

# 4-Stroke Engine Cycle with Gasoline direct Injection

## Intake Stroke



Intake valve opens and allows air to be pulled into cylinder.  
Fuel is sprayed directly into cylinder

## Compression Stroke



Air/Fuel mixture is compressed as piston moves up

## Power Stroke



Spark plug ignites Air/Fuel mixture  
Combustion pushes piston down

## Exhaust Stroke



Exhaust valve opens allowing piston to push exhaust out as it moves up

# Gasoline Direct Injection Engine Cold Start Improvement By

**New Brunswick. Department of  
Transportation**



## **Gasoline Direct Injection Engine Cold Start Improvement By:**

**Automotive Spark-Ignited Direct-Injection Gasoline Engines** F. Zhao, M.-C. Lai, D.L. Harrington, 2000-02-08 The process of fuel injection spray atomization and vaporization charge cooling mixture preparation and the control of in cylinder air motion are all being actively researched and this work is reviewed in detail and analyzed The new technologies such as high pressure common rail gasoline injection systems and swirl atomizing gasoline fuel injections are discussed in detail as these technologies along with computer control capabilities have enabled the current new examination of an old objective the direct injection stratified charge DISC gasoline engine The prior work on DISC engines that is relevant to current GDI engine development is also reviewed and discussed The fuel economy and emission data for actual engine configurations have been obtained and assembled for all of the available GDI literature and are reviewed and discussed in detail The types of GDI engines are arranged in four classifications of decreasing complexity and the advantages and disadvantages of each class are noted and explained Emphasis is placed upon consensus trends and conclusions that are evident when taken as a whole thus the GDI researcher is informed regarding the degree to which engine volumetric efficiency and compression ratio can be increased under optimized conditions and as to the extent to which unburned hydrocarbon UBHC NO<sub>x</sub> and particulate emissions can be minimized for specific combustion strategies The critical area of GDI fuel injector deposits and the associated effect on spray geometry and engine performance degradation are reviewed and important system guidelines for minimizing deposition rates and deposit effects are presented The capabilities and limitations of emission control techniques and after treatment hardware are reviewed in depth and a compilation and discussion of areas of consensus on attaining European Japanese and North American emission standards presented All known research prototype and production GDI engines worldwide are reviewed as to performance emissions and fuel economy advantages and for areas requiring further development The engine schematics control diagrams and specifications are compiled and the emission control strategies are illustrated and discussed The influence of lean NO<sub>x</sub> catalysts on the development of late injection stratified charge GDI engines is reviewed and the relative merits of lean burn homogeneous direct injection engines as an option requiring less control complexity are analyzed

**Emission Control and Fuel Economy** John H Johnson, 2005-06-27 Emission and fuel economy regulations and standards are compelling manufacturers to build ultra low emission vehicles As a result engineers must develop spark ignition engines with integrated emission control systems that use reformulated low sulfur fuel Emission Control and Fuel Economy for Port and Direct Injected SI Engines is a collection of SAE technical papers that covers the fundamentals of gasoline direct injection DI engine emissions and fuel economy design variable effects on HC emissions and advanced emission control technology and modeling approaches All papers contained in this book were selected by an accomplished expert as the best in the field reprinted in their entirety they present a pathway to integrated emission control systems that meet 2004 2009 EPA standards for light duty vehicles

**A Study to Quantitatively Analyze Cold Start**

**Emissions for a Gasoline Direct Injection Engine** Jinghu Hu,2023 The gasoline direct injection GDI technology is a technology with which the gasoline is directly injected in the cylinder GDI technology has been gaining popularity among vehicle manufacturers due to multiple advantages it presents compared with the port fuel injection technology and has been widely implemented in the light duty passenger vehicles on the US market One weakness of the GDI engine is the excessive hydrocarbon HC emission during the cold start where the engine speed cylinder and piston top temperature and engine fuel rail pressure are all far from optimal Given the more stringent Tier 3 HC emissions regulations enforced by United States Environmental Protection Agency and California Air Resources Board a detailed research on the GDI engine cold start HC emissions was essential to facilitate the compliance with HC emission standards from the modern GDI engines A novel experimental system was designed prototyped and installed The in house instrumentation and control system was designed based on the National Instruments hardware and aimed to control the Ford 2 0 L GDI engine and realize the engine cold start using custom engine powertrain parameters The novel gas collection and analysis system was designed and prototyped to allow a cycle based emission analysis The entire study was carried out using three steps First the validation experiment was conducted to validate whether the designed system hardware and software operated as desired and to provide some basic qualitative understanding of the GDI engine cold start profiles Second the preliminary quantitative analysis was carried out using both gasoline and iso pentane as fuel to further understand the contributing factors of the cold start HC emissions for GDI engines In the final step a parametric study multiple parametric sweeps were carried out for various powertrain parameters to identify the quantitative effect of each parameter on the engine power output and emission performances respectively The initial validation experiment results showed that the designed novel experimental system performed as expected and that HC emissions actually decreased monotonically among the first five firing cycles of the cold start The preliminary quantitative analysis revealed that for gasoline fueled cold starts not all the injected fuel was collected in the exhaust gas The non collected fuel was potentially due to fuel wall wetting and piston top impingement which could be the main reason for the HC emissions The parametric study found that the main contributing factor of the HC emissions for the very first firing cycle was the injected fuel that did not evaporate in time for combustion but still in time for the emissions The parametric study also found that the HC emissions increased with injected equivalence ratio The change in fuel rail pressure had a complicated effect on the HC emissions at the first firing cycle The increase in injection times from 2 to 4 injections given the same amount of total injected fuel did improve the fuel evaporation and combustion status and led to higher power output and lower HC emissions given the same injected fuel mass The study showed that the key to mitigate the HC emissions during the GDI engine cold start was improving the fuel evaporation and air fuel profile so as to minimize the fuel wall wetting and piston top impingement effect Highway Safety Literature ,1976 *Gasoline Direct Injection Engine and Spark Ignition Performance* Society of Automotive Engineers,2003 *System Innovation for a Global Economy*

Artde Donald Kin-Tak Lam, Stephen D. Prior, Siu-Tsen Shen, Sheng-Joue Young, Liang-Wen Ji, 2025-10-10 System Innovation for a Global Economy contains the contribution to the 2025 International Conference on Applied System Innovation ICASI 2025 Tokyo Japan April 22 25 2025 Of the more than 500 submitted papers from 14 different countries after review approximately a quarter was accepted for publication The book aims to provide an integrated communication platform for researchers from a wide range of topics including information technology communication science applied mathematics computer science advanced material science and engineering System Innovation for a Global Economy enhances interdisciplinary collaborations between science and engineering technologists and is aimed at academics and technologists interested in the above mentioned areas

**Annual Index/abstracts of SAE Technical Papers** ,2007      **Combustion Modeling for Gasoline Direct Injection Engines Using KIVA-3V**. Bruno P. Vanzieleghem,2004      Technical Literature Abstracts Society of Automotive Engineers,2000      **SAE Transactions** Society of Automotive Engineers,1928 Vols for include index which has title SAE transactions and literature developed      **Government Reports Announcements & Index** ,1988

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