

GFOP

Green Fuel Oil Processor



TAIWAN WOLMO INC

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FEATURES OF HEAVY FUEL OIL

- **HFO & ITS FEATURES**

1. HFO IS BOTTOM RESIDUE FROM THE TOPPING UNIT , WHICH IS OF HIGH CALORIFIC VALUE (8,500~11,000 Kcal/kg) , WITH HIGH CONCENTRATION OF ASPHALTENE AND SULFATE
2. POPULAR TO USE DUE TO COST-EFFICIENCY

- **PROBLEMS**

1. HIGH POLLUTION EMISSION PROBLEMS SUCH AS S.S , SO_x , NO_x , NO , CO AND FLARE GAS TEMP.
2. CAUSES PROBLEMS DUE TO BLOCKAGE OF ASPHALTENE IN THE PIPELINE & INJECTION NOZZLE OF THE BURNER BECAUSE OF NEED TO BE CONSTANTLY HEATED TO MINIMIZE THE VISCOSITY OF HFO

THE EXISTING SOLUTION (1)

DOSING ADDITIVE:

- INCLUDING DISPERSANT, DE-EMULSIFIER AND SO ON , MANUFACTURERS INCLUDE Bycosin AB (Sweden) , Octel (USA), Alken Murray(USA), Firson (Taiwan), Unik (India), WRT (The Netherlands), Infineum (UK),AND SO ON.

PROBLEMS

1. HIGH COST OF ADDITIVE , REDUCES COST-SAVING
 2. REQUIRES AUXILIARY EQUIPMENT
- AVERAGE SAVING RATE : 2~3%

THE EXISTING SOLUTION (2)

USING HOMOGENIZER

- DILUTION OF ASPHALTENE, TO INCREASE OXYGENISATION OF THE OIL DROPLET

PROBLEM

- IT TENDS TO REDUCE THE DROPLET SIZE TO INCREASE THE AMOUNT OF OXYGEN
NEVERTHELESS, THE PROBLEMS CAUSED BY ASPHALTENE WILL HAVE AN EFFECT.

ENERGY SAVING RATE: 2~3%

THE EXISTING SOLUTION (3)

USING EMUSIFIED FUEL OIL

- A FURTHER ALTERNATIVE SOLUTION IS TO USE EMULSIFIED FUEL OIL. IT CAN EITHER BE OIL-IN-WATER IN WHICH WATER IS IN CONSTANT PHASE, OR WATER-IN-OIL IN WHICH OIL IS IN CONSTANT PHASE. DURING THE BURN, WATER IS EVAPORATED AND SEPARATES FROM THE OIL DROPLET, SO THAT THE OIL DROPLETS CAN THEN BE ATOMIZED INTO A HUGE NUMBER OF MUCH SMALLER DROPLETS IN ORDER TO ABSORB MUCH MORE OXYGEN.

PROBLEMS

1. DE-EMULSIFICATION CAN OCCUR EASILY DUE TO HEATING OF THE PRODUCT DURING TRANSPORTATION CAUSING PARTIAL SEPARATION
2. OPTIMIZATION TO FIT EACH INDIVIDUAL APPLICATION IS NOT POSSIBLE

MEAN ENERGY SAVING RATE: 10% (DEPENDING ON WATER DOSING RATE)

COMPARASION FOR THE SOLUTIONS


COMPARA- SION \ SOLUTION	USING ADDITIVE	USING HOMOGENIZER	USING EMULSIFIED FUEL OIL
1. FUEL SAVING (DECREASING FUEL CONSUMPTION)	LOW (2~3%)	LOW (2~3%)	HIGH*(~10%) (DEPENDING ON WATER DOSING RATE)
2. EMISSION REDUCTION	HIGH*	MED	HIGH*
3. STABLIZATION	HIGH*	HIGH*	LOW
4. PERIPHERIES REQUIRED	HIGH	HIGH	LOW*
5. BENEFITS	LOW	MED	HIGH*

REMARKS: THE LOWER THE BETTER IN ITEM 4, THE HIGHER THE BETTER FOR ALL OTHER ITEMS

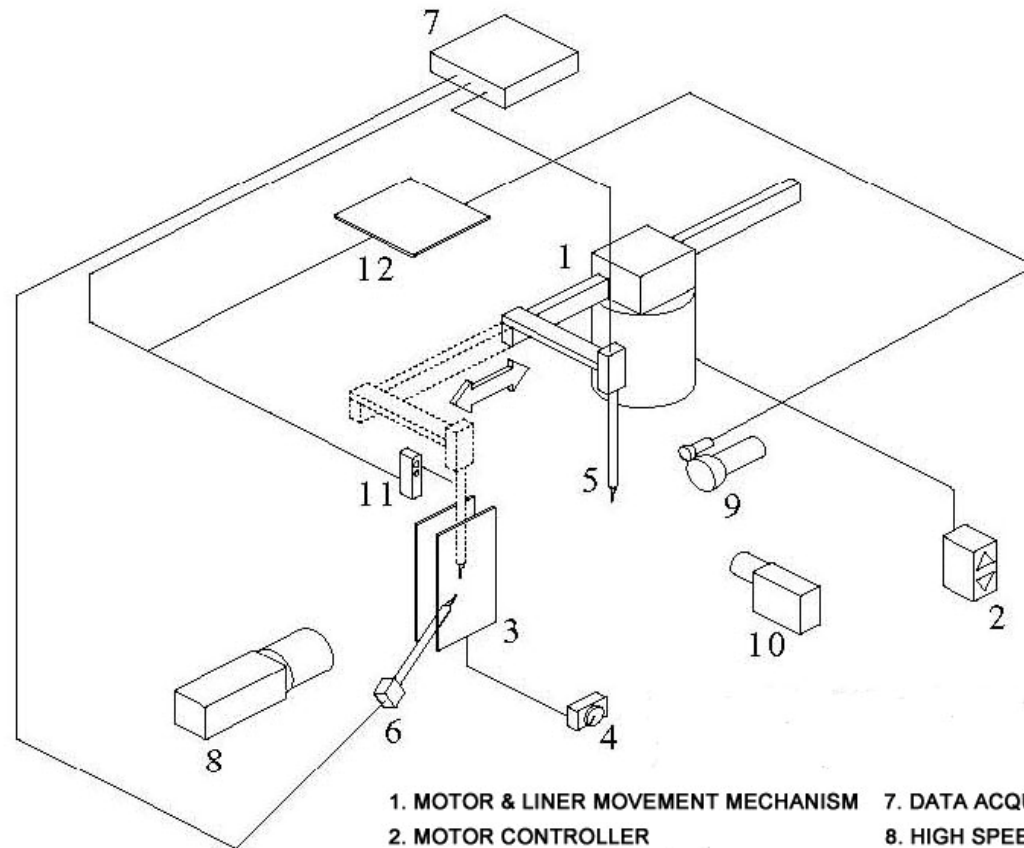
TOTAL SOLUTION – GFOP GREEN FUEL OIL PROCESSOR ON-LINE

CONCEPT OF GFOP

1. PROCESSING ON-LINE, AVOIDING DE-EMULSIFIED PROBLEM IN TRANSPORTATION
2. HOMOGENIZATION OF FUEL OIL + EMULSIFIER + WATER. COMBUSTION EFFICIENCY OF THIS GREEN FUEL OIL IS MUCH BETTER DUE TO SECONDARY ATOMIZATION OF ATOMIZED OIL IN COMBUSTION CHAMBER, FUEL SAVING CAN BE AS HIGH AS 15%)
3. COMPLETELY HOMOGENIZED & STABILIZED
4. DOSING RATE OF WATER CAN BE OPTIMIZED FOR EACH INDIVIDUAL APPLICATION

