Improving Fuel Oil (MGO, DMA)

Implementation of fuel additive XMILE on auxiliary engine 1 Stena Trader

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Implementation of fuel additive XMILE on auxiliary engine 1 Stena Trader

Test period March 2008 – October 2008
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Fuel MGO (DMA)

Fuel additive XMILE Europe BV, m.overbeeke@xmile.eu

Active product, bio enzyme, dosing 1:10000

Engine: 2006 Mitsubishi model S16R-MPTA

Lubrication engine oil sample: Pon Alert Service lab

Combustion efficiency analyzer: Kane 900 plus www.kane.co.uk

Data presentation and calculations: Excel sheet

SUMMARY Data collecting and measurement

The performance of the engine is calculated from concentration of gasses in the exhaust, using a combustion efficiency analyzer
The project team developed a calculation sheet that directly shows the fuel or engine efficiency [%] and Specific Fuel Consumption [g/kWh].
The calculation shows also the emission of CO2, N0x and CO [g/kWh].

Project progress

The project was started by daily measurement of the exhaust gasses and creating the base line of the fuel/engine performance as also the emission of the Mitsubishi engine.
After creating the base line the crew started dosing the XMILE to the bunker tank.
XMILE is active inside the fuel tanks as XMILE enzymes dissolve fuel elements in the sludge back into fuel and acts as a Cetane improver.
In the combustion system it prevents or removes deposits and controls the buil-up of combustion camber deposits.
The first notice of XMILE effect was a temporary increase of the CO emission; the fuel system cleaning up stage.
When the cleaning up stage ended the measurements showed a reducing of the CO and N0x emission and an increase of the combustion efficiency; a better SFC.

Conclusion

The use of XMILE fuel additive shows a lowering of the fuel consumption by 8% and a decrease of the CO and N0x emission with respectively 22% and 9%.
The measurements show also a cleaning up of the fuel system.
The cost/efficiency of XMILE is very good; break even point is 1% fuel saving (price MGO €600 mT).
During the test period lubrication oil samples ware analyzed.
It appeared that with the use of XMILE the lubrication oil was cleaner; cleaner oil is increasing the engine durability.

Discussion:

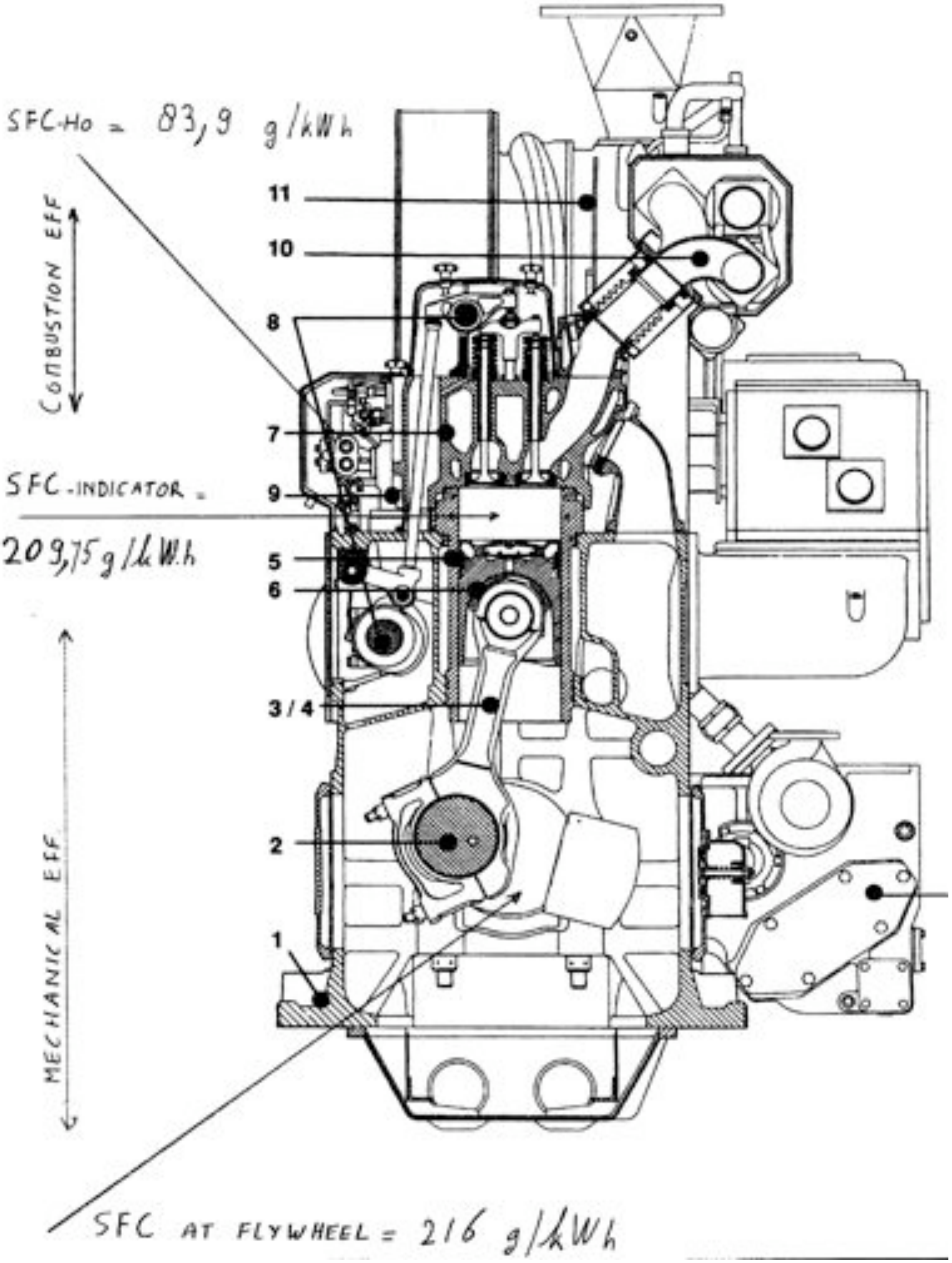
Fuel consumption, exhaust gas concentration, exhausts gas analyser and Excel

