Dynamic Exhaust Valve Flow 1-D Modelling during Blowdown Conditions

Ted Holmberg

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Project

- Valve strategies and exhaust pulse utilization
- 1-D GT-Power
- Engine experiments
1D flow: quasi-steady assumption

Valve profile

Flow coefficient

$C_F$ only a function of valve lift
Simulation vs Experiments

800 rpm

1350 rpm

- QS valve flow over predicts the rate of cylinder emptying
- $C_F$ function of valve opening speed and initial cylinder pressure
GT-Power model

- Replicate the experimental conditions
  - Initial cylinder pressure
  - Volumes and pipe dimensions

Valve object: Steady-flow $C_F$ from the same setup

Measured valve profile imposed
Model tuning

Steady-flow valve flow coefficients
(Choked flow conditions)

Cylinder emptying

Flow coefficient [-]

Valve lift [mm]

Cylinder pressure [bar]

Valve lift 2mm

Reducing CF → Cylinder pressure decreases slower
Flow multiplier (fraction of steady-flow C_F)

- Influence of initial pressure reduces with valve speed
- Influence of valve lift reduces with valve speed
At the same valve lift, the instantaneous pressure ratio is different for each test case.
Flow multiplier model

- GTP → Flow multiplier & instantaneous PR at a given lift
- Plot all initial pressures together

\[ k = -a(speed)^{-b} \]
Final model

- Dependent on engine speed and pressure ratio
- Origin point \((x_0, y_0) = (1.89, 0.79)\)

\[
k = -a(speed)^{-b}
\]

\[
y = k(PR - x_0) + y_0
\]
Future Work

- Implementing flow multiplier model in a GT-Power engine model to investigate impact on performance

- Engine test to measure valve flow through fast cylinder pressure and exhaust port measurement