- 
- SECONDARY ATOMIZATION
= KEY OF GFOP PROCESS
TO ACHIEVE FUEL SAVING &
EMISSION REDUCTION

CONFIGURATION FOR OBSERVATION OF SECONDARY ATOMIZATION



- | | |
|-------------------------------------|--------------------------------|
| 1. MOTOR & LINER MOVEMENT MECHANISM | 7. DATA ACQUISITION & COMPUTER |
| 2. MOTOR CONTROLLER | 8. HIGH SPEED CAMERA |
| 3. ELEC. HEATING PLATE | 9. LIGHT & LED FOR MARKING |
| 4. THERMAL CONTROLLER | 10. DIGITAL CAMERA |
| 5. MOVABLE THERMAL HEATER | 11. LIGHT CONTROL SWITCH |
| 6. FIXED THERMAL HEATER | 12. DELAY CIRCUIT |

PROCESS OF SECONDARY ATOMIZATION – TEST REPORT

1. HEATING ATOMIZED OIL DROPLET



2. WHEN TEMP EXCEEDS 100°C, WATER IN ATOMIZED OIL DROPLET STARTS TO EVAPORATE AND VOLUME OF WATER EXPANDS RAPIDLY



3. WHEN THE STEAM PRESSURE IS IN EXCESS OF THE SURFACE TENSION, SECONDARY ATOMIZATION OCCURS (MICRO EXPLOSION)



4. MICRO-EXPLOSION CAUSES ATOMIZED OIL DROPLETS TO SPLIT INTO A HUGE NUMBER OF SMALLER OIL DROPLETS

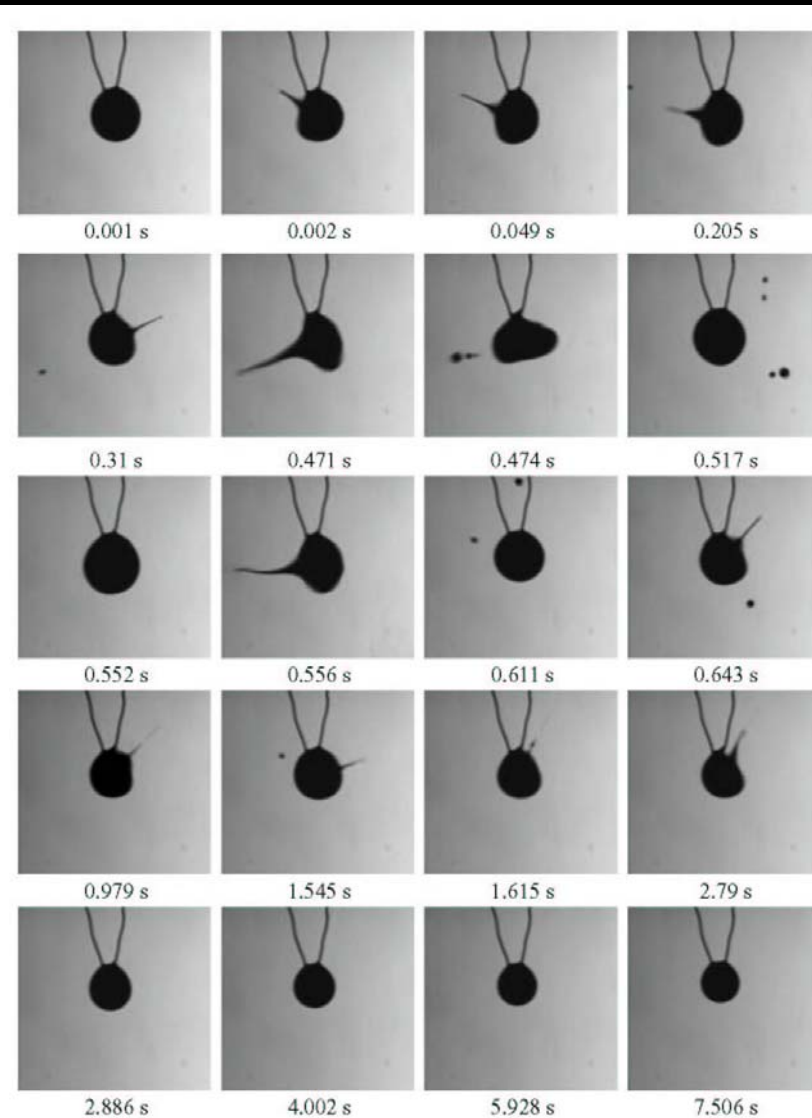


FIG6 $T_c = 300^\circ\text{C}$, $D = 0.94 \text{ mm}$ Oil sample F03-29-07A,
Oil droplet heating test # E04-14-07, showing its changing constantly

SECONDARY ATOMIZATION – TEST REPORT (SECONDARY MICRO-EXPLOSION)

