Thermochemical Recuperation (TCR) for Engines

- Energy recovery from exhaust gas to increase calorific value of fuel
- Fuel consumption reduction
- Hydrogen enrichment (up to 30%) of fuel to improve combustion.
- Hydrogen enrichment increases flame speed, reduces emissions of hydrocarbons, and allows higher levels of air or EGR
- NO_x emissions reduction

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TCR Potential

- TCR for landfill gas ($CH_4 + CO_2$). Exhaust heat is used to reform the fuel

$$CH_4 + CO_2 = 2CO + 2H_2$$

- Fuel reforming with steam. Exhaust heat and steam are used to reform the fuel

$$CH_4 + H_2O = CO + 3H_2$$

$$CO + H_2O = CO_2 + H_2$$

- Fuel reforming with EGR. Exhaust heat and EGR are used to reform the fuel

$$CH_4 + 0.33(CO_2 + 2H_2O + 7.52N_2) = 1.33(CO + 2H_2 + 1.88N_2)$$

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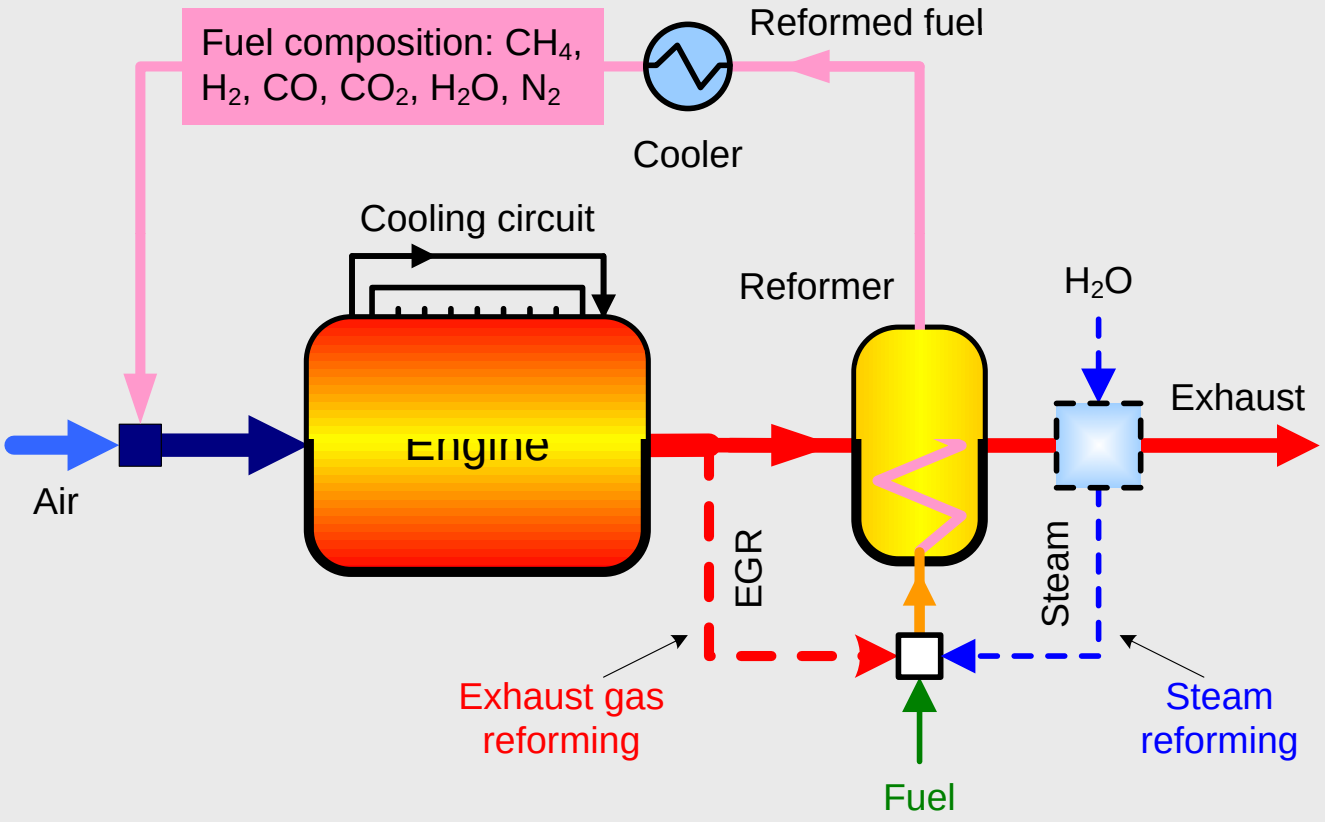
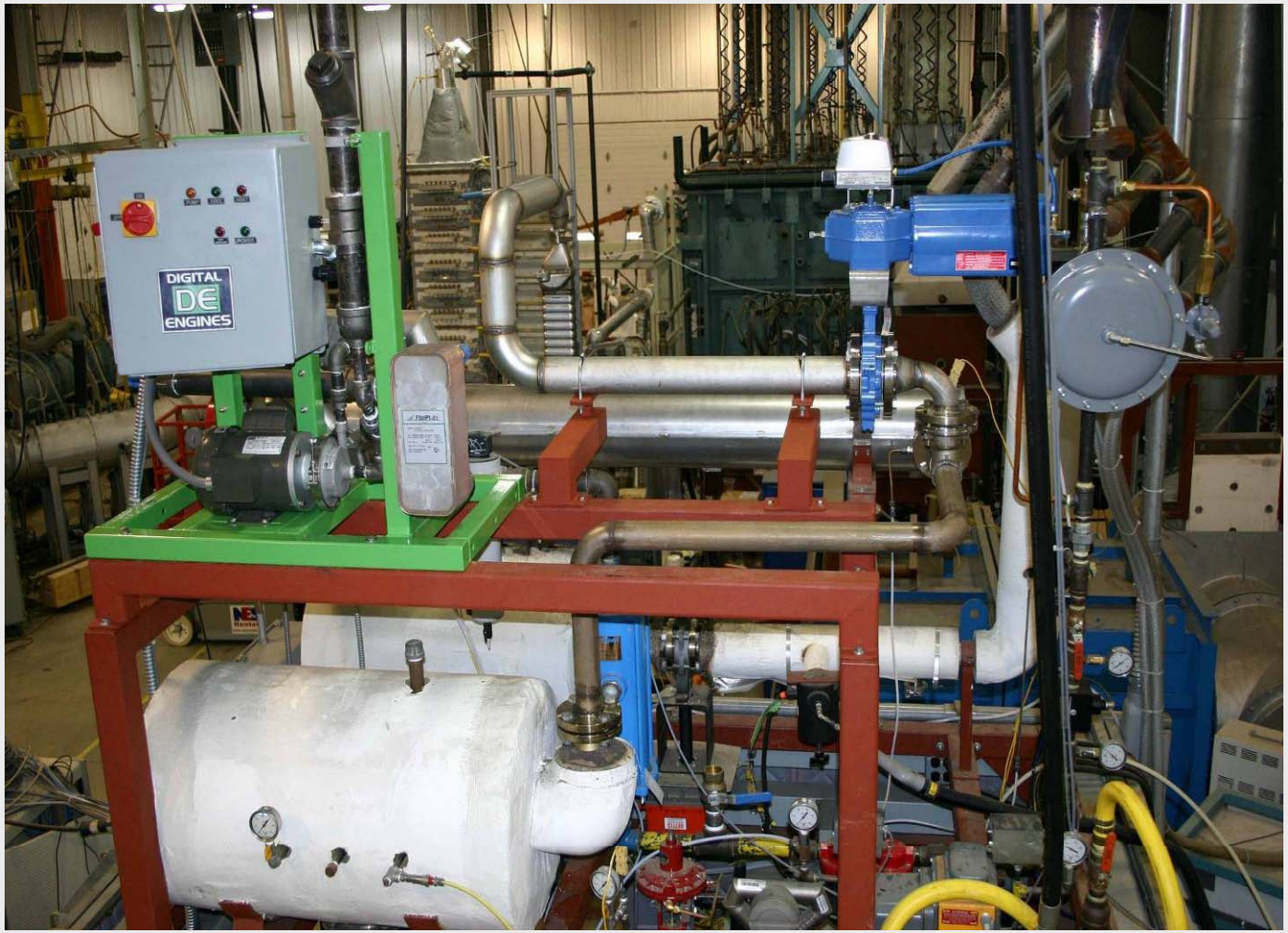
Engine TCR System



