconut**	Jatropha
Lauric acid	12:0		**47.0**	
Myristic acid	**14:0**		**18.0**	
Palmtic acid	16:0	6.7	**9.0**	14.0
Stearic acid	18:0	3.7	**3.0**	8.0
Oleic acid	**18:1**	**19.0**	**7.0**	**34.0**
Linoleic acid	**18:2**	**69.9**	**2.0**	**43.0**
Linolenic acid	**18:3**	**0.7**		

Structure Of A Fat Molecule or Triglyceride:



http://wikipedia.org

Kratzeisen M.and Müller J., *Fuel*, **89**, 2010, 1583-1589.

FATTY ACID COMPOSITION

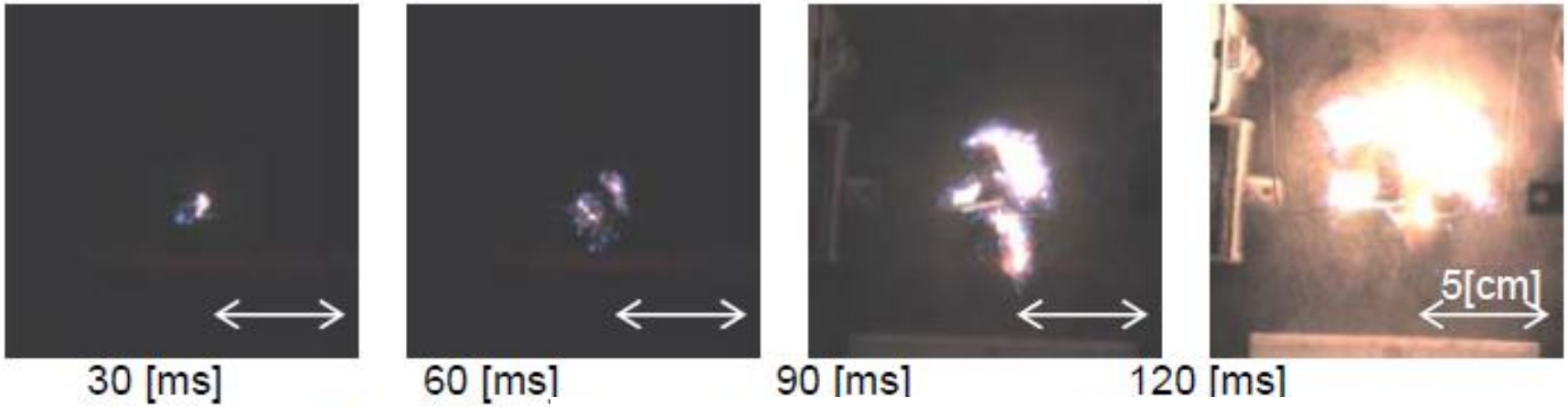
Fatty Acid Structure (wt.%)	C Number: Dbl Bond Number	Vegetable Oil		
		Ceiba Pentandra	**Coconut**	Cottonseed
Lauric acid	12:0	-	**47.0**	-
Myristic acid	**14:0**	**0.4**	**18.0**	**1.2**
Palmtic acid	16:0	12.5	**9.0**	19.6
Stearic acid	18:0	1.8	**3.0**	0.9
Oleic acid	**18:1**	**39.0**	**7.0**	**19.2**
Linoleic acid	**18:2**	**22.9**	**2.0**	**40.0**
Linolenic acid	**18:3**	**0.7**	**-**	**-**

PROBLEM OF COCONUT OIL

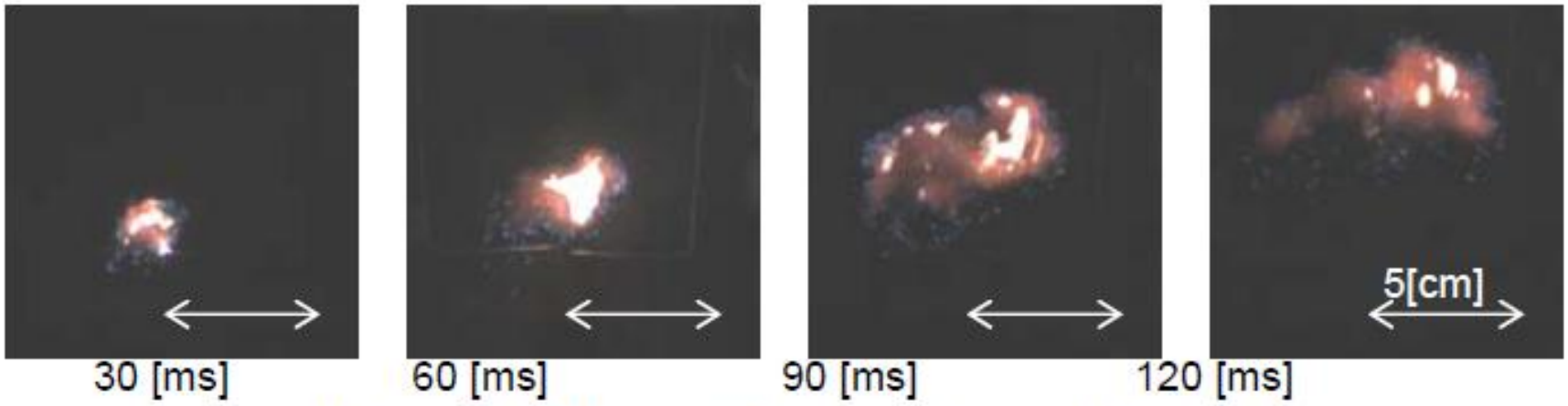
- Multi-component oil : mainly GLYCEROR and FATTY ACIDS
- FATTY ACIDS: mainly consist of medium chain (LAURIC and MYRISTIC acids)
- Contain Less spontaneous combustion (DOUBLE BOND)component
- High evaporation temperture
- Energy content: **3,607 kJ (862 kcal)/100g**
- Viscosity : 10 x fossil diesel fuel (Comonly be used for Diesel Engine)

MYRISTIC ACID TENDS TO EXPLODE

Anezaki, T., and Dobashi, R., Effects of Particle Materials on Flame Propagation During Dust Explosion, *Proc. 5th Int. Seminar on Fire and Explosion Hazards*, Edinburgh, UK, 23-27 April 2007.



