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APPENDIX A

Table A1 Input parameters for same level of design (Sal oil biodiesel blends)

Input Parameter	Designation	Level 1	Level 2	Level 3	Level 4
Engine torque (N-m)	A	14	21	28	35
Engine speed (rpm)	B	1400	1600	1800	2000
Fuel type	C	Diesel	SOB10	SOB20	SOB30

Table A2 Input parameters for same level of design (water emulsification diesel fuel)

Input Parameter	Designation	Level 1	Level 2	Level 3	Level 4
Engine torque (N-m)	A	14	21	28	35
Engine speed (rpm)	B	1400	1600	1800	2000
Fuel type	C	Diesel	WiDE5	WiDE10	WiDE15

Table A3 Input parameters for same level of design (water emulsification OPB nano fuel)

Input Parameter	Designation	Level 1	Level 2	Level 3	Level 4
Engine torque (N-m)	A	14	21	28	35
Engine speed (rpm)	B	1400	1600	1800	2000
Fuel type	C	Diesel	OPB20+ WiDE5	OPB20+ WiDE5+ Al_2O_3	OPB20+ WiDE5+ CNT

Table A4 Input parameters for same level of design (water emulsification SOB nano fuel)

Input Parameter	Designation	Level 1	Level 2	Level 3	Level 4
Engine torque (N-m)	A	14	21	28	35
Engine speed (rpm)	B	1400	1600	1800	2000
Fuel type	C	Diesel	SOB20+ WiDE5	SOB20+ WiDE5+ Al_2O_3	SOB20+ WiDE5+ CNT

Table A5 L16 orthogonal array for same level of design (Sal oil biodiesel blends)

S.No.	Engine Torque (N-m)	Engine Speed (rpm)	Fuel type
1.	14	1400	Diesel
2.	14	1600	SOB10
3.	14	1800	SOB20
4.	14	2000	SOB30
5.	21	1400	SOB10
6.	21	1600	Diesel
7.	21	1800	SOB30
8.	21	2000	SOB20
9.	28	1400	SOB20
10.	28	1600	SOB30
11.	28	1800	Diesel

12.	28	2000	SOB10
13.	35	1400	SOB30
14.	35	1600	SOB20
15.	35	1800	SOB10
16.	35	2000	Diesel

Table A6 L16 orthogonal array for same level of design (water emulsification diesel fuel)

S.No.	Engine Torque (N-m)	Engine Speed (rpm)	Fuel type
1.	14	1400	Diesel
2.	14	1600	WiDE5
3.	14	1800	WiDE10
4.	14	2000	WiDE15
5.	21	1400	WiDE5
6.	21	1600	Diesel
7.	21	1800	WiDE15
8.	21	2000	WiDE10
9.	28	1400	WiDE10
10.	28	1600	WiDE15
11.	28	1800	Diesel
12.	28	2000	WiDE5
13.	35	1400	WiDE15
14.	35	1600	WiDE10
15.	35	1800	WiDE5

16.	35	2000	Diesel

Table A7 L16 orthogonal array for same level of design (water emulsification OPB nano fuel)

S.No.	Engine Torque (N-m)	Engine Speed (rpm)	Fuel type
1.	14	1400	Diesel
2.	14	1600	OPB20+WiDE5
3.	14	1800	OPB20+WiDE5+Al_2O_3
4.	14	2000	OPB20+WiDE5+CNT
5.	21	1400	OPB20+WiDE5
6.	21	1600	Diesel
7.	21	1800	OPB20+WiDE5+CNT
8.	21	2000	OPB20+WiDE5+Al_2O_3
9.	28	1400	OPB20+WiDE5+Al_2O_3
10.	28	1600	OPB20+WiDE5+CNT
11.	28	1800	Diesel
12.	28	2000	OPB20+WiDE5
13.	35	1400	OPB20+WiDE5+CNT
14.	35	1600	OPB20+WiDE5+Al_2O_3
15.	35	1800	OPB20+WiDE5
16.	35	2000	Diesel

Table A8 L16 orthogonal array for same level of design (water emulsification SOB nano fuel)