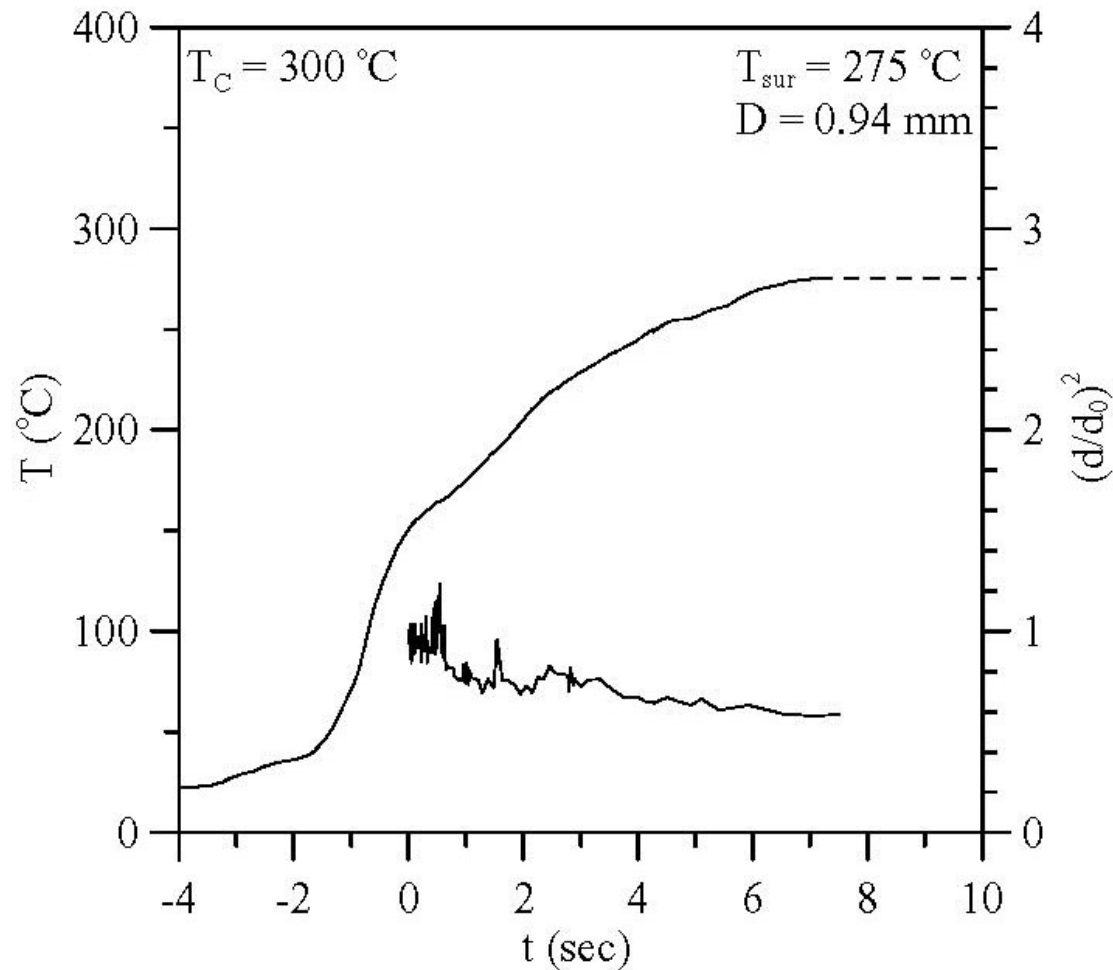
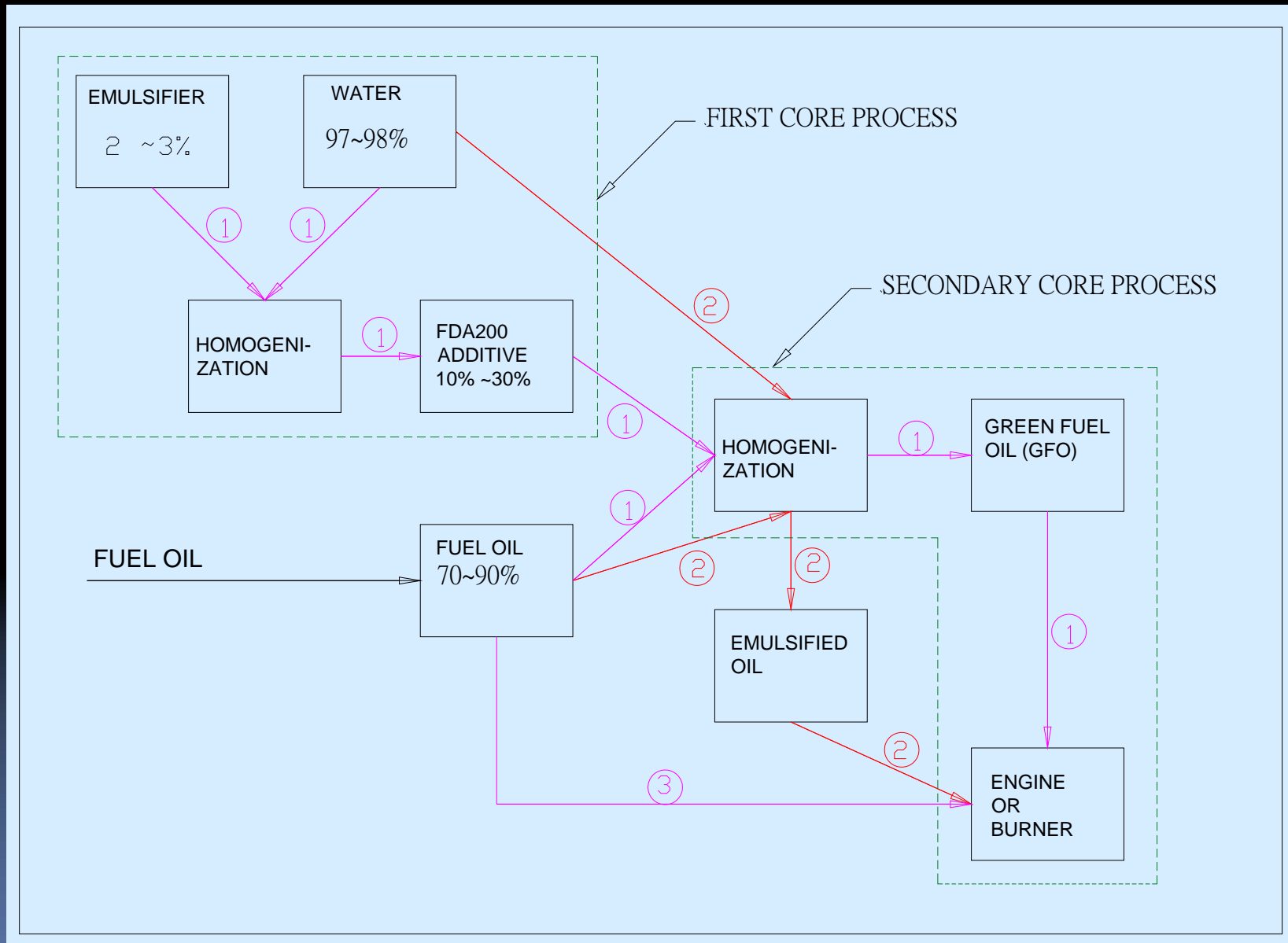


Fig4 $T_c = 300^{\circ}\text{C}$, use oil sample F03-29-07A, test # E04-14-07

GFOP vs. EMULSIFIED FUEL OIL

COMPARASION	GFOP	USING EMULSIFIED FUEL OIL
CORE TECHNOLOGY	SECONDARY ATOMIZATION	SECONDARY ATOMIZATION
PREPARATION & APPLICATION	ON-LINE	PREPARED AT FACTORY AND SHIPPED TO THE USER
TRANSPORTATION MANAGEMENT	NONE	REQUIRED
DOSING RATE OF WATER & EMULSIFIER	OPTIMIZED ON-LINE	DETERMINED BY THE EMULSIFIED OIL MANUFACTURER

CORE PROCESSES OF GFOP



FS2+WATER+HOMOGENIZATION=ADDITIVE FDA200



+



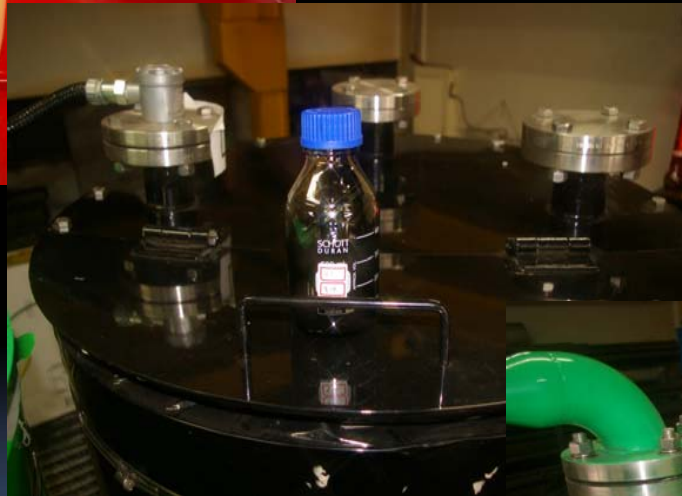
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FDA200 ADDITIVE + FUEL OIL + HOMOGENIZATION =GREEN FUEL OIL



+



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GFOP PACKAGED UNIT



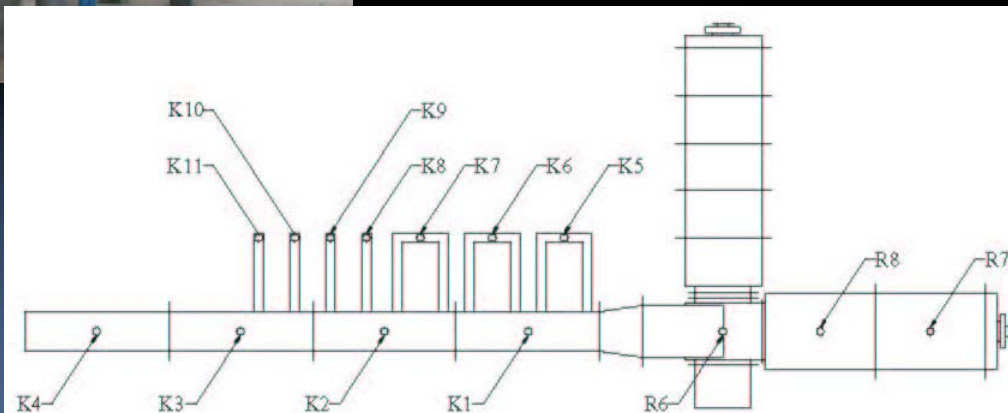
TEST REPORT OF GFOP



#6 FUEL OIL VS. GREEN FUEL OIL TEST BURNER



FUEL BURNER



TEMPERATURE TEST POINTS ON HORIZONTAL BURNER

#6 FUEL OIL VS. GREEN FUEL OIL TEMPERATURE COMPARASION (3)