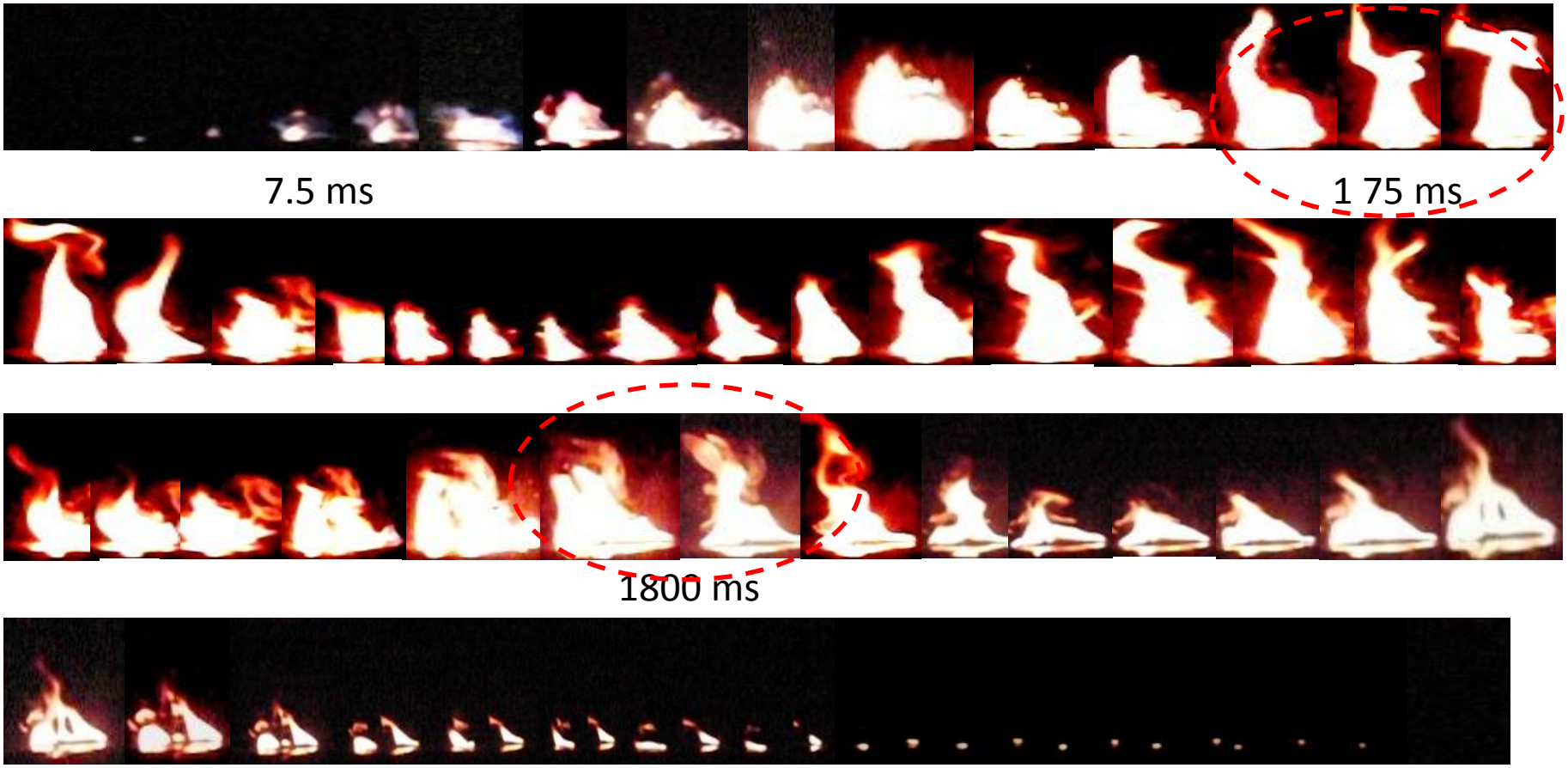
behenic acid ($CH_3(CH_2)_{20}COOH$, m.p.=80.5)



myristic acid ($CH_3(CH_2)_{12}COOH$, m.p.=53.9)

