



Additive Assessment Report

For SulNOx

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INTRODUCTION

Thirty samples were selected for an assessment of any detrimental influence of SulNOx Eco (B-6430BFDC1L1121) on the ISO 8217 fuel quality specification. The samples were blended into six different groups, dosed at requested concentration with SulNOx Eco, and tested with/without the additive according to ISO 8217.

The additive is expected to improve the marine fuel properties and engine performance, however, the evaluation on additive improvements in fuel economy is not within the scope of this report.

SAMPLE PREPARATION

Thirty samples, 15 VLSFOs and 15 distillate fuels, were selected for investigating the additive performance of SulNOx Eco (B-6430BFDC1L1121). All selected samples were placed in a heating oven at 50 °C for 60 mins and homogenized with a mechanical shaker at 240 rpm for 5 mins before they were poured up, dosed, and tested.

The samples were blended into six groups as shown in the Table 1. All mixed samples were poured up with equal amount into two different containers, and SulNOx Eco (B-6430BFDC1L1121) was added to one of the blank samples in each group at 500 ppm (mass concentration). The dosed samples were homogenized with a mechanical shaker at 240 rpm for 15 mins and placed in a heating oven at 50 °C for 24 hours before further tests.

Table 1: Sample details of each blended group.

Group Number	Sample Number	Port Name	Bunker Date	Product Type	Ordered Grade
Group 1	HOU22F006418	BOLIVAR ROADS	05-Mar-2022	Fuel 0.50%	RMG380
	HOU22F006423	BOLIVAR ROADS	04-Mar-2022	Fuel 0.50%	RMG380
	HOU22F006939	BOLIVAR ROADS	08-Mar-2022	Fuel 0.50%	RMG380
	HOU22F007177	BOLIVAR ROADS	01-Mar-2022	Fuel 0.50%	RMG380S3.5
	HOU22F007413	BOLIVAR ROADS	04-Mar-2022	Fuel 0.50%	RMG380
Group 2	HOU22F006167	BALBOA	27-Feb-2022	Fuel 0.50%	RMG380
	HOU22F006479	BALBOA	06-Mar-2022	Fuel 0.50%	RMG380
	HOU22F006717	BALBOA	08-Mar-2022	Fuel 0.50%	RMG380
	HOU22F007404	BALBOA	09-Mar-2022	Fuel 0.50%	RMG380
	HOU22F008064	BALBOA	22-Mar-2022	Fuel 0.50%	RMG380
Group 3	HOU22F006468	SANTOS	28-Feb-2022	Fuel 0.50%	RMG380
	HOU22F006611	SANTOS	27-Feb-2022	Fuel 0.50%	RMG380
	HOU22F007594	SANTOS	08-Mar-2022	Fuel 0.50%	AMG38005
	HOU22F007924	SANTOS	11-Mar-2022	Fuel 0.50%	RMG380
	HOU22F008062	SANTOS	11-Mar-2022	Fuel 0.50%	RMG380
Group 4	HOU22F008159	SANTOS	16-Mar-2022	Distillate Fuel	DMA
	HOU22F008008	SANTOS	14-Mar-2022	Distillate Fuel	DMALS0.1
	HOU22F007897	SANTOS	13-Mar-2022	Distillate Fuel	DMA
	HOU22F006830	SANTOS	06-Mar-2022	Distillate Fuel	DMA
	HOU22F006318	SANTOS	01-Mar-2022	Distillate Fuel	DMA
Group 5	HOU22F008195	BALBOA	19-Mar-2022	Distillate Fuel	DMA
	HOU22F007346	BALBOA	10-Mar-2022	Distillate Fuel	DMA
	HOU22F006683	BALBOA	08-Mar-2022	Distillate Fuel	DMA
	HOU22F006462	BALBOA	04-Mar-2022	Distillate Fuel	DMA
	HOU22F005566	BALBOA	23-Feb-2022	Distillate Fuel	DMA
Group 6	HOU22F008448	HOUSTON	23-Mar-2022	Distillate Fuel	DMA
	HOU22F007465	HOUSTON	16-Mar-2022	Distillate Fuel	DMA
	HOU22F006905	HOUSTON	11-Mar-2022	Distillate Fuel	DMA
	HOU22F006257	BOLIVAR ROADS	06-Mar-2022	Distillate Fuel	DMA
	HOU22F006632	HOUSTON	06-Mar-2022	Distillate Fuel	DMA

RESULTS

Residual Fuel

The testing results of the mixed residual fuel oils are listed in the Table 2 below. The results of blank and dosed samples are displayed together with the testing acceptance limit (0.59R, 95% confidence, based on ISO 8217 and ISO 4259). The limit will be marked as “Not Applicable” (NA) if the results are out of the testing scope or not defined.

