

Vehicle Changes for E85 Conversion

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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

