



行有道·達天下

CAE分析在增压汽油机降低油耗中的应用

GT-SUITE & Converge

北京汽车动力总成有限公司

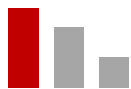
技术中心

刘系嵩

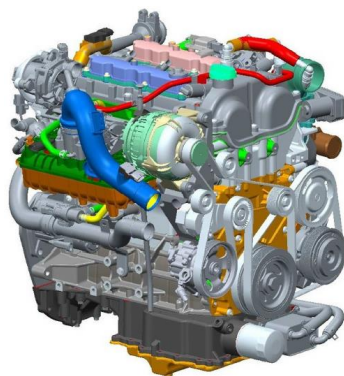
2016.11.22

- 概述
- 技术路线
- 模拟分析
- 试验测试
- 总结

- 概述
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概述



- 2.3L，增压，气道喷射
- 四阶段油耗法规
- 国六排放法规
- 动力保持，油耗降低10%

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LP-EGR

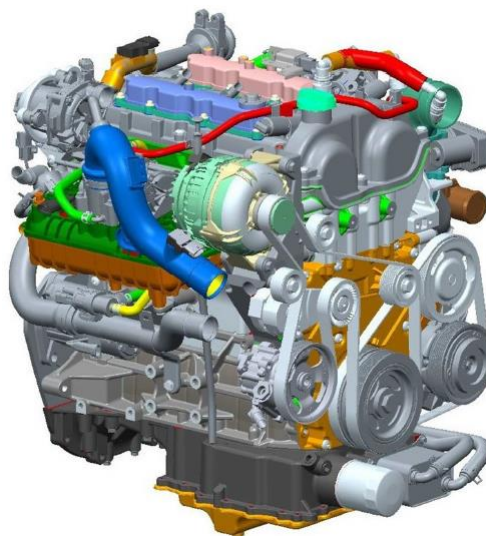
D-VVT

提高压缩比

降低摩擦

电子节温器

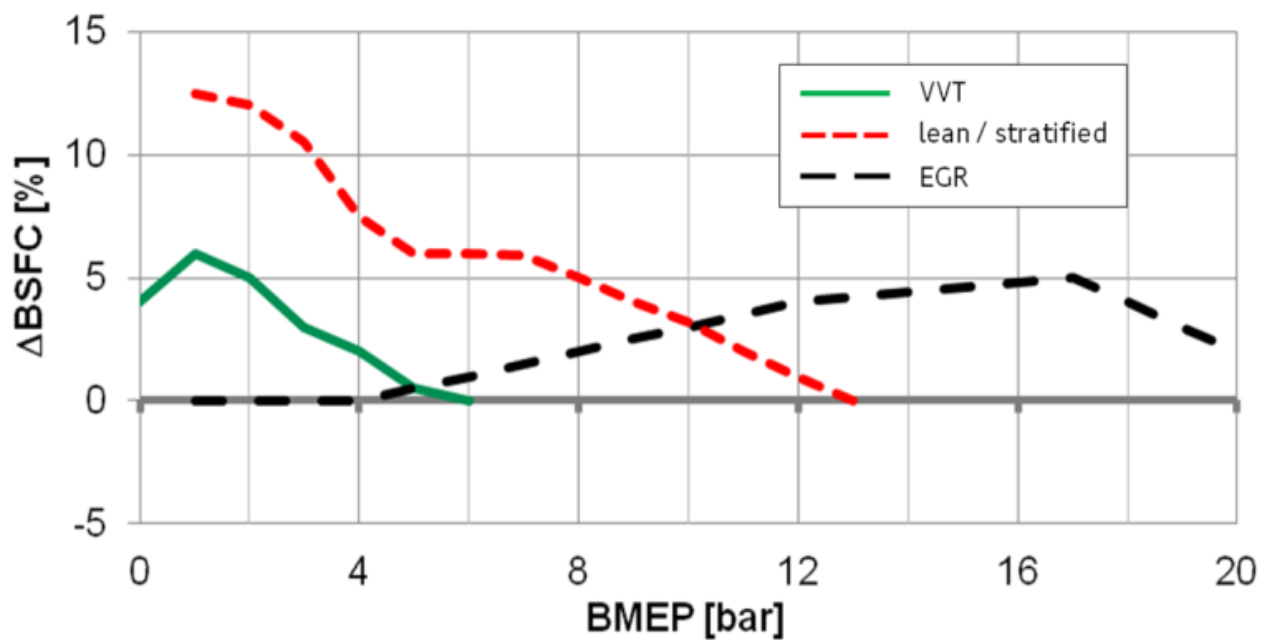
优化燃烧





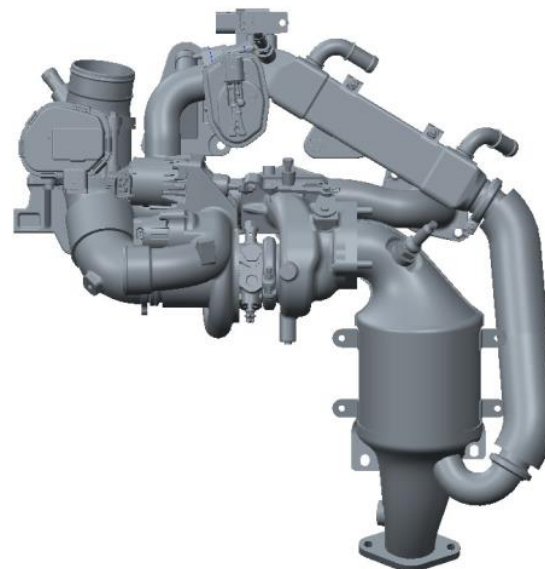
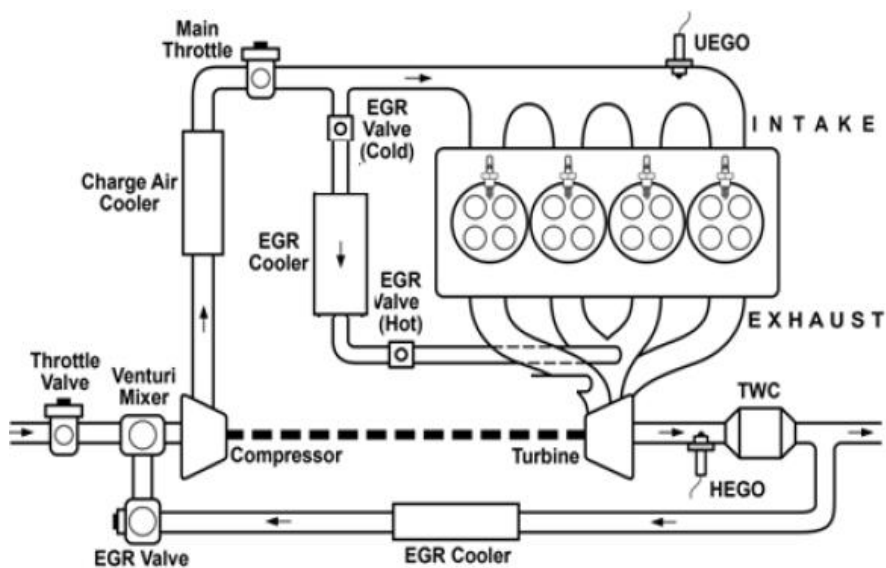
■ D-VVT