Heat is put into the engine via the fuel = 100%
Heat coming out via the piston; the indicator power ±40%
Heat that goes out via the funnel; the losses ±60%
We measure the combustion efficiency with an exhaust gas analyser
Gas samples ware taken before and after the engine
Analyser compares engine room air with exhaust gas
Analyser presents combustion efficiency in %
Analyser presents CO2, CO, NOx levels in % or ppm
The probe is inserted just after the turbo exhaust

The heat content of the fuel is indicated as Ho [kg/kJ]
We can recalculate the Ho into something like an SFC (the same way as we usually calculate the flywheel SFC in g/kWh)
SFC-Ho = mass fuel flow / produced heat at a complete burning
SFC-ind = mass fuel flow / produced heat during the combustion process
SFC = mass fuel flow / produced power at flywheel (shaft)
Combustion efficiency is between SFC-Ho and SFC-ind

Example
Typical values for MGO: density = 858kg/m³ ; Ho=42,898 MJ/kg
SFC-Ho = 1/42,898 kg/MJ = 0,0233 kg/MW = 23,31 g/MW = 83,9 g/kWh
83,9 g/kWh is the max SFC that is ever possible for this fuel (no losses)
SFC-Ho = 83,9 g/kWh
If the gas meter tells us an efficiency of 40% then the indicator SFC-ind is 83,9/0,40=209,75 g/kWh
SFC-ind = 209,75 g/kWh
CO2 production is factor 3,1 > 209,75*3,1=650 g/kWh
CO2 = 650 g/kWh

On top of the efficiency the gas meter tells also
CO2 = 5.0%
CO = 152 ppm (0,0152%)
NOx = 678 ppm (0,0678%)
The molecular mass
CO2 = 44
CO = 28
NOx = 46 (calculated as NO2)
We know the CO2 level
Make this the base value for calculating the CO and NOx (NO2)
CO = CO2[g/kWh]/CO2[%]/MolCO2*CO[%]*MolCO
CO = 646/5/44*0.0152*28=1.25g/kWh
CO = 1,25 g/kWh
NOx = CO2[g/kWh]/CO2[%]/MolCO2*NO2[%]*MolNO2
NOx = 646/5/44*0.0678*46=9.2 g/kWh
NOx = 9.2 g/kWh
All above is indicator measured (No engine friction)


SFC-Ho = 83,9 g/kWh
COMBUSTION EFF
11
10
8
7
SFC-INDICATOR =
209,75 g/kW.h
9
5
6
3 / 4
2
1
MECHANICAL EFF.
SFC AT FLYWHEEL = 216 g/kWh