FUEL OIL	#6 FUEL OIL %	WATER CONTENT %	FS2 EMULSIFIER %	FLAME TEMP. LOWEST °C (R7)	FLAME TEMP. HIGHEST °C (R7)
#6 FUEL OIL	100%	0%	0%	1118	1144
GFO #1	86.55%	12.80%	0.65%	1102	1108
GFO#2	72.97%	25.70%	1.33%	1045	1066
GFO#3	67.98%	31.06%	0.96%	991	997

*BASE OF GREEN FUEL OIL (GFO) ARE #6 HEAVY FUEL OIL

#6 FUEL OIL VS. GREEN FUEL OIL TEMPERATURE COMPARASION- TEST REPORT (1)

CST/ME/NCKU 測試報告 No.RF05-14-07C

#6 FUEL OIL

96年5月14日

燃燒性能 (油品編號: F03-08-07, 測試編號: B03-22-07C)

時間* (分)	0	30	60	90	120	150	180	
R7 (°C)	1118	1127	1142	1135	1140	1145	1144	
R8 (°C)	986	986	994	992	999	1002	998	
R6 (°C)	815	816	820	824	827	827	833	
T _{flue gas} (°C)	223	225	226	222	228	228	230	
O ₂ (%)	3.5	3.6	3.4	3.7	3.5	3.5	3.7	
CO (ppm)	0	0	0	1.9	3.2	0.9	0	
CO ₂ (%)	13.9	14	14	13.7	13.9	13.9	14	
NO _x (ppm)	原始數據	349	389	378	367	353	377	371
	6% O ₂ 修正	299	336	322	318	303	323	321
SO _x (ppm)	原始數據	203	194	208	206	211	215	218
	6% O ₂ 修正	174	167	178	178	181	184	189

* 經 1 小時預燃測試油品後，才開始計時。

GFO#1

燃燒性能 (油品編號: F03-29-07A, 測試編號: B03-29-07A)

時間* (分)	0	30	60	90	120	150	180	
R7 (°C)	1102	1116	1106	1112	1108	1107	1106	
R8 (°C)	959	968	962	965	964	963	963	
R6 (°C)	787	790	792	798	794	796	799	
T _{flue gas} (°C)	205	203	205	205	203	204	205	
O ₂ (%)	4	4.1	3.8	3.6	3.8	4.2	4.5	
CO (ppm)	0	0	0	7	0	5	0	
CO ₂ (%)	13.4	13.6	13.3	13.6	13.5	13.4	13.1	
NO _x (ppm)	原始數據	349	347	352	337	341	349	338
	6% O ₂ 修正	308	308	307	290	297	312	307
SO _x (ppm)	原始數據	187	191	182	188	197	191	180
	6% O ₂ 修正	165	170	158	162	171	171	164

* 經 1 小時預燃測試油品後，才開始計時。

#6 FUEL OIL VS. GREEN FUEL OIL TEMPERATURE COMPARASION- TEST REPORT (2)

CST/ME/NCKU 測試報告 No.RF05-14-07C

GFO#2

96年5月14日

燃燒性能 (油品編號: F03-29-07B, 測試編號: B03-29-07B)								
時間* (分)	0	30	60	90	120	150	180	
R7 (°C)	1045	1053	1057	1060	1062	1060	1066	
R8 (°C)	915	919	923	925	927	926	930	
R6 (°C)	757	759	760	761	765	762	763	
T _{flue gas} (°C)	197	197	198	197	196	195	193	
O ₂ (%)	4.4	4.2	4.5	4.9	4.3	4.8	5	
CO (ppm)	8.6	0	0	0	11.5	1.5	0	
CO ₂ (%)	13.1	12.9	12.7	12.7	13.1	12.7	12.4	
NO _x (ppm)	原始數據	249	272	274	286	262	277	289
	6% O ₂ 修正	225	243	249	266	235	256	269
SO _x (ppm)	原始數據	206	213	212	214	237	233	235
	6% O ₂ 修正	186	190	192	199	213	215	220

* 經 1 小時預燃測試油品後，才開始計時。

GFO#3

燃燒性能 (油品編號: F04-03-07, 測試編號: B04-03-07)								
時間* (分)	0	30	60	90	120	150	180	
R7 (°C)	974	987	983	983	989	991	997	
R8 (°C)	857	862	863	862	865	866	869	
R6 (°C)	706	712	707	708	705	705	706	
T _{flue gas} (°C)	169	169	168	167	166	165	164	
O ₂ (%)	5.7	5.9	7.1	7	7	7	6.8	
CO (ppm)	0	0	0	7	0	5	0	
CO ₂ (%)	12	11.9	11	11.1	11.1	11.3	11.4	
NO _x (ppm)	原始數據	206	202	208	211	210	210	210
	6% O ₂ 修正	202	201	225	226	225	225	222
SO _x (ppm)	原始數據	213	223	205	212	214	209	220
	6% O ₂ 修正	208	222	222	227	229	224	232

* 經 1 小時預燃測試油品後，才開始計時。

#6 FUEL OIL VS. GREEN FUEL OIL PRE-HEATING TEMP – TEST REPORT

CST/ME/NCKU 測試報告 No.RF05-14-07C

96年5月14日

		PRE-HEATING TEMP.	TRANSPORTATION		
		#6 fuel oil	GFO#1 燃燒性能	GFO#2	GFO#3
FUEL #	油品編號	F03-08-07	F03-29-07A	F03-29-07B	F04-03-07
TEST #	測試編號	B03-22-07C	B03-29-07A	B03-29-07B	B04-03-07
測試油品	輸送過程	80°C	60°C		
預熱溫度	燃油霧化	90°C	80°C		
燃油供油率 (L/h)		ATOMIZATION 20			
二次空氣供給率(m ³ /h)		170	145	135	110
燃燒爐內壓力(Pa)		-100±20			
燃燒爐預熱過程		以柴油燃燒約 17 時直到 R7 溫度接近 1140°C。			
測試油品預燃過程		預燃測試油品 1 小時，以清除管路中前次測試之殘油。			

*BASE OF GREEN FUEL OIL (GFO) ARE #6 HEAVY FUEL OIL

#6 FUEL OIL VS. GREEN FUEL OIL COMPARASION – SECONDARY AIR SUPPLY

FUEL OIL	#6 FUEL OIL %	WATER CONTENT %	FS2 ADDITIVE %	FUEL FLOW RATE L/Hr	BLOWN AIR M3/hr
#6 FUEL	100%	0%	0%	20	220
GFO #1	86.55%	12.80%	0.65%	20	195
GFO#2	72.97%	25.70%	1.33%	20	185
GFO#3	67.98%	31.06%	0.96%	20	160

* BASE OIL OF GREEN FUEL OIL (GFO) ARE #6 HEAVY FUEL OIL

#6 FUEL OIL VS. GREEN FUEL OIL TEST RECORD- SECONDARY AIR SUPPLY – TEST REPORT (1)