■ LP-EGR





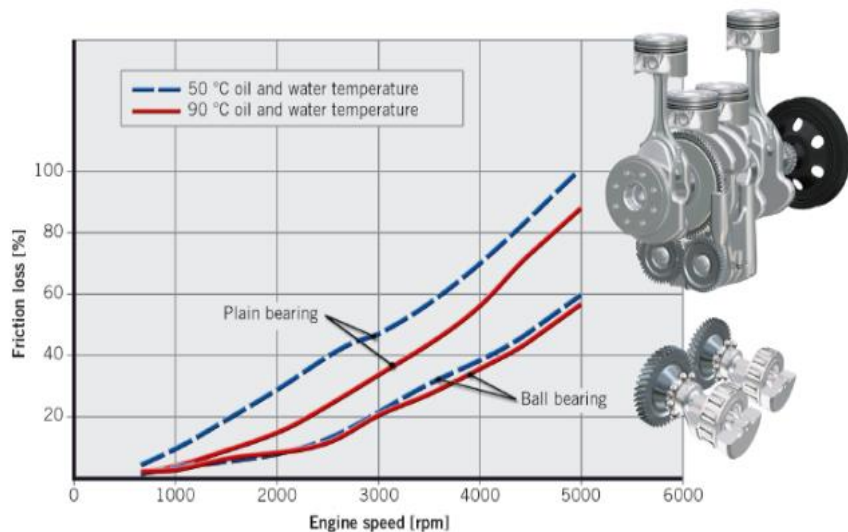
■ LP-EGR+提高压缩比



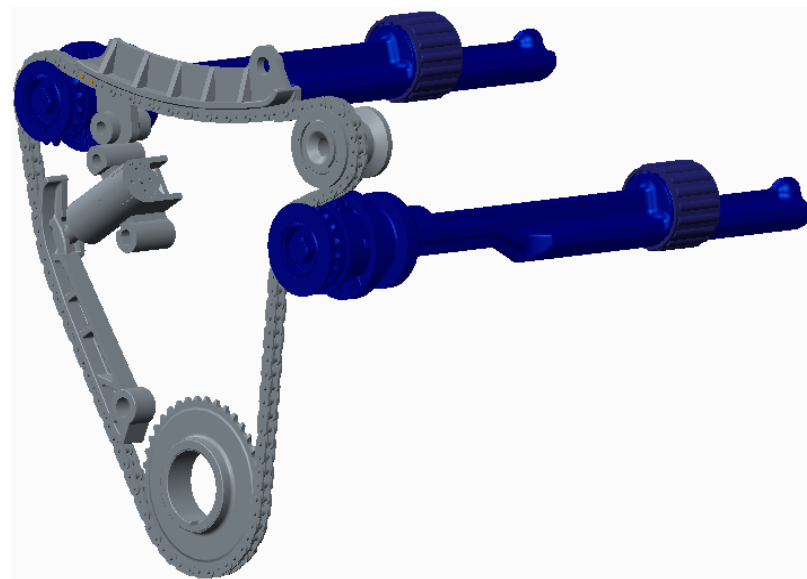


■ 滚针平衡轴承

➤ 减摩25%~50%

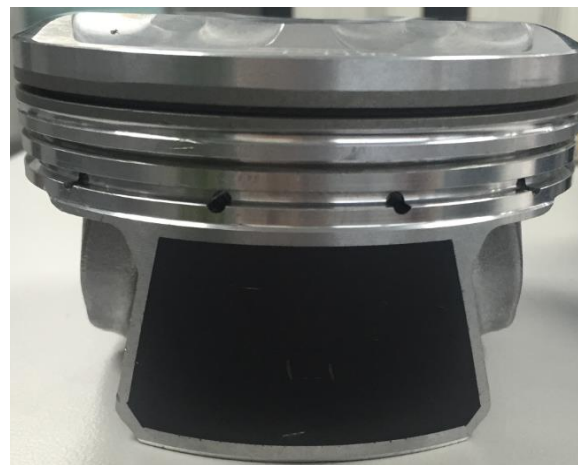


⑥ Difference in friction between a lancaster balancer with roller bearings and with journal bearings for the four-cylinder M 270/274 gasoline engine