<u>Measured profit by using the fuel additive Soltron XMILE:</u>

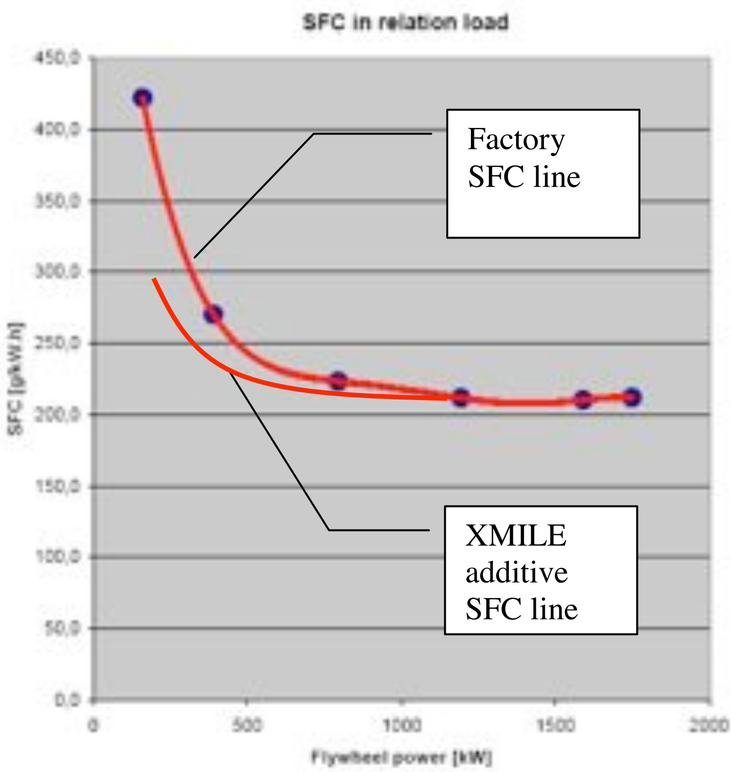
No1 Auxiliary engine Stena Trader
FC ↓ 8%
NOx ↓ 9%
CO ↓ 22%
Eff ↑ 10%

Above figures show a relatively high improvement because the engine was at low load during the tests

MITSUBISHI
DIESEL ENGINES
TURBOCHARGERS
CORRUGATING MACHINERY

Customer	DIESELPOWER AS		Orderno. 535278
Eng. Mfr	Sagamihara Machinery Works Mitsubishi Heavy Industries LTD.		
Model & Serial No.	S16R-MPTA	serial no. 12714	
No. of Cyl. 16	bore 170 mm	Stroke 180 mm	
Total St. Vol. Ltr.	65.37	Comp. Ratio 14.0 :1	
Injection Pump No.	5585	5586	
Governor No.	14471445		
Rated Output	1590 kW	1800 rpm.	Without fan *

Time	No.	Load %	Eng. Speed rpm.	Torque Nm.	Torque kgm.	Output PS.	Output kW.	Fuel Consumption l/h	Fuel Consumption g/PSh	Fuel Consumption g/kWh
00.15	1	0	1800							
00.45	2	10	1800	844	86.0	216	159	80.8	310.2	421.8
01.15	3	25	1800	2109	215.0	540	398	129.4	198.7	270.2
01.45	4	50	1800	4218	429.9	1081	795	213.9	164.2	223.3
02.15	5	75	1800	6326	644.9	1621	1193	304.0	155.6	211.6
02.45	6	100	1800	8435	859.9	2162	1590	402.7	154.6	210.2
03.15	7	110	1800	9279	945.8	2378	1749	446.8	155.9	212.0
04.00	7	110	1800	9279	945.8	2378	1749	446.8	155.9	212.0



