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## ***Investigation on Effect of Multiple Injection on Performance and Emission Reduction in a DI Diesel Engine***

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### ***ABSTRACT***

Aim of this paper is to investigate mechanism of NO and soot reduction by using multiple injection as useful strategy for reducing DI diesel engines emissions. In this paper, we first studied the mechanism of NO and soot reduction by using double injection. Then after investigating different modes of injection, at last we introduce optimum mode of fuel injection for a DI diesel engine manufactured in our country. Experiments were induced at Motorsazan Tabriz to validate results of CFD simulation. Amount of fuel in each pulse and dwell time between injection pulses are essential parameters. Results showed that by using double injection soot and NO will reduce by 33% and 11% respectively.

**KEYWORDS :** DI diesel engine, multiple injections, KIVA-3V, Soot, NO.

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CFD

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K-ε

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$u_{rel}$

m

$$F_{spring} = k.x$$

$$F_{damping} = d.\dot{x}$$

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$$\ddot{x} = \frac{F}{m} - \frac{k}{m}x - \frac{d}{m}\dot{x}$$

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x

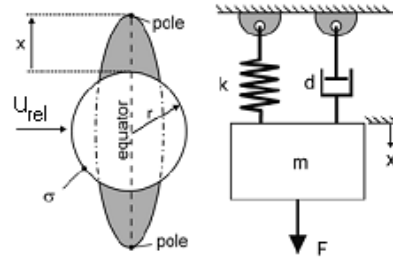
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$$t_d = \frac{2}{C_d} \frac{\rho_l r^2}{\mu_l} \quad (10)$$

$$\omega^2 = C_k \frac{\sigma}{\rho_d r^3} - \frac{1}{t_d^2} \quad (11)$$

$$\dot{y}_0 = (dy/dt)_{t=0}, y_0 = y_{t=0} \quad (12)$$



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$\sigma$   $u_{rel}$   $r$   $We_g$   
 $\mu_l$   $t_d$   
 $\omega$   
 $t_d We_g$

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$y \geq$  ,  $x \geq$  ,  $r$   
 $C_F = /$

$$\frac{d}{m} = C_d \frac{\mu_l}{\rho_l r^2} \quad (2)$$

$$\frac{k}{m} = C_k \frac{\sigma}{\rho_l r^3} \quad (3)$$

$$\frac{F}{m} = C_F \frac{\rho_g u_{rel}^2}{\rho_l r} \quad (4)$$

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$$y = x / C_b r \quad (5)$$

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$$\ddot{y} = \frac{C_F \rho_g u_{rel}^2}{C_b \rho_l r^2} - C_k \frac{\sigma}{\rho_l r^3} y - C_d \frac{\mu_l}{\rho_l r^2} \dot{y} \quad (6)$$

$u_{rel}$

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bar

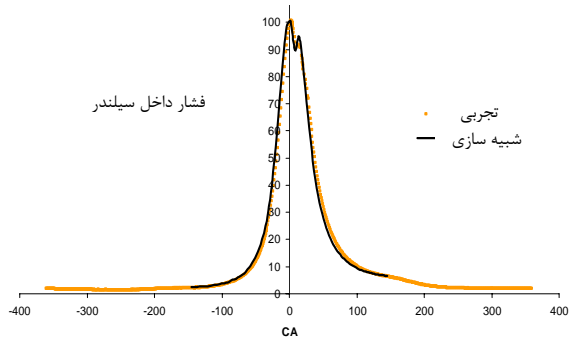
$$y(t) = \frac{C_F}{C_k C_b} We_g + \exp\left(-\frac{t}{t_d}\right) \left[ A \cos \omega t + \frac{1}{\omega t_d} B \sin \omega t \right] \quad (7)$$

$$A = \left( y_0 - \frac{C_F}{C_k C_b} We_g \right) \quad (8)$$

$$B = \left( \dot{y} t_d + y_0 - \frac{C_F}{C_k C_b} We_g \right) \quad (9)$$

$$We_g = \frac{\rho u_{rel}^2 r}{\sigma} \quad (10)$$

$m^{-1}$  ,  $m^{-1}$  (k-value) , %  
 % Vol  
 HC , %  
 NOx ppm , ppm  
 O<sub>2</sub> ppm , ppm vol



