



**California
Off-road Mobile Source Technology Review**

**JOHN DEERE LE ENGINE
TECHNOLOGY**

**John Deere Consumer Products
February 2, 2000**



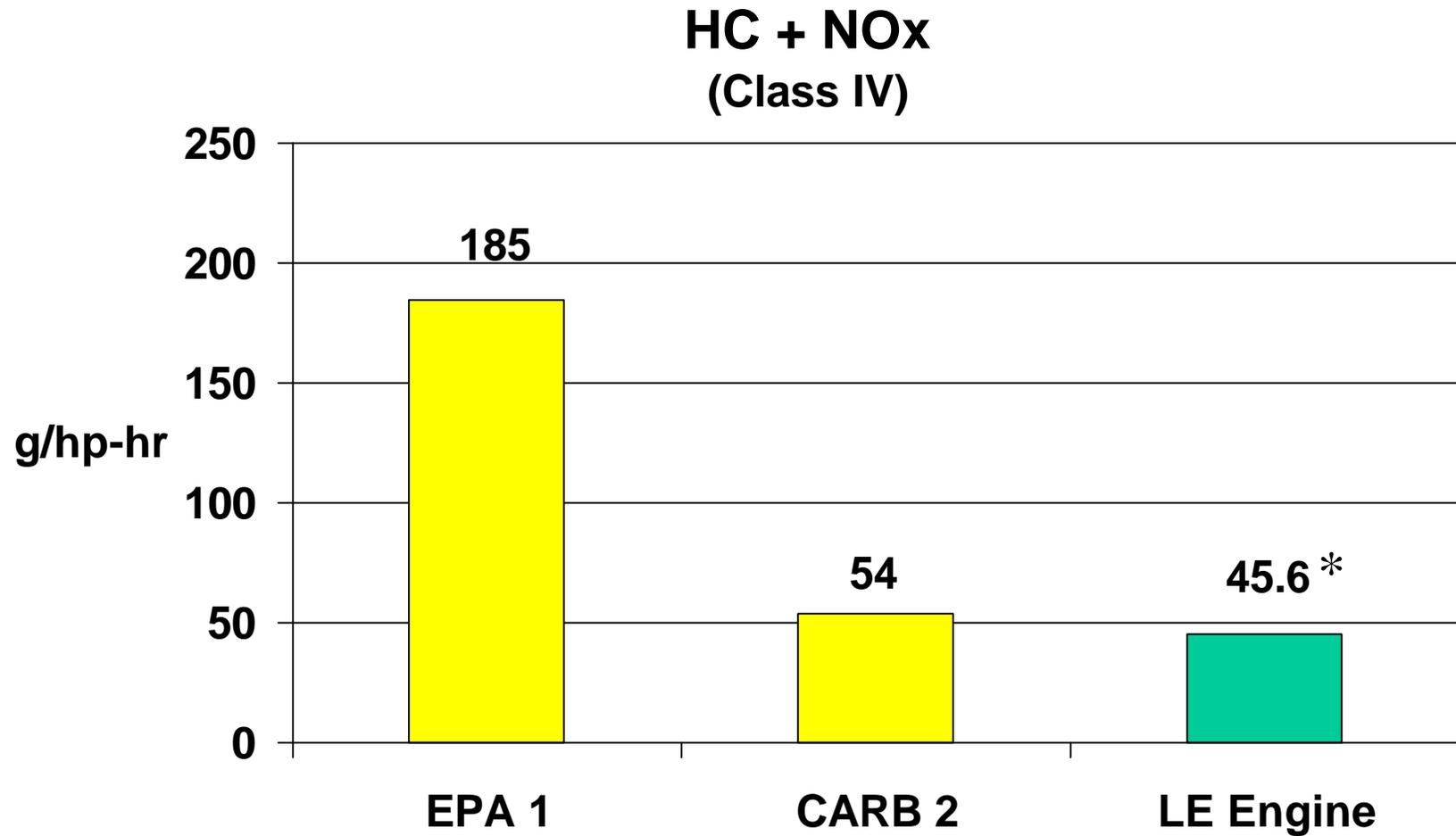
Handheld Products



2 Feb 2000



Emissions Performance



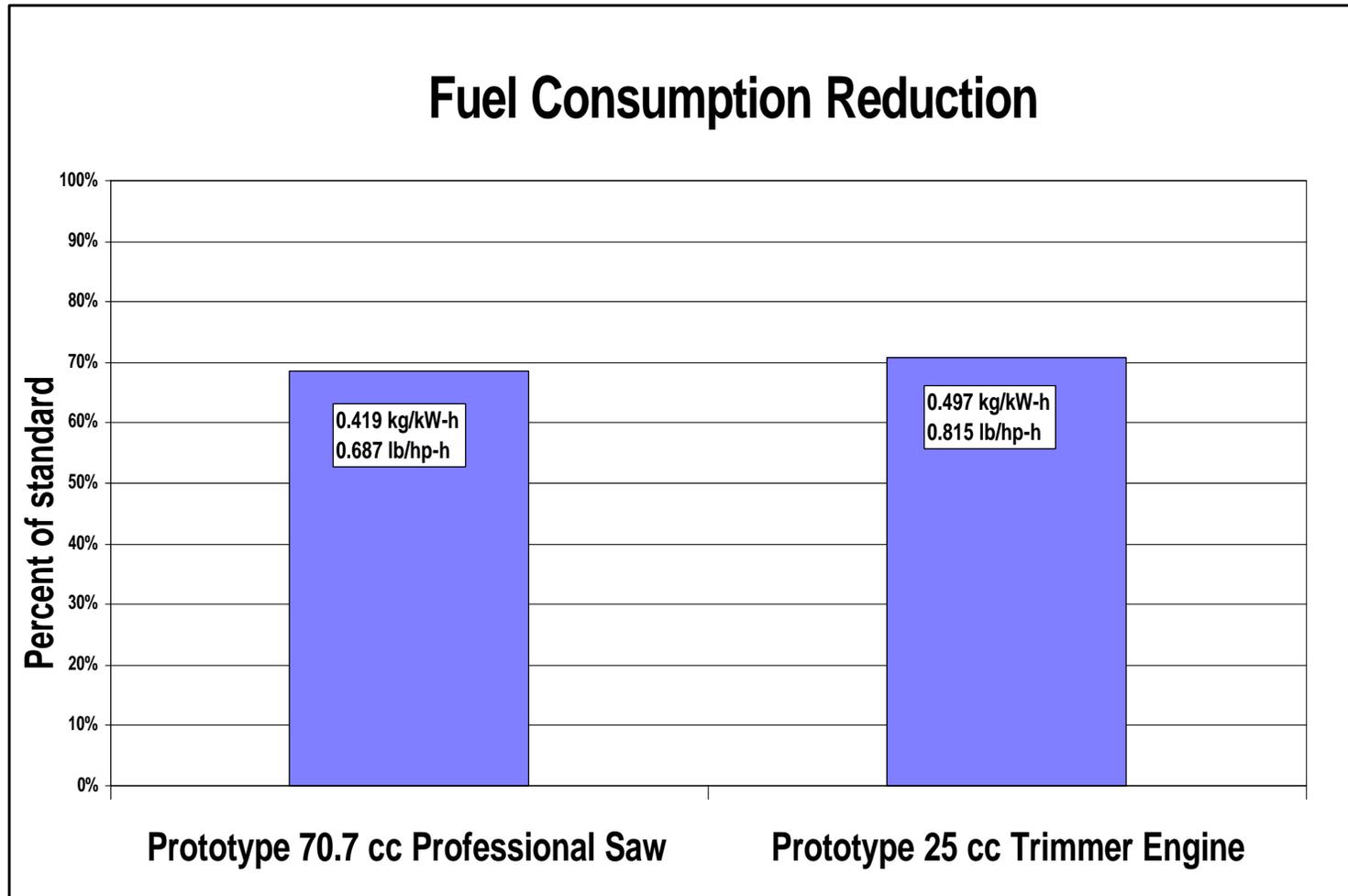


Certification

- Certified for durability period of 125 hours
- Required same level of maintenance as current 25 cc engine
 - No catalyst to replace
 - No valve train, so no need for lash adjustment
- Power was constant at .95 hp
- DF of 1.1
- Low NO_x of less than 2 g/hp-hr
- Fuel efficient with low CO₂



