

Parametric Investigation of Energy Balance in a Spark Ignition

Engines: Experimental

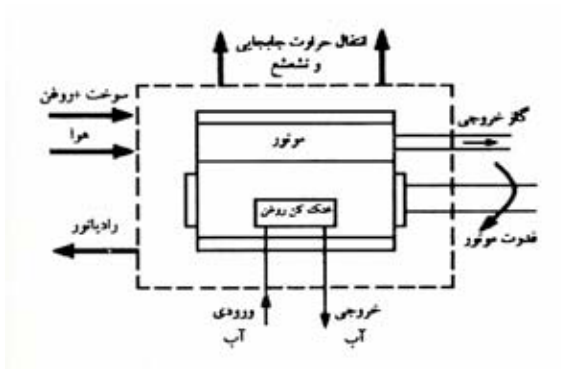
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Abstract

An energy balance is applied to an internal combustion engine for evaluation of different types of energies, which interacts with the engine during its operation. A 1600 CC spark ignition engine was taken as a system in this study. The effect of different engine parameters such as speed, load, cylinder head material, spark advance, compression ratio and coolant flow direction on the energy balance was investigated. The results show that the higher thermal efficiencies of the engine occurred in the middle engine speed, higher compression ratio, aluminum cylinder head and more spark advance.

Key words: Spark ignition engine, Energy balance, Thermal efficiency, Cylinder head material

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$h_o \quad h_f \quad h_a \quad \dot{m}_o \quad \dot{m}_f \quad \dot{m}_a \quad ()$

$\dot{m}_o h_o$

$h_{Exh.}$

()

[2]

$$\dot{m}_f Q_{LHV} = P_b + \dot{Q}_{Cool.} + \dot{Q}_{Exh.} + \dot{Q}_{IC} + \dot{Q}_{Misc.} \quad [1]$$

()

()

(Steady)

\dot{Q}_{IC}

$$\dot{m}_f h_f + \dot{m}_a h_a + \dot{m}_o h_o = P_b + \dot{Q}_{Cool.}$$

$$+ (\dot{m}_f + \dot{m}_a) h_{Exh.} + \dot{Q}_{Misc.} \quad ()$$

$\dot{m}_f Q_{LHV}$

$\dot{Q}_{cool.}$

P_b

()

$h_{Exh.}$

)

$\dot{Q}_{Misc.}$

[3]

	P_b	$\dot{Q}_{Cool.}$	$\dot{Q}_{Misc.}$	\dot{Q}_{IC}	$\dot{Q}_{Exh.}$
	25-28	17-26	3-10	2-5	34-45
	34-38	16-35	2-6	1-2	22-35

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[6] [5]

$$\frac{\dot{Q}_{Cool.}}{P_b}$$

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[4]

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P_b

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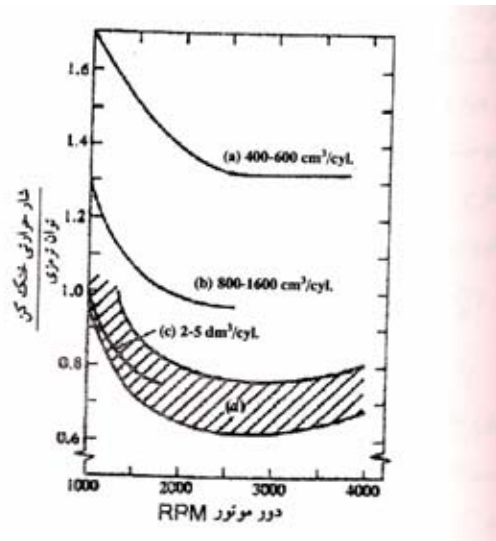
$$P = \frac{2\pi}{60} N \times T$$

N

T

()

()



(a)

(d)

(c)

(b)