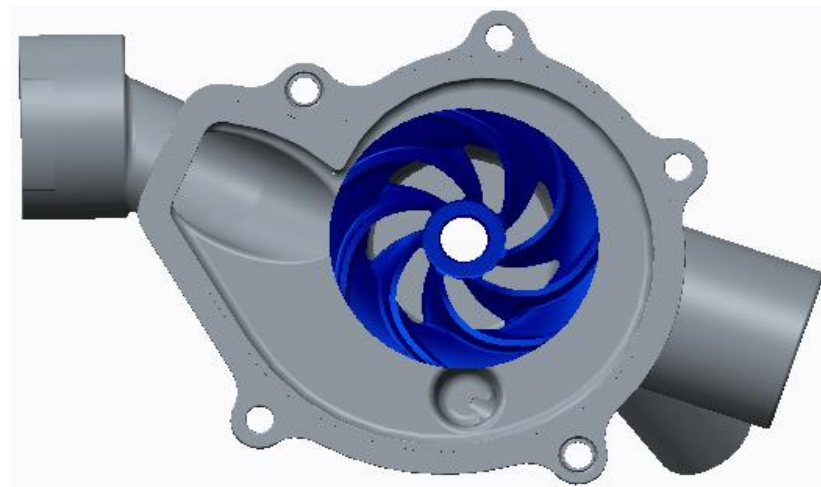
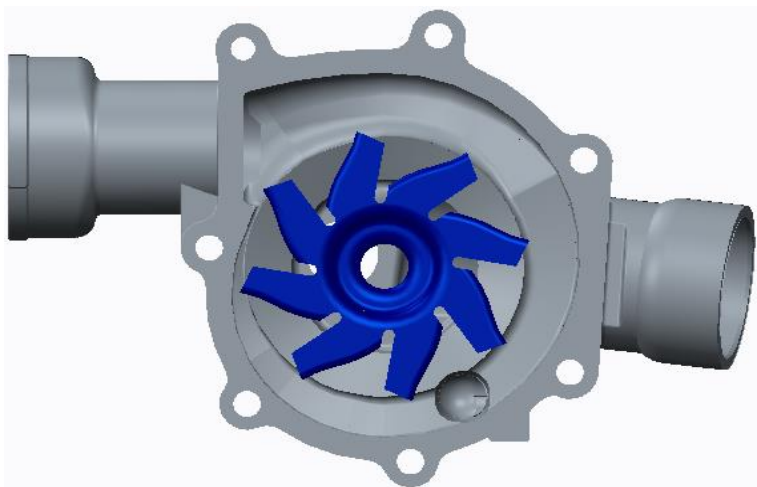
■ 活塞优化

- 轻量化：质量减轻3%；
- 裙部面积减小44%，如图4所示；
- 活塞环张力减小45%~58%；
- 气环和油环的表面涂料升级为更加减摩的涂料。



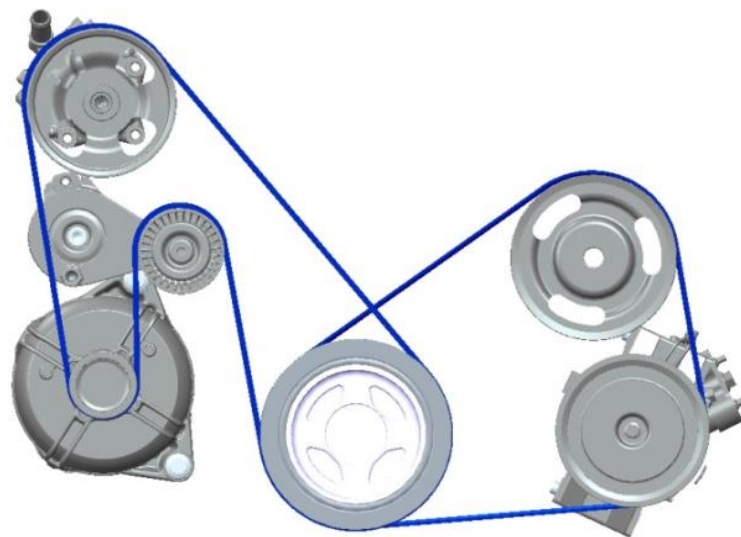
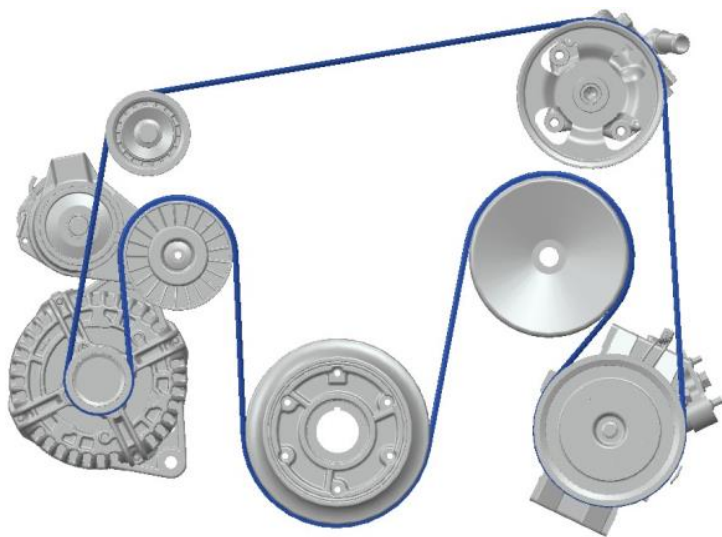
■ 高效水泵