Fuel Consumption



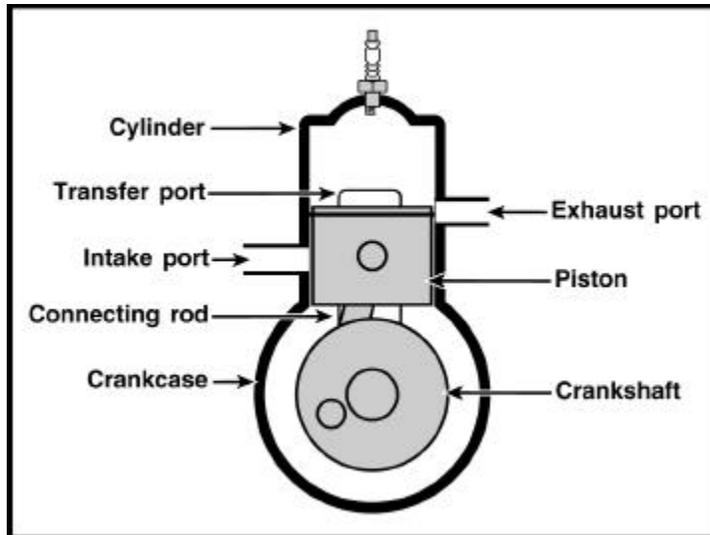


LE Technology

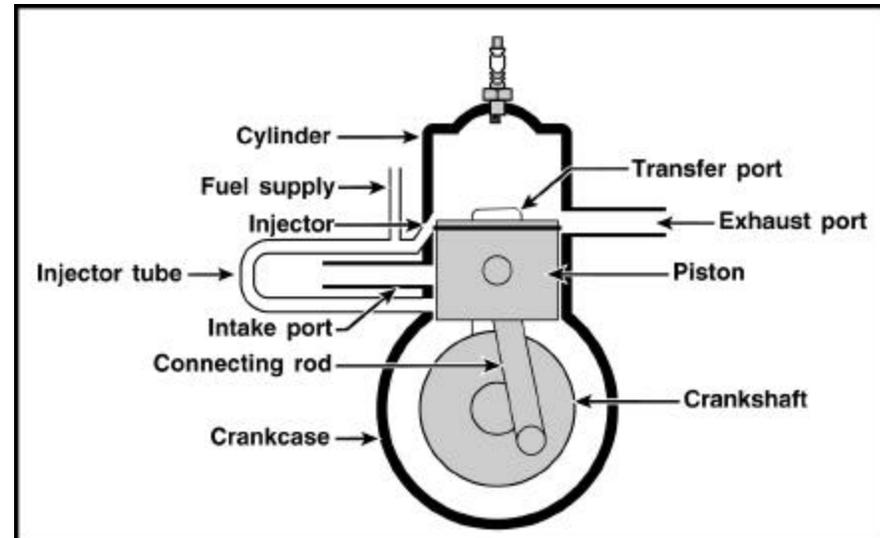
Component Comparison Between JDCP & Standard Two stroke