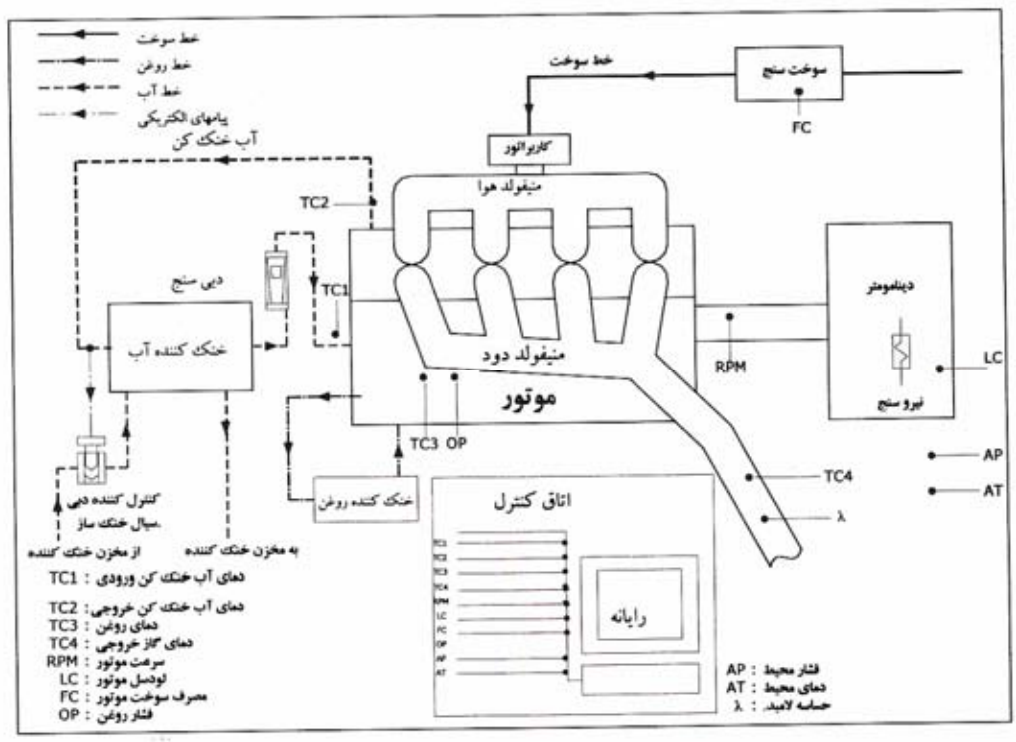
SI

$\dot{Q}_{Cool.}$

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$$\frac{\dot{Q}_{Cool.}}{P_b}$$

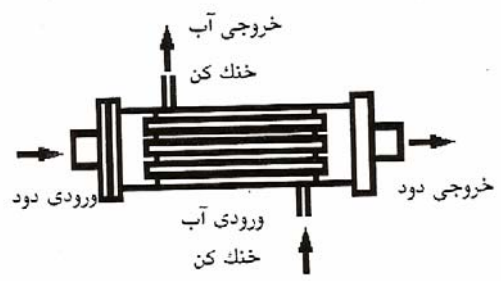
- 1- Empirical
- 2- Eddy Current
- 3- Load Cell



$$\dot{Q}_{Cool} = \dot{m}_{w,c} C_{p,w} (T_{w,out} - T_{w,in}) \quad (1)$$

C_p

K



$$\dot{Q}_{Exh} \quad (2)$$

$$\dot{Q}_{Exh} = \dot{m}_{w,c} C_{p,w} (T_{out,c} - T_{in,c}) + (\dot{m}_f + \dot{m}_a) C_{p,g} T_{out,g} \quad (3)$$

$C_{p,g}$

A/F

$C_{p,g}$

[] ()

$C_{p,g}$

[7]

*		
0.7868	0.7368	
0.05	0.04	
10444	10527	[Kcal/Kg]
8217.3	7756.3	[Kcal/Lit]
95.3	87.9	(RON)
7.105	7.0241	(C/H)