Table 2: Testing results of blank and dosed residual fuel oils.

Parameters	Testing Method	Unit	Group 1			Group 2			Group 3		
			Blank	Dosed	0.59R	Blank	Dosed	0.59R	Blank	Dosed	0.59R
Density 15°C	ISO 12185	kg/m ³	937.5	937.5	0.9	936.4	936.3	0.9	943.2	943.2	0.9
Visc. 50°C	A-D7042	mm ² /s	162.5	161.2	7.1	38.23	38.02	1.7	136.4	136.0	6.0
Water	A-D6304C	%V/V	0.06	0.06	0.05	0.05	0.05	0.04	0.03	0.03	0.03
MCR	ISO 10370	%m/m	5.50	5.47	0.45	2.83	2.85	0.29	10.20	6.94	0.68
Sulfur	ISO 8754	%m/m	0.42	0.42	0.03	0.46	0.46	0.03	0.43	0.44	0.03
TSP	ISO 10307	%m/m	0.07	0.06	0.05	0.05	0.04	0.04	<0.01	<0.01	NA
Ash	LP 1001	%m/m	0.043	0.044	0.003	0.028	0.028	0.003	0.015	0.016	0.003
Vanadium	IP 501	mg/kg	6	6	3	7	8	3	17	14	5
Sodium	IP 501	mg/kg	14	14	3	11	12	2	3	3	1
Aluminium	IP 501	mg/kg	7	7	1	10	10	2	2	2	0
Silicon	IP 501	mg/kg	11	12	2	10	10	2	3	2	1
Iron	IP 501	mg/kg	43	44	4	13	14	2	2	2	1
Nickel	IP 501	mg/kg	5	5	2	4	4	2	12	11	4
Calcium	IP 501	mg/kg	10	10	2	3	3	1	1	1	0
Magnesium	LP 1101	mg/kg	2	2	NA	<1	<1	NA	<1	<1	NA
Zinc	IP 501	mg/kg	6	6	1	<1	1	<1	<1	<1	<1
Phosphorus	IP 501	mg/kg	17	17	4	3	3	1	<1	<1	<1
Potassium	LP 1101	mg/kg	3	3	NA	3	3	NA	<1	<1	NA
Flash Point	ISO 2719-B	°C	>70.0	>70.0	NA	>70.0	>70.0	NA	>70.0	>70.0	NA
Pour Point	ISO 3016	°C	6	6	5	<0	<0	NA	18	21	5
Acid Number	A-D664	mg KOH/g	0.13	0.11	0.03	0.14	0.15	0.04	0.20	0.21	0.05
Strong Acid Number	A-D664	mg KOH/g	0	0	NA	0	0	NA	0	0	NA
CCAI	ISO 8217	SI	807.8	807.9	NA	826.9	826.9	NA	815.7	815.7	NA
Net Specific Energy	ISO 8217	MJ/kg	41.76	41.76	NA	41.77	41.77	NA	41.70	41.70	NA
Gross Specific Energy	ISO 8217	MJ/kg	44.26	44.26	NA	44.27	44.27	NA	44.19	44.19	NA

All tested parameters of dosed samples remain within the acceptance limit compared to their blank samples in the same group, which indicates that the additive has no negative impact on the samples' intrinsic properties at the dosing level of 500 ppm.

Distillate Fuel

The testing results of the mixed distillate fuel oils are listed in the Table 3 below. The results of blank and dosed samples are compared together with their testing acceptance limit (0.59R, 95% confidence, based on ISO 8217 and ISO 4259). The limit will be marked as "Not Applicable" (NA) if the results are out of the testing scope or not defined.

All tested parameters, including both ISO 8217 scope and extra VPS analysis on cold flow properties, of dosed samples remain within the acceptance limit compared to their blank samples in the same group, which indicates that the additive has no detrimental effect on the samples' intrinsic properties at the dosing level of 500 ppm.

Table 3: Testing results of blank and dosed distillate fuel oils.