- Injector
- Injection Tube

Standard



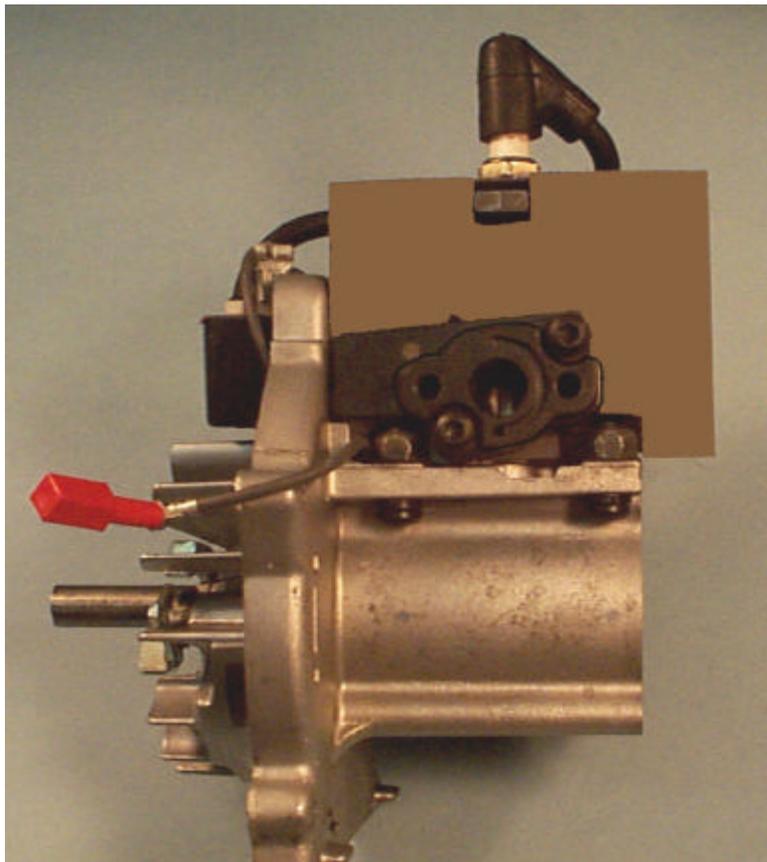
JDCP LE Engine





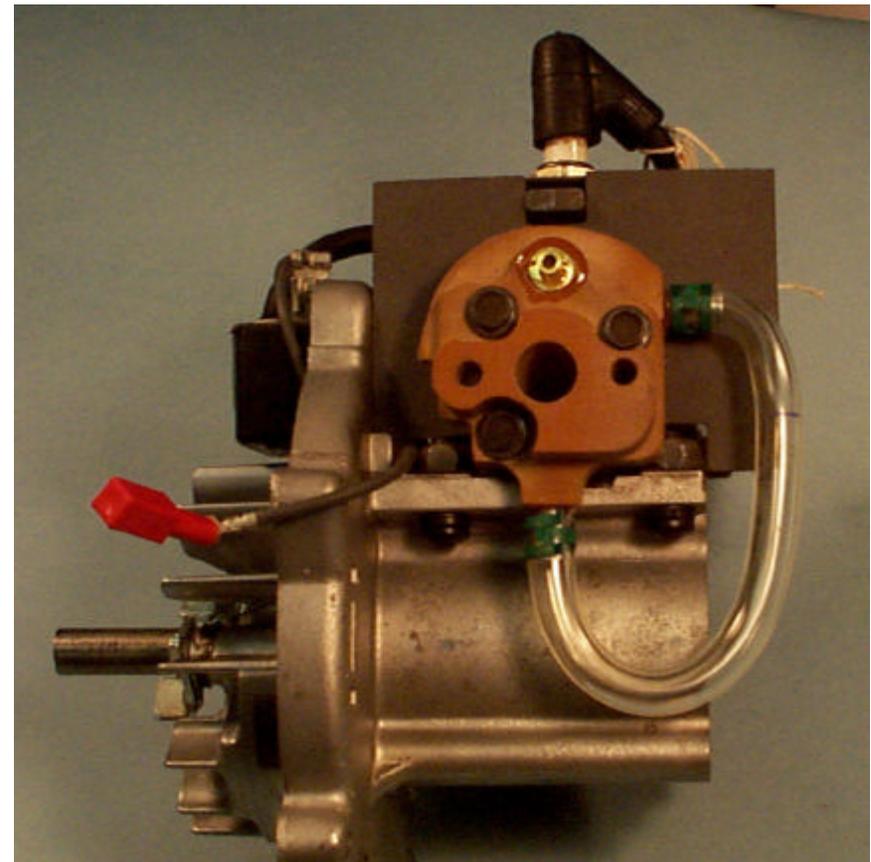
JDCP 25 cc Engine

Standard 25 cc Engine



2 Feb 2000

Prototype LE 25 cc Engine