\dot{Q}_{IC}

λ

$$\lambda = \frac{(A/F)_{Actual}}{(A/F)_{Theoretical}}$$

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()

$\lambda < 1$

()

\dot{m}_a

λ

$$\dot{Q}_{IC} = \dot{m}_f Q_{LHV} (1 - \lambda)$$

()

$\lambda \geq 1$

λ

$\dot{m}_f \times Q_{LHV}$

1- Rich
2- Stoichiometric

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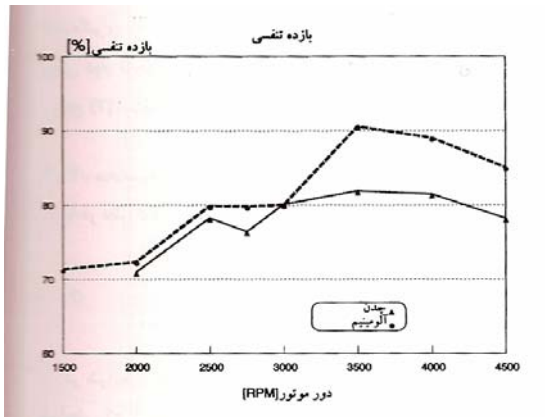
%

%

rpm

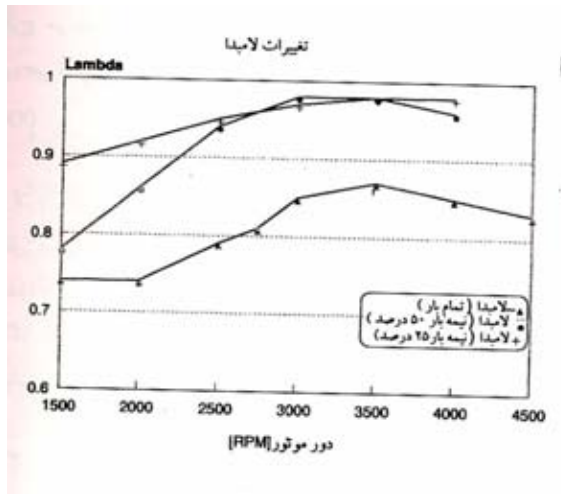
%

rpm



CC

/ /



)

(

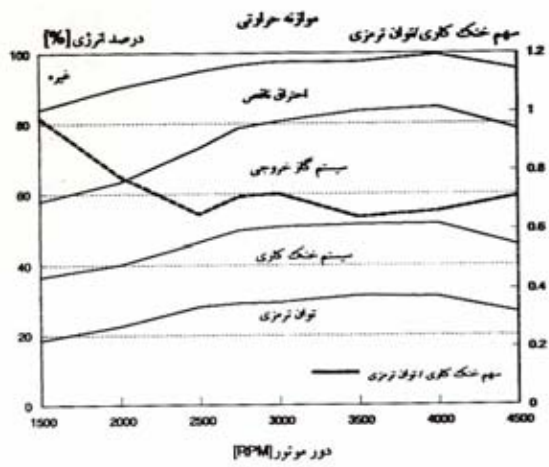
()