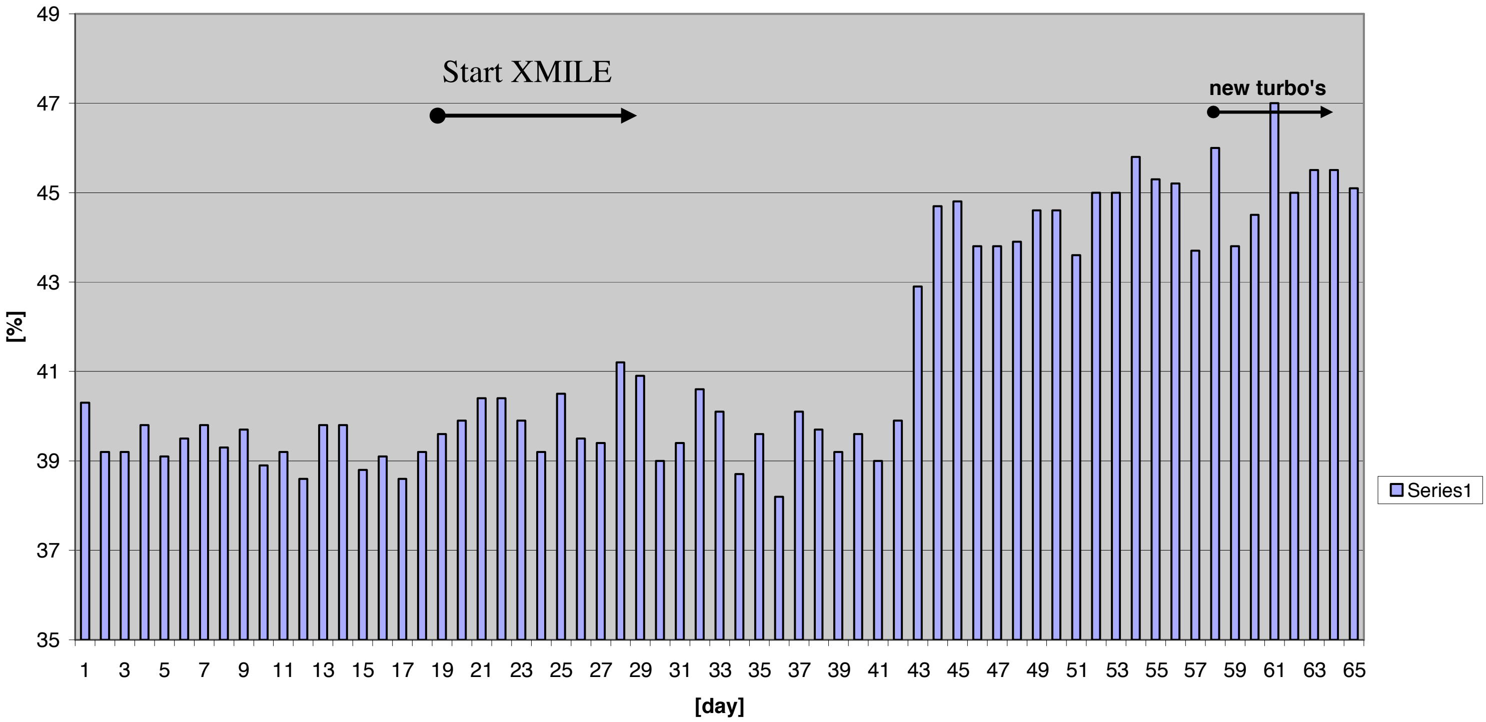
At low load the engine is less efficient and therefore the additive can perform very well
We have learned that this well performing also depends on the engine quality and type

1. No improvement if engine has already a high combustion efficiency > 40%
2. Positive improvement if the engine has a low combustion efficiency < 40%

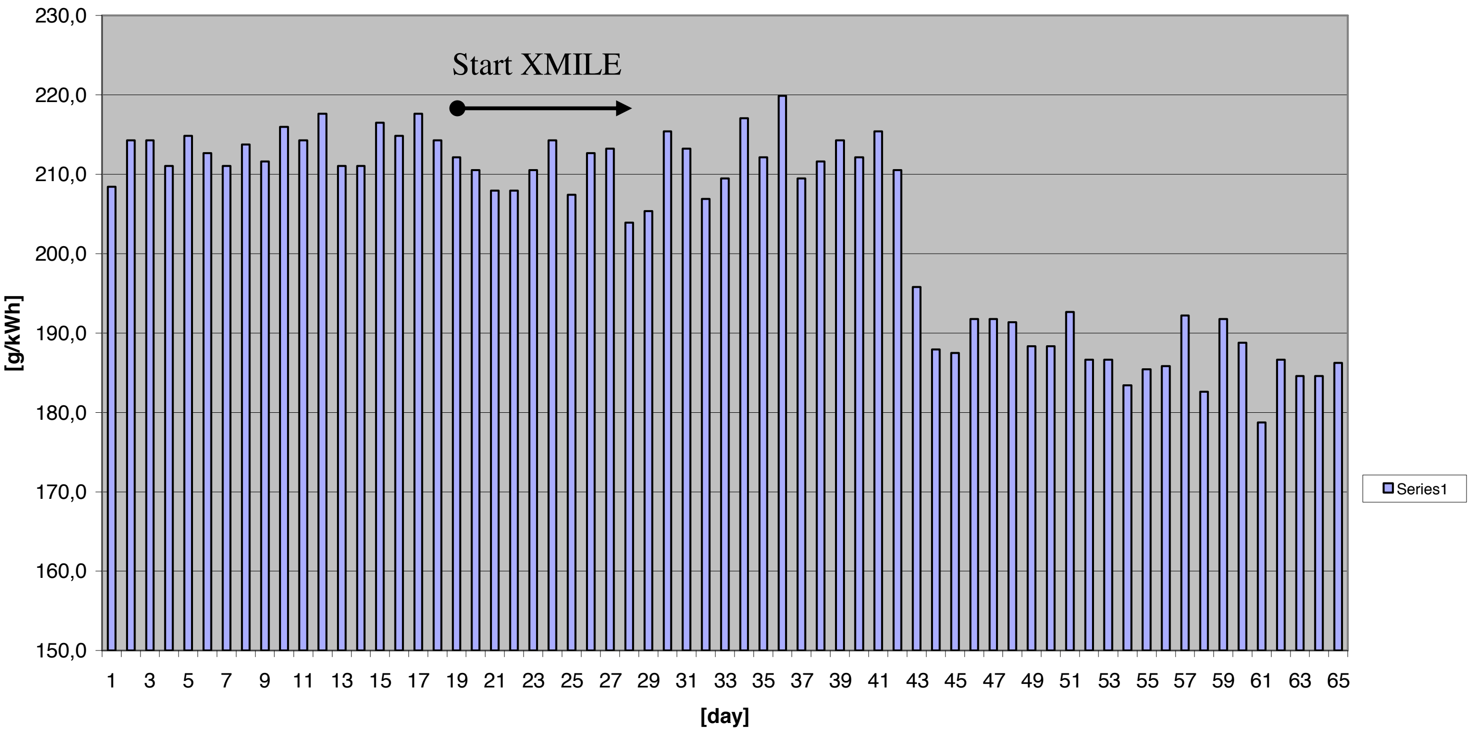
p.s. Negligible improvement at 100% load!

