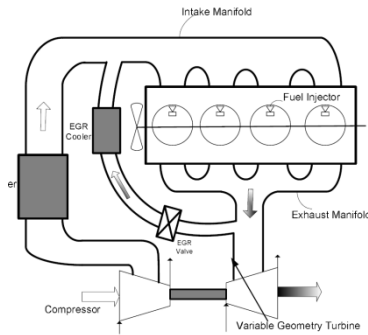


# EGR System Real-Time Fault Diagnostics in Diesel Engines Using Least-Squares Methods

**Research Summary:** A model-based real-time fault detection and estimation methodology is proposed to detect high flow or low flow in the EGR system of Diesel engines. An advantage of the proposed method is its capability for estimating the magnitude of a fault. The method was successfully validated to diagnose low flow and high flow faults in Diesel engines using experimental data.

## Problem Statement



Simplified schematic view of the air path in a diesel engine

Objective: Detection and estimation (by the on-board diagnostics system) of the EGR valve failures such as restrictions or leaks (e.g. due to a stuck or faulty valve) that lead to low flow or high flow, respectively, in the EGR passage.

$$W_{egr} = \begin{cases} C_{egr}(\xi_{egr}) \frac{p_o}{\sqrt{RT_o}} \phi\left(\frac{p_i}{p_o}\right) & \text{if } p_i < p_o \\ 0 & \text{if } p_i = p_o \\ C_{egr}(\xi_{egr}) \frac{p_i}{\sqrt{RT_i}} \phi\left(\frac{p_o}{p_i}\right) & \text{if } p_i > p_o \end{cases}$$

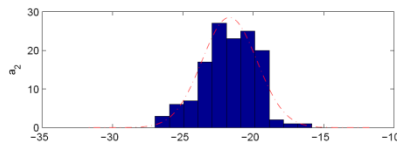
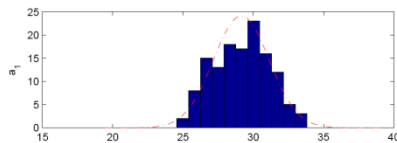
$$\Psi(p_i, p_o, T_o, W_{egr}) = a_1 \xi_{egr} + a_2 \xi_{egr}^2$$

## Experimental Validation

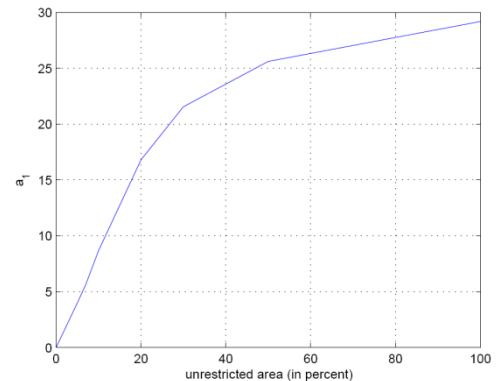
### Detection and Estimation of the Restriction in the EGR System

Table 1: The model coefficients ( $a_1, a_2$ ) for the EGR system operation under the healthy and restrictive flow conditions

	Coefficients	Error vector $E$	$\ E\ _2$
Healthy	(113.63, -113.15)	(0,0)	0
Restrictive flow	(13.15, -11.43)	(0.884, 0.899)	1.261



Histograms of the identified baseline coefficients  $a_1$  and  $a_2$

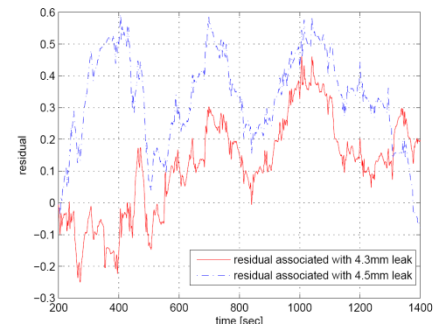


Coefficient  $a_1$  identified using the RTLS algorithm vs. the percentage unrestricted EGR valve area

### Detection and Estimation of the Leak in the EGR System

Table 2: Model coefficients ( $a_1, a_2$ ) for the EGR system operation in the healthy and leaky conditions

	Coefficients	Error vector $E$	$\ E\ _2$
Healthy	(11.37, -7.86)	×	×
4.3mm Leak	(13.51, -10.32)	(-0.188, -0.313)	0.365
4.5mm Leak	(14.08, -11.05)	(-0.238, -0.405)	0.469



The EGR mass flow residual signal calculated using the measurement and output of the adapted healthy model