S.No.	Engine Torque (N-m)	Engine Speed (rpm)	Fuel type
1.	14	1400	Diesel
2.	14	1600	SOB20+WiDE5
3.	14	1800	SOB20+WiDE5+Al_2O_3
4.	14	2000	SOB20+WiDE5+CNT
5.	21	1400	SOB20+WiDE5
6.	21	1600	Diesel
7.	21	1800	SOB20+WiDE5+CNT
8.	21	2000	SOB20+WiDE5+Al_2O_3
9.	28	1400	SOB20+WiDE5+Al_2O_3
10.	28	1600	SOB20+WiDE5+CNT
11.	28	1800	Diesel
12.	28	2000	SOB20+WiDE5
13.	35	1400	SOB20+WiDE5+CNT
14.	35	1600	SOB20+WiDE5+Al_2O_3
15.	35	1800	SOB20+WiDE5
16.	35	2000	Diesel

APPENDIX B

Table B1 The values S/N ratio for L16 orthogonal array prepared for diesel, OPB10, OPB20, and OPB30 fuel (Table 4.3)

BSFC	BTE	EE	NO	CO	HC	CO_2	Smoke	EDR	EGT
2.78	22.57	22.01	52.69	24.44	28.94	12.54	30.56	22.52	52.25
3.35	23.20	22.72	53.55	25.04	27.60	13.35	29.77	22.83	52.55
4.32	25.01	23.30	53.80	25.19	26.44	14.29	28.95	23.18	52.87
5.22	24.38	23.68	54.00	25.04	28.30	14.95	28.98	23.64	53.16
5.80	24.93	24.40	54.12	24.73	27.23	14.17	31.15	23.21	52.79
7.72	26.03	25.33	53.87	23.74	29.25	14.25	33.16	23.20	52.78
7.99	25.99	25.28	54.50	24.19	28.30	15.90	30.51	24.37	53.54
8.68	26.66	25.90	54.55	23.73	24.61	15.96	31.82	24.48	53.54
6.83	27.79	26.86	54.27	21.97	26.44	15.68	31.46	24.23	53.43
8.62	26.68	25.96	54.65	23.47	28.30	16.53	31.22	24.93	53.81
8.56	27.90	27.29	53.93	22.38	30.37	15.97	34.87	24.02	53.49
8.36	26.36	25.63	54.52	24.01	25.11	17.01	33.66	24.92	53.80
8.85	27.63	27.15	54.24	22.50	34.15	16.78	32.04	23.80	54.25
8.95	27.87	27.40	54.40	22.38	34.65	16.90	33.44	24.67	54.34
9.06	28.30	27.79	54.85	21.94	35.12	16.90	33.80	25.12	54.32
9.90	28.54	28.06	54.07	21.41	35.85	17.03	35.71	25.55	54.29

Table B2 The values of S/N Ratio for L16 orthogonal array prepared for diesel, SOB10, SOB20, and SOB30 fuel (Table A1)

BSFC	BTE	EE	NO	CO	HC	CO_2	Smoke	EDR	EGT
2.78	22.57	22.01	52.69	24.44	28.94	12.54	30.56	22.52	52.25
3.36	22.92	22.49	53.73	24.88	31.13	13.81	30.67	22.70	52.61
4.32	24.50	24.03	53.94	24.73	31.36	14.45	29.92	22.93	52.89
5.38	23.92	23.36	54.26	25.04	31.60	15.01	29.82	23.41	53.21
5.80	24.70	24.20	54.29	24.44	31.82	14.62	31.96	23.07	52.85
7.72	26.03	25.33	53.87	23.74	29.25	14.25	33.16	23.20	52.78
8.25	25.65	25.08	54.74	24.15	32.87	15.79	31.43	24.09	53.57
8.73	26.33	25.73	54.75	23.48	33.06	15.89	32.50	24.02	53.58
8.36	27.59	26.71	54.70	23.74	32.67	15.68	32.17	23.82	53.45
8.97	26.44	25.86	54.85	23.35	33.44	16.30	32.27	24.62	53.84
8.56	27.90	27.29	53.93	22.38	30.37	15.97	34.87	24.02	53.49
7.41	27.73	26.80	54.54	21.51	34.49	17.10	34.22	24.70	53.86
8.89	27.26	26.90	54.34	22.62	33.98	17.15	32.67	23.74	54.30
9.21	27.62	27.24	54.52	22.27	34.32	17.03	33.62	24.58	54.39
9.57	28.25	27.63	54.87	21.72	34.81	17.15	35.12	25.04	54.39
9.90	28.54	28.06	54.07	21.41	35.85	17.03	35.71	25.55	54.29

Table B3 The values of S/N ratio for L16 orthogonal array prepared for diesel, WiDE5, WiDE10, and WiDE15 fuel (Table A2)