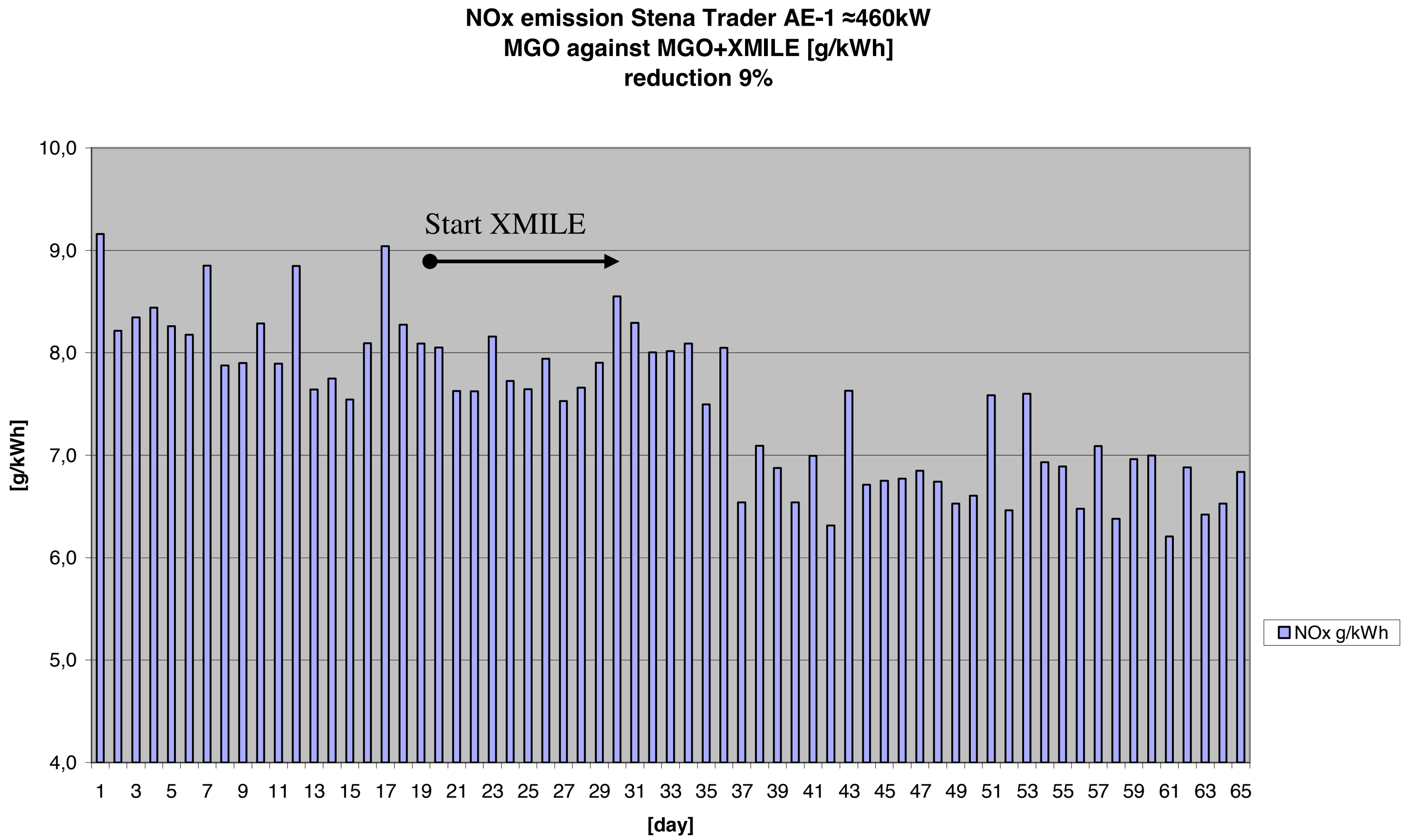
Presentation of measuring data

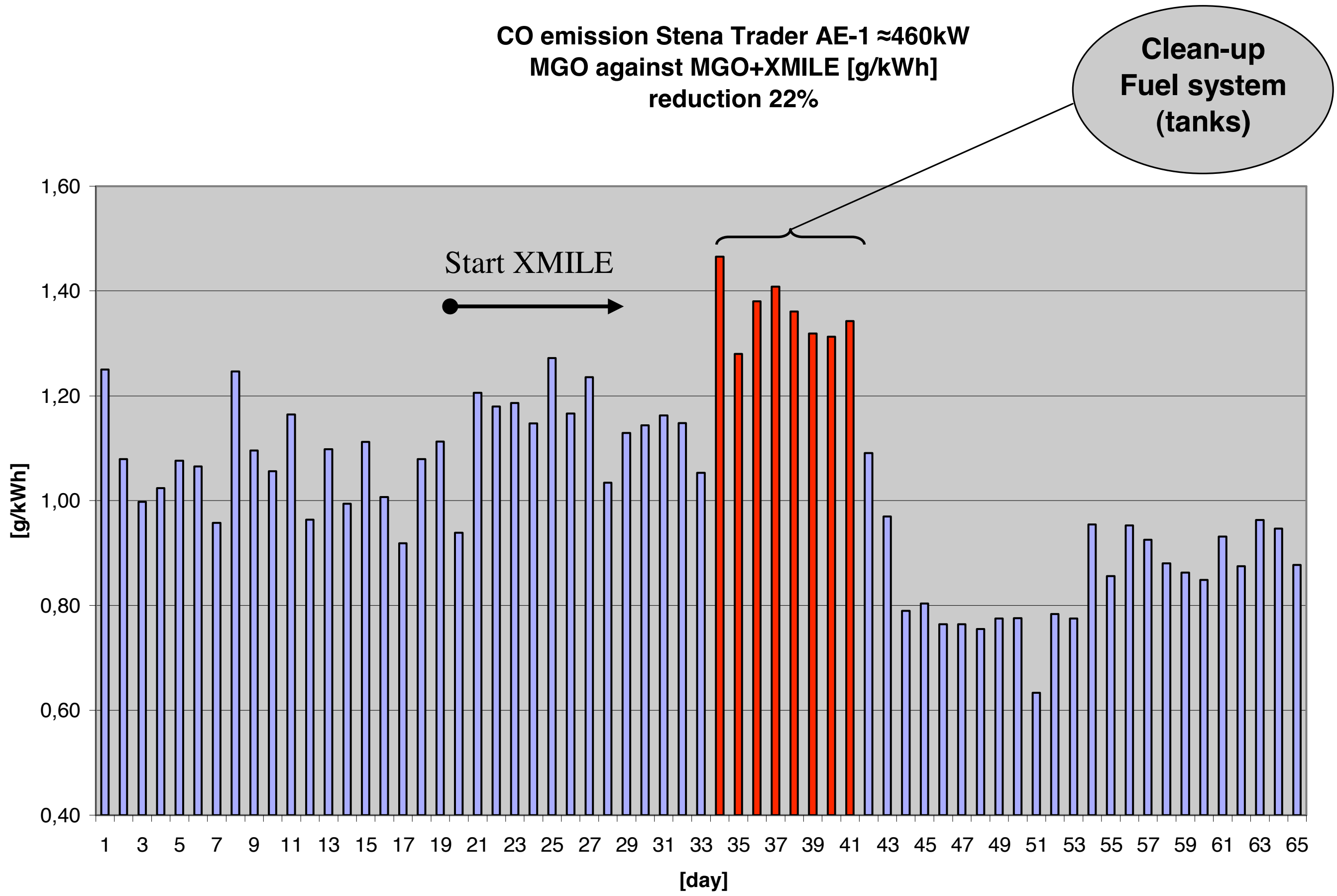
Combustion efficiency Stena Trader AE-1 ≈460kW
MGO against MGO+XMILE [g/kWh]
improvement 10%



Specific Fuel Consumption (CO2) Stena Trader AE-1 ≈460kW
MGO against MGO+XMILE [g/kWh] ≈460kW
reduction 8%




NOx emission Stena Trader AE-1 ≈460kW
MGO against MGO+XMILE [g/kWh]
reduction 9%
Start XMILE
[g/kWh]
[day]
NOx g/kWh


CO emission Stena Trader AE-1 ≈460kW
MGO against MGO+XMILE [g/kWh]
reduction 22%
Clean-up Fuel system (tanks)
Start XMILE
[g/kWh]
[day]