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(gr/kW.h)	(gr/kW.h)	
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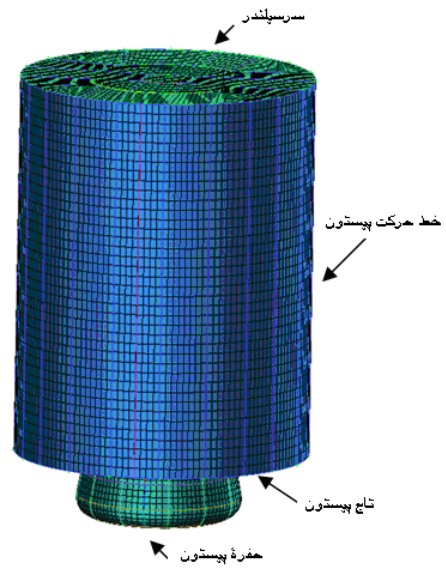
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$\lambda$  , ppm , ppm vol

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mm	
mm	
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ATDC	
bar	
rpm	
$\omega$	

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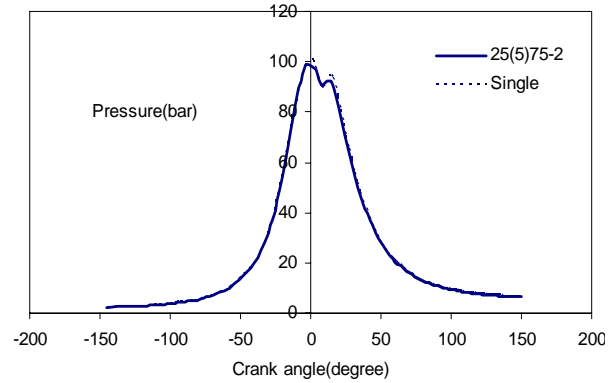
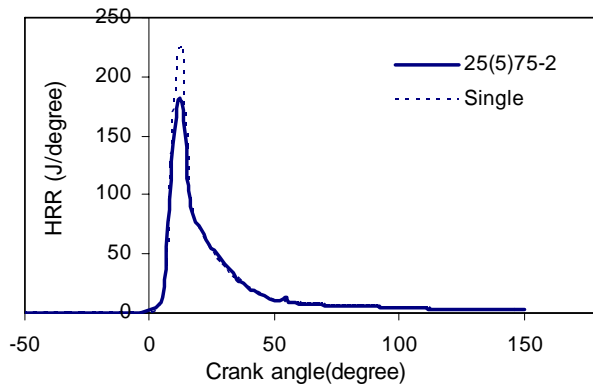
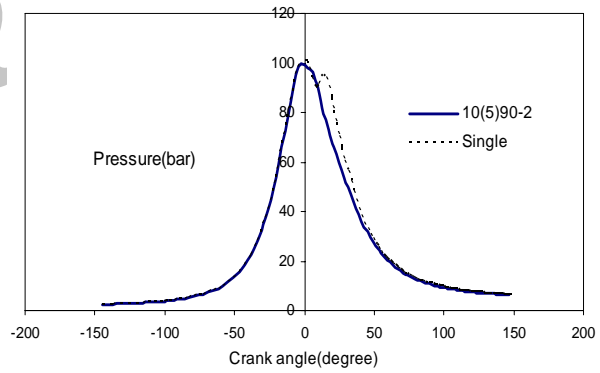
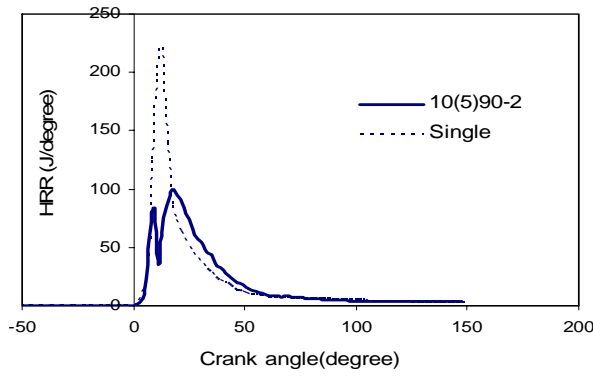
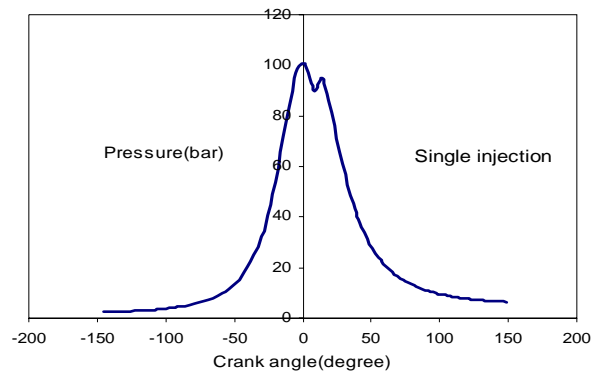