MULTICOMPONET OIL COMBUSTION

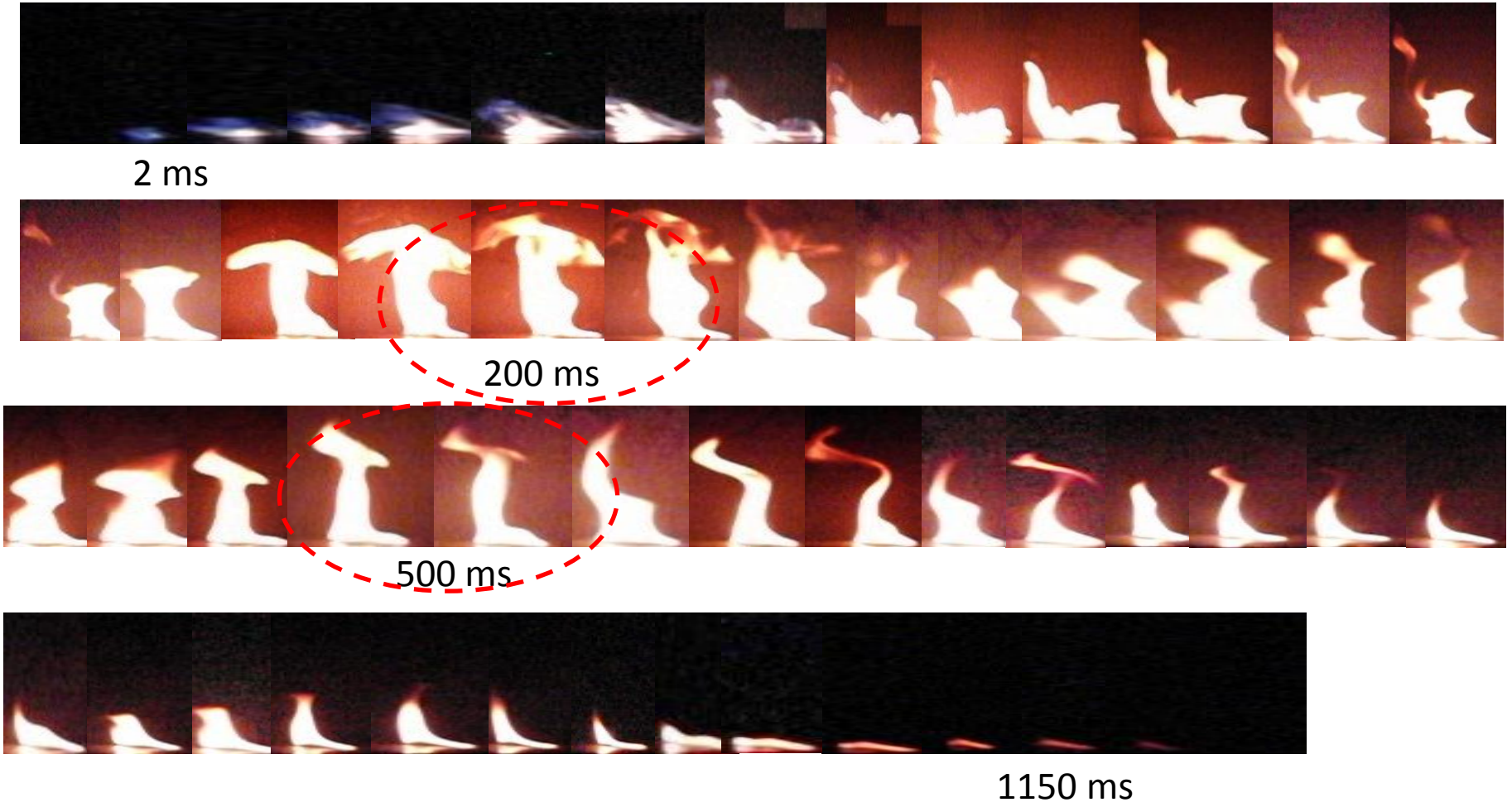
VEGETABLE OIL (**CEIBA PENTANDRA**)
15% GLYCEROL



