

Technical Overview & Cooling Systems Capability

Experience

- 25+ years in thermo-fluid systems
- 1D performance modelling (code writing & applications)
- Engine thermal loading R & D
- Chief engineer for complete diesel engine design & development programme
- R & D programme leader (Euro 4/5 diesel, mild diesel hybrid)
- Programmes with OEMs & Tier 1 suppliers
- Work in a range of industries & markets:
 - Automotive
 - Motorsports
 - Aerospace
 - Military
 - Marine & Industrial

Expertise

- Thermo-fluid systems
- Diesel engine performance & emissions
- Cooling & lubrication systems
- Boosting & EGR systems
- Diesel particulate aftertreatment
- Programme planning & management
- Technology strategy

Capabilities

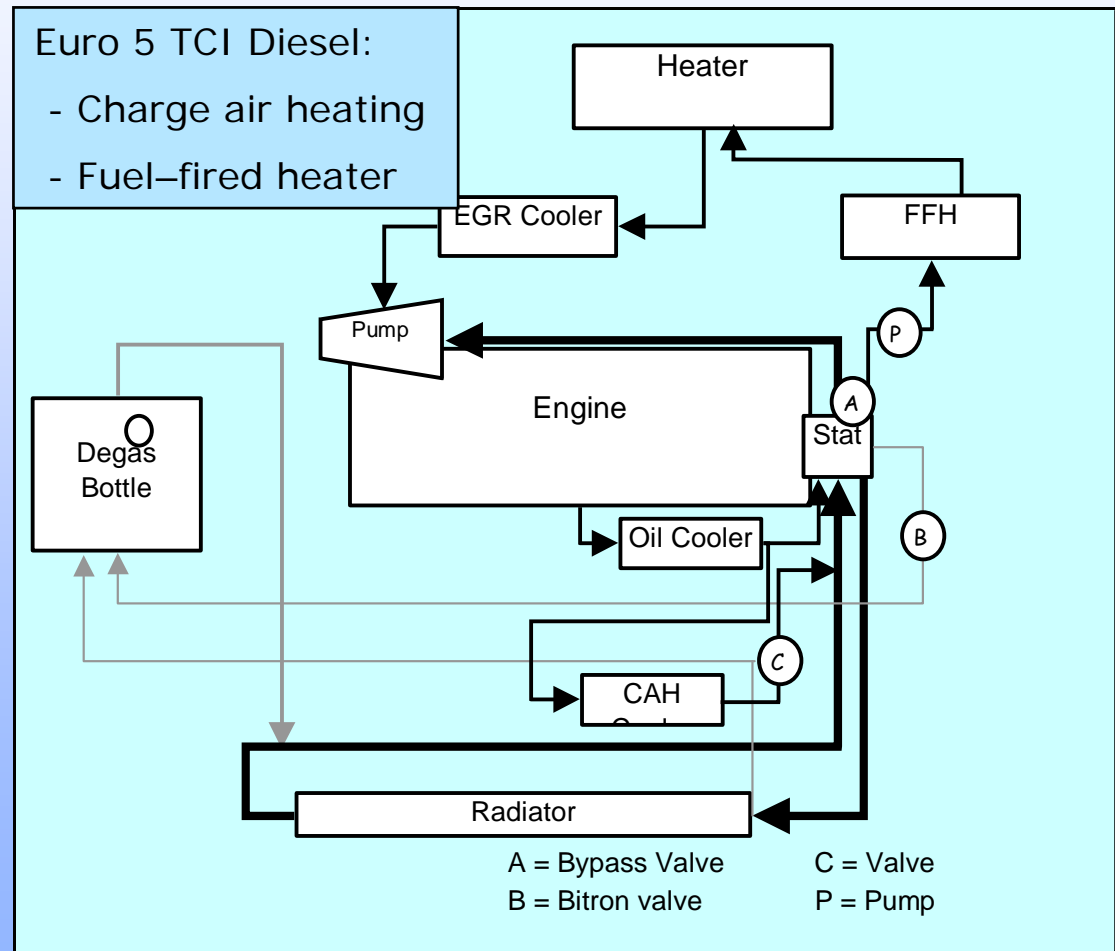
- Design:
 - Heat exchangers (radiator, charge air cooler, oil cooler, EGR cooler)
- Analysis:
 - 1D Engine Performance
 - 1D system modelling (steady state/transient ~ AMESim)
 - In-house heat rejection & heat exchanger design
 - Heat exchanger database
 - Engine heat rejection model & database
- Manufacture:
 - Prototype fluid system components
- Test & Development:
 - Component/system test & analysis (with Young Calibration)

