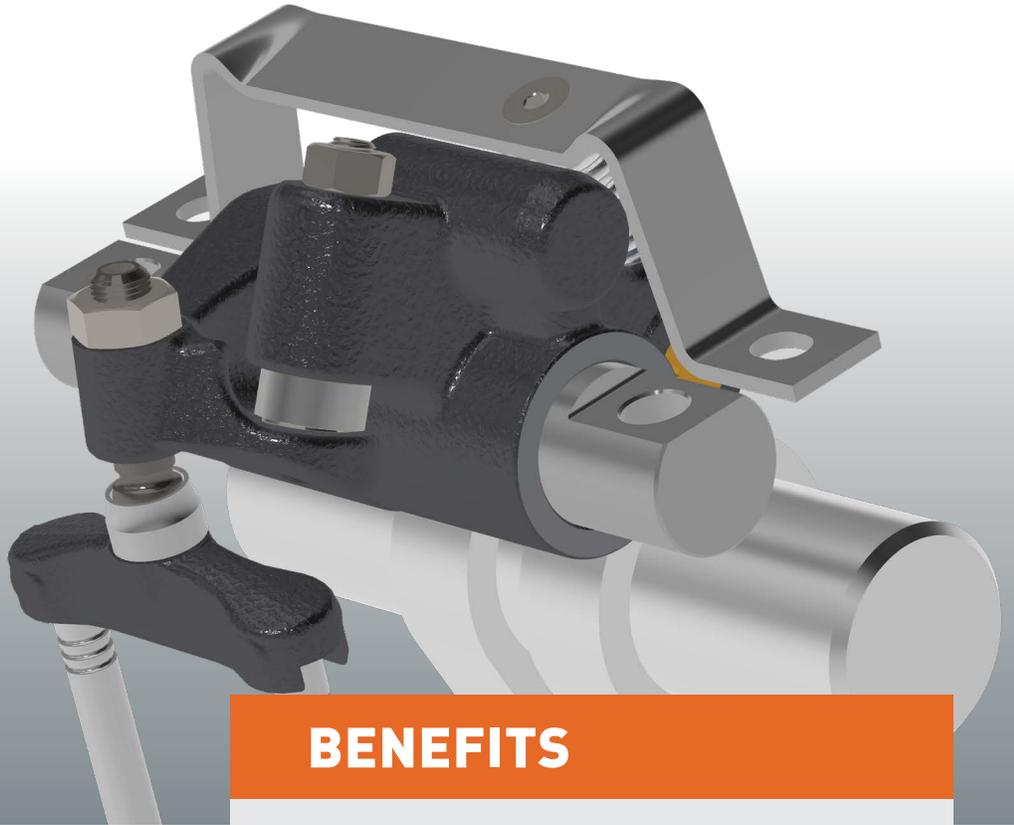




Jacobs Vehicle Systems®

VVA

2-Step Variable Valve Actuation



FOR EXHAUST THERMAL MANAGEMENT, ENGINE PERFORMANCE & EMISSIONS

Jacobs' Two-Step Variable Valve Actuation (VVA) is for OEMs challenged with meeting future transient emissions and fuel economy targets. A variable lift valvetrain opens up possibilities to meet these needs with minimal changes to the base engine and aftertreatment system while using proven mechanisms to achieve these benefits.

LEARN MORE & SEE
**2-Step VVA
IN ACTION**



BENEFITS

- ▶ Helps OEMs meet the 2027/29 NO_x emissions regulations
- ▶ Reduces fuel consumption
- ▶ Optimizes compression ratio vs load
- ▶ Improves transient response when compared to fixed miller
- ▶ Improves emissions by keeping the aftertreatment system hot during low load operation
- ▶ Reduces engine out NO_x emissions
- ▶ Developed with over 60 years of engine brake and integrated valvetrain experience
- ▶ Available for multiple valvetrain and fuel types including diesel, natural gas, and hydrogen
- ▶ Applicable to all engine displacements, including large engines
- ▶ Provides the benefits of a fully-flexible VVA system with a less complex, lower cost system
- ▶ Compatible with Jacobs' CDA and engine brake
- ▶ Higher engine braking power due to increased compression ratio

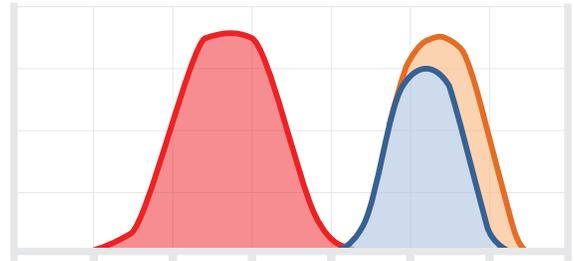
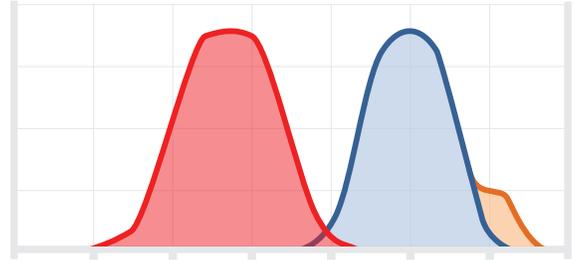
BENEFITS

EARLY OR LATE INTAKE VALVE CLOSING

- ▶ Reduces fuel consumption 1-2%
- ▶ Improves emissions by keeping the aftertreatment system hot during low load operation up to 125°C without BSFC penalty
- ▶ Reduces engine out NO_x up to 3 g/kWh at equivalent BSFC

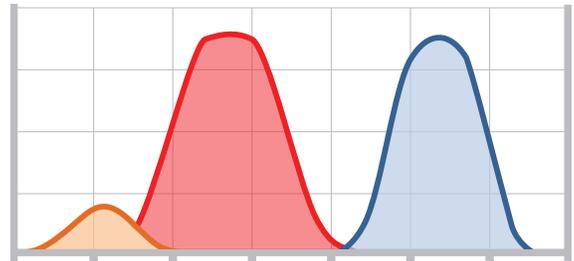
VVA Benefits Over Fixed Miller

- ▶ Optimizes compression ratio for two operating modes with up to 20% reduced CPC
- ▶ Eliminates engine start problem due to compression ratio
- ▶ Faster transient torque response
- ▶ Better low engine speed performance
- ▶ Corrects engine brake power losses and allows for even higher brake power potential due to greater net compression ratio



EARLY EXHAUST VALVE OPENING

- ▶ Faster warm up of engine and aftertreatment system
- ▶ Improves transient turbocharger response
- ▶ Improves torque at lowest engine speeds
- ▶ In-cylinder solution for DPF regeneration replacing expensive exhaust heaters and dosers
- ▶ Improves emissions by keeping the aftertreatment system hot during low load operation



INTERNAL EXHAUST GAS RECIRCULATION

- ▶ Improves emissions
- ▶ Stabilizes cold start-up combustion
- ▶ Improves engine warm-up time
- ▶ Eliminates or downsizes problematic external EGR systems and intake throttles
- ▶ Provides up to 40% EGR at low loads
- ▶ Improves aftertreatment performance
- ▶ Faster response than external EGR systems
- ▶ Improves transient emissions
- ▶ Improves emissions by keeping the aftertreatment system hot during low load operation
- ▶ Intake or exhaust opening systems available