BSFC	BTE	EE	NO	CO	HC	CO_2	Smoke	EDR	EGT
2.78	22.57	22.01	52.69	24.44	28.94	12.54	30.56	22.52	52.25
3.17	23.80	23.17	52.71	24.88	30.63	16.18	29.90	22.53	52.26
4.27	24.07	23.39	52.77	25.04	30.37	16.46	29.32	22.54	52.23
5.04	24.44	23.81	52.69	24.84	30.10	16.76	28.84	22.40	52.26
5.83	25.55	24.90	53.33	24.48	31.36	16.42	31.27	22.85	52.52
7.72	26.03	25.33	53.87	23.74	29.25	14.25	33.16	23.20	52.78
7.99	26.32	25.61	53.27	24.15	31.13	17.06	30.61	22.89	52.63
9.02	26.95	26.37	53.61	23.88	32.04	16.98	32.05	23.31	52.90
8.87	26.72	26.02	53.55	24.11	31.82	16.89	31.70	23.18	52.78
8.64	27.25	26.47	53.46	23.54	32.26	17.27	31.55	23.26	52.93
8.56	27.90	27.29	53.93	22.38	30.37	15.97	34.87	24.02	53.49
7.08	28.46	27.72	53.55	22.08	34.15	17.25	34.01	24.09	53.61
8.84	27.84	27.53	52.44	23.10	32.67	16.52	32.26	22.59	53.59
9.16	28.28	27.75	52.97	22.50	33.62	16.65	33.44	23.61	53.82
9.22	28.55	28.08	53.59	21.83	34.49	16.78	34.65	24.73	53.98
9.90	28.54	28.06	54.07	21.41	35.85	17.03	35.71	25.55	54.29

Table B4 The values of S/N ratio for L16 orthogonal array prepared for diesel, OPB20+WiDE5, OPB20+WiDE5+Al_2O_3, and OPB20+WiDE5+CNT fuel (Table A3)

BSFC	BTE	EE	NO	CO	HC	CO2	Smoke	EDR	EGT
2.78	22.57	22.01	52.69	24.44	28.94	12.54	30.56	22.52	52.25
3.17	23.80	23.17	52.71	24.88	30.63	16.18	29.90	22.53	52.26
4.27	24.07	23.39	52.77	25.04	30.37	16.46	29.32	22.54	52.23
5.04	24.44	23.81	52.69	24.84	30.10	16.76	28.84	22.40	52.26
5.83	25.55	24.90	53.33	24.48	31.36	16.42	31.27	22.85	52.52
7.72	26.03	25.33	53.87	23.74	29.25	14.25	33.16	23.20	52.78
7.99	26.32	25.61	53.27	24.15	31.13	17.06	30.61	22.89	52.63
9.02	26.95	26.37	53.61	23.88	32.04	16.98	32.05	23.31	52.90
8.87	26.72	26.02	53.55	24.11	31.82	16.89	31.70	23.18	52.78
8.64	27.25	26.47	53.46	23.54	32.26	17.27	31.55	23.26	52.93
8.56	27.90	27.29	53.93	22.38	30.37	15.97	34.87	24.02	53.49
7.08	28.46	27.72	53.55	22.08	34.15	17.25	34.01	24.09	53.61
8.84	27.84	27.53	52.44	23.10	32.67	16.52	32.26	22.59	53.59
9.16	28.28	27.75	52.97	22.50	33.62	16.65	33.44	23.61	53.82
9.22	28.55	28.08	53.59	21.83	34.49	16.78	34.65	24.73	53.98
9.90	28.54	28.06	54.07	21.41	35.85	17.03	35.71	25.55	54.29

Table B5 The values of S/N ratio for L16 orthogonal array prepared for diesel, SOB20+WiDE5, SOB20+WiDE5+Al_2O_3, and SOB20+WiDE5+CNT fuel (Table A4)