λ

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%

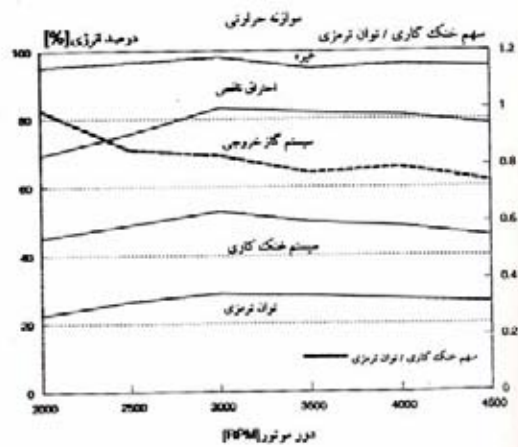
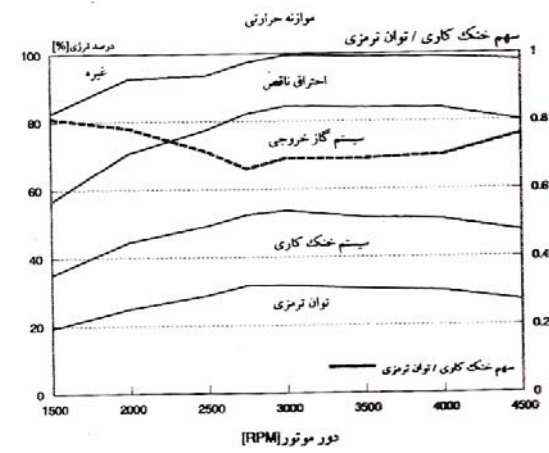
λ



() ()

rpm

rpm

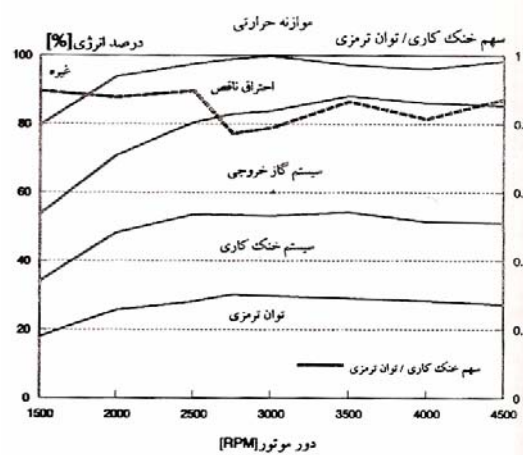


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rpm)

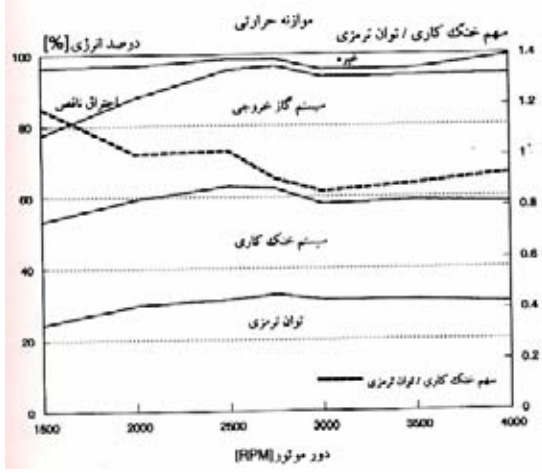
(rpm

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()

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$$(\lambda = 1)$$

λ

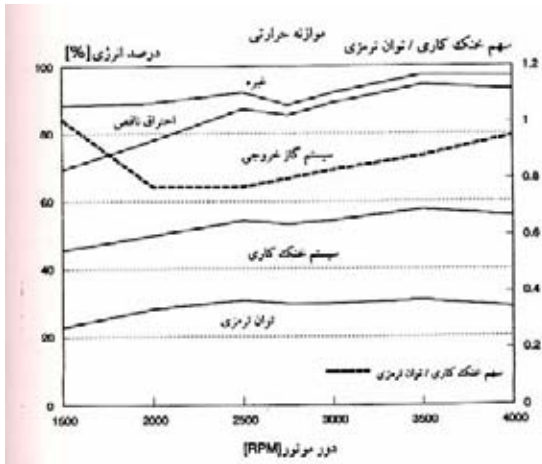
$$Q_{Cool.} / P_{Brake}$$

(/ /)