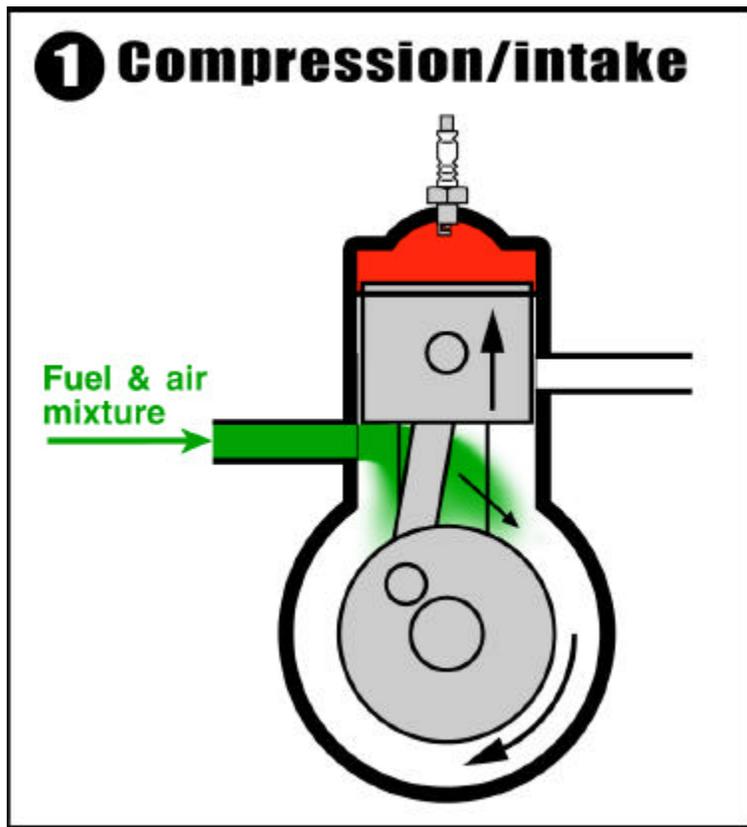


7

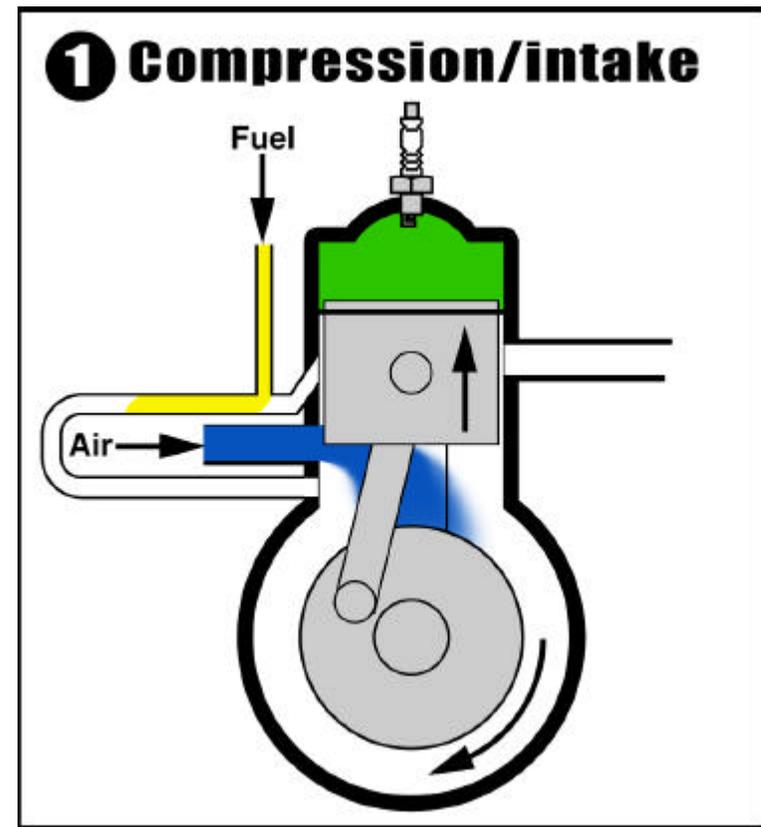


Low Emission Engine Technology

Fuel & air is drawn into crankcase



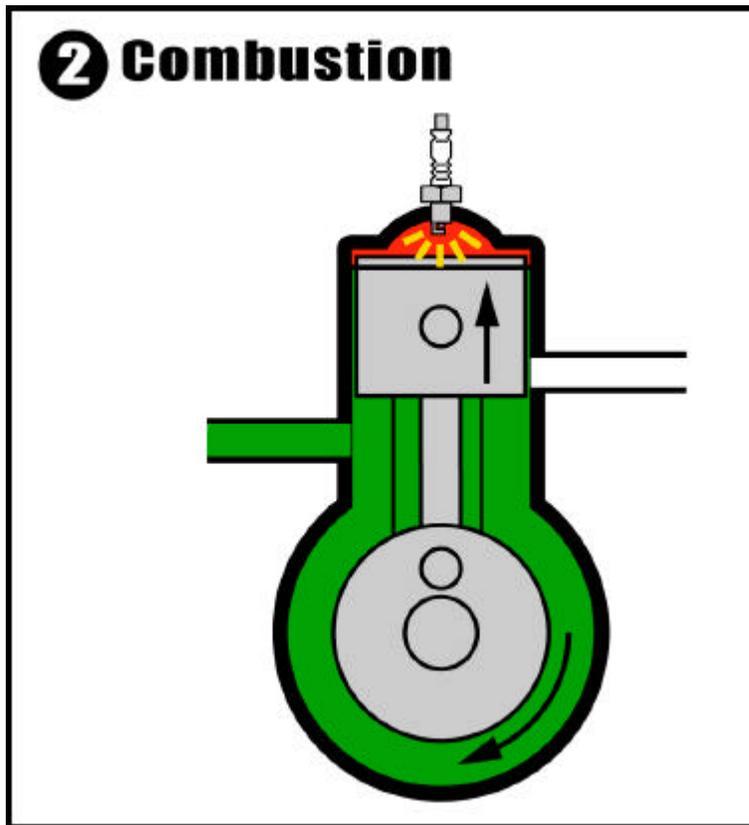
Only Air is drawn into crankcase