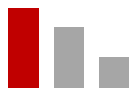
- 效率最高达到58%



■ 前段轮系优化

➤ 预计减摩40%

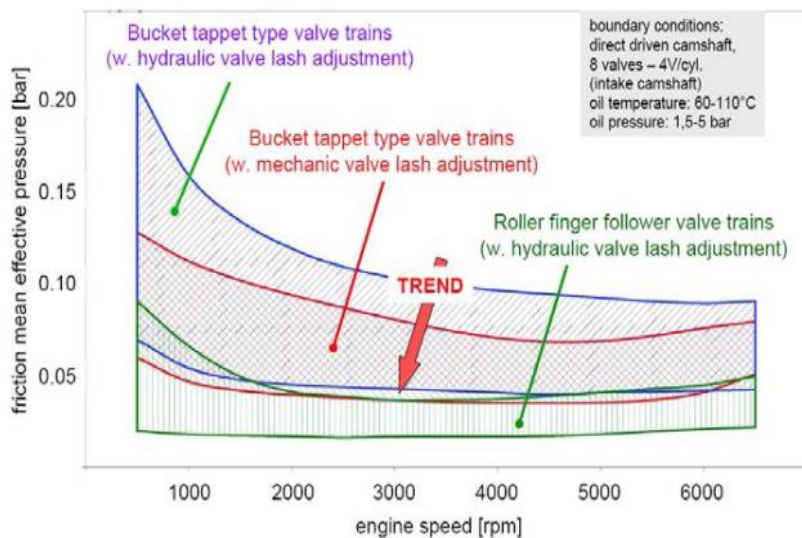




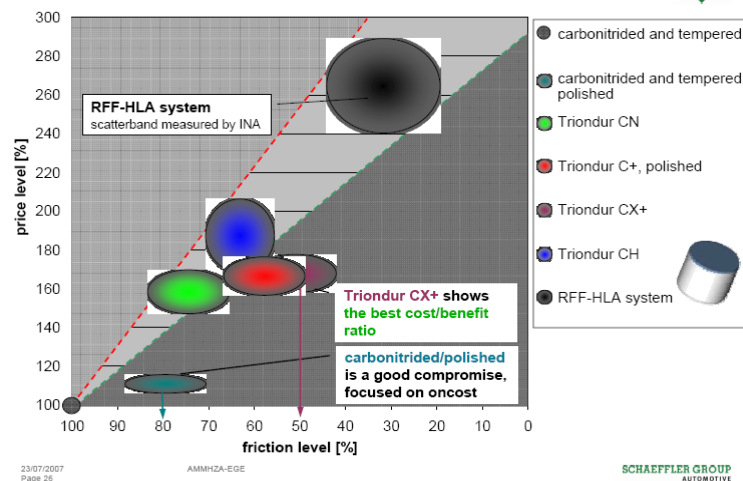
■ 液压挺柱DLC涂层

➤ 预计减摩20%

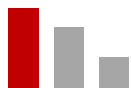
■ 中空凸轮轴承



Friction Measurements of Mechanical Tappets
Cost/Value Comparison

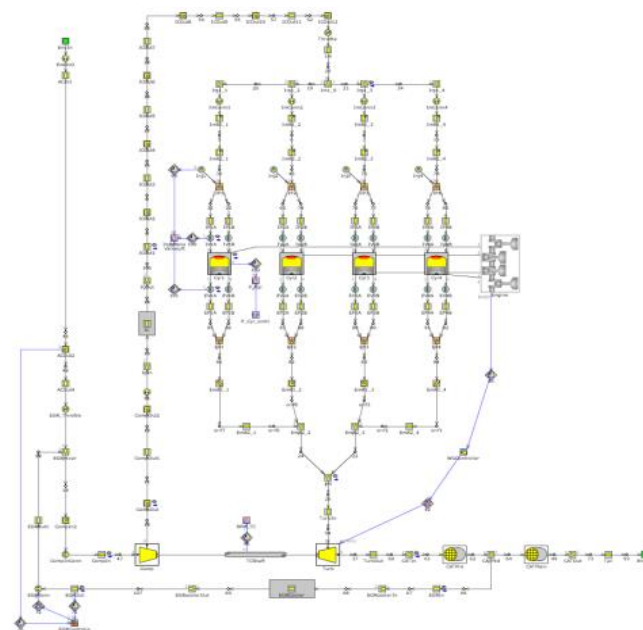
