Vehicle Changes for E85 Conversion

Coleman Jones
Clean Cities Webcast
03MY07
Conversion Types

1. **Conversion where a Flexfuel vehicle of the same type exists**
   - An example is 2002-2007 GM pickups and utilities with 5.3 liter engines
   - Flexfuel parts and calibrations have been engineered and are available
   - Process involves swapping parts and installing software and calibrations – not as simple as it sounds

2. **Conversion where no Flexfuel vehicle of the same type exists**
   - This is the vast majority of the fleet
   - No flexfuel parts and calibrations exist
   - These parts, software, and calibrations would need to be developed from scratch
     - Requirements determined
     - Suppliers identified
     - Parts validated
     - Software and calibrations developed
Vehicle System Changes for E85/Flexfuel

- Fuel storage and handling
  - Filler neck
  - Tank and associated parts
  - Fuel lines
- Engine hardware
- Engine control system
  - Engine controller
  - Control software
  - Control calibrations
Fuel Storage and Handling

- Filler neck may need changing
  - Material may not be compatible with ethanol
  - Leaks could result due to shrinkage or swelling
  - Leak will cause OBD system to set codes (check engine light)
  - Leak will cause vehicle to fail evaporative emissions requirements

- Flame arrester is generally added to filler neck
  - E85 typically has lower vapor pressure than gasoline

- Metal fuel tanks would have to be examined for E85 tolerance
  - Terne metal material (typical metal tank) is not compatible with ethanol without special coatings
  - Corrosion and leaks can result
  - Leaks will cause OBD system to set codes
  - Leaks will cause vehicle to fail evaporative emissions requirements
Fuel Storage and Handling

• Seals and grommets need to be evaluated for compatibility
  – Shrinkage, swell, or mechanical failure can lead to leaks, codes and evaporative emissions

• Fuel pump must be changed
  – Material changes, higher flow rate
  – Pump failures will lead to walk-homes
  – Inadequate pump flow, whether a result of not upgrading pump or pump deterioration, will lead to diagnostic codes
  – Inadequate pump flow will lead to ineffective catalyst protection routines, catalyst damage and emissions failures

• Fuel sender is typically changed
  – Corrosion resistance and mode of operation
  – Fuel sender failure leads to fuel gauge loss and, possibly, loss of ethanol estimate and control diagnostic codes.

• Vapor pressure sensor is typically changed
  – Materials compatibility
  – Device required for evaporative emissions compliance
Fuel Storage and Handling

• Fuel lines are often changed
  – Polymer lines
    • Polymer can be extracted into ethanol and precipitate at injector
    • Fouled injectors lead to codes, uneven cylinder operation and emissions, loss of power…
  – Metal lines can corrode
    • Leakage will cause evaporative emissions
    • Corrosion products can degrade and plug injectors
    • Degraded injectors lead to codes, uneven cylinder operation and emissions, loss of power…
Engine Hardware

• Fuel rails should be stainless steel
  – Other materials lead to the same problems as fuel lines

• Fuel injectors are changed
  – Materials compatibility
    • Winding insulation must be ethanol compatible to prevent shorts
    • Corrosion resistance is very important to correct operation
  – Flow must be adequate
    • Allows commanded flow
    • Enables rated power
    • Enables catalyst protection mode and thus required catalyst life
Engine Hardware

- Valves and valve seats are usually changed
  - Wear of these components leads to valve seat recession,
  - Valve seat recession, once valve lash is exhausted will produce valve leaks, misfire, codes, emissions, valve burning, head replacement

- Piston rings are often changed
  - Ring wear lead to blow-by, loss of power codes, emissions
Engine Control System

• Engine controller
  – Controller may need to be changed to have enough capacity to accept required software
  – Controller may have to be changed to be compatible with fuel sender

• Fuel composition sensor may need to be added
  – This provides the ethanol composition to the controller so that the correct calibrations can be used

• If there is no fuel composition sensor control software to determine ethanol concentration is needed.
  – The software must be able to distinguish between fuel and hardware induced changes in air-fuel ratios to ensure diagnostic (OBD) compliance
Engine Control System

- Control calibrations
  - New calibrations are required to adjust fuel, spark, EGR, etc. for the ethanol content
  - Variables are non-linear between E0 and E85
  - Special calibration revisions are required for cold and hot start
  - Depending on software architecture, special calibrations are required for catalyst protection routines
  - Inadequate calibrations can lead to poor running, elevated emissions, and vehicle and emissions systems durability issues.
Conclusion

- Developing a flexfuel or even a dedicated E85 vehicle is a major undertaking
  - Conversion to an existing flexfuel design requires extensive swapping of parts often deep inside the vehicle
  - Conversion of a vehicle that has never been flexfuel requires extensive engineering of new parts, finding suppliers, and validating the resulting hardware
    - Software and calibration development will be a major undertaking requiring specialists to execute
- Conversions that do not include these elements will result in vehicles with significantly reduced life that will probably not be compliant for their useful life
  - Consumers will be dissatisfied with the product and, by extension, with ethanol
• OBD = On Board Diagnostics
• EGR = Exhaust Gas Recirculation