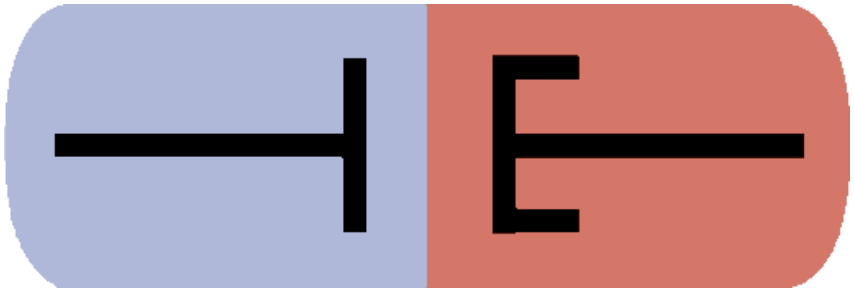
ARPA-E Kickoff Meeting 10/21/2015

Novel split-cycle Internal Combustion Engine



Efficient, Green, Simple

Tour Engine, Inc.
Next Step Engineering Solutions, LLC
Wisconsin Engine Research Consultants, LLC

Tour Engine - Key Features

Efficient - High Potential

- Our GT-Power simulations predicts above 43% ITE for small engine
- Other independent computer models had higher numbers for split-cycle engines in general
- Well suited for Genset applications

Green - Reduced Emissions

- Proportional reduction in CO_2 emissions
- Potential reduction in other emissions: NOx, HC and CO

Simple - Standard Components

- Based on standard components – Easy to adopt
- Reuse standard technology to a large extent: Piston/rings/valves

The Problem of Modern Engines – Conflicting Optimization Requirements

Our Solution – True Atkinson Cycle with Superior Thermal Management

Reducing Cooling Loss

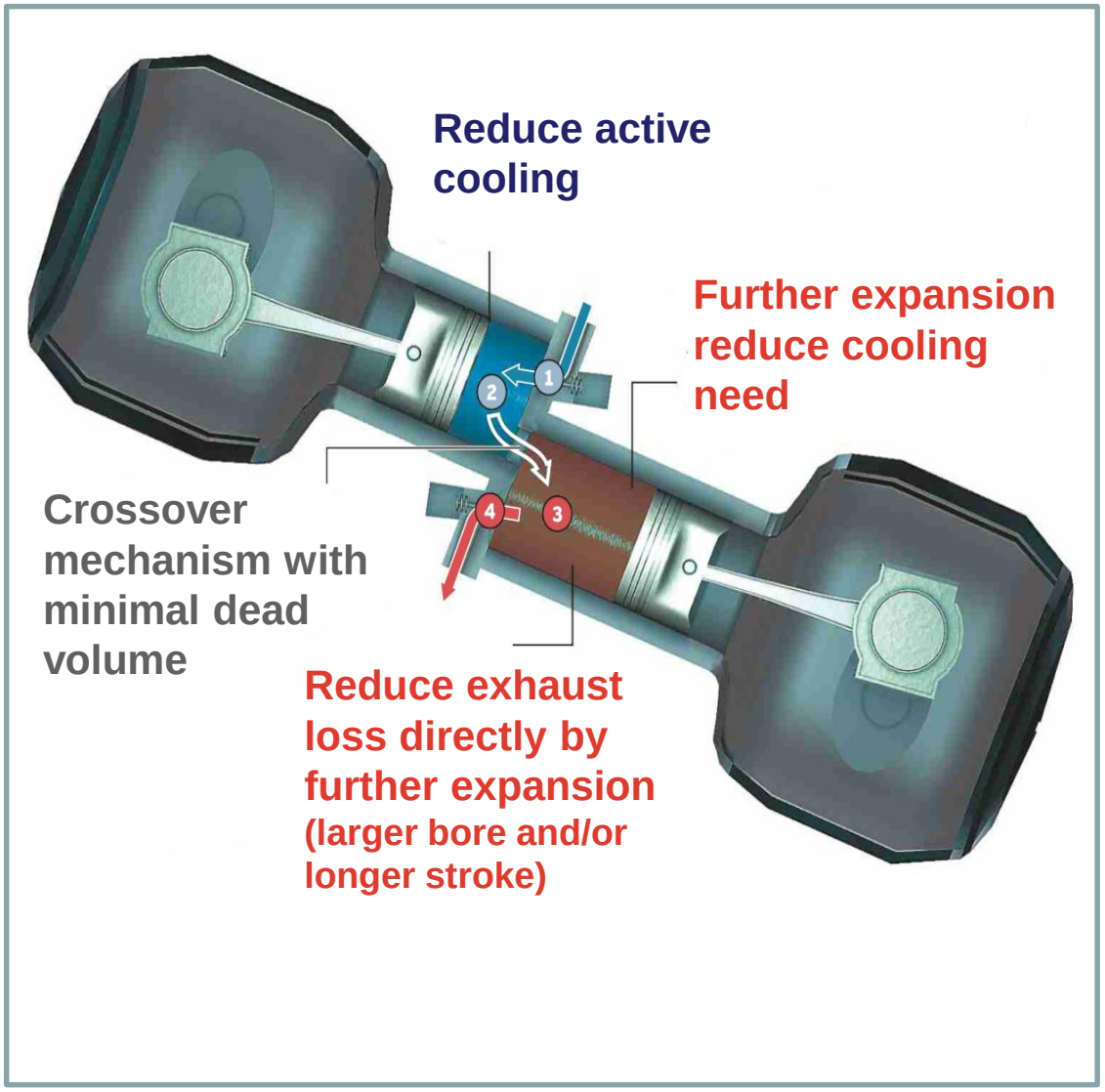
- Intake and compression occur in a separate cylinder that is relatively cold, therefore less active cooling is needed.
- The extra expansion lowers the average temperature of the working fluid and reduces the need for active cooling.