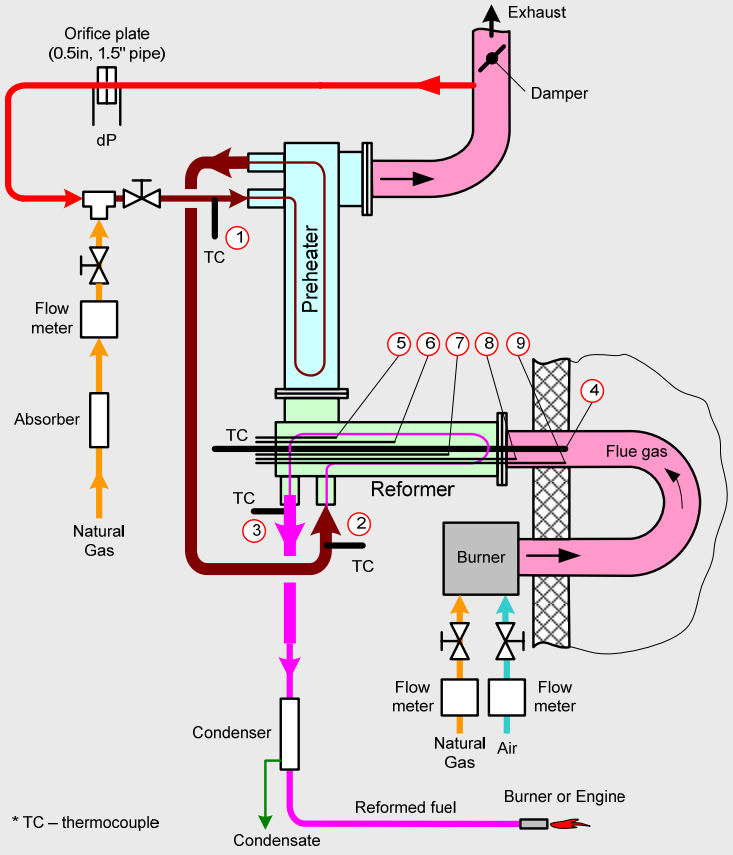
TCR Experimental Rig (~70 $kW_{thermal}$ capacity)