ICKU 測試報告 No.RF05-14-07C

96年5月14日

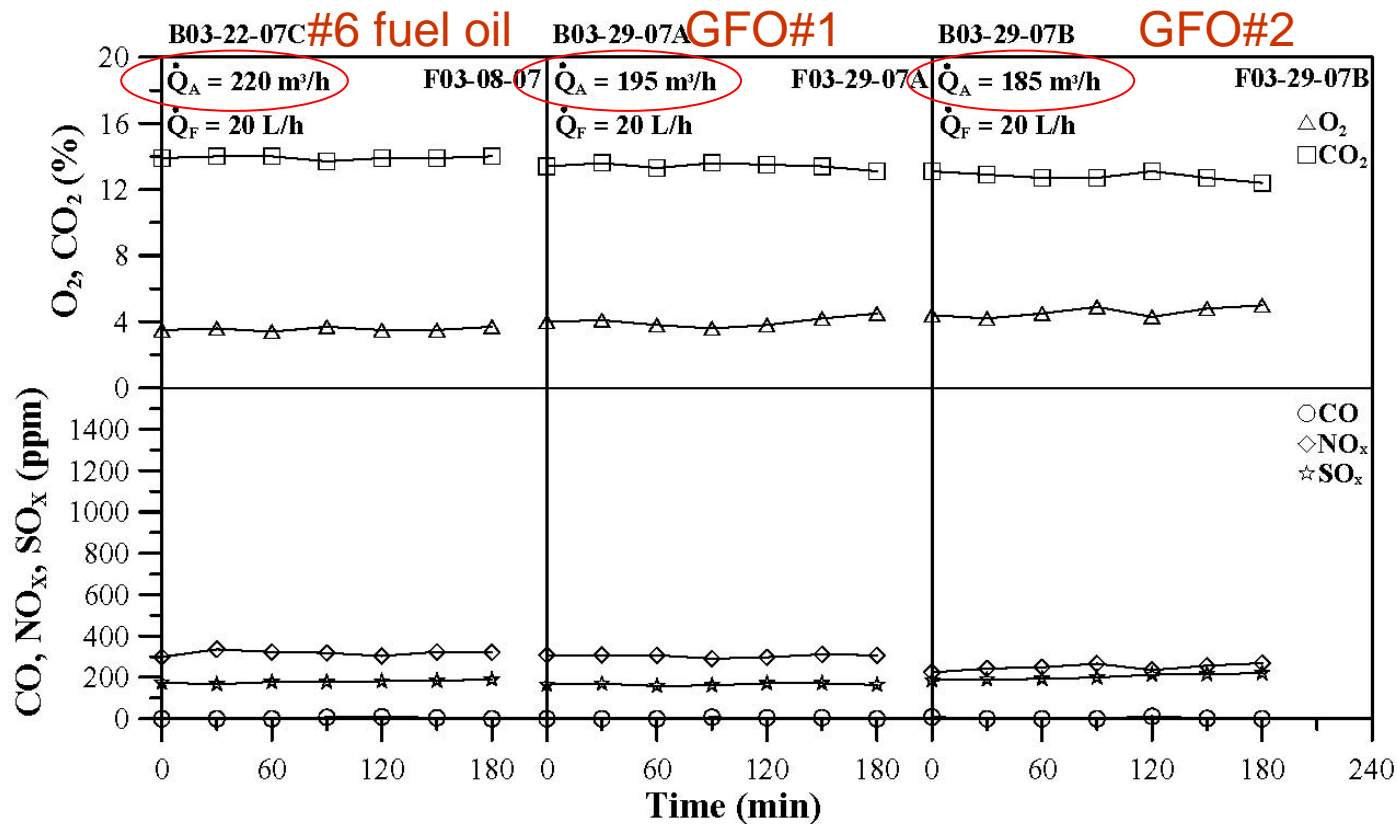


圖 34 使用編號 F03-08-07、F03-29-07A 與 F03-29-07B 油品進行燃燒性能測試之排放特性比較圖

#6 FUEL OIL VS. GREEN FUEL OIL TEST RECORD- SECONDARY AIR SUPPLY- TEST REPORT(2)

CKU 測試報告 No.RF05-14-07C

96年5月14日

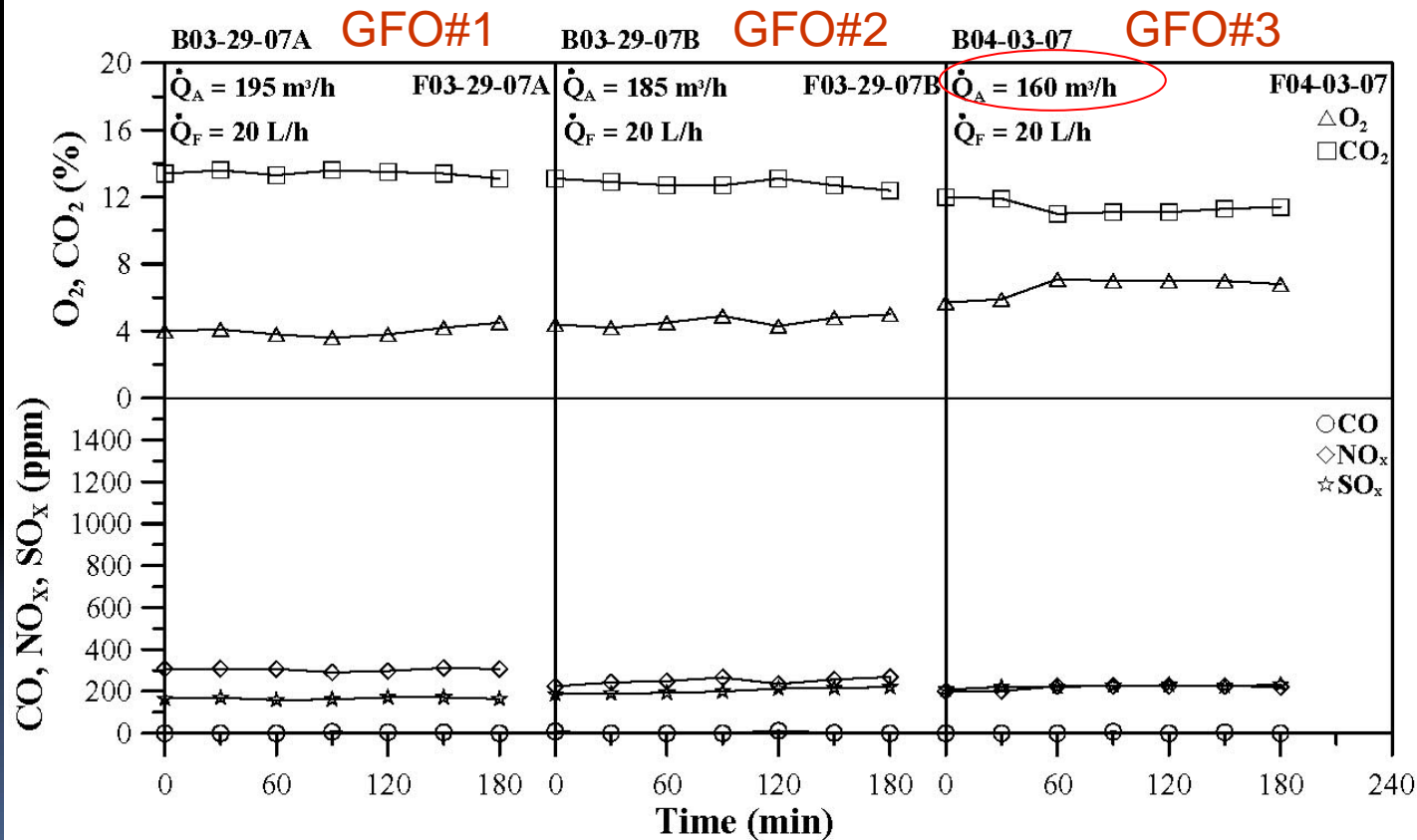


圖 36 使用編號 F03-29-07A、F03-29-07B 與 F04-03-07 油品進行燃燒性能測試之排放特性比較圖

#6 FUEL OIL VS. GREEN FUEL OIL COMBUSTION EFFICIENCY

FUEL OIL	#6 FUEL OIL %	WATER CONTENT %	FS2 ADDITIVE CONTENT %	LOWEST COMBUSTION EFF. %	HIGHEST COMBUSTION EFF. %
#6 FUEL OIL	100%	0%	0%	84%	85%
GFO #1	86.55%	12.80%	0.65%	85%	86%
GFO#2	72.97%	25.70%	1.33%	86%	87%
GFO#3	67.98%	31.06%	0.96%	86%	87%