MULTICOMPONET OIL COMBUSTION

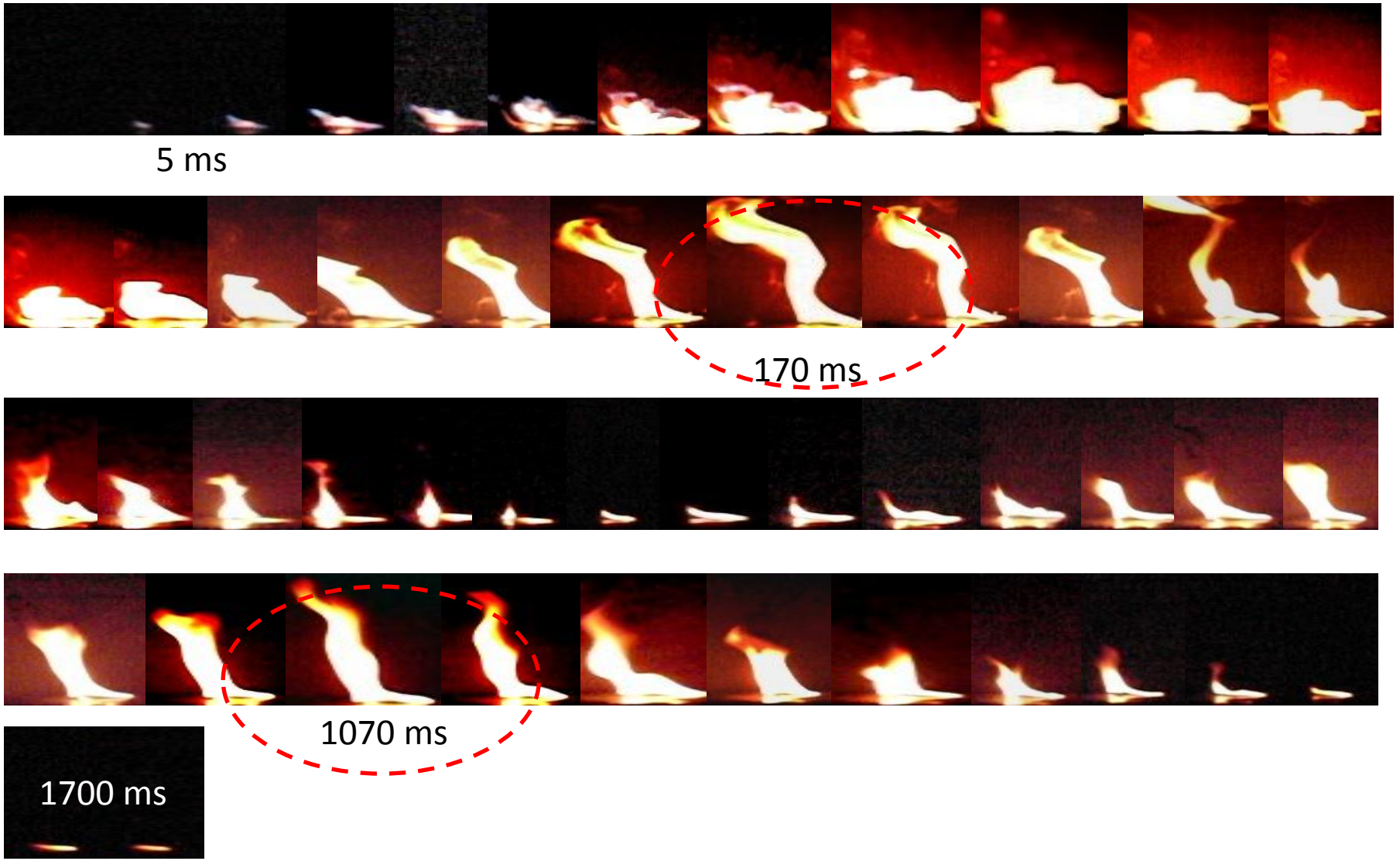
JATROPHA OIL

4.4% GLYCEROL

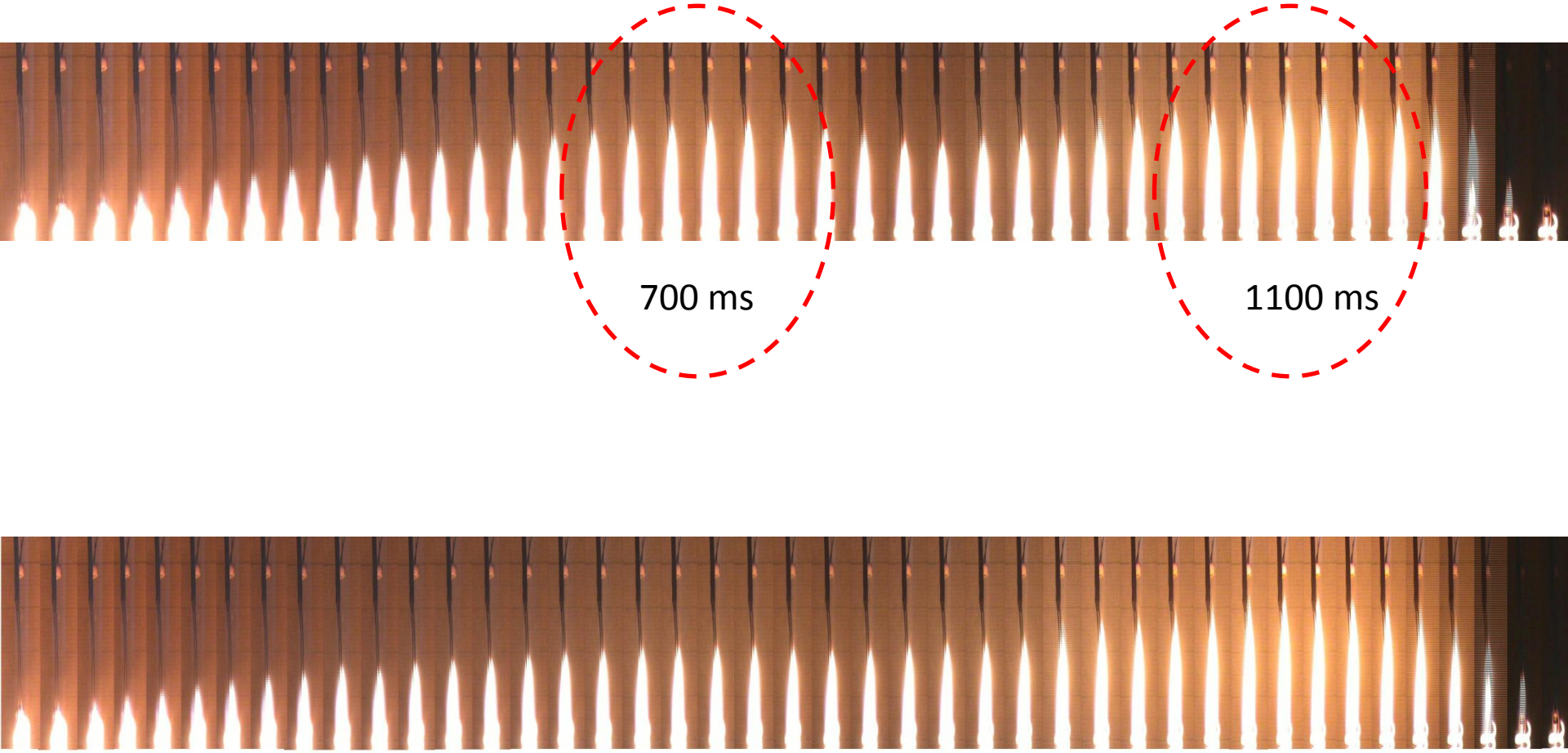


MULTICOMPONET OIL COMBUSTION

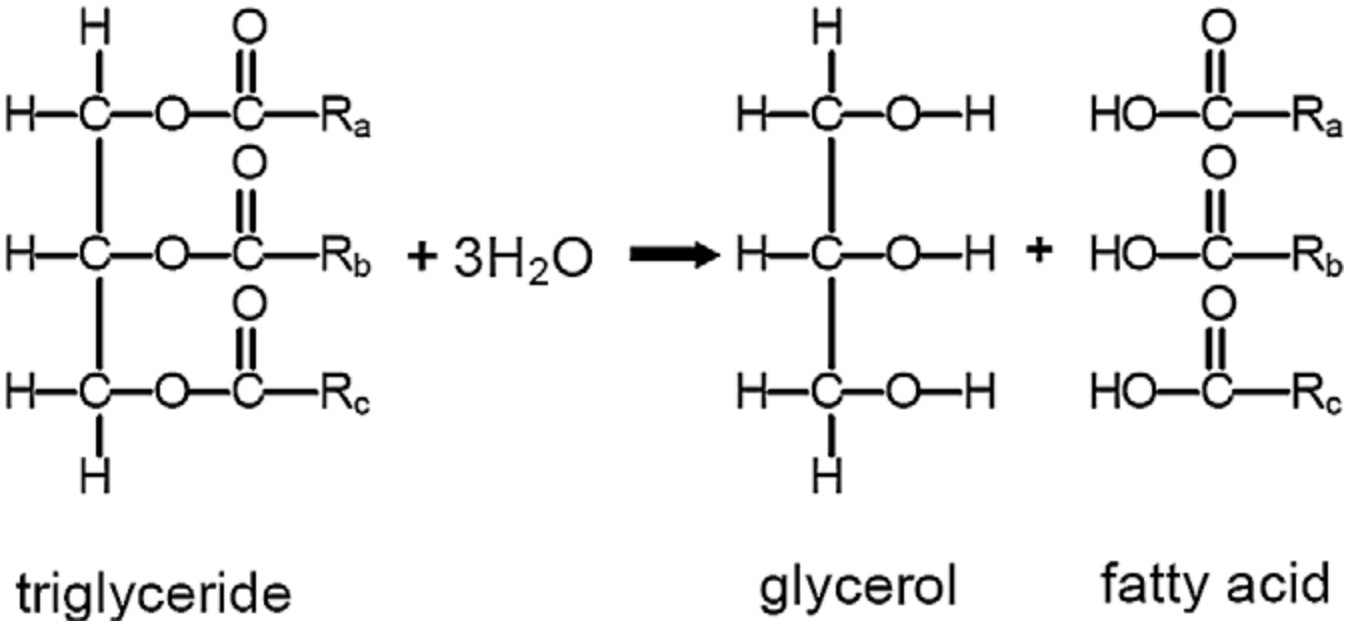
COTTONSEED OIL: 11.3% GLYCEROL