DATA collection Stena Trader AE-1 ≈460kW MGO against MGO+XMILE													
DATA collection									CALCULATIONS				
Date	time	O2	CO2	CO	NOx	ekW	loss	eff	CO2	CO	NOx	fuel	Comment
		%	%	ppm	ppm	kW	%	%	g/kWh i	g/kWh i	g/kWh	g/kWh	
26-feb	15:45:00	13,8	5,0	152	678	556	40,3	59,7	**646**	**1,25**	**9,2**	**208,4**	MGO
27-feb	16:00:00	14,7	4,7	120	556	450	39,2	60,8	**664**	**1,08**	**8,2**	**214,3**	
28-feb	16:00:00	14,1	5,0	118	601	534	39,2	60,8	**664**	**1,00**	**8,3**	**214,3**	
1-mrt	15:44:00	14,2	5,0	123	617	503	39,8	60,2	**654**	**1,02**	**8,4**	**211,1**	
2-mrt	15:48:00	14,2	5,0	127	593	482	39,1	60,9	**666**	**1,08**	**8,3**	**214,8**	
5-mrt	15:56:00	14,2	5,0	127	593	538	39,5	60,5	**659**	**1,07**	**8,2**	**212,7**	
7-mrt	15:43:00	14,1	5,0	115	647	539	39,8	60,2	**654**	**0,96**	**8,9**	**211,1**	
9-mrt	15:46:31	14,7	4,6	136	523	408	39,3	60,7	**663**	**1,25**	**7,9**	**213,7**	
10-mrt	15:41:00	14,4	4,8	126	553	475	39,7	60,3	**656**	**1,10**	**7,9**	**211,6**	
11-mrt	15:42:00	14,1	5,0	124	592	481	38,9	61,1	**669**	**1,06**	**8,3**	**215,9**	
12-mrt	16:05:00	14,3	4,9	135	557	409	39,2	60,8	**664**	**1,16**	**7,9**	**214,3**	
13-mrt	15:43:00	13,8	5,3	119	665	515	38,6	61,2	**675**	**0,96**	**8,8**	**217,6**	
14-mrt	16:10:00	14,5	4,7	124	525	428	39,8	60,2	**654**	**1,10**	**7,6**	**211,1**	
15-mrt	15:45:00	14,3	4,9	117	555	459	39,8	60,2	**654**	**0,99**	**7,7**	**211,1**	Start
16-mrt	15:54:00	14,5	4,8	125	516	432	38,8	61,2	**671**	**1,11**	**7,5**	**216,5**	MGO+XMILE
17-mrt	15:44:00	14,4	4,8	114	558	487	39,1	60,1	**666**	**1,01**	**8,1**	**214,8**	
18-mrt	15:47:00	14,1	5,0	107	641	495	38,6	61,4	**675**	**0,92**	**9,0**	**217,6**	
19-mrt	15:46:00	14,5	4,7	120	560	456	39,2	60,8	**664**	**1,08**	**8,3**	**214,3**	
20-mrt	16:17:00	14,5	4,7	125	553	472	39,6	60,4	**658**	**1,11**	**8,1**	**212,1**	
21-mrt	15:43:00	14,2	5,0	113	590	476	39,9	60,1	**653**	**0,94**	**8,1**	**210,5**	
28-mrt	16:12:00	14,3	5,0	147	566	499	40,4	59,6	**645**	**1,21**	**7,6**	**207,9**	
29-mrt	15:35:00	14,6	4,8	138	543	419	40,4	59,6	**645**	**1,18**	**7,6**	**207,9**	
30-mrt	15:35:00	14,4	4,9	140	586	412	39,9	60,1	**653**	**1,19**	**8,2**	**210,5**	
31-mrt	15:33:00	14,5	4,9	133	545	475	39,2	60,8	**664**	**1,15**	**7,7**	**214,3**	
1-apr	15:35:00	14,8	4,6	143	523	416	40,5	59,5	**643**	**1,27**	**7,6**	**207,4**	
2-apr	16:36:00	14,3	5,0	139	576	416	39,5	61,9	**659**	**1,17**	**7,9**	**212,7**	
3-apr	15:36:00	14,6	4,8	141	523	425	39,4	62,0	**661**	**1,24**	**7,5**	**213,2**	
5-apr	15:38:00	14,5	4,9	126	568	436	41,2	58,8	**632**	**1,03**	**7,7**	**203,9**	
6-apr	15:57:00	14,7	4,7	131	558	417	40,9	60,1	**637**	**1,13**	**7,9**	**205,4**	
7-apr	15:37:00	14,0	5,2	140	637	417	39	61	**668**	**1,14**	**8,6**	**215,4**	
8-apr	15:35:00	14,2	5,1	141	612	484	39,4	60,6	**661**	**1,16**	**8,3**	**213,2**	
10-apr	15:58:00	14,6	4,8	135	573	423	40,6	59,4	**641**	**1,15**	**8,0**	**206,9**	
11-apr	15:36:00	14,2	5,1	130	602	481	40,1	59,9	**649**	**1,05**	**8,0**	**209,5**	
15-apr	15:55:00	14,0	5,2	178	598	505	38,7	61,3	**673**	**1,47**	**8,1**	**217,1**	
16-apr	15:37:00	14,2	5,1	156	556	460	39,6	60,4	**658**	**1,28**	**7,5**	**212,1**	
17-apr	15:31:00	13,7	5,5	175	621	561	38,2	61,8	**682**	**1,38**	**8,0**	**219,9**	
18-apr	15:32:00	14,5	4,9	167	472	403	40,1	59,9	**649**	**1,41**	**6,5**	**209,5**	
19-apr	15:38:00	14,3	5,0	163	517	439	39,7	60,3	**656**	**1,36**	**7,1**	**211,6**	
20-apr	15:37:00	14,3	5,0	156	495	430	39,2	60,8	**664**	**1,32**	**6,9**	**214,3**	
21-apr	15:31:00	14,2	5,1	160	485	450	39,6	60,4	**658**	**1,31**	**6,5**	**212,1**	
23-apr	15:32:00	14,3	5,0	158	501	482	39	61	**668**	**1,34**	**7,0**	**215,4**	
25-apr	15:38:00	14,2	5,1	134	472	479	39,9	60,1	**653**	**1,09**	**6,3**	**210,5**	
30-apr	17:35:00	15,0	4,5	113	541	422	42,9	57,1	**607**	**0,97**	**7,6**	**195,8**	
2-mei	12:13:00	14,8	4,6	98	507	430	44,7	55,3	**583**	**0,79**	**6,7**	**187,9**	
3-mei	12:22:00	14,8	4,6	100	511	420	44,8	55,2	**581**	**0,80**	**6,8**	**187,5**	
10-mei		14,6	4,7	95	512	400	43,8	56,2	**595**	**0,76**	**6,8**	**191,8**	
11-mei		14,5	4,7	95	518	400	43,8	56,2	**595**	**0,76**	**6,9**	**191,8**	