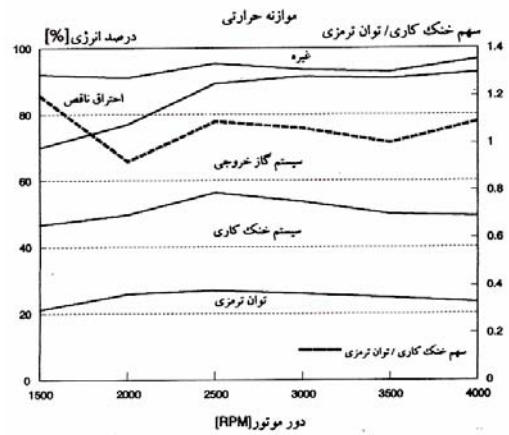
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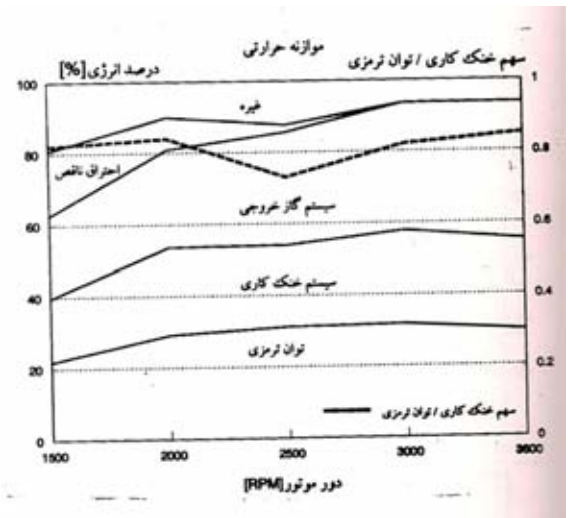
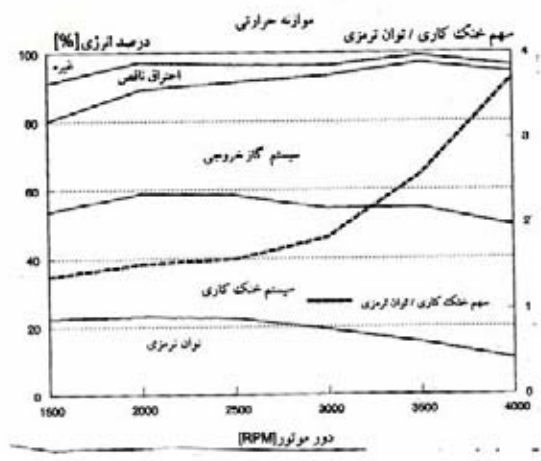
$$Q_{Cool.} / P_b$$

$$Q_{Cool}$$

$$P_b$$

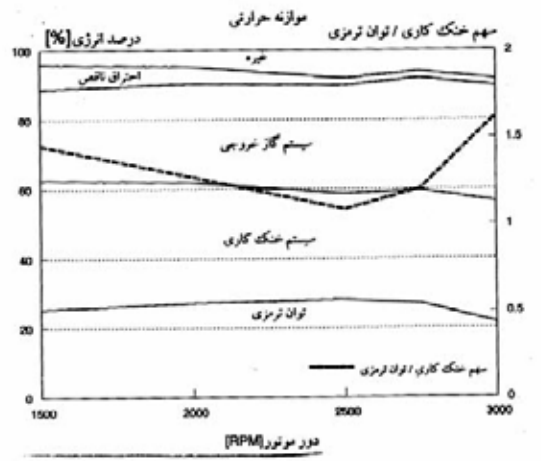
$$Q_{Cool.} / P_b$$

() ()



%

%



() ()

%

rpm

()

$$Q_{Cool.} / P_{Brake}$$

() ()