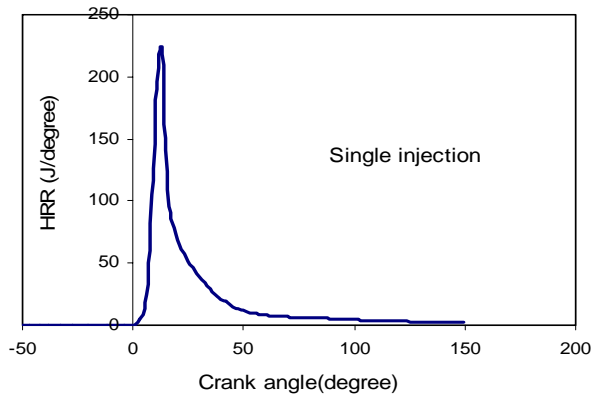
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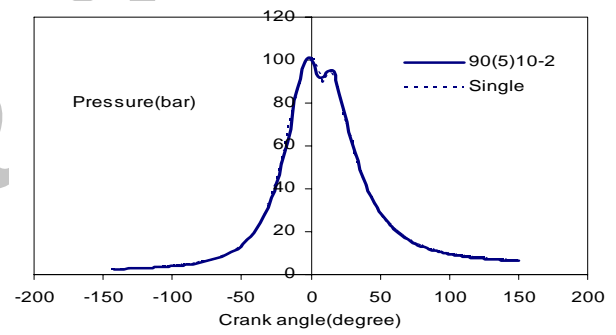
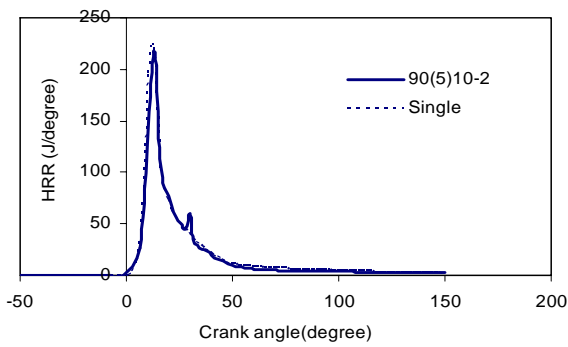
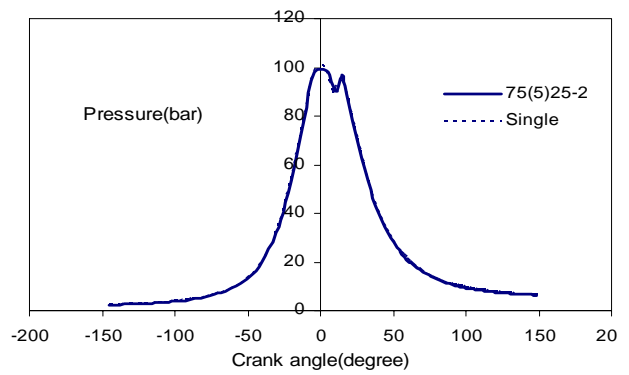
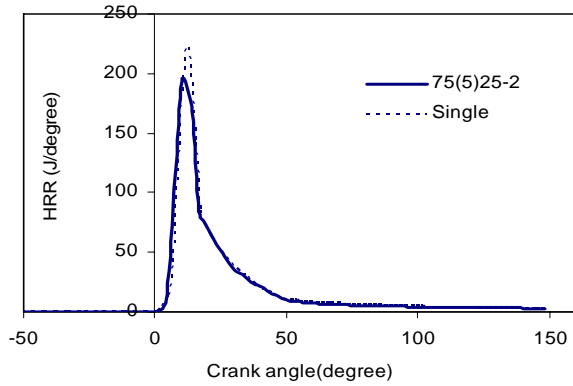
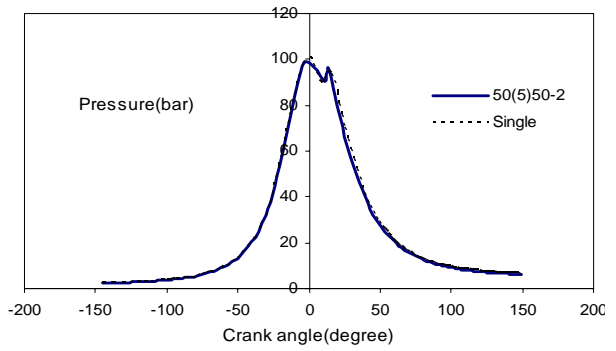
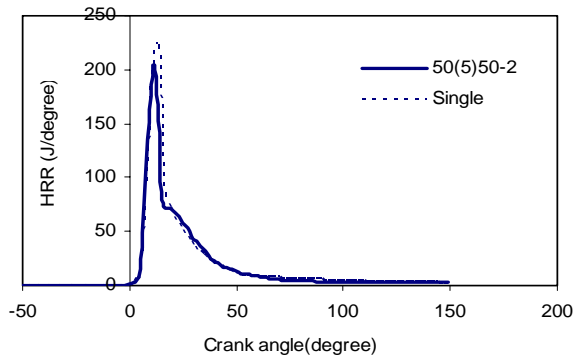
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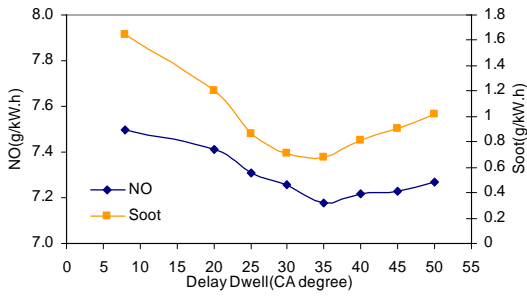
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(g / kW. h)	(g / kW. h)	
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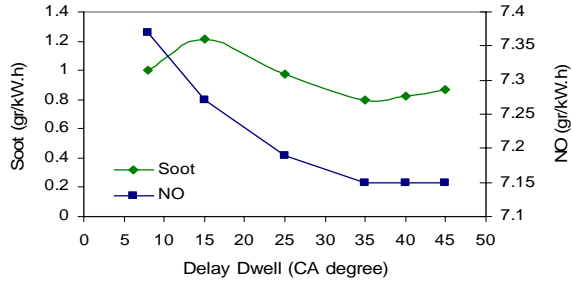