COCONUT OIL



HYDROLYSIS



Wardana I.N.G., *Fuel*, **89**, 2010, 659-664

OBJECTIVE

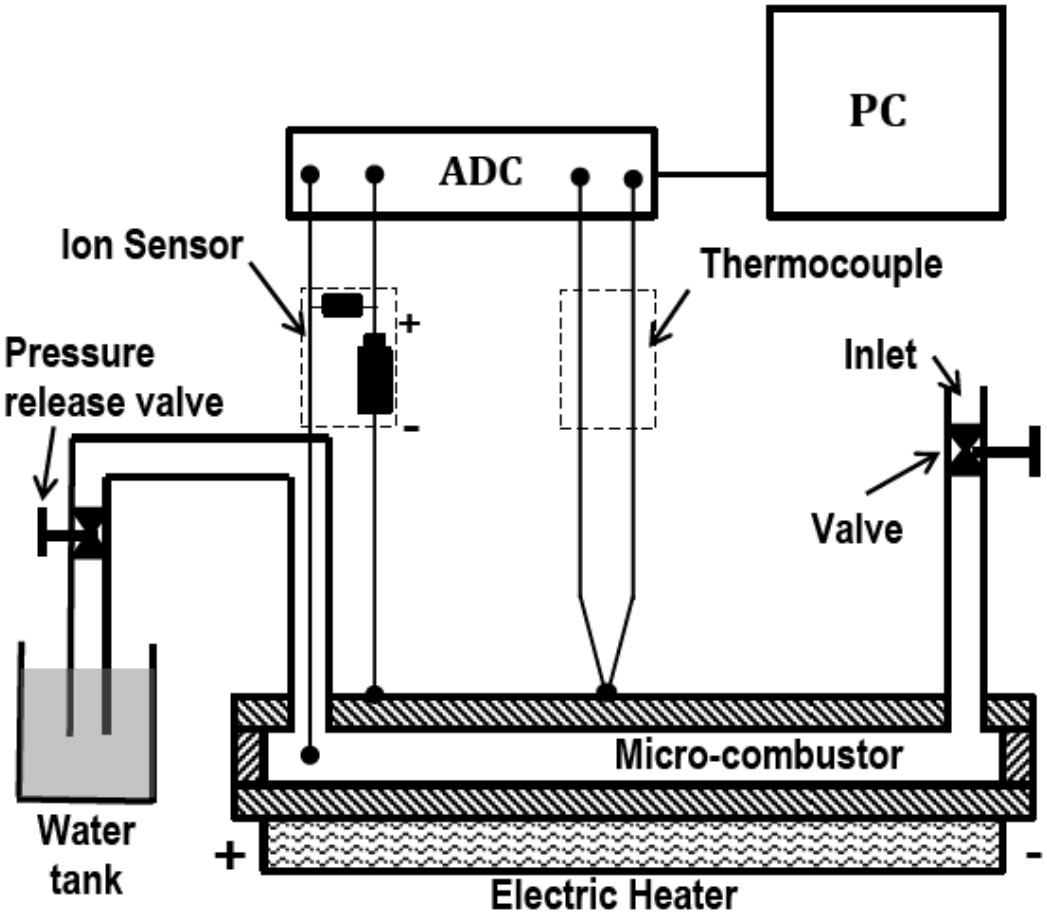
- To study the possibility of premixed combustion for coconut oil in micro combustor.