GTI 50 kWe Engine with cooled EGR System

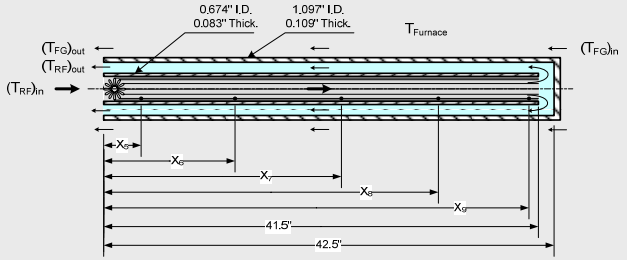


GTI Engine test with Reformed Fuel

Simplified Flow Diagram



Heat Exchange Tube with Catalytic Insert

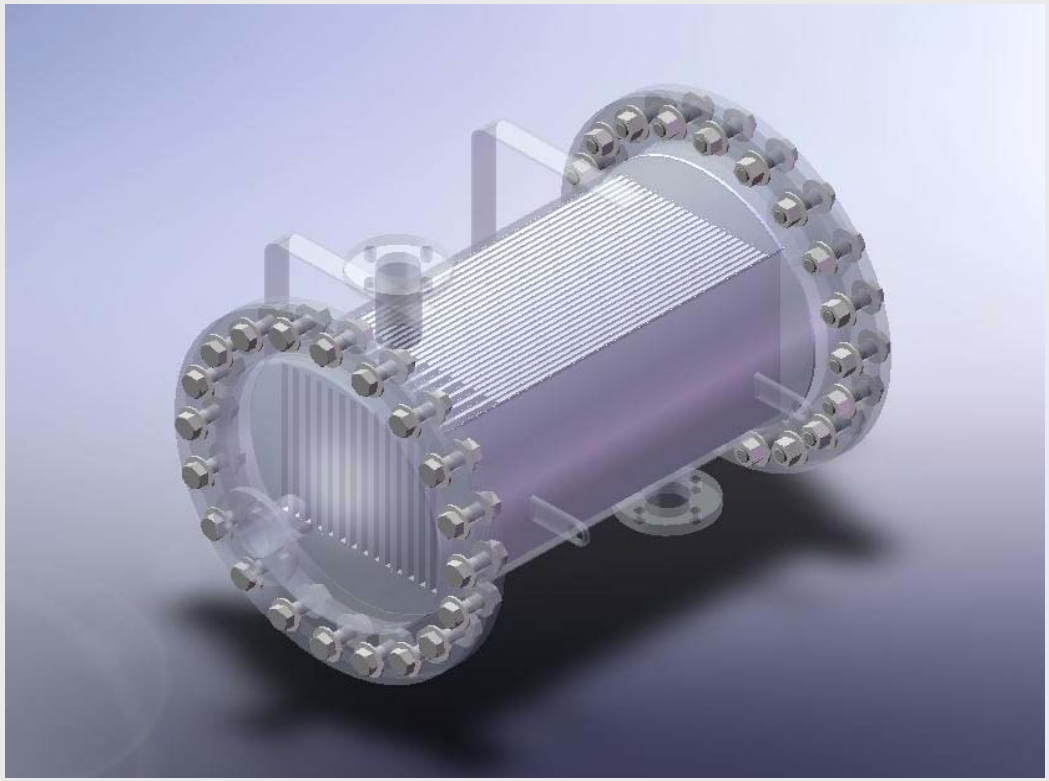


Catalytic Inserts Tested

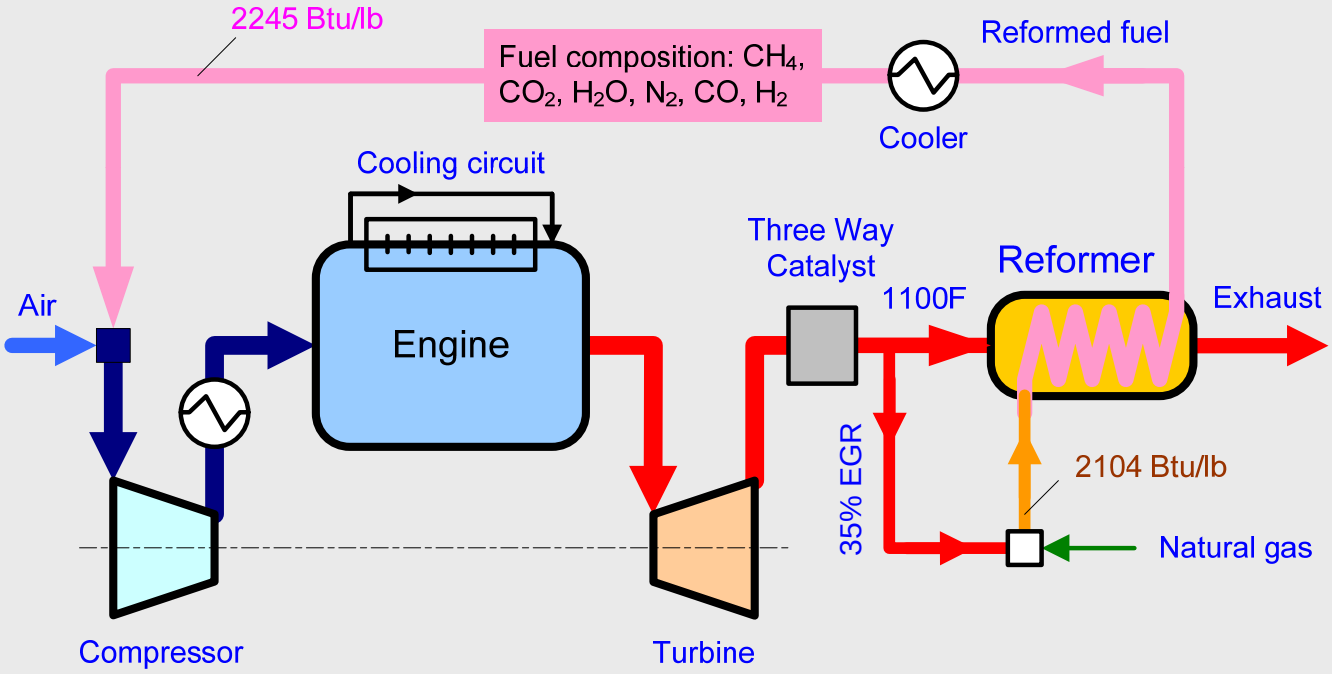