Recent Projects

- Cooling Systems:
 - System development for 5 powertrain in a C Class platform
 - Design & analysis of advanced cooling system (electric pump & flow valve)
 - Integration of WCAC into main engine cooling circuit
 - Intensive cylinder head cooling with coolant jets
- Charge air cooling:
 - Design & development of a new water-cooled CAC concept
 - Vehicle transient response modelling & test with WCAC
 - Advanced low temperature CAC concept
 - Combined CAC system for 2-stage boosted diesel engine
- Lubrication:
 - Lubrication system design & analysis for small engines
- EGR cooling:
 - Advanced low temp. EGR cooler (patent, design, test)

Cooling System ~ Case Study

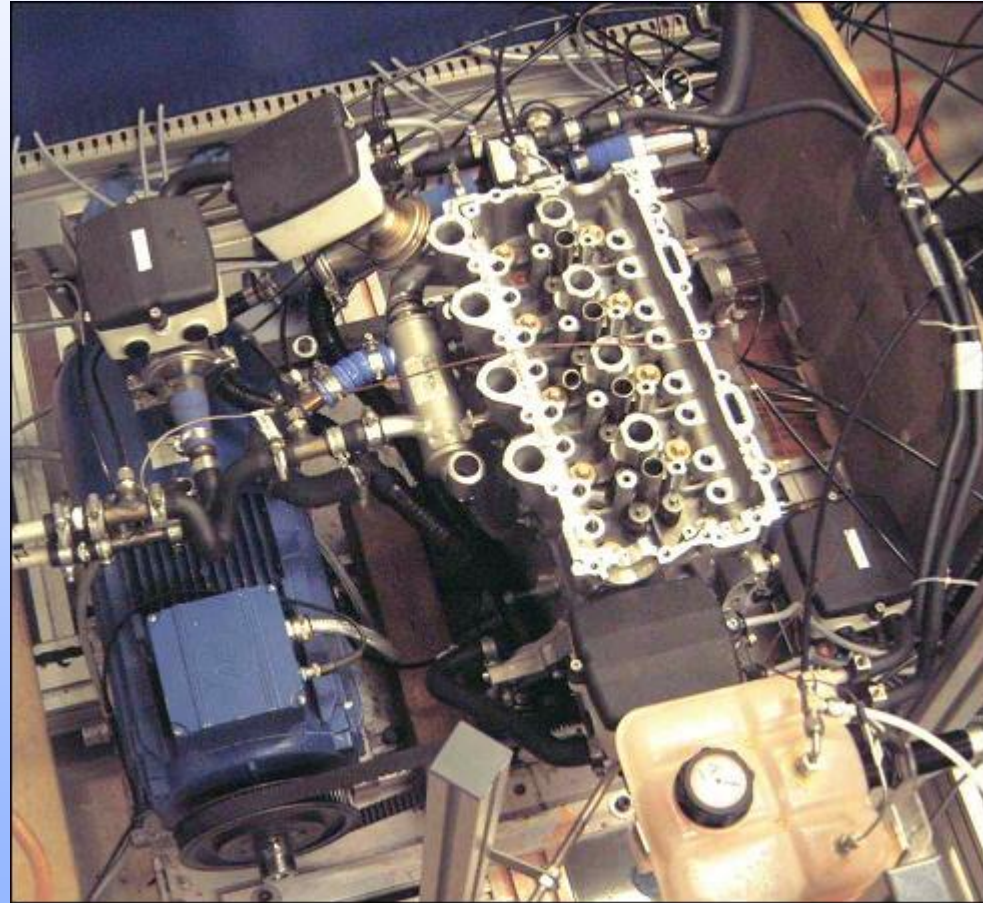
- Common car platform
- 5 engines (2 diesel, 3 gasoline)
- Fill, degas & performance validation