BSFC	BTE	EE	NO	CO	HC	CO_2	Smoke	EDR	EGT
2.78	22.57	22.01	52.69	24.44	28.94	12.54	30.56	22.52	52.25
3.17	23.80	23.17	52.71	24.88	30.63	16.18	29.90	22.53	52.26
4.27	24.07	23.39	52.77	25.04	30.37	16.46	29.32	22.54	52.23
5.04	24.44	23.81	52.69	24.84	30.10	16.76	28.84	22.40	52.26
5.83	25.55	24.90	53.33	24.48	31.36	16.42	31.27	22.85	52.52
7.72	26.03	25.33	53.87	23.74	29.25	14.25	33.16	23.20	52.78
7.99	26.32	25.61	53.27	24.15	31.13	17.06	30.61	22.89	52.63
9.02	26.95	26.37	53.61	23.88	32.04	16.98	32.05	23.31	52.90
8.87	26.72	26.02	53.55	24.11	31.82	16.89	31.70	23.18	52.78
8.64	27.25	26.47	53.46	23.54	32.26	17.27	31.55	23.26	52.93
8.56	27.90	27.29	53.93	22.38	30.37	15.97	34.87	24.02	53.49
7.08	28.46	27.72	53.55	22.08	34.15	17.25	34.01	24.09	53.61
8.84	27.84	27.53	52.44	23.10	32.67	16.52	32.26	22.59	53.59
9.16	28.28	27.75	52.97	22.50	33.62	16.65	33.44	23.61	53.82
9.22	28.55	28.08	53.59	21.83	34.49	16.78	34.65	24.73	53.98
9.90	28.54	28.06	54.07	21.41	35.85	17.03	35.71	25.55	54.29

Table B6 The values of S/N ratio for L16 orthogonal array prepared for OPB20+WiDE5+CNT, and SOB20+WiDE5+CNT fuel (Table A4.4)

BSFC	BTE	EE	NO	CO	HC	CO_2	Smoke	EDR	EGT
2.58	22.85	22.18	52.82	25.85	24.08	14.43	24.68	23.08	52.29
3.64	23.77	23.09	53.14	25.68	25.11	14.74	25.49	23.22	52.39
4.69	24.38	23.75	53.48	25.51	24.61	15.01	26.55	23.11	52.57
5.78	25.04	24.42	53.64	25.35	25.11	15.30	26.59	23.27	52.68
6.19	25.52	24.83	53.73	25.04	26.02	15.46	27.13	23.62	52.67
7.52	26.29	25.59	53.96	25.37	26.85	15.85	27.91	23.90	52.85
8.50	26.73	26.10	54.13	24.73	26.85	16.24	28.61	23.92	53.09
9.09	27.20	26.60	54.26	24.29	27.23	16.64	28.83	24.24	53.27
8.77	26.91	26.28	54.22	25.19	26.85	15.43	28.46	24.03	53.15
9.22	27.50	26.87	54.24	24.15	27.60	16.89	29.75	24.46	53.39
8.54	28.09	27.38	54.05	3.48	29.54	17.20	30.10	25.23	53.57
7.12	28.35	27.64	53.79	22.85	29.83	17.58	30.63	25.72	53.82
9.41	28.27	27.80	53.14	22.97	30.10	17.15	29.83	23.44	53.93
9.58	28.48	27.98	53.50	22.50	30.88	17.38	30.68	24.52	54.07
9.22	28.74	28.05	53.71	22.62	32.04	17.27	31.64	25.53	54.21
9.29	28.78	28.00	54.14	22.38	32.67	17.39	32.46	26.34	54.32

APPENDIX C

Table C1 Values GRC and GRG for L16 orthogonal array prepared for diesel, OPB10, OPB20, and OPB30 fuel (Table 4.3)

BSFC	BTE	EE	NO	CO	HC	CO_2	Smoke	EDR	EGT	GRG
1.00	0.44	0.44	1.00	0.50	0.67	1.00	0.77	1.00	1.00	0.78
0.91	0.47	0.48	0.67	0.45	0.75	0.82	0.87	0.89	0.85	0.71
0.79	0.58	0.50	0.61	0.44	0.83	0.67	1.00	0.79	0.73	0.69
0.70	0.53	0.53	0.57	0.45	0.71	0.60	1.00	0.68	0.65	0.64
0.65	0.57	0.57	0.55	0.48	0.77	0.69	0.71	0.78	0.75	0.65
0.54	0.66	0.64	0.59	0.56	0.66	0.68	0.56	0.78	0.76	0.64
0.52	0.65	0.64	0.49	0.52	0.71	0.52	0.78	0.57	0.56	0.60
0.49	0.72	0.69	0.48	0.57	1.00	0.51	0.65	0.55	0.56	0.62
0.58	0.87	0.80	0.52	0.84	0.83	0.53	0.68	0.59	0.59	0.68
0.49	0.72	0.70	0.47	0.60	0.71	0.47	0.70	0.50	0.52	0.59
0.50	0.88	0.86	0.58	0.76	0.61	0.51	0.48	0.62	0.57	0.64
0.51	0.69	0.67	0.49	0.54	0.95	0.45	0.53	0.50	0.52	0.58
0.48	0.84	0.84	0.53	0.74	0.49	0.46	0.64	0.65	0.45	0.61
0.48	0.88	0.88	0.50	0.76	0.47	0.45	0.55	0.53	0.44	0.59
0.48	0.95	0.95	0.44	0.85	0.46	0.45	0.53	0.48	0.45	0.60
0.44	1.00	1.00	0.56	1.00	0.44	0.44	0.44	0.44	0.45	0.62