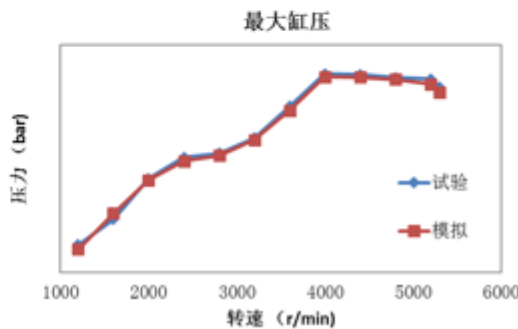
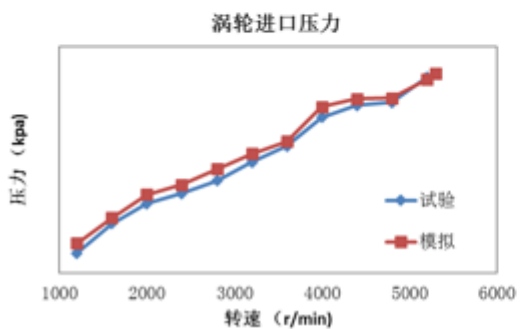
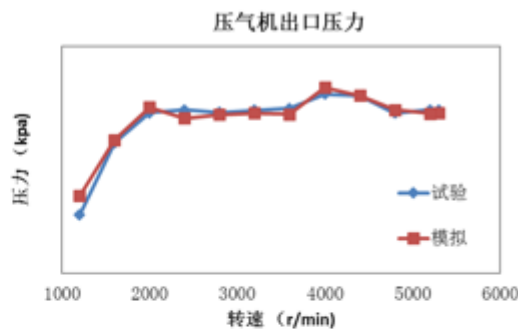
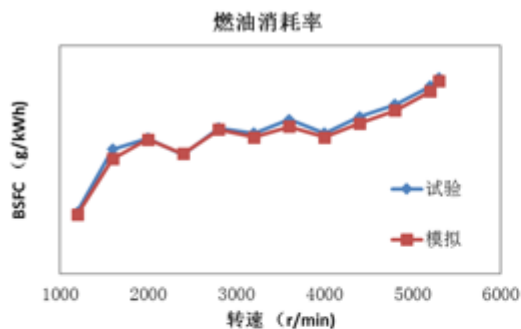
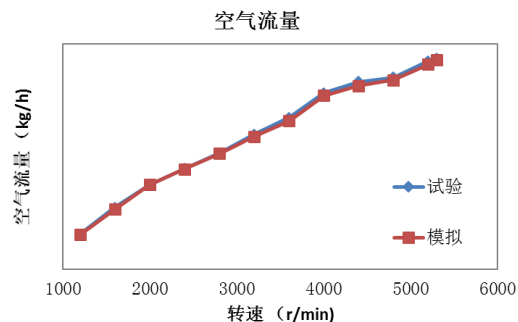


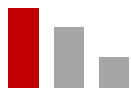
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1D模型标定