Cooling System ~ Case Study



- Full system installation
- Correct vehicle geometry
- Heated engine structure
- Motored coolant pump
- Instrumentation:
 - Pressures
 - Flows
 - Temperature
 - Sight glasses

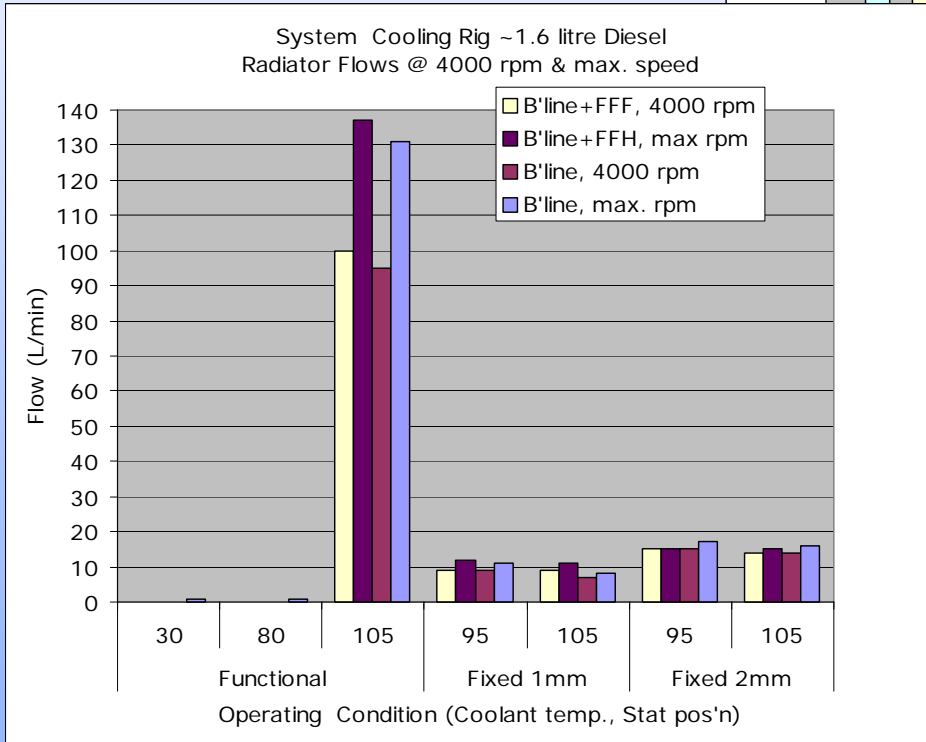
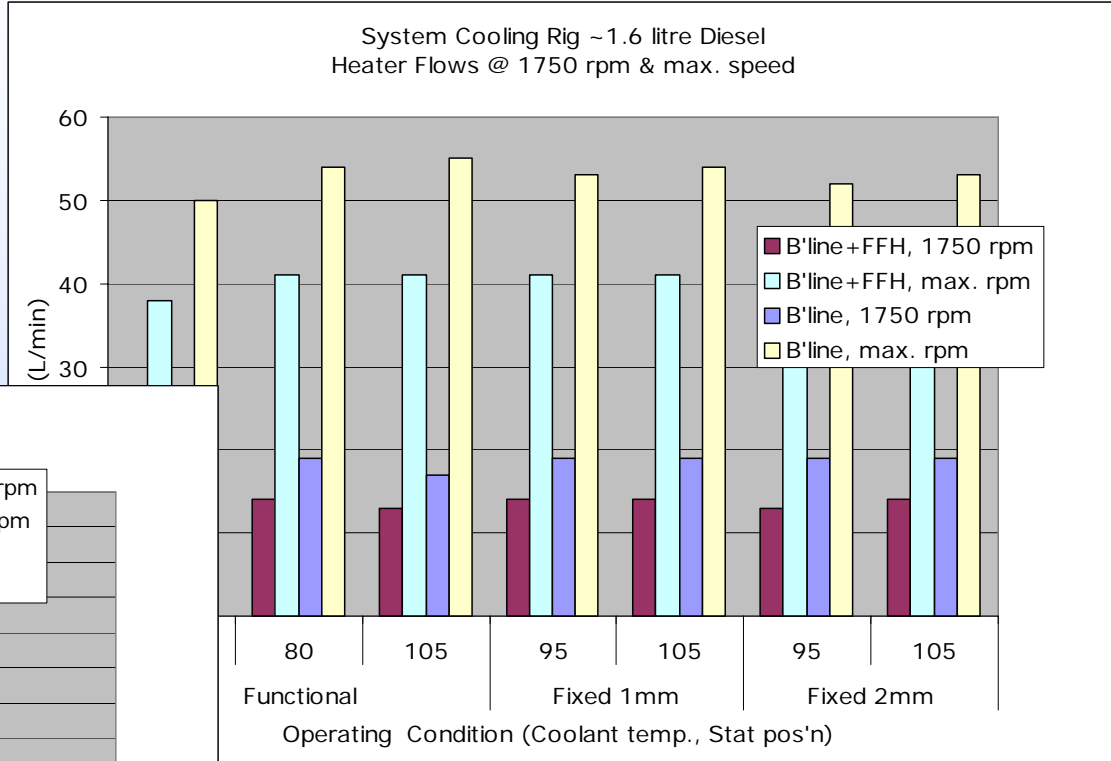


