

**Numerical simulation and Investigation of Producer gas based dual fuel mode SI engine performance:  
Parametric and Optimization study**



**Thesis Submitted in Partial Fulfilment  
For the Award of Degree**

**Doctor of Philosophy**

By

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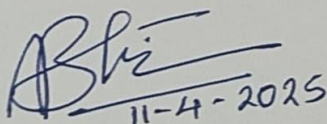
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## List of Figures:

Figure 1.2.1. Dried SS-residual samples pre and post digestion .....	4
Figure 3.1.1. Two-zone combustion modelling schematic .....	44
Figure 3.1.2. Process layout for the simulation .....	46
Figure 3.2.1. Engine simulation and optimization procedure layout.....	64
Figure 3.2.2. RSM-based optimization layout .....	65
Figure 4.1.1. Model validation with experimental with pressure vs crank angle .....	70
Figure 4.1.2. Model validation with brake power vs relative ratio.....	70
Figure 4.1.3. Pareto chart for the performance parameters of the engine.....	72
Figure 4.1.4. Pareto chart for emission parameters of the engine.....	73
Figure 4.1.5. Simultaneous effects of decision variables on ITE .....	78
Figure 4.1.6. Simultaneous effects of decision variables on IMEP .....	78
Figure 4.1.7. Simultaneous effects of decision variables on BTE.....	80
Figure 4.1.8. Simultaneous effects of decision variables on BP.....	81
Figure 4.1.9. Simultaneous effects of decision variables on BMEP.....	82
Figure 4.1.10. Simultaneous effects of decision variables on BSEC.....	83
Figure 4.1.11. Simultaneous effects of decision variables on CO emission .....	84
Figure 4.1.12. Simultaneous effects of decision variables on NO emissions .....	85
Figure 4.1.13. RSM optimizer plot .....	88
Figure 4.2.1. Simulated peak pressure and Brake power Validation .....	92
Figure 4.2.2. Efficiency and CO-emission validation.....	93
Figure 4.2.3. Modelled outputs vs. predicted response plots.....	95
Figure 4.2.4. Effects on ITE.....	99
Figure 4.2.5. Effects on IP .....	102
Figure 4.2.6. Effects on BTE .....	102
Figure 4.2.7. Effects on BP.....	103
Figure 4.2.8. Effects on BSEC.....	104
Figure 4.2.9. Effects on CO-emissions .....	105
Figure 4.2.10. Effects on NO-emissions .....	106
Figure 4.2.11. Optimized results and corresponding desirability values .....	109
Figure 4.3.1. Pressure vs crank angle plots for model validation .....	113
Figure 4.3.2. Power vs relative ratio for different blend validation.....	114
Figure 4.3.3. Efficiency and CO-emission validation.....	114

Figure 4.3.4. Simultaneous impacts on combustion parameters.....	120
Figure 4.3.5. Simultaneous impacts on performance parameters .....	122
Figure 4.3.6. Simultaneous impacts on BSEC and emission parameters .....	125
Figure 4.3.7. Optimal results ramp view.....	126
Figure 4.3.8. (A)-Individual desirability of optimal responses, (B)-Composite desirability contours.....	128
Figure 4.4.1. Schematic of the operational layout .....	133
Figure 4.4.2. Simulation Validation for neat and blended SSPG.....	135
Figure 4.4.3. Normal Probability plots .....	139
Figure 4.4.4. Simultaneous effects on power-representing parameters .....	141
Figure 4.4.5. Simultaneous effects on efficiency-representing parameters .....	143
Figure 4.4.6. Simultaneous effects on considered emission parameters.....	146
Figure 4.4.7. Ramp-view of optimized results.....	148
Figure 4.4.8. Parametric individual desirability values .....	149
Figure 4.5.1. Simulation Validation for neat and blended SSPG.....	153
Figure 4.5.2. Numerical vs. Predicted response plots.....	154
Figure 4.5.3. Ramp-view of optimized results.....	157
Figure 4.5.4. Parametric Individual desirability values .....	158
Figure 4.5.5. Effects of Boosting Intake Pressure .....	160
Figure 4.6.1. Simulated and Experimental outcomes for validation.....	165
Figure 4.6.2. P-crank angle validation.....	167
Figure 4.6.3. BP- Relative ratio validation .....	167
Figure 4.6.4. CO- Relative ratio emission validation .....	167
Figure 4.6.5. Impacts of BF, simultaneous CR, ER, IT variations on brake-performances ..	175
Figure 4.6.6. Impacts of BF, simultaneous CR, ER, IT variations on CO, NO emissions ....	178
Figure 4.6.7. Optimization results for CASE-A .....	180
Figure 4.6.8. Optimization results for CASE-B.....	181
Figure A.1. Sewage management processes layout .....	201