Table C2 Values of GRC and GRG for L16 orthogonal array prepared for diesel, SOB10, SOB20, and SOB30 fuel (Table A1)

BSFC	BTE	EE	NO	CO	HC	CO_2	Smoke	EDR	EGT	GRG
1.00	0.44	0.44	1.00	0.49	1.00	1.00	0.86	1.00	1.00	0.82
0.91	0.46	0.47	0.63	0.46	0.72	0.74	0.85	0.93	0.83	0.70
0.79	0.54	0.55	0.58	0.47	0.70	0.66	0.98	0.86	0.73	0.68
0.69	0.51	0.51	0.53	0.44	0.68	0.60	1.00	0.73	0.64	0.63
0.65	0.55	0.56	0.52	0.49	0.66	0.64	0.69	0.82	0.74	0.63
0.54	0.66	0.64	0.60	0.55	0.95	0.68	0.59	0.78	0.76	0.67
0.51	0.62	0.62	0.46	0.51	0.58	0.53	0.74	0.61	0.56	0.58
0.49	0.68	0.68	0.46	0.58	0.57	0.52	0.64	0.62	0.56	0.58
0.50	0.83	0.78	0.47	0.55	0.60	0.54	0.67	0.65	0.59	0.62
0.48	0.70	0.69	0.45	0.60	0.55	0.50	0.66	0.54	0.52	0.57
0.50	0.88	0.86	0.58	0.75	0.79	0.52	0.48	0.62	0.58	0.66
0.55	0.86	0.79	0.49	0.97	0.50	0.45	0.52	0.53	0.51	0.62
0.48	0.79	0.81	0.51	0.71	0.52	0.44	0.62	0.67	0.45	0.60
0.47	0.84	0.86	0.49	0.77	0.51	0.45	0.55	0.54	0.44	0.59
0.46	0.94	0.92	0.44	0.90	0.49	0.44	0.47	0.49	0.44	0.60
0.44	1.00	1.00	0.56	1.00	0.44	0.45	0.44	0.44	0.46	0.62

Table C3 Values of GRC and GRG for L16 orthogonal array prepared for diesel, WiDE5, WiDE10, and WiDE15 fuel (Table A2)

BSFC	BTE	EE	NO	CO	HC	CO_2	Smoke	EDR	EGT	GRG
1.00	0.44	0.44	0.84	0.49	1.00	1.00	0.76	0.96	0.99	0.79
0.94	0.50	0.50	0.83	0.46	0.77	0.51	0.84	0.95	0.98	0.73
0.79	0.52	0.51	0.80	0.44	0.79	0.49	0.92	0.95	1.00	0.72
0.72	0.54	0.53	0.84	0.46	0.83	0.47	1.00	1.00	0.99	0.74
0.65	0.61	0.60	0.59	0.49	0.70	0.49	0.69	0.85	0.85	0.65
0.54	0.66	0.64	0.48	0.55	0.95	0.69	0.56	0.76	0.75	0.66
0.52	0.68	0.66	0.61	0.51	0.72	0.46	0.76	0.84	0.81	0.66
0.48	0.75	0.74	0.53	0.54	0.64	0.46	0.63	0.74	0.71	0.62
0.48	0.72	0.70	0.54	0.52	0.66	0.47	0.66	0.76	0.75	0.63
0.49	0.79	0.75	0.56	0.58	0.63	0.44	0.67	0.75	0.70	0.64
0.50	0.88	0.86	0.47	0.75	0.79	0.52	0.48	0.61	0.57	0.64
0.57	0.98	0.93	0.54	0.81	0.51	0.45	0.52	0.60	0.54	0.65
0.48	0.87	0.90	1.00	0.63	0.60	0.49	0.62	0.93	0.55	0.71
0.47	0.95	0.94	0.71	0.73	0.54	0.48	0.54	0.68	0.51	0.65
0.47	1.00	1.00	0.53	0.87	0.50	0.47	0.49	0.52	0.49	0.63
0.44	1.00	1.00	0.44	1.00	0.44	0.46	0.44	0.44	0.44	0.61