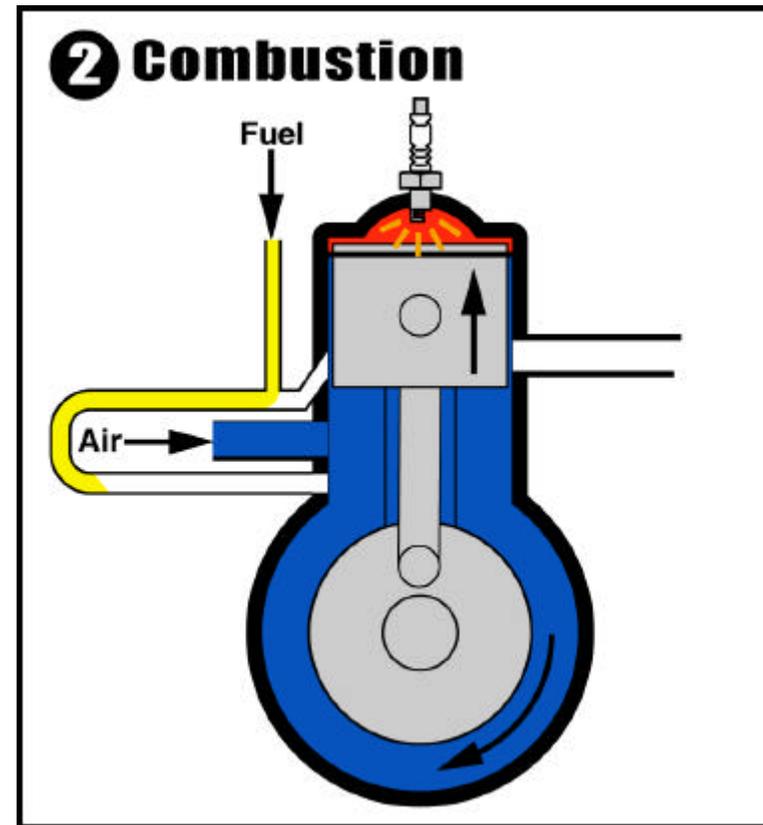


Low Emission Engine Technology

Crankcase is filled with air/fuel mixture



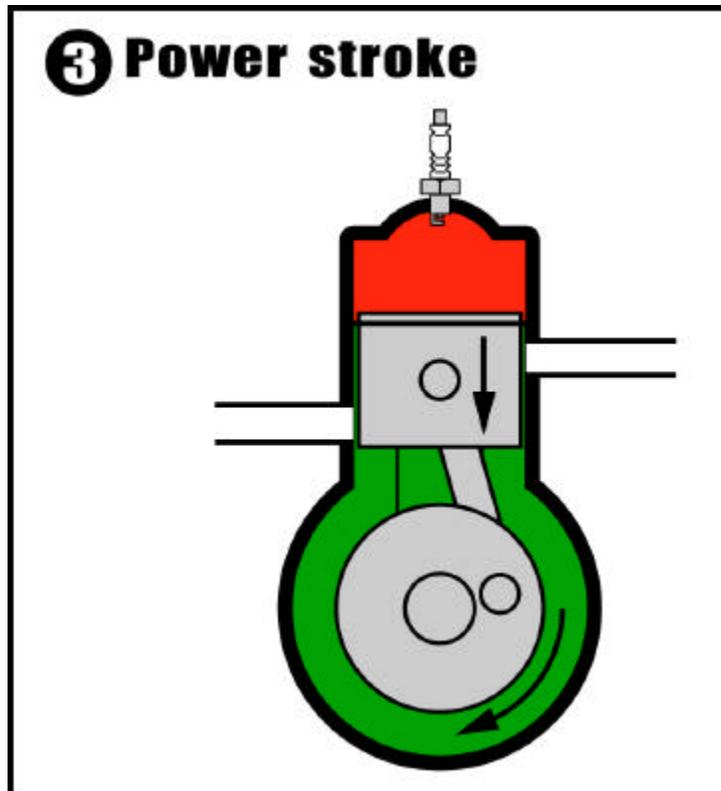
Crankcase is filled with air while injection tube draws fuel