*BASE OF GREEN FUEL OIL (GFO) ARE #6 HEAVY FUEL OIL

#6 FUEL OIL VS. GREEN FUEL OIL COMBUSTION EFFICIENCY- TEST REPORT (1)

KU 測試報告 No.RF05-14-07C

96 年

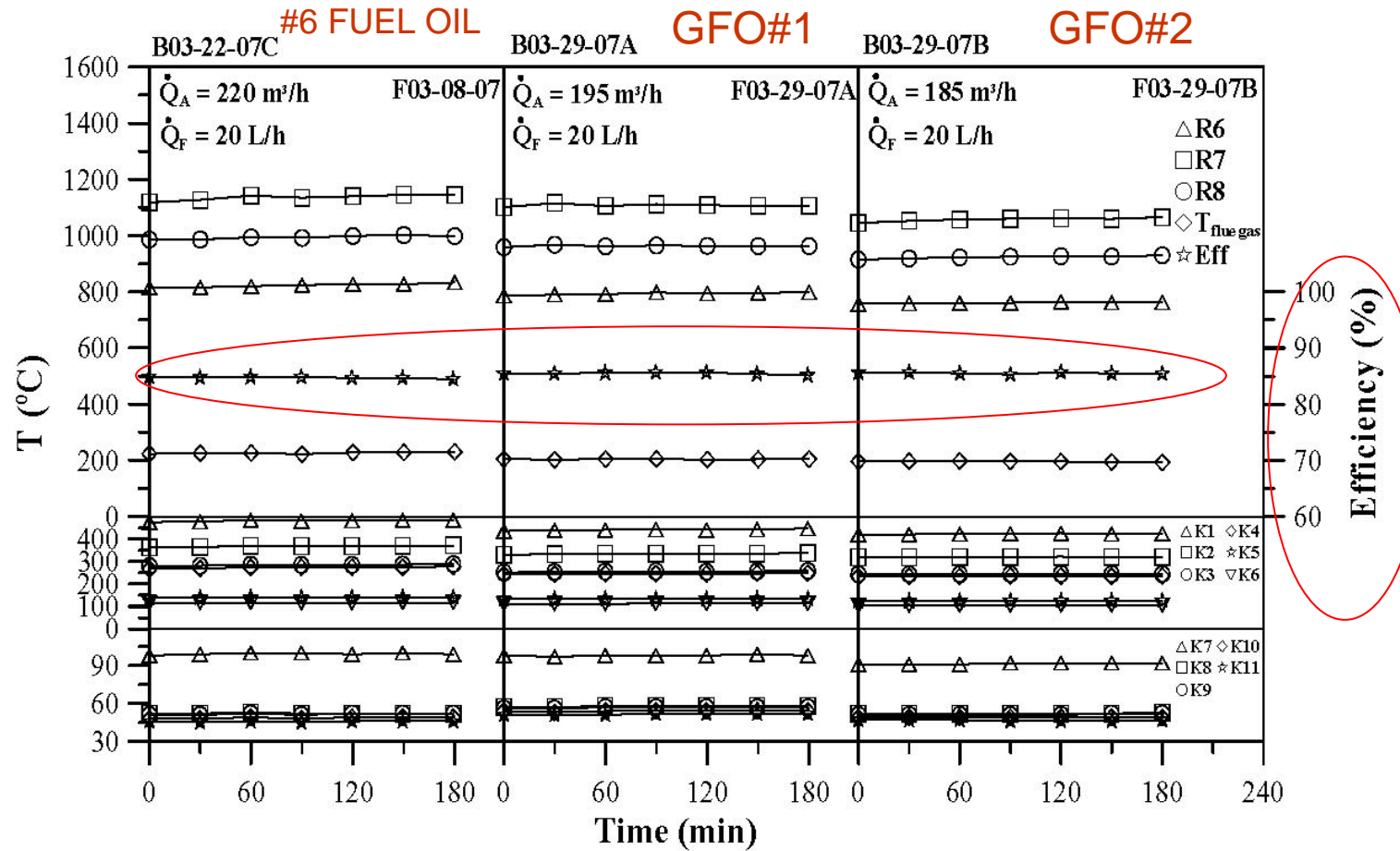


圖 33 使用編號 F03-08-07、F03-29-07A 與 F03-29-07B 油品進行燃燒性能測試之溫度變化比較圖

#6 FUEL OIL VS. GREEN FUEL OIL COMBUSTION EFFICIENCY-TEST REPORT (2)