12-mei		14,6	4,7	94	511	400	43,9	58,1	**593**	**0,75**	**6,7**	**191,3**	
13-mei		14,7	4,6	96	492	390	44,6	55,4	**584**	**0,78**	**6,5**	**188,3**	
14-mei		14,8	4,5	94	487	487	44,6	55,4	**584**	**0,78**	**6,6**	**188,3**	
30-mei		13,6	5,4	90	656	580	43,6	56,4	**597**	**0,63**	**7,6**	**192,7**	
5-sep	11:59:00	14,6	4,7	100	502	430	45	55	**579**	**0,78**	**6,5**	**186,7**	
19-sep	16:32:00	14,4	4,8	101	603	460	45	55	**579**	**0,77**	**7,6**	**186,7**	new turbo
20-sep	17:11:00	14,1	4,7	124	548	479	45,8	54,2	**569**	**0,95**	**6,9**	**183,4**	
21-sep	15:42:00	14,6	4,7	110	539	503	45,3	54,7	**575**	**0,86**	**6,9**	**185,4**	
22-sep	15:34:00	14,8	4,5	117	484	378	45,2	54,8	**576**	**0,95**	**6,5**	**185,8**	
23-sep	15:39:00	14,2	5,0	122	569	574	43,7	56,3	**596**	**0,93**	**7,1**	**192,2**	
24-sep	16:06:00	14,9	4,5	110	485	498	46	54	**566**	**0,88**	**6,4**	**182,6**	
25-sep	15:22:00	14,3	5,0	114	560	441	43,8	56,2	**595**	**0,86**	**7,0**	**191,8**	
26-sep	15:39:00	14,2	5,0	114	572	468	44,5	55,6	**585**	**0,85**	**7,0**	**188,8**	
27-sep	15:52:00	15,1	4,2	111	450	439	47	53	**554**	**0,93**	**6,2**	**178,7**	
28-sep	15:40:00	14,4	4,8	114	546	422	45	55	**579**	**0,87**	**6,9**	**186,7**	
29-sep	15:38:00	14,9	4,5	119	483	416	45,5	54,5	**572**	**0,96**	**6,4**	**184,6**	
30-sep	15:42:00	14,8	4,5	117	491	447	45,5	54,5	**572**	**0,95**	**6,5**	**184,6**	
1-okt	15:37:00	14,3	4,9	117	555	554	45,1	54,9	**577**	**0,88**	**6,8**	**186,3**