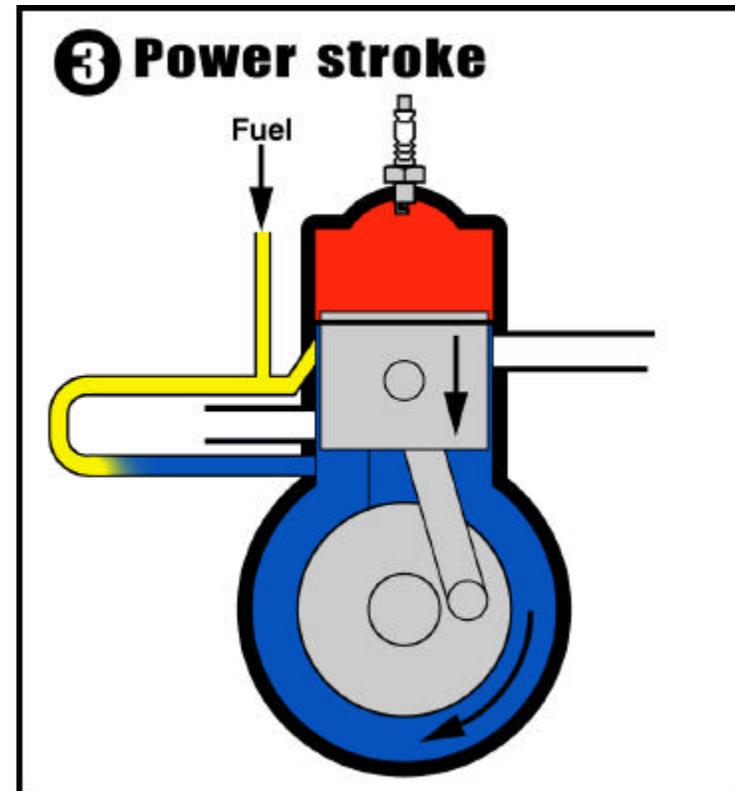
Low Emission Engine Technology

Air/fuel mixture compressed in crankcase



2 Feb 2000

Air is compressed in crankcase and fuel is compressed in injection tube

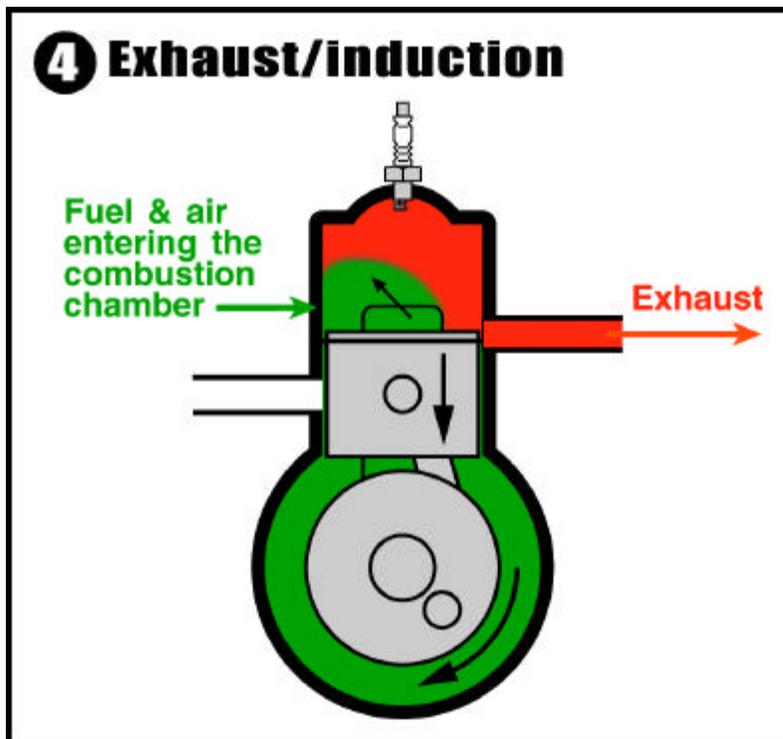


10



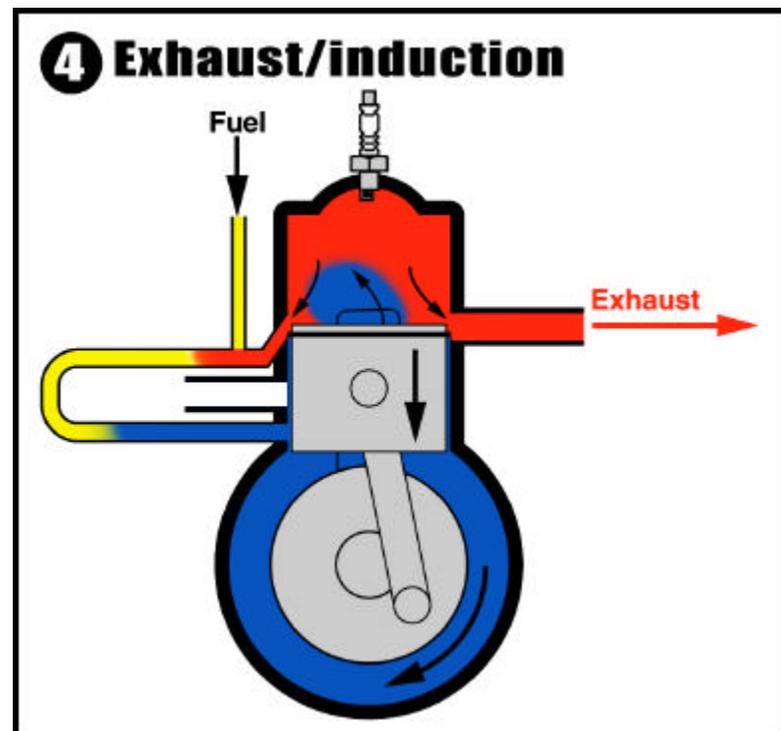
Low Emission Engine Technology

Air/fuel mixture is forced through transfer ports into combustion chamber.



2 Feb 2000

Only air is forced through transfer ports into combustion chamber
Expansion gases compress fuel in injection tube.