KU 測試報告 No.RF05-14-07C

96 年

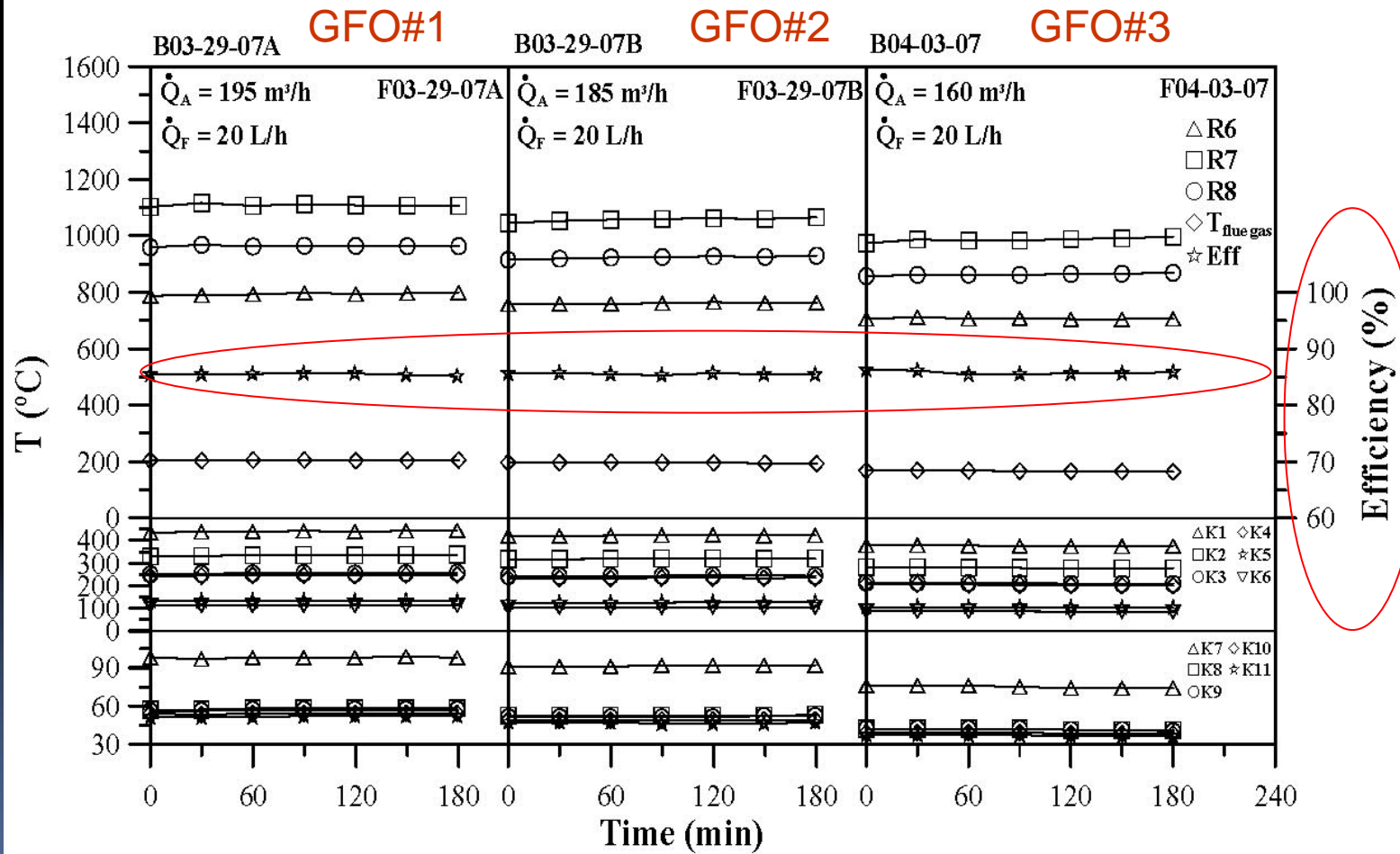


圖 35 使用編號 F03-29-07A、F03-29-07B 與 F04-03-07 油品進行燃燒性能測試之溫度變化比較圖

#6 FUEL OIL VS. GREEN FUEL OIL COMPARASION – CALORIC VALUE

FUEL OIL	#6 FUEL OIL %	WATER CONTENT %	FS2 ADDITIVE CONTENT %	NET HEATING VALUE Cal/g
#6 FUEL OIL	100%	0%	0%	10,627
GFO #1	86.55%	12.80%	0.65%	10,162
GFO#2	72.97%	25.70%	1.33%	8,941
GFO#3	67.98%	31.06%	0.96%	7,443

- BASE OF GREEN FUEL OIL (GFO) ARE #6 FUEL OIL
- TEST METHOD ASTM D240 (SHOWN ON TEST REPORT)

#6 FUEL OIL VS. GREEN FUEL OIL COMPARASION – CALORIC VALUE – TEST REPORT

CST/ME/NCKU 測試報告 No.RF05-14-07C

96年5月14日

3. 測試油品特性 #6 fuel oil GFO#1 GFO#2 GFO#3

FUEL	油品編號	F03-08-07	F03-29-07A	F03-29-07B	F04-03-07	檢驗方法	
DENSITY	密度@15.5°C, kg/L	0.9495	0.9258	0.9332	0.9488	ASTM D1298	
FLASH POINT	閃火點, °C	141	-	-	-	ASTM D93	
SULFATE	含硫量, wt%	0.42	0.39	0.26	0.16	ASTM D4294	
POUR POINT	流動點, °C	24	21	21	24	ASTM D97	
K. VISCOSITY	動力黏度, cSt	@50°C	79.01	89.50	126.89	189.6	ASTM D445
		@70°C	-	37.68	51.72	80.83	
		@90°C	-	19.90	25.48	35.69	
WATER & SEDIMENT	水份及沈澱物, vol%	0.1	-	-	-	ASTM D1796	
PARAFFIN	總芳香烴, wt%	34.5	-	-	-	HPLC	
CARBON	含碳量, wt%	86.61	83.15	72.85	61.22	ASTM D5291	
HYDROGEN	含氫量, wt%	12.28	12.02	12.07	11.92	ASTM D5291	
HELIUM	含氮量, µg/g	1850	-	-	-	ASTM D4629	
TOTAL CALORIC VALUE	總熱值, cal/g	10627	10162	8941	7443	ASTM D240	
NET CALORIC VALUE	淨熱值, cal/g	-	9553	8329	6839	ASTM D240	

註：表中“-”表示無進行此項分析。

BASED ON TEST REPORT OF CPC LAB – PLEASE SEE COMPLETED TEST REPORT

#6 FUEL OIL VS. GREEN FUEL OIL COMPARASION – EMISSION TEST



EMISSION TEST FACILITIES

#6 FUEL OIL VS. GREEN FUEL OIL COMPARASION - EMISSION TESTS

FUEL OIL	O2 % Max.	CO2 % Max.	CO (ppm) Min.	NOx (ppm) Max.	SOx (ppm) Max.
#6 FUEL OIL	3.7	14	0	389	218
GFO #1 WATER CONTENT 12.80%	4	13.6	0	349	197
GFO#2 WATER CONTENT 25.70%	4.9	13.1	0	289	235
GFO#3 WATER CONTENT 31.06%	7.1	12	0	211	223

*BASE OF GREEN FUEL OIL (GFO) ARE #6 HEAVY FUEL OIL

#6 FUEL OIL VS. GREEN FUEL OIL COMPARASION - EMISSION TESTS- TEST REPORT

CST/ME/NCKU 測試報告 No.RF05-14-07C

#6重油

96年5月14日

CST/ME/NCKU 測試報告 No.RF05-14-07C

GFO#2

96年5月14日

時間* (分)	0	30	60	90	120	150	180
R7 (°C)	1118	1127	1142	1135	1140	1145	1144
R8 (°C)	986	986	994	992	999	1002	998
R6 (°C)	815	816	820	824	827	827	833
T _{flue gas} (°C)	223	225	226	222	228	228	230
O ₂ (%)	3.5	3.6	3.4	3.7	3.5	3.5	3.7
CO (ppm)	0	0	0	1.9	3.2	0.9	0
CO ₂ (%)	13.9	14	14	13.7	13.9	13.9	14
NO _x (ppm)	原始數據	349	389	378	367	377	371
	6% O ₂ 修正	299	336	322	318	303	321
SO _x (ppm)	原始數據	203	194	208	206	215	218
	6% O ₂ 修正	174	167	178	178	184	189

* 經 1 小時預燃測試油品後, 才開始計時。

GFO#1

時間* (分)	0	30	60	90	120	150	180
R7 (°C)	1102	1116	1106	1112	1108	1107	1106
R8 (°C)	959	968	962	965	964	963	963
R6 (°C)	787	790	792	798	794	796	799
T _{flue gas} (°C)	205	203	205	205	205	204	205
O ₂ (%)	4	4.1	3.8	3.6	3.8	4.2	4.5
CO (ppm)	0	0	0	7	0	5	0
CO ₂ (%)	13.4	13.6	13.3	13.6	13.5	13.4	13.1
NO _x (ppm)	原始數據	349	347	352	337	341	338
	6% O ₂ 修正	308	308	307	290	297	307
SO _x (ppm)	原始數據	187	191	182	188	191	180
	6% O ₂ 修正	165	170	158	162	171	164

* 經 1 小時預燃測試油品後, 才開始計時。

時間* (分)	0	30	60	90	120	150	180
R7 (°C)	1045	1053	1057	1060	1062	1060	1066
R8 (°C)	915	919	923	925	927	926	930
R6 (°C)	757	759	760	761	765	762	763
T _{flue gas} (°C)	197	197	198	197	196	195	193
O ₂ (%)	4.4	4.2	4.5	4.9	4.3	4.8	5
CO (ppm)	8.6	0	0	0	11.5	1.5	0
CO ₂ (%)	13.1	12.9	12.7	12.7	13.1	12.7	12.4
NO _x (ppm)	原始數據	249	272	274	286	262	277
	6% O ₂ 修正	225	243	249	266	235	269
SO _x (ppm)	原始數據	206	213	212	214	237	233
	6% O ₂ 修正	186	190	192	199	213	215

* 經 1 小時預燃測試油品後, 才開始計時。

GFO#3

時間* (分)	0	30	60	90	120	150	180
R7 (°C)	974	987	983	983	989	991	997
R8 (°C)	857	862	863	862	865	866	869
R6 (°C)	706	712	707	708	705	705	706
T _{flue gas} (°C)	169	169	168	167	166	165	164
O ₂ (%)	5.7	5.9	7.1	7	7	7	6.8
CO (ppm)	0	0	0	7	0	5	0
CO ₂ (%)	12	11.9	11	11.1	11.1	11.3	11.4
NO _x (ppm)	原始數據	206	202	208	211	210	210
	6% O ₂ 修正	202	201	225	226	225	222
SO _x (ppm)	原始數據	213	223	205	212	214	220
	6% O ₂ 修正	208	222	222	227	229	232