Ni

Ni-Rh

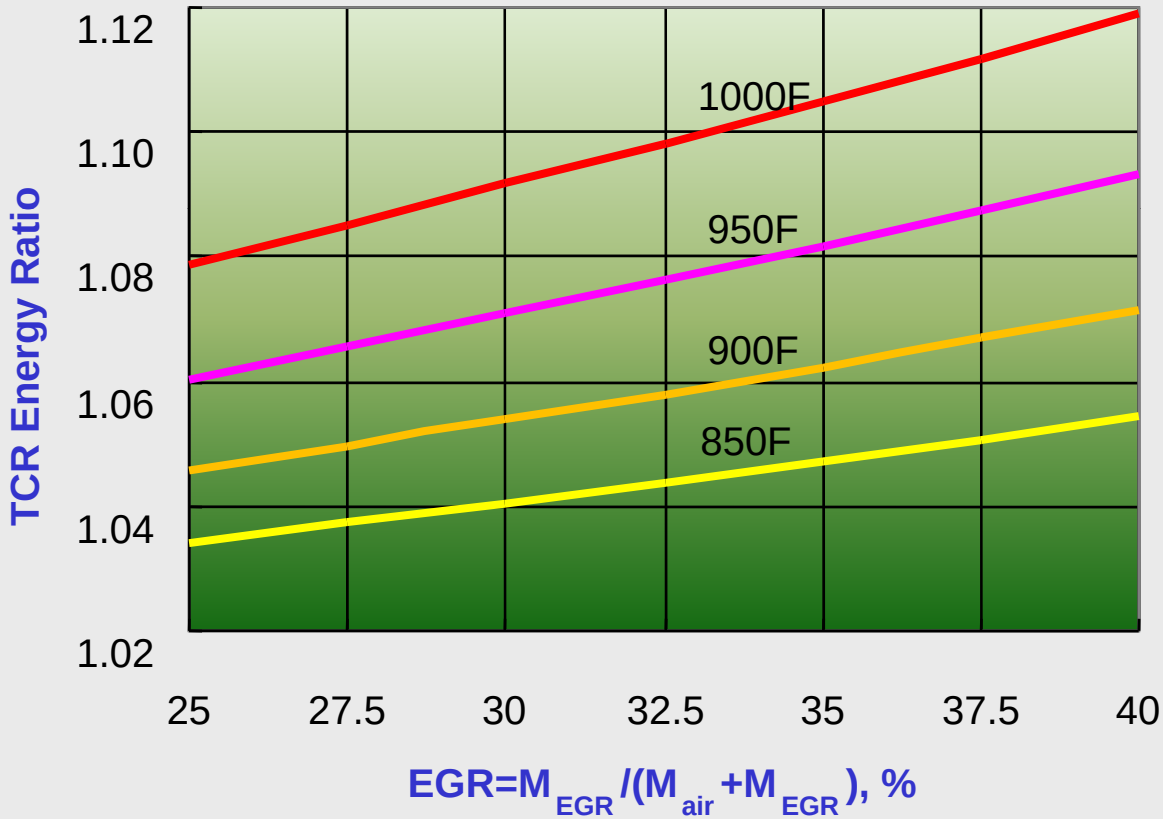
Plate reformer for GTI Engine



TCR System for Stochiometric Engine with EGR



TCR Energy Ratio vs. EGR fraction and Reforming Temperature



TCR System for Landfill Gas Engine

Landfill gas composition: 45% CH_4, 35% CO_2, 20%N_2