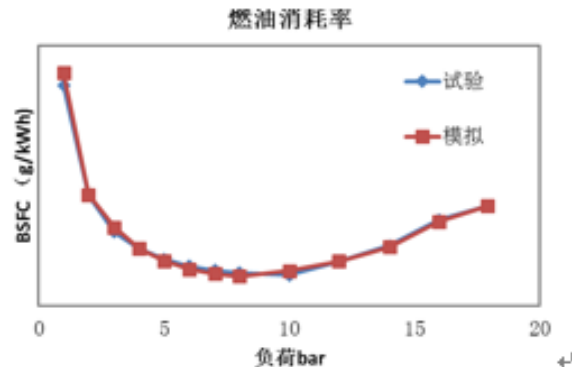
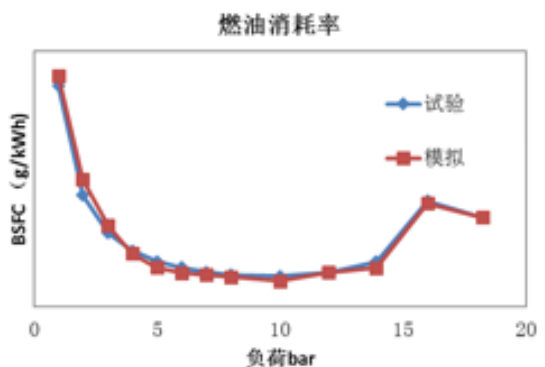
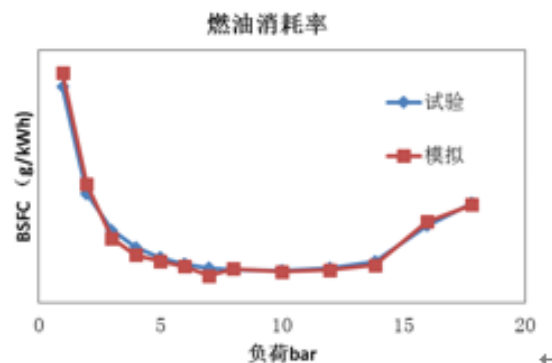
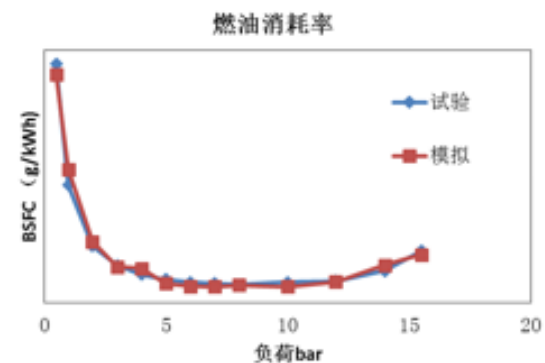
➤ WOT