Cooling System ~ Case Study



- Heater Flows

- Radiator flows

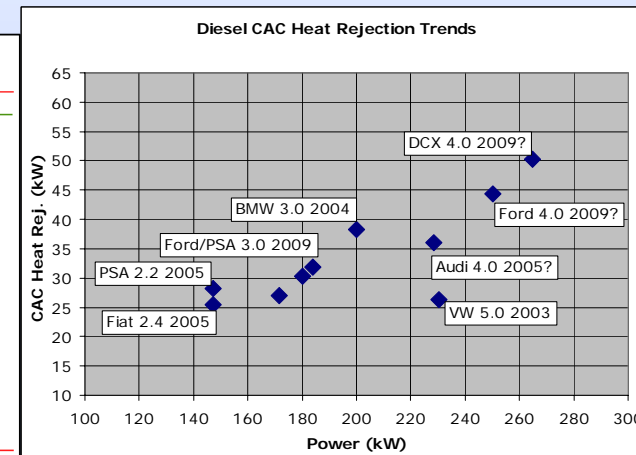
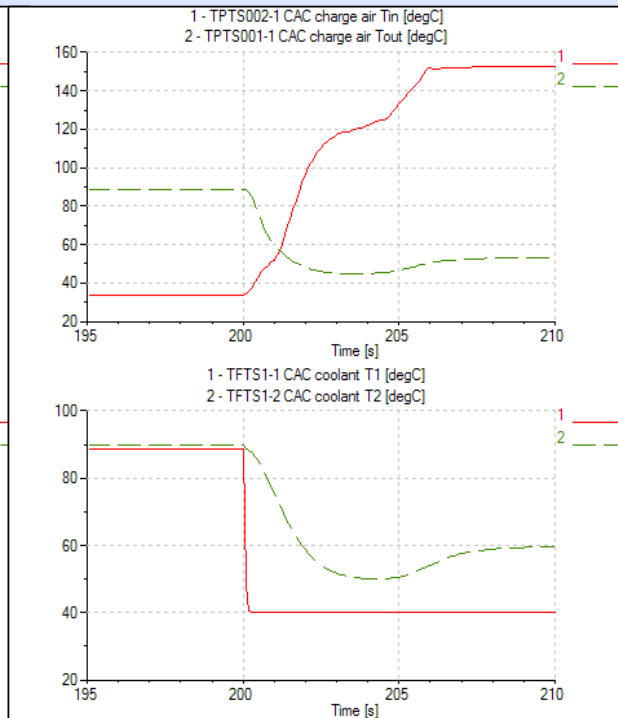
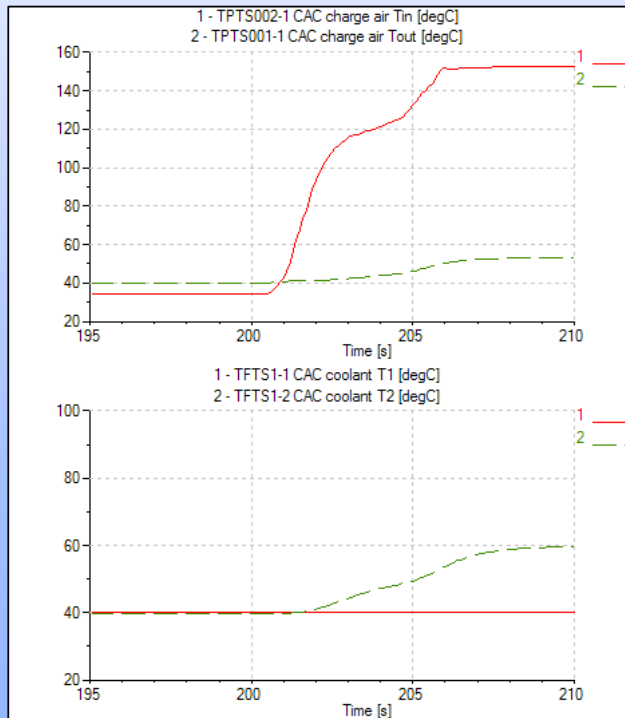
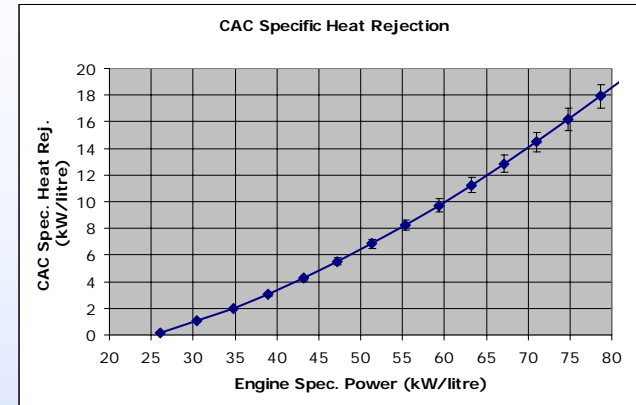