Parameters	Testing Method	Unit	Group 4			Group 5			Group 6		
			Blank	Dosed	0.59R	Blank	Dosed	0.59R	Blank	Dosed	0.59R
Density 15°C	ISO 12185	kg/m ³	844.9	844.6	0.295	846.4	846.6	0.295	854.8	854.8	0.295
Viscosity 40°C	A-D7042	mm ² /s	3.245	3.237	0.021	2.896	2.887	0.019	3.665	3.668	0.023
Water Content	A-D6304-C	%V/V	<0.01	<0.01	NA	<0.01	<0.01	NA	<0.01	<0.01	NA
MCR 10% Bottom	ISO 10370	%m/m	<0.10	<0.10	NA	<0.10	<0.10	NA	<0.10	<0.10	NA
Sulfur	ISO 8754	%m/m	<0.03	<0.03	NA	<0.03	<0.03	NA	0.091	0.089	NA
Ash	LP 2605	%m/m	<0.01	<0.01	NA	<0.01	<0.01	NA	<0.01	<0.01	NA
Vanadium	LP 1105	mg/kg	<1	<1	NA	<1	<1	NA	<1	<1	NA
Sodium	LP 1105	mg/kg	<1	<1	NA	<1	<1	NA	<1	<1	NA
Aluminium	LP 1105	mg/kg	<1	<1	NA	<1	<1	NA	<1	<1	NA
Silicon	LP 1105	mg/kg	<1	<1	NA	<1	<1	NA	<1	<1	NA
Iron	LP 1105	mg/kg	<1	<1	NA	<1	<1	NA	<1	<1	NA
Nickel	LP 1105	mg/kg	<1	<1	NA	<1	<1	NA	<1	<1	NA
Calcium	LP 1105	mg/kg	<1	<1	NA	<1	<1	NA	<1	<1	NA
Magnesium	LP 1105	mg/kg	<1	<1	NA	<1	<1	NA	<1	<1	NA
Zinc	LP 1105	mg/kg	<1	<1	NA	<1	<1	NA	<1	<1	NA
Phosphorus	LP 1105	mg/kg	<1	<1	NA	<1	<1	NA	<1	<1	NA
Potassium	LP 1105	mg/kg	<1	<1	NA	<1	<1	NA	<1	<1	NA
Flash Point	ISO 2719-A	°C	63.5	62.5	2.7	66.5	66.5	2.8	>70.0	>70.0	NA
Appearance	LP 1902	-	Pass	Pass	NA	Pass	Pass	NA	Pass	Pass	NA
Temperature at 10% recovery	ISO 3405	°C	207	205	2.69	217	215	2.82	237	238	3.08
Temperature at 50% recovery	ISO 3405	°C	268	268	1.75	271	272	1.75	288	288	1.75
Temperature at 90% recovery	ISO 3405	°C	367	366	3.25	332	331	2.94	344	344	3.04
FAME content	EN 14078	%V/V	<0.10	<0.10	NA	<0.10	<0.10	NA	<0.10	<0.10	NA
Pour Point	ISO 3016	°C	<-6	<-6	NA	<-6	<-6	NA	<-6	<-6	NA
Cold Filter Plugging Point	IP 309	°C	0	-1	1.5	<-6	<-6	NA	-6	-7	1.9
Lubricity (HFRR)	ISO 12156-1	µm	390	390	60	380	370	60	360	350	60
Cloud Point	LP 1305	°C	7	7	1.5	-10	-10	1.5	-4	-4	1.5
Total Acid Number	A-D664	mg KOH/g	0.15	0.19	0.05	0.17	0.22	0.06	0.17	0.19	0.06
Strong Acid Number	ASTM D664	mg KOH/g	0	0	NA	0	0	NA	0	0	NA
Calculated Cetane Index	ISO 4264	SI	48.6	48.6	NA	49.1	49.0	NA	50.4	50.4	NA
Net Specific Energy	ISO 8217	MJ/kg	42.81	42.81	NA	42.79	42.79	NA	42.67	42.67	NA

CONCLUSION

As can be seen in Table 2 and Table 3, no evidence has been observed that the additive, SulNOx ECO, can introduce any negative impact to the performance and properties on the tested fuel oil, for both residual and distillate, at the given dosing rates.

However, the conclusion is only based on the selected fuel oils and the testing results in our lab. Any other types of approval or technology validation, which may require more tests with a different protocol, are not in the discussion scope of this report.