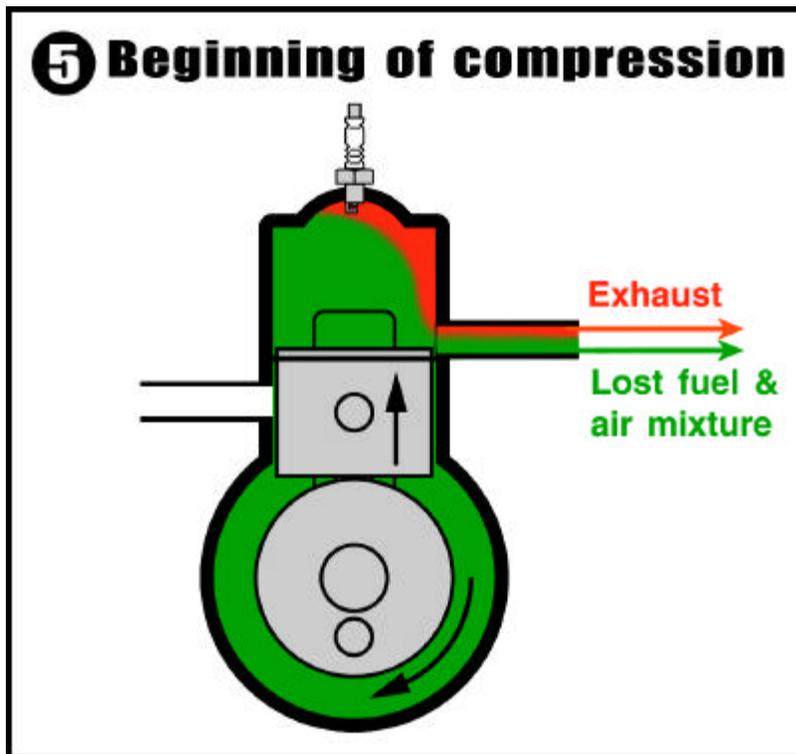


11

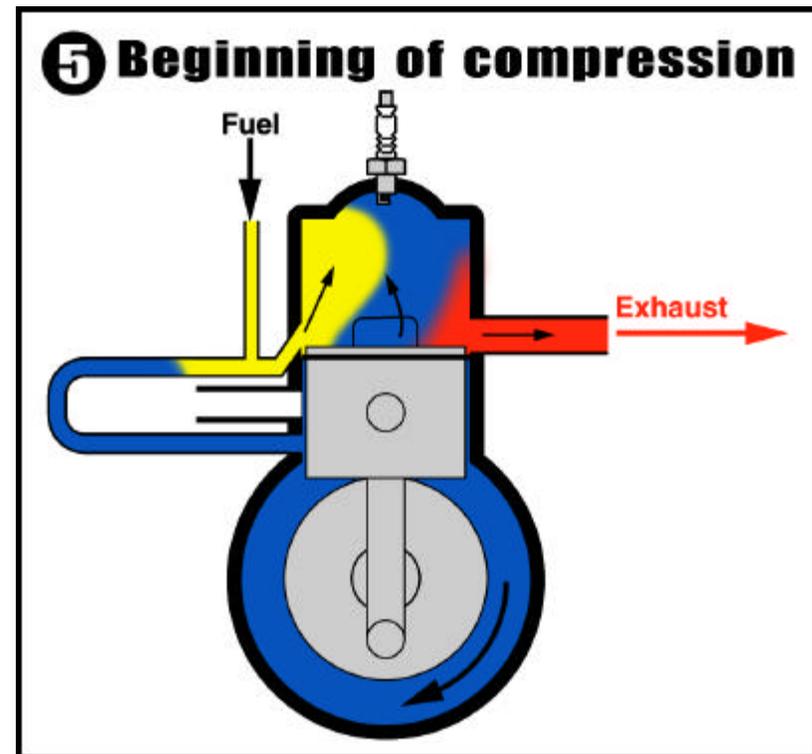


Low Emission Engine Technology

Air/fuel mixture escapes through exhaust port



Fuel injection starts. Only air through exhaust





Lubrication

- Introduces small portion of fuel/oil mixture into the crankcase
- Operates in high viscosity oil mist environment versus standard flooded condition
- No bearing failures or evidence of poor lubrication



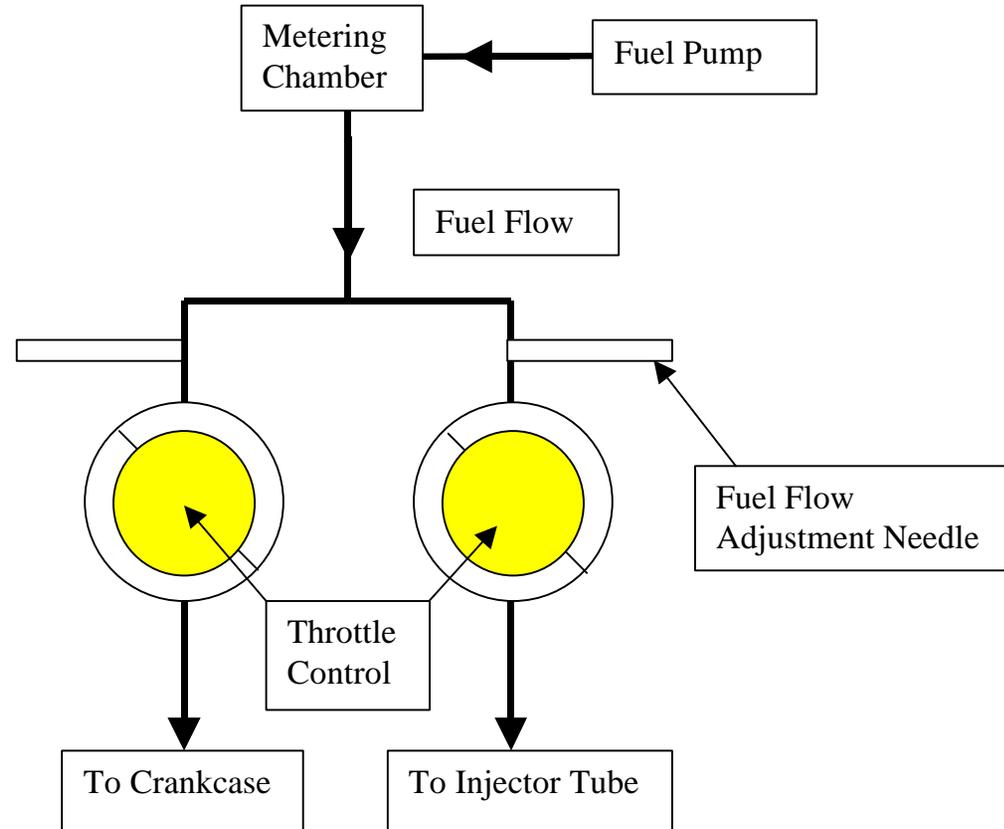
Fuel Delivery System

- Current fuel systems are based on the standard carburetor and address all operating modes of the engine



Fuel System

Vacuum Fuel System for Compressed Air Assisted Injection System





Power

- LE prototypes of same displacement (25 cc) engines have demonstrated equivalent and improved power
 - 25 cc LE engine produces almost 1 horsepower
- Power can be tailored using conventional engine design criteria
 - Port timing and size
 - Fuel system venturi/throttle bore size



Weight

- Additional weight is insignificant
- LE parts adds about 40 grams (less than 2 ounces)



Ambient Temperature Operation

- LE engine provides same operating performance as current carbureted engines across wide range of ambient temperatures



Engine Temperatures

- No “new” heat management issues are presented with the LE Technology
- Good initial designs for heat management, as with typical commercial engines, will have fewer or no heat problems
- Engineering solutions are readily available
- LE engine certified at 125 hours of operation, demonstrating no heat problems



Manufacturability

Requires only

- Minimal cylinder modification
- New fuel delivery system, which will be commercially available
- Miscellaneous hardware

LOW COST SOLUTION



Advantages

- Lower cost
- Lower fuel consumption
- Comparable performance to other direct injected two stroke technologies
- Lower NO_x , CO & CO_2 than 4 stroke technology
- Adaptable to larger displacement engines