Charge Cooling ~ Examples



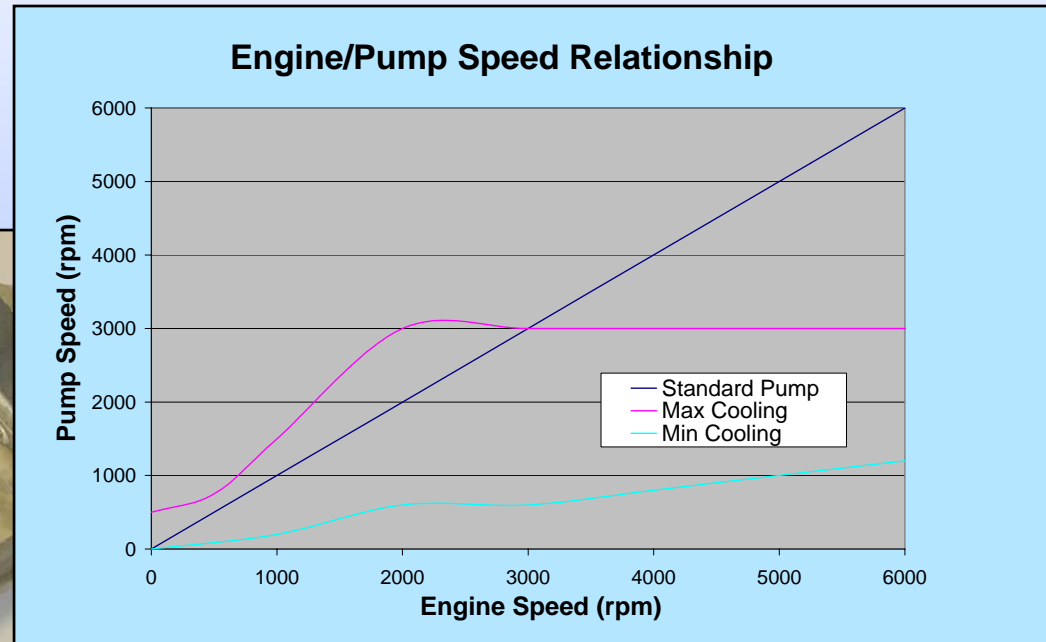
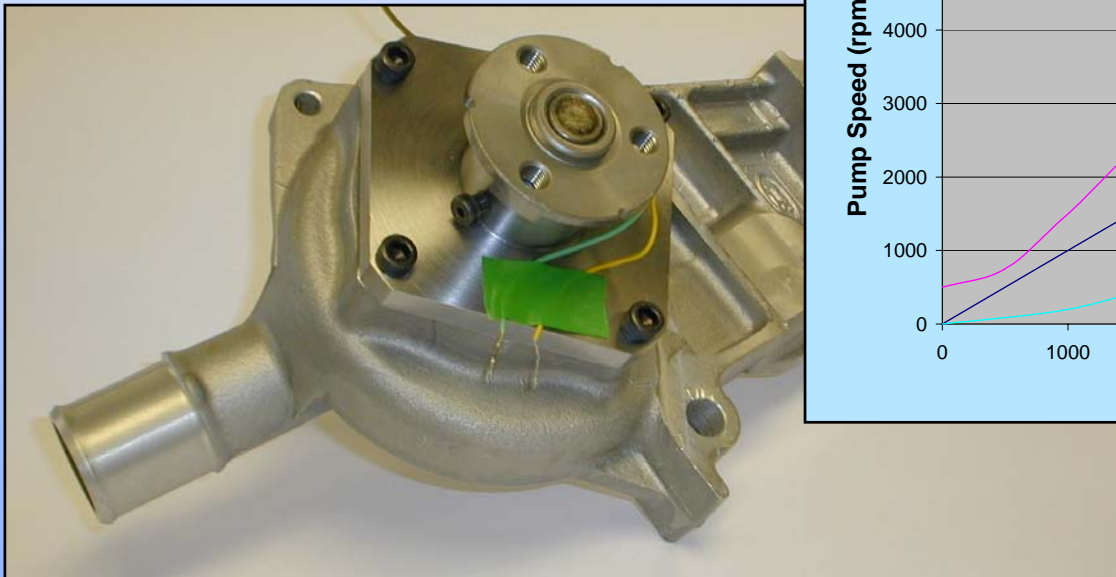
- Charge Cooling Trends

- AMESim model:
 - HCCI charge air control system
 - Water-cooled CAC
 - WOT response