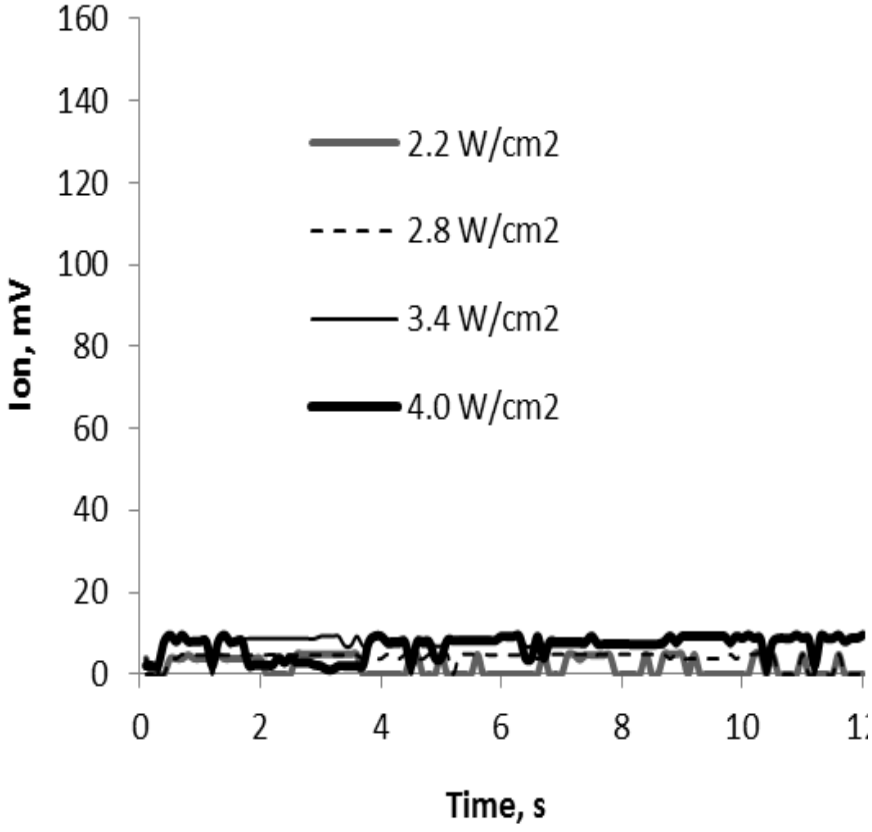
- To study the influence of heat flux or heat loss on the premixed combustion characteristics of coconut oil