## List of Tables:

Table 1.1: Advantages and Limitations of the modelling techniques .....	10
Table 2.1: Comparative physiochemical properties of relevant fuels .....	32
Table 2.2: Comparison among the modelling techniques .....	38
Table 2.3. Previous investigation vs. this study .....	41
Table 2.4. Distinctions of Grape wood-based PG composition and LHV [39] .....	42
Table 3.1: Properties of sewage sludge producer gas–methane blends .....	43
Table 3.2: Engine specifications particular to the simulation .....	46
Table 3.3: Value of the constants .....	50
Table 3.4: Constants to compute flame speed[110] .....	53
Table 3.5: Equations for NO-emission, with rate constants.....	56
Table 3.6. Depiction of C-H-N-O atoms in the Propane-Grape PG mixture .....	58
Table 3.7: Optimizer Constraints .....	63
Table 4.1: Engine specifications respective to simulation .....	68
Table 4.2: Thermophysical properties of considered PG~CH <sub>4</sub> blends.....	68
Table 4.3: ANOVA for engine performance parameters. ....	75
Table 4.4: ANOVA for engine emission parameters .....	76
Table 4.5: Results from confirmation run at optimized input-levels .....	88
Table 4.6: Validation for NO.....	92
Table 4.7: Performance parameters ANOVA analysis .....	97
Table 4.8: Energy efficiency and emission parameters ANOVA analysis .....	97
Table 4.9: Optimizer Constraints .....	107
Table 4.10: Optimum responses and confirmation run.....	109
Table 4.11: Laminar flame-speed computational constants.....	112
Table 4.12: Validation for NO.....	113
Table 4.13: Design matrix associated simulation results .....	115
Table 4.14: Fitting solutions with decreasing Composite Desirability values (D) .....	127
Table 4.15: Confirmation run for Optimum responses .....	127
Table 4.16: Particular model considerations (engine specifications, fuel properties) .....	131
Table 4.17: Simulated results as per the Design matrix.....	135
Table 4.18: Relative engine performance improvements in the investigations .....	146
Table 4.19: Optimum responses and confirmation run.....	148
Table 4.20: Fit Statistics.....	155

Table 4.21: ANOVA analysis for the performance parameters .....	155
Table 4.22: ANOVA analysis for the emission parameters .....	156
Table 4.23: Confirmation run for optimum responses .....	157
Table 4.24: Values for Propane-Grape PG blend constants .....	162
Table 4.25: Validation for NO .....	167
Table 4.26: Parameter settings plan along with the responses and simulation results.....	168
Table 4.27: Optimum responses confirmation run.....	182

## Abbreviations

		<i>Symbol and units</i>	
<i>ANOVA</i>	Analysis of Variance	$a_c$	Crank length ( <i>metre</i> )
<i>BTDC</i>	Before Top Dead-center	$^\circ$	Angular degree
<i>ABDC</i>	After Bottom Dead-center	$\alpha, \theta$	Crank angle
<i>BDC</i>	Bottom dead-centre	$C_p$	const. pres. Specific heat ( $kJ/kgK$ )
<i>BMEP</i>	Brake-mean effective pressure	$\beta$	regression coefficient
<i>BF</i>	Volumetric Propane Blend fraction	$C_v$	const. vol. Specific heat ( $kJ/kgK$ )
<i>BP</i>	Brake Power	<i>bars</i>	IMEP and BMEP units
<i>BTE</i>	(%) Brake Thermal Efficiency	<i>MJ</i>	Mega joules
<i>BSEC</i>	( $MJ/kWh$ ) Brake-Specific Energy Consumption	$f$	Fractions (0~1)
<i>BSFC</i>	( $kg/kWh$ ) Brake-Specific Fuel Consumption	$g$	Specific-Gibbs function ( $kJ/kg$ )
<i>CD</i>	Combustion duration (10V%-90V%)	$kW$	Kilo watt
<i>CA</i>	( $^\circ$ ) Crank angle	$\rho_u$	Density-unburned charge ( $kg/m^3$ )
<i>CR</i>	Compression ratio	$L$	Connecting rod length ( $m$ )
<i>CO</i>	(V%) Carbon mono-oxide: <i>response</i>	$S_p$	Mean piston speed
<i>CV</i>	( $MJ/kg$ ) Calorific value	$\Phi$	Fuel-air equivalence ratio
<i>COV</i>	Coefficient of variance	$K_{lb}$	Backward rate constant
<i>ER</i>	Equivalence ratio	$T$	Cylinder-Temperature ( $K$ )
<i>FS</i>	Flame Speed	$V$	Chamber volume ( $m^3$ )
<i>EVO</i>	Exhause-valve open	$m$	Mass ( $kg$ )
<i>HHV</i>	Higher Heating Value ( $MJ/kg$ )	$K_{lf}$	Forward rate constant
<i>IMEP</i>	Indicated Mean Effective Pressure ( <i>bars</i> )	$p$	Product
<i>ITE</i>	Indicated Thermal Efficiency (%)	$R_j$	Rate constant
<i>LIVC</i>	( $^\circ ABDC$ ) Late Inlet-valve Closure	$R$	Gas constant ( $kJ/kgK$ )

<i>NO</i>	( <i>V%</i> ) Nitrogen Oxide: <i>response</i>	<i>u'</i>	Turbulent flame intensity
<i>PP</i>	Peak pressure ( <i>bars</i> )	<i>u<sub>T</sub></i>	Turbulent flame speed ( <i>m/sec</i> )
<i>PG</i>	Producer Gas	<i>S<sub>p</sub></i>	Mean piston speed
<i>RPM</i>	Revolutions per minute	<i>V</i>	Volume ( <i>m<sup>3</sup></i> )
<i>SOI</i>	( <i>° BTDC</i> ) Start of Ignition	<i>V%</i>	Percentage by volume
<i>TDC</i>	Top dead-centre		
<i>MBT</i>	( <i>Nm</i> ) Max. Brake-torque		
<i>TM</i>	Thermodynamic Modelling		
<i>QDTM</i>	Quasi-Dimensional TM		
<i>One-D</i>	one-Dimensional modelling	<i>Suffixes</i>	
<i>Three-D</i>	Three-Dimensional modelling	<i>ch</i>	Charge property
<i>SSPG</i>	Sewage Sludge Producer Gas	<i>m</i>	Unburned mixture
<i>CI</i>	Compression Ignition	<i>T</i>	Turbulent nature
<i>SI</i>	Spark Ignition	<i>e</i>	Equilibrium condition
		<i>p</i>	Burned product