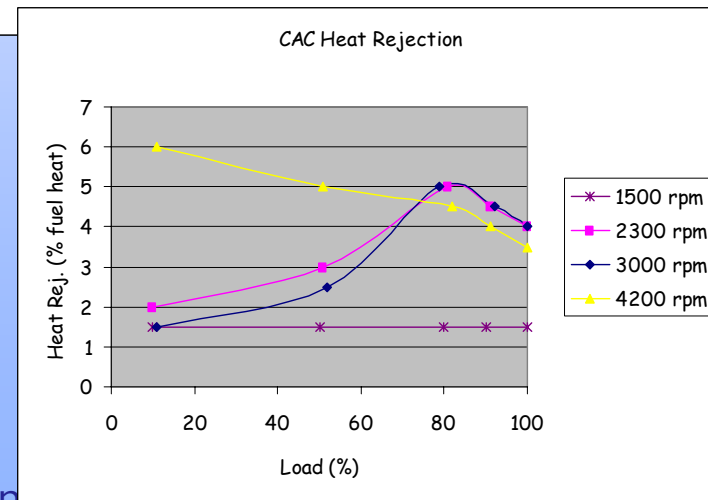
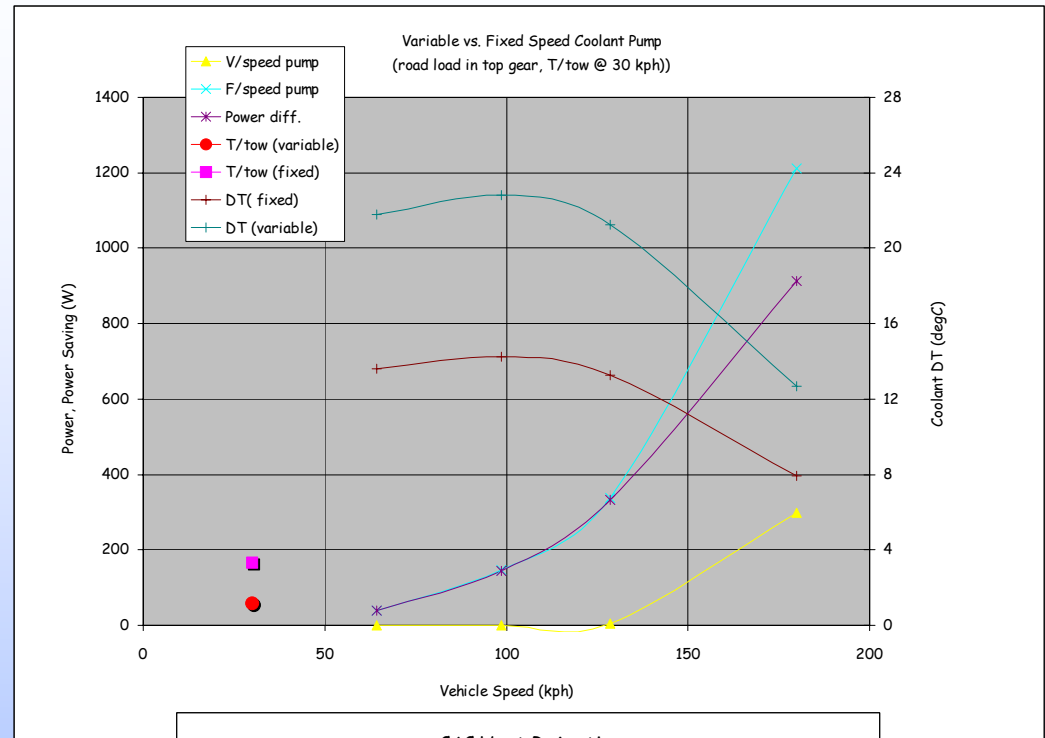
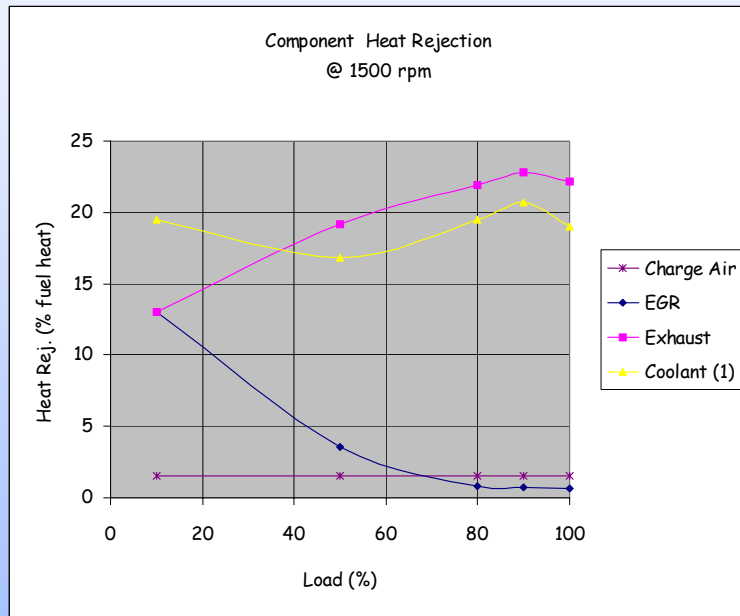
Advanced Cooling (1)

- Design & development of variable speed mechanical pump:
 - Modelling
 - Performance development
 - Initial durability



Advanced Cooling (2)

- LDT Turbo Diesel
- Heat rejection prediction
- Pump matching to on-road conditions



Summary

- WDL has a wide range of skills & experience in thermo-fluid systems
- We have a portfolio of cooling system related customers, suppliers & projects
- We are well placed to provide design & development related services for current & future diesel & gasoline engine programmes
- We are flexible & cost-effective