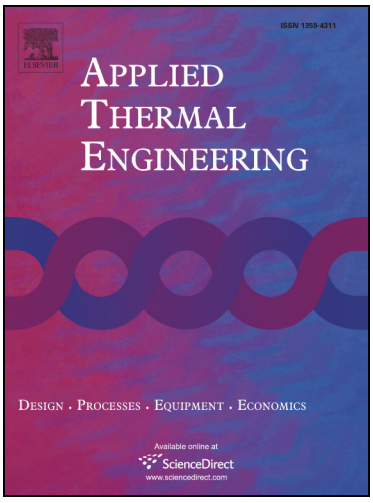

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Roberto Berlini Rodrigues da Costa, Fernando Antonio Rodrigues Filho, Christian J.R. Coronado, Alysson Fernandes Teixeira, Nilton Antonio Diniz Netto

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Research on hydrous ethanol stratified lean burn combustion in a DI spark-ignition engine

Roberto Berlini Rodrigues da Costa[a], Fernando Antonio Rodrigues Filho[b], Christian J.R.Coronado[a], Alysson Fernandes Teixeira[c] , Nilton Antonio Diniz Netto[c]

[a] Universidade Federal de Itajubá, Av. BPS 1303 – Itajubá – MG – Brazil CEP37500-903
[b] Centro Federal de Educação Tecnológica de Minas Gerais, Av. Amazonas 7675 – Belo Horizonte – MG – Brazil CEP30510-000
[c] Universidade Federal de Minas Gerais, Av. Antônio Carlos 6627. Belo Horizonte – MG – Brasil CEP 31270-90

Abstract

Fulfilling emission restrictions is the most challenging task considering future engine development. Stratified lean burn combustion mode associated with the use of biofuels has been widely studied to overcome current and future environmental regulation and global weather concerns. Power modulation by means of a throttle valve increases the pumping mean effective pressure with a corresponding penalty in engine fuel consumption at part load. De-throttling by means of direct injection (DI) is an attractive way of improving fuel economy and exhaust emissions at low and part load operation in spark-ignition (SI) engines. In this research, a study has been made of the investigations concerning stratified lean burn combustion in a wall-air guided type SI single cylinder optical research engine (SCORE) using Brazilian hydrous ethanol (E100) as fuel. Experiments were conducted at a constant load of 3 bar of net indicated mean effective pressure (NIMEP), for a wide range of injection, ignition and mixture formation parameters. Engine fuel conversion efficiency, combustion characteristics and emissions were evaluated for each excess air ratio (λ). Optical visualization illustrated the spray behavior and flame propagation. Specific fuel consumption and engine fuel conversion efficiency achieved an improvement of 8.1% and 2.6%, respectively, for λ = 1.4. Engine-out specific emissions were reduced by 66% for nitrogen oxides (NOx) and by 20% for total hydrocarbon (THC) and carbon dioxide (CO). A detailed combustion analysis based on in-cylinder pressure measurement was carried out and provided useful data for ethanol direct injection engine development.

Keywords: ethanol DI engine; stratified lean burn combustion; hydrous ethanol

Corresponding author's email: robertoberlini@gmail.com

DI	direct injection	COV_{NIMEP}	NIMEP covariation
SI	spark-ignition	TDC	top dead center
SCORE	single cylinder optical research engine	BTDC	before top dead center
E100	Brazilian hydrous ethanol	ATDC	after top dead center
rpm	revolutions per minute	HRR	heat release rate
NIMEP	net indicated mean effective pressure	NISFC	net indicated specific fuel consumption
λ	excess air ratio	MON	motor octane number
NOx	nitrogen oxides	RON	research octane number
THC	total hydrocarbon	LHV	lower heating value
CO	carbon monoxide	SAT	spark advance timing
GDI	gasoline direct injection	MBT	maximum break torque
USA	United Stated of America	SOC	start of combustion
PFI	port-fuel injection	MBF 10	10% burn point
LATAM	Latin America market	MBF 50	50 % burn point
PMEP	pumping mean effective pressure	MBF 90	90% burn point
EGR	exhaust gas recirculation	FTP-75	Federal Test Procedure
CO_2	carbon dioxide	EDC	European Driving Cycle