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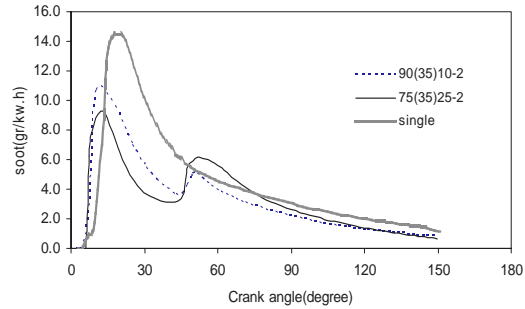
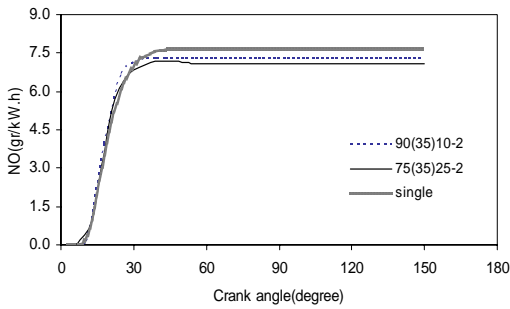
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دوده (%)	مونواکسید نیتروژن (%)	حالت‌های پاشش
۳۲/۸۵	۱۰/۸۷	۷۵ (۲۵) ۲۵-۲
۲۱/۵۶	۷/۶۸	۹۰ (۳۵) ۱۰-۲