Reducing Exhaust Loss

- Extra expansion lowers the exhaust enthalpy and increases the mechanical energy output of the engine.

Reducing Dead Volume

- High volumetric efficiency requires minimal dead volumes

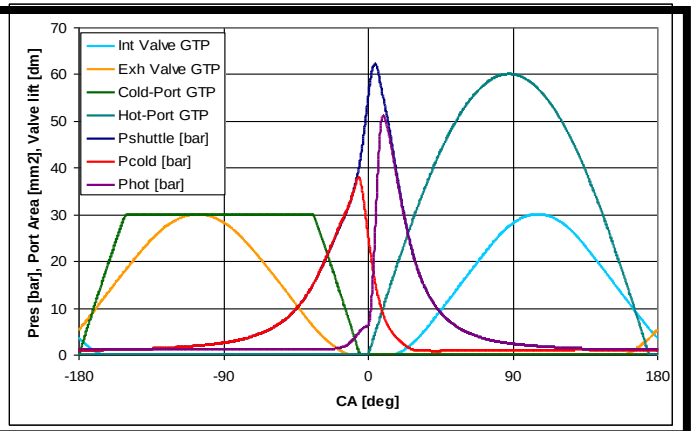


An “aluminum engine block” mockup

- Tour Engine will produce a clean sheet design for the GENSETS program
- Pistons and valves will be sourced from Honda GX100 (reusing key components)
- The engine will have 70 cc displacement for compression and 140 cc for expansion, giving it an compression to expansion ratio (overexpansion) of 2:1. NG fueled with a compression ratio of 13:1

Analytical Verification planed

- 1-D gas dynamics modeling.
- Status
  - Model built.
  - Volumes and port areas/timing verified.
  - Initial combustion run at 1800rev/min (Results shown).



- 3-D CFD flow and combustion modeling.
- Status
  - Mesh motion verified.
  - Hydrodynamic simulations various mesh densities performed.