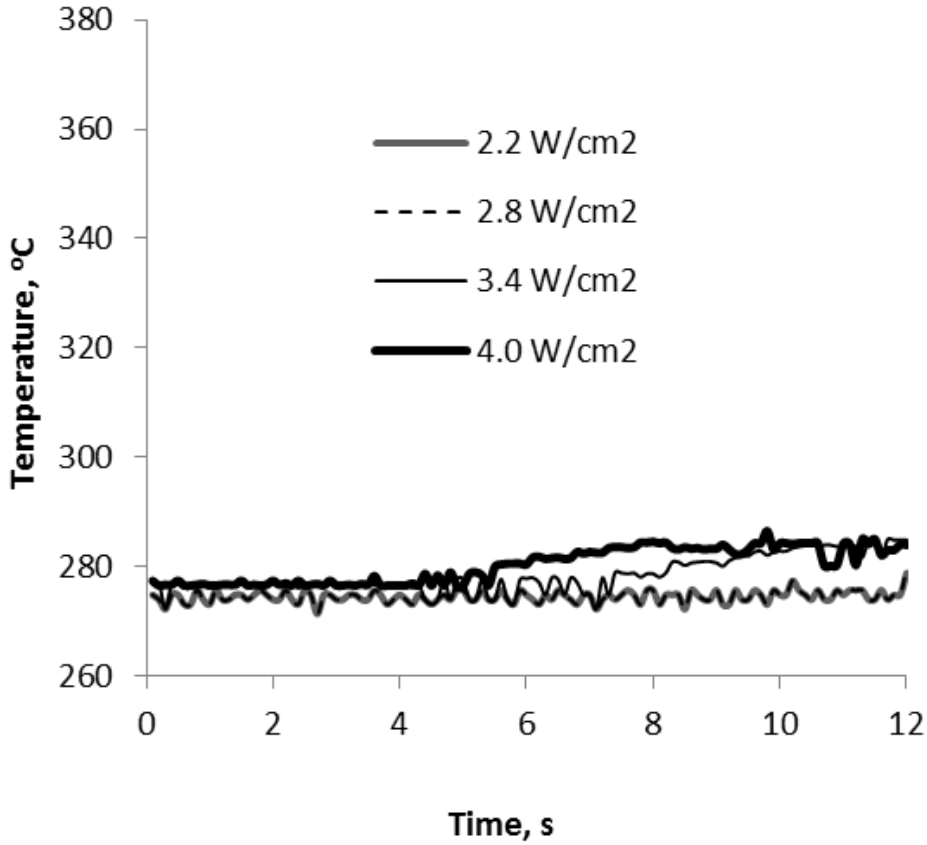
FUTURE GOAL

- To promote premixed combustion technology for coconut oil

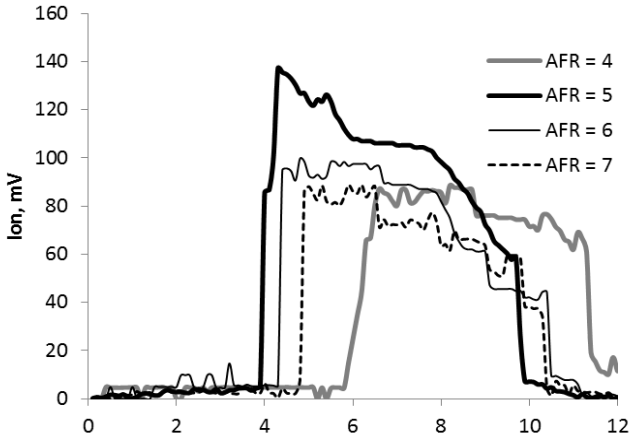
EXPERIMENT

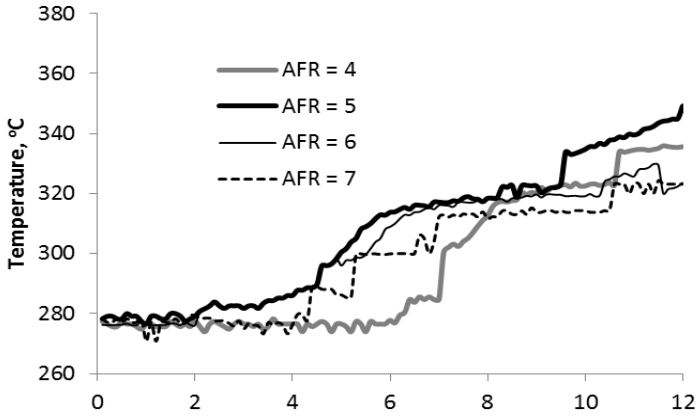

PC
ADC
Ion Sensor
Thermocouple
+
-
Pressure
release valve
Inlet
Valve
Micro-combustor
Water
tank
+
-
Electric Heater



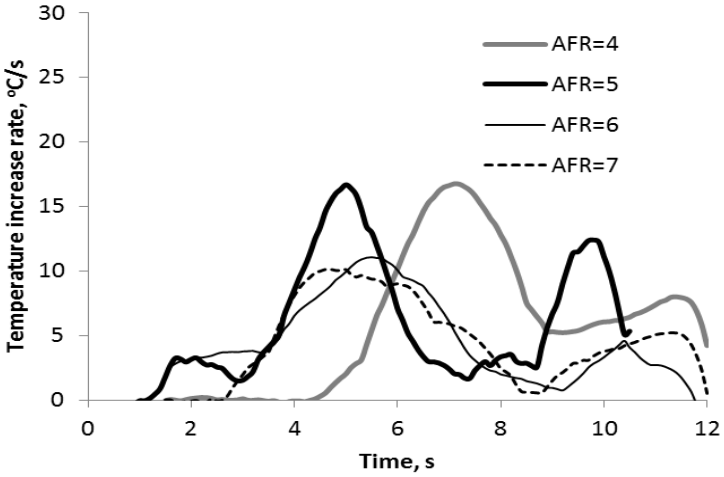


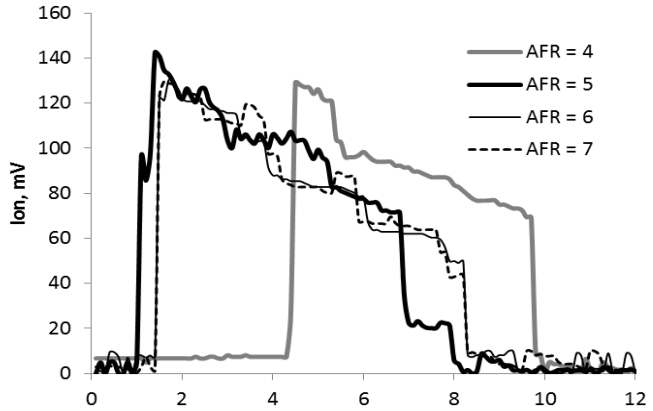
Ion concentration and temperature at AFR = 3