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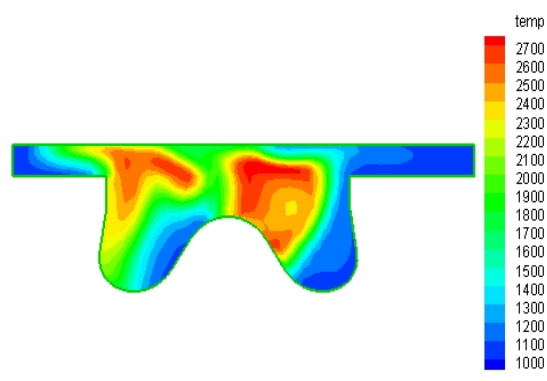
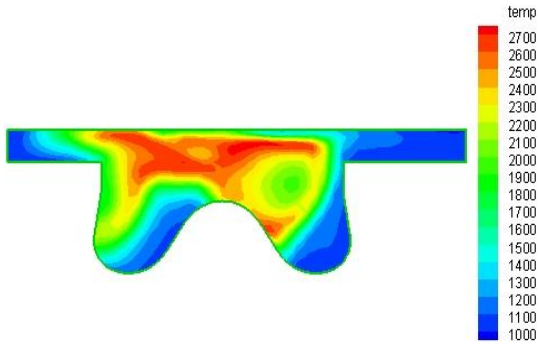
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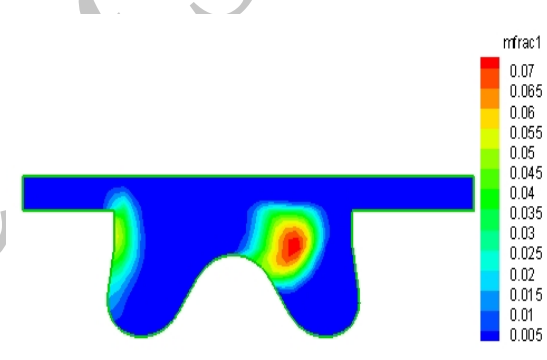
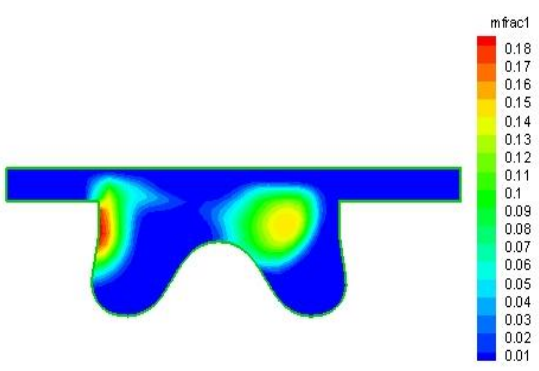
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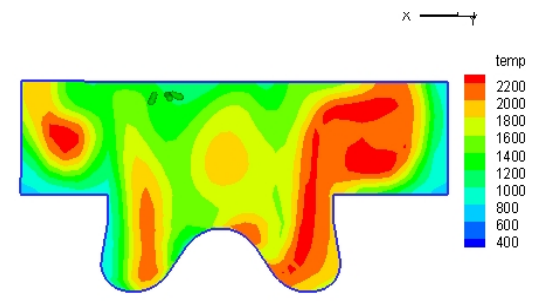
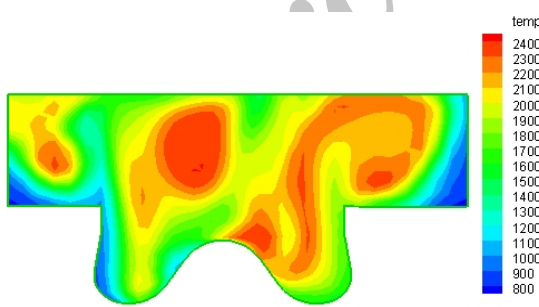
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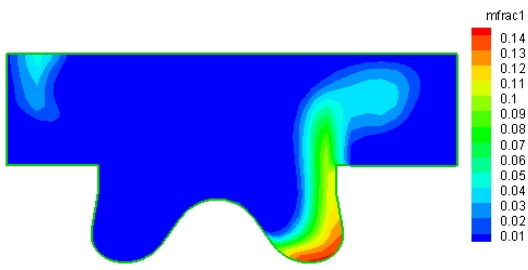
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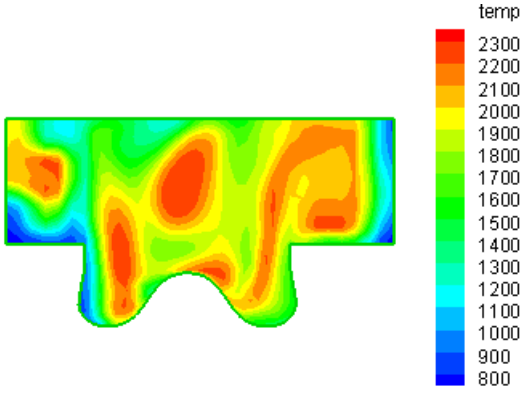