* 經 1 小時預燃測試油品後, 才開始計時。

#6 FUEL OIL vs. GREEN FUEL OIL COMPARASION- EXHAUST TEMPERATURE

FUEL OIL	#6 FUEL OIL %	WATER CONTENT %	FS2 ADDITIVE CONTENT %	EXHAUST TEMP. °C
#6 FUEL OIL	100%	0%	0%	230°C
GFO #1	86.55%	12.80%	0.65%	205°C
GFO#2	72.97%	25.70%	1.33%	198°C
GFO#3	67.98%	31.06%	0.96%	169°C

#6 FUEL OIL vs. GREEN FUEL OIL COMPARASION- EXHAUST TEMPERATURE – TEST REPORT

CST/ME/NCKU 測試報告 No.RF05-14-07C

#6重油

96年5月14日

CST/ME/NCKU 測試報告 No.RF05-14-07C

GFO#2

96年5月14日

時間* (分)	0	30	60	90	120	150	180	
R7 (°C)	1118	1127	1142	1135	1140	1145	1144	
R8 (°C)	986	986	994	992	999	1002	998	
R6 (°C)	815	816	820	824	827	827	833	
T _{flue gas} (°C)	223	225	226	222	228	228	230	
O ₂ (%)	3.5	3.6	3.4	3.7	3.5	3.5	3.7	
CO (ppm)	0	0	0	1.9	3.2	0.9	0	
CO ₂ (%)	13.9	14	14	13.7	13.9	13.9	14	
NO _x (ppm)	原始數據	349	389	378	367	353	377	371
	6% O ₂ 修正	299	336	322	318	303	323	321
SO _x (ppm)	原始數據	203	194	208	206	211	215	218
	6% O ₂ 修正	174	167	178	178	181	184	189

* 經 1 小時預燃測試油品後, 才開始計時。

GFO#1

時間* (分)	0	30	60	90	120	150	180	
R7 (°C)	1102	1116	1106	1112	1108	1107	1106	
R8 (°C)	959	968	962	965	964	963	963	
R6 (°C)	787	790	792	798	794	796	799	
T _{flue gas} (°C)	205	203	205	205	203	204	205	
O ₂ (%)	4	4.1	3.8	3.6	3.8	4.2	4.5	
CO (ppm)	0	0	0	7	0	5	0	
CO ₂ (%)	13.4	13.6	13.3	13.6	13.5	13.4	13.1	
NO _x (ppm)	原始數據	349	347	352	337	341	349	338
	6% O ₂ 修正	308	308	307	290	297	312	307
SO _x (ppm)	原始數據	187	191	182	188	197	191	180
	6% O ₂ 修正	165	170	158	162	171	171	164

* 經 1 小時預燃測試油品後, 才開始計時。

時間* (分)	0	30	60	90	120	150	180	
R7 (°C)	1045	1053	1057	1060	1062	1060	1066	
R8 (°C)	915	919	923	925	927	926	930	
R6 (°C)	757	759	760	761	765	762	763	
T _{flue gas} (°C)	197	197	198	197	196	195	193	
O ₂ (%)	4.4	4.2	4.5	4.9	4.3	4.8	5	
CO (ppm)	8.6	0	0	0	11.5	1.5	0	
CO ₂ (%)	13.1	12.9	12.7	12.7	13.1	12.7	12.4	
NO _x (ppm)	原始數據	249	272	274	286	262	277	289
	6% O ₂ 修正	225	243	249	266	235	256	269
SO _x (ppm)	原始數據	206	213	212	214	237	233	235
	6% O ₂ 修正	186	190	192	199	213	215	220

* 經 1 小時預燃測試油品後, 才開始計時。

GFO#3

時間* (分)	0	30	60	90	120	150	180	
R7 (°C)	974	987	983	983	989	991	997	
R8 (°C)	857	862	863	862	865	866	869	
R6 (°C)	706	712	707	708	705	705	706	
T _{flue gas} (°C)	169	169	168	167	166	165	164	
O ₂ (%)	5.7	5.9	7.1	7	7	7	6.8	
CO (ppm)	0	0	0	7	0	5	0	
CO ₂ (%)	12	11.9	11	11.1	11.1	11.3	11.4	
NO _x (ppm)	原始數據	206	202	208	211	210	210	210
	6% O ₂ 修正	202	201	225	226	225	225	222
SO _x (ppm)	原始數據	213	223	205	212	214	209	220
	6% O ₂ 修正	208	222	222	227	229	224	232

* 經 1 小時預燃測試油品後, 才開始計時。

GFOP FUEL SAVING SIMULATION*

ACCORDING TO TEST REPORT DATED 07/05/14 - SAMPLE GFO#1 (GF-3)

I. Fuel saving

1. #6 heavy fuel oil heat value $10,627 \text{ cal/g} = 10,627,000 \text{ kcal/MT}$
2. GFO#1 (12.85% water content) heat value $= 10,162 \text{ cal/g} = 10,162,000 \text{ kcal/MT}$
3. Based on same heat value $10,627,000 \text{ kcal/MT}$, total volume of GFO#1 $= 10,627,000 \text{ kcal/MT} / 10,162,000 \text{ kcal/MT} = 1.046 \text{ MT} = 1,046 \text{ kg}$, meaning total combustion volume of GFO#1 based on the same heat value will be $1,046 - 1,000 \text{ kg} = 46 \text{ kg}$ more, in which 12.85% is water, 0.65% is FSD200
4. Therefore, consumption using GFO #1 from GFOP $= 1,000 \text{ kg} - (865.5 \text{ kg} + 46 \text{ kg}) = 88.5 \text{ kg}$, a fuel saving $= 88.5 \text{ kg} / 1,000 \text{ kg} = 8.85\%$

II. Cost saving

1. Assuming price of #6 is USD 406 / MT
2. Cost of GFO#1 Green Fuel Oil $= \text{USD } 406 / \text{MT} * 0.8655 (\text{fuel oil}) + (\text{USD } 2.15 * 0.1280) (\text{water}) + (\text{USD } 970 * 0.0065) (\text{FS2 additive}) + (\text{USD } 0.085 \text{ kw-h} * 7.6 \text{ kw-h}) (\text{power}) = \text{USD } 351.4 + 0.27 + 6.30 + 0.65 = \text{USD } 358.62$
3. Based on the same heat value, GFO#1 $= \text{USD } 358.62 / \text{MT} * 1.046 \text{ MT} = \text{USD } 375.10$
4. Cost saving of GFO#1 $= \text{USD } 406 - \text{USD } 375.10 = \text{USD } 30.90$
5. Therefore cost saving in using GFO#1 $= \text{USD } 30.90 / \text{USD } 406 = 7.6\%$
 - This confirms that cost savings when using GFO#1 (12.85% water content) = 7.60%., or average cost saving is 0.59% when dosing with 1% of water.

RECOMMENDED DOSING RATE WITH WATER

INDUSTRY	APPLICATION	WATER DOSING RATE	COST SAVING
FRP Fiber, Glass, Ceramics, Cement, Mining Industry, Asphalt factory, Power plant	Furnace, Kiln Stove, Oven	~12.8%	~7.6%
Pharmaceutical, Petrochemical, Dyeing, Printing, Textile, Dairy, Chemical, Pigment,....etc	Steam boiler	~25.7%	~15.1%
Food, Hospital, Hotel, Swimming pool, Public building, General industry	Steam boiler, Hot water boiler	~31.06.%	~18.3%