USING 1D SIMULATIONS TO OPTIMIZE A SUPERCHARGER FOR A TWIN CHARGED DI GASOLINE ENGINE

2015-10-26 RAGNAR BURENIUS, VOLVO CAR GROUP
VEA ARCHITECTURE
VEA - DIFFERENTIATED BY BOOSTING

T3
T4
T5
T6

D2
D3
D4
D5
INTRODUCTION – T6 SC-TURBO SCHEMATIC
INTRODUCTION - OPERATING RANGE OF THE SC

[Diagram showing engine speed vs. engine brake torque with different operating modes: steady state, transients, N/A, Turbo, Turbo+Supercharger, and Supercharger Speed.]
INTRODUCTION – SC PERFORMANCE MAP

Using 1D simulations to optimize a supercharger for a twin charged DI gasoline engine, Ragnar Burenius, Volvo Car Group
What looks like a complex shape is really just a helix extrusion
A scheme for geometry definition of the meshing event was developed in Matlab.
- Areas of 2D integrated to volumes of 3D.
- Leakage lengths integrated to leakage areas.
- Discretized in ten segments to account for meshing and axial resolution.
The system of volumes and orifices is implemented as a model in GT-Power
RESULTS - PERFORMANCE PREDICTION

MEASUREMENT

1D CFD SIMULATION

Press Ratio

Mass Flow [kg/s]

Corrected massflow [kg/s]

Pressure Ratio

Mass flow [kg/s]

Corrected massflow [kg/s]
IN-CYCLE ANALYSIS – SLOW SPEED, PR=1.50

Using 1D simulations to optimize a supercharger for a twin charged DI gasoline engine, Ragnar Burenius, Volvo Car Group
IN-CYCLE ANALYSIS – HIGH SPEED, PR=1.05

2015-10-26 
USING 1D SIMULATIONS TO OPTIMIZE A SUPERCHARGER FOR A TWIN CHARGED DI GASOLINE ENGINE, RAGNAR BURENIUS, VOLVO CAR GROUP
THE ADDITION OF OUTLET SLOTS
IN-CYCLE ANALYSIS – EFFECT OF OUTLET SLOTS

Without outlet slots

With outlet slots

2015-10-26
USING 1D SIMULATIONS TO OPTIMIZE A SUPERCHARGER FOR A TWIN CHARGED DI GASOLINE ENGINE, RAGNAR BURENIUS, VOLVO CAR GROUP
OUTLET SLOTS – PERFORMANCE IMPACT

Simulation

Test

Corrected massflow [kg/s]

Corrected massflow [kg/s]
• Methodology presented for simulating a helix roots type blower using 1D CFD.
• Calculated performance compared to test data.
• Improvements in geometry implemented based on analysis of gas exchange model.
• Improvements verified in testing, and later put in production.