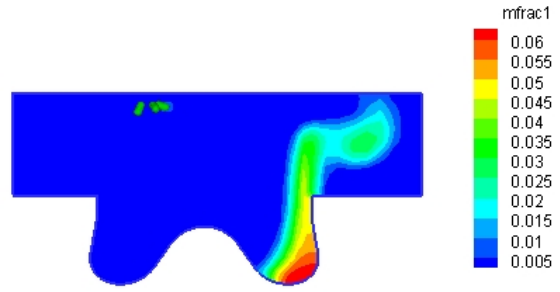
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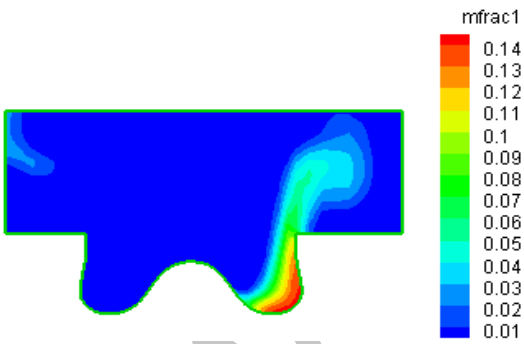
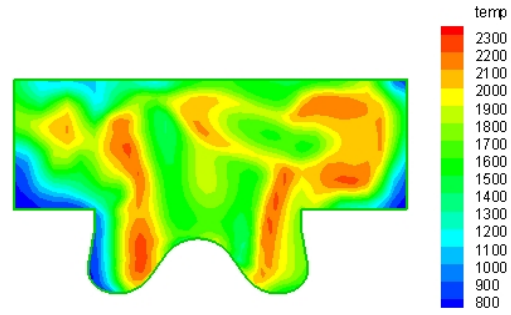




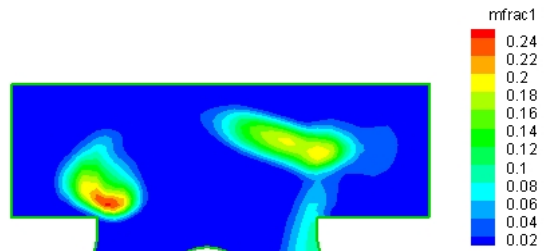
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CFD	مکانیک سیالات محاسباتی	NO	مونواکسید نیتروژن
Simple	سیمپل	Soot	دوده
TDC	نقطه مرگ بالا	Multiple Injection	پاشش چند مرحله ای
ATDC	بعد از نقطه مرگ بالا	Common Rail	ریل مشترک
Direct injection	پاشش مستقیم	Pilot Injection	پیش پاشش سوخت
Kiva-3V Code	کد کیوا-۳	Split Injection	پاشش مجزا