Table C4 Values of GRC and GRG for L16 orthogonal array prepared for diesel, OPB20+WiDE5, OPB20+WiDE5+Al_2O_3, and OPB20+WiDE5+CNT fuel (Table A3)

BSFC	BTE	EE	NO	CO	HC	CO_2	Smoke	EDR	EGT	GRG
1.00	0.44	0.44	1.00	0.52	0.67	1.00	0.65	1.00	1.00	0.77
0.93	0.47	0.47	0.69	0.48	0.61	0.70	0.84	0.86	0.78	0.68
0.77	0.52	0.51	0.59	0.46	0.77	0.62	1.00	0.78	0.78	0.68
0.67	0.59	0.58	0.58	0.44	1.00	0.57	0.96	0.71	0.82	0.69
0.65	0.57	0.57	0.53	0.51	0.57	0.61	0.71	0.75	0.69	0.62
0.54	0.66	0.64	0.53	0.58	0.66	0.68	0.53	0.78	0.76	0.64
0.50	0.75	0.72	0.48	0.50	0.90	0.50	0.78	0.59	0.69	0.64
0.49	0.76	0.74	0.45	0.57	0.66	0.49	0.72	0.56	0.59	0.60
0.50	0.72	0.71	0.45	0.54	0.67	0.50	0.74	0.60	0.61	0.61
0.47	0.85	0.82	0.47	0.56	0.86	0.47	0.71	0.52	0.62	0.63
0.50	0.88	0.86	0.52	0.77	0.61	0.52	0.47	0.62	0.58	0.63
0.58	0.88	0.87	0.48	0.89	0.45	0.45	0.55	0.44	0.49	0.61
0.48	0.97	0.95	0.80	0.64	0.60	0.46	0.66	0.68	0.52	0.67
0.48	0.96	0.95	0.64	0.73	0.56	0.45	0.62	0.55	0.46	0.64
0.49	0.92	0.94	0.44	0.81	0.49	0.44	0.54	0.47	0.44	0.60
0.44	1.00	1.00	0.49	1.00	0.44	0.45	0.44	0.45	0.46	0.62

Table C5 Values of GRC and GRG for L16 orthogonal array prepared for diesel, SOB20+WiDE5, SOB20+WiDE5+Al_2O_3, and SOB20+WiDE5+CNT fuel (Table A4)

BSFC	BTE	EE	NO	CO	HC	CO_2	Smoke	EDR	EGT	GRG
1.00	0.44	0.44	1.00	0.51	0.69	1.00	0.65	1.00	1.00	0.77
0.91	0.46	0.46	0.63	0.47	0.62	0.69	0.81	0.93	0.78	0.68
0.76	0.51	0.51	0.62	0.45	0.87	0.63	0.93	0.85	0.80	0.69
0.65	0.58	0.57	0.60	0.44	1.00	0.58	1.00	0.76	0.80	0.70
0.65	0.56	0.55	0.51	0.50	0.59	0.61	0.69	0.80	0.70	0.62
0.54	0.66	0.64	0.54	0.57	0.67	0.69	0.53	0.78	0.77	0.64
0.50	0.73	0.71	0.49	0.49	0.83	0.51	0.78	0.63	0.68	0.64
0.48	0.75	0.73	0.46	0.57	0.71	0.50	0.67	0.60	0.60	0.61
0.50	0.71	0.70	0.47	0.55	0.73	0.51	0.69	0.64	0.63	0.61
0.47	0.82	0.80	0.48	0.53	0.77	0.47	0.70	0.56	0.61	0.62
0.50	0.88	0.86	0.53	0.76	0.62	0.53	0.47	0.62	0.59	0.64
0.57	0.85	0.85	0.48	0.86	0.49	0.44	0.54	0.49	0.48	0.60
0.46	0.95	0.95	0.76	0.67	0.63	0.45	0.69	0.73	0.51	0.68
0.47	0.94	0.92	0.57	0.76	0.60	0.45	0.59	0.54	0.47	0.63
0.47	0.90	0.91	0.44	0.86	0.50	0.45	0.52	0.48	0.44	0.60
0.44	1.00	1.00	0.51	1.00	0.44	0.46	0.44	0.44	0.46	0.62