%

TDC

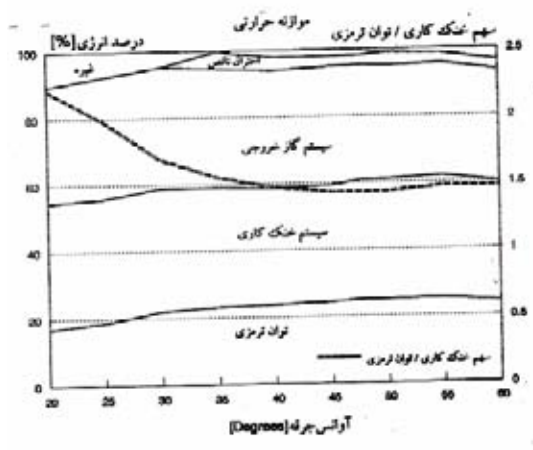
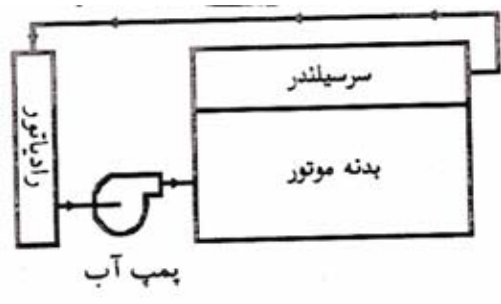
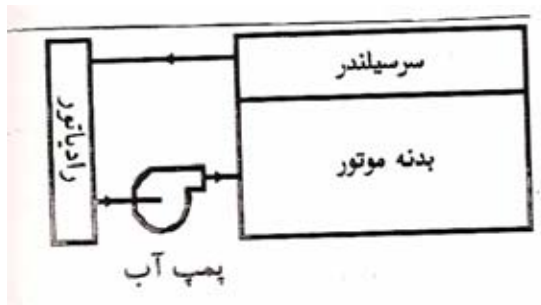
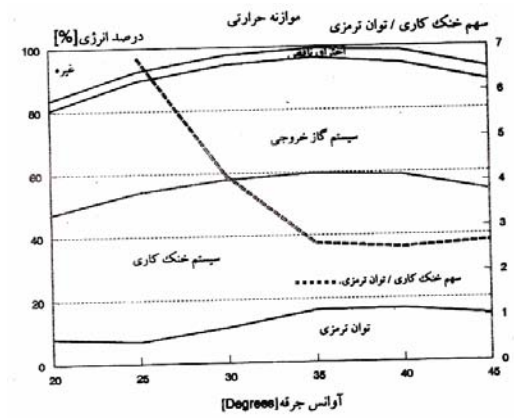
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() ()

$$Q_{Cool.} / P_{Brake}$$

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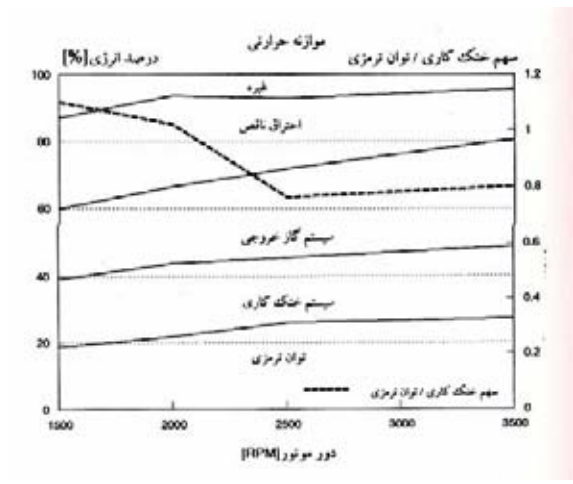
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()

/
()

()



() ()

()

$T_{w,in}$

$T_{w,out}$

λ

TDC

rpm

RON

C/H

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":

"

A/F

$C_{p,g}$

$C_{p,w}$

h_a

$h_{Exh.}$

h_f

h_o

\dot{m}_a

\dot{m}_f

\dot{m}_o

\dot{m}_w

$\dot{m}_{w,c}$

N

P_b

$\dot{Q}_{Cool.}$

$\dot{Q}_{Exh.}$

\dot{Q}_{IC}

Q_{LHV}

$\dot{Q}_{Misc.}$

T

$T_{in,c}$

$T_{out,c}$

$T_{out,g}$