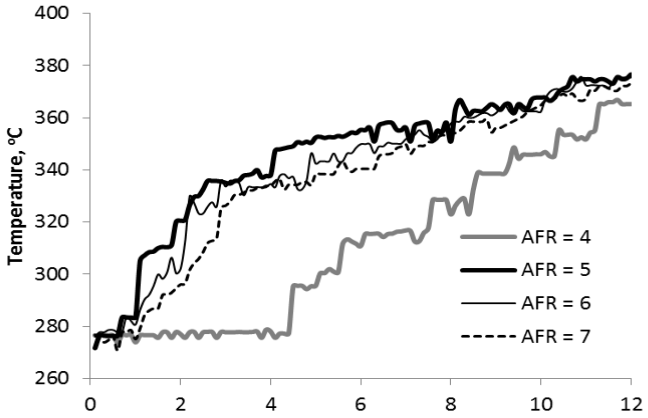


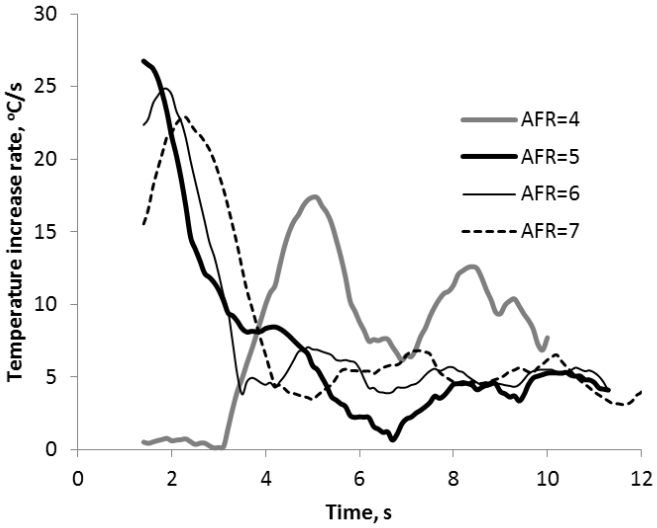


HEAT FLUX = 2.2 W/cm^2

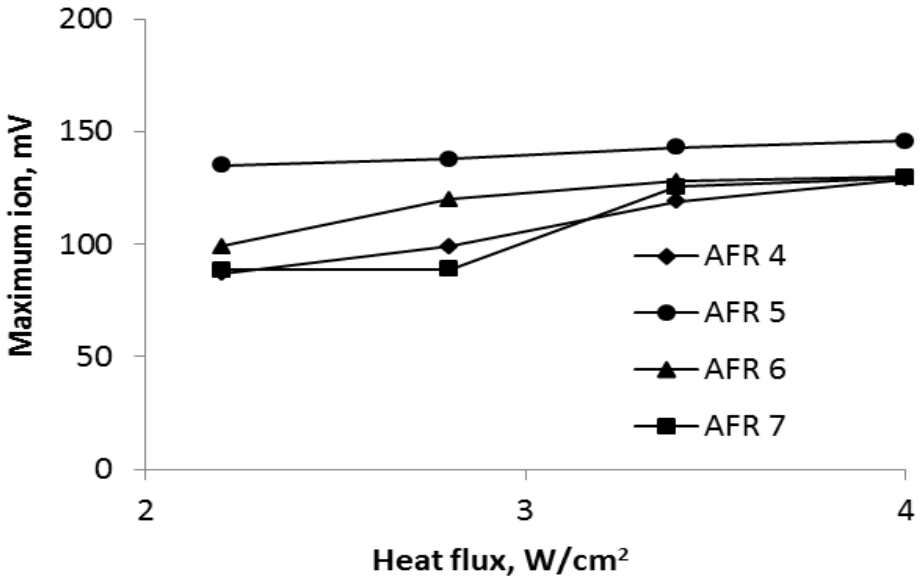


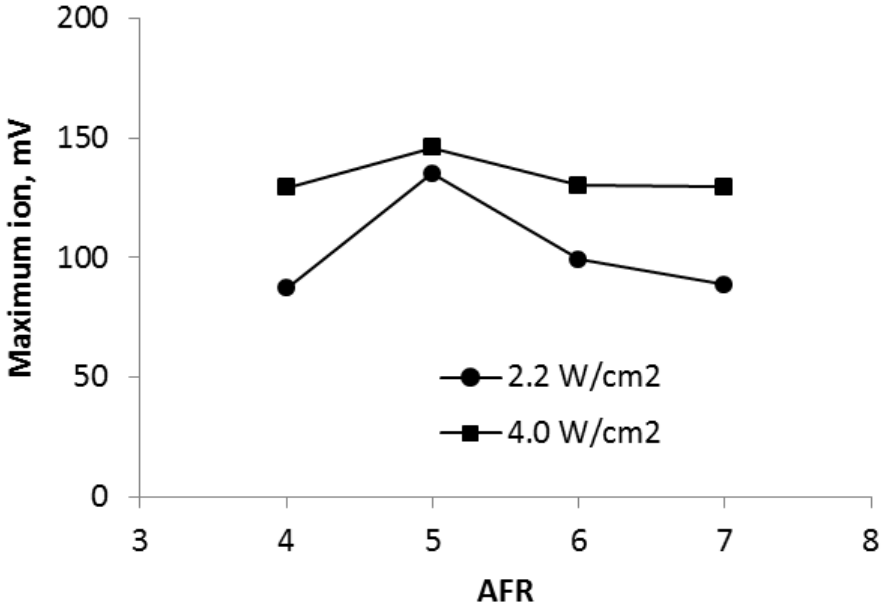






HEAT FLUX = 4.0 W/cm^2


200
150
100
50
0
Maximum ion, mV
2
3
4
Heat flux, W/cm²
AFR 4
AFR 5
AFR 6
AFR 7


200
150
100
50
0
Maximum ion, mV
3
4
5
6
7
8
AFR
2.2 W/cm2
4.0 W/cm2

CONCLUSION

1. At lower wall heat flux, the burning process of coconut oil has 3 periods. The fatty acids burn in the 1st period which release high thermal energy. The glycerol which is hygroscopic absorbs substantial heat energy for evaporation in the 2nd period. This heat absorption interrupts the burning process so that the glycerol burns in the 3rd period with lower heat energy release.

CONCLUSION

2. At higher wall heat flux the thermal energy is sufficient to overcome the heat absorbed by evaporation of glycerol so that the multi-component in the coconut oil burn simultaneously without interruption by evaporation.
3. The combustion of coconut oil in micro combustor is the best at AFR equals 5.