Table C6 Values of GRC and GRG for L16 orthogonal array prepared for OPB20+WiDE5+CNT, and SOB20+WiDE5+CNT fuel (Table A4.4)

BSFC	BTE	EE	NO	CO	HC	CO_2	Smoke	EDR	EGT	GRG
0.44	0.44	0.44	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.83
0.50	0.47	0.47	0.79	1.00	0.92	0.91	0.92	0.96	0.94	0.79
0.57	0.50	0.50	0.64	1.00	0.96	0.84	0.83	0.99	0.86	0.77
0.64	0.53	0.54	0.59	0.99	0.92	0.77	0.82	0.94	0.82	0.76
0.67	0.56	0.56	0.56	0.99	0.84	0.74	0.78	0.85	0.82	0.74
0.79	0.61	0.62	0.51	0.99	0.78	0.66	0.72	0.79	0.76	0.72
0.88	0.65	0.66	0.47	0.99	0.78	0.60	0.67	0.78	0.69	0.72
0.94	0.70	0.72	0.44	0.98	0.76	0.55	0.65	0.72	0.64	0.71
0.91	0.67	0.68	0.45	0.99	0.78	0.74	0.68	0.76	0.67	0.73
0.96	0.74	0.76	0.45	0.98	0.73	0.52	0.59	0.68	0.61	0.70
0.89	0.84	0.84	0.49	0.44	0.61	0.48	0.57	0.56	0.57	0.63
0.75	0.89	0.90	0.55	0.96	0.59	0.44	0.54	0.51	0.52	0.66
0.98	0.87	0.93	0.79	0.96	0.57	0.49	0.59	0.89	0.50	0.76
1.00	0.92	0.98	0.64	0.95	0.53	0.46	0.54	0.67	0.48	0.72
0.96	0.99	1.00	0.57	0.96	0.47	0.47	0.49	0.53	0.46	0.69
0.97	1.00	0.99	0.47	0.95	0.44	0.46	0.44	0.44	0.44	0.66

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LIST OF PUBLICATIONS

Journals

1. Rai, R.K. and Sahoo, R.R., Effect of CNT and Al_2O_3-CNT hybrid nano-additive in water-emulsified fuels on DICI engine energetic and exergetic performances. *Journal of Thermal Analysis and Calorimetry*, 147(5), pp.3577-3589, 2022. https://doi.org/10.1007/s10973-021-10746-x
2. Rai, R.K. and Sahoo, R.R.,. Engine performance, emission, and sustainability analysis with diesel fuel-based Shorea robusta methyl ester biodiesel blends. *Fuel,* 292, pp.120234, 2021. https://doi.org/10.1016/j.fuel.2021.120234
3. Rai, R.K. and Sahoo, R.R., Impact of different shape based hybrid nano additives in emulsion fuel for exergetic, energetic, and sustainability analysis of diesel engine. *Energy,* 214, p.119086, 2021. https://doi.org/10.1016/j.energy.2020.119086
4. Rai, R.K. and Sahoo, R.R., Experimental energetic and exergetic analysis with the novel emulsion fuels incorporating CNT and Al_2O_3 nano additive for DICI engine, *International Journal of Exergy*, Vol. 34, No. 4, pp.492–514, 2021. https://www.inderscienceonline.com/doi/abs/10.1504/IJEX.2021.114096
5. Rai, R.K. and Sahoo, R.R.,. Effect of Shorea robusta methyl ester biodiesel blends on the exergy and sustainability analysis of diesel engine. *Experimental Heat Transfer*, 34(5), pp.443-460, 2021. https://doi.org/10.1080/08916152.2020.1776419
6. Rai, R.K. and Sahoo, R.R., Taguchi-Grey method optimization of VCR engine performance and heat losses by using Shorea robusta biodiesel fuel. *Fuel*, 281,

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Conferences

1. Rai, R.K. and Sahoo, R.R., Optimization of Performance with Heat Transfer characteristics of a VCR engine fuelled with Mahua Diesel blends using Grey-Taguchi Method. '25th National and 3rd International ISHMT-ASTFE Heat and Mass Transfer (IHMTC-2019), December 28-31, IIT Roorkee, Uttarakhand'