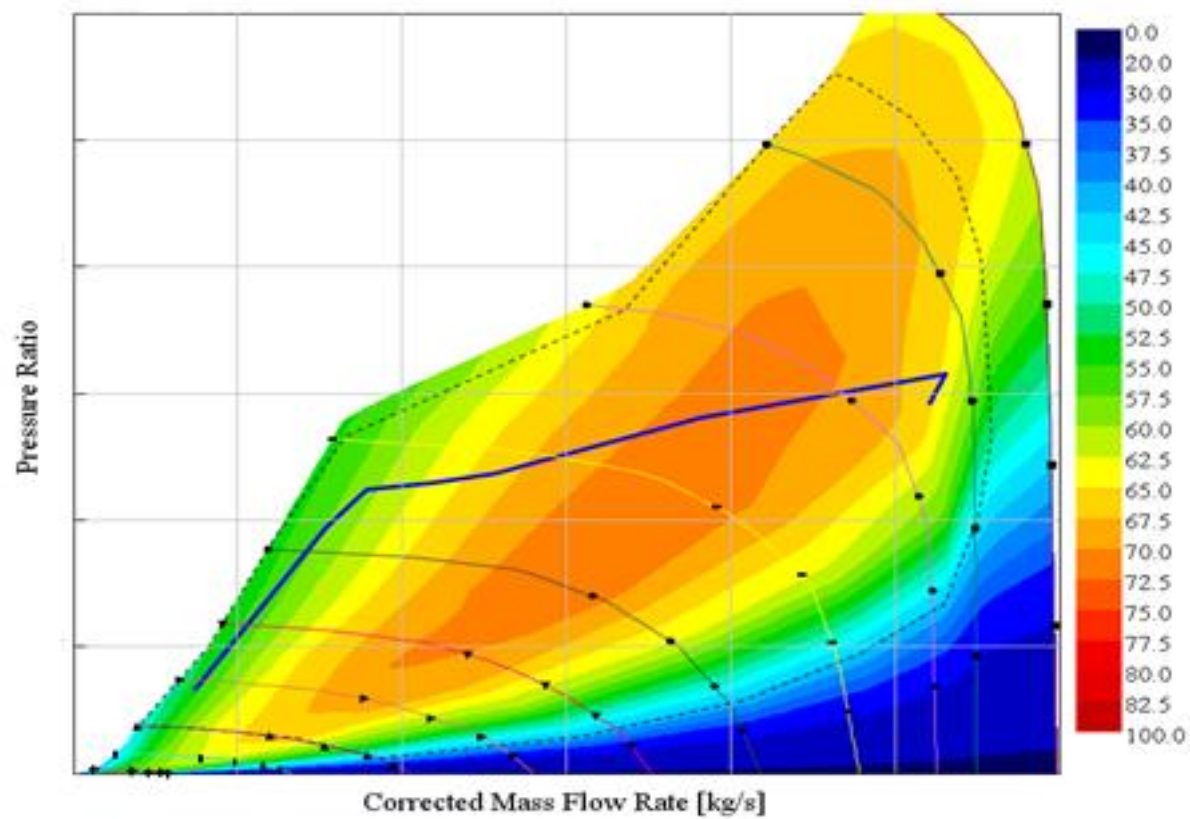
■ 1D模型标定

➤ 部分负荷





■ 增压匹配



■ 外特性性能预测

- 根据动力性优化VVT
- 低速无扫气或不能过大
- P3-P2
- 相位平顺
- 爆震指数
- CA50不能过于靠后
- Lambda不能过小

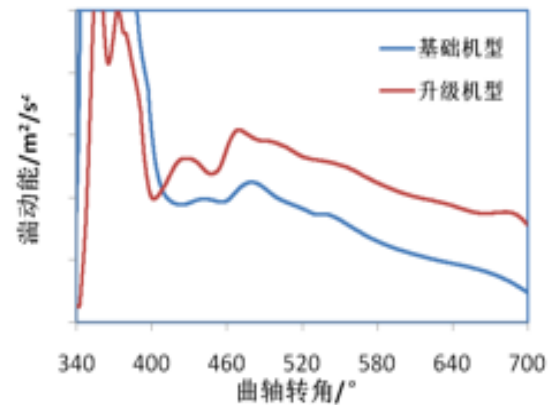
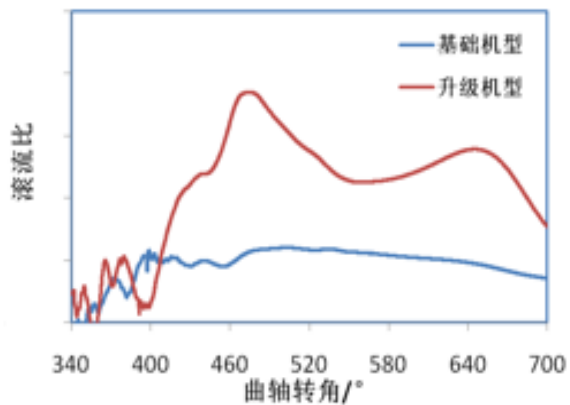
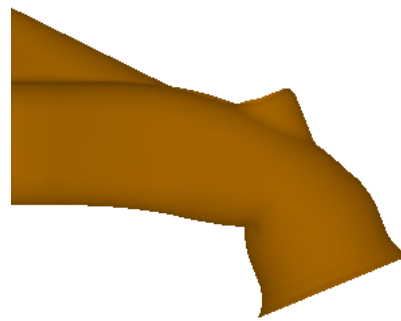
转速 (r/min)	1500	1600	1900	5200
动力性差距	-11.0%	-4.7%	-7.0%	-2.5%

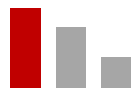
■ 需进行燃烧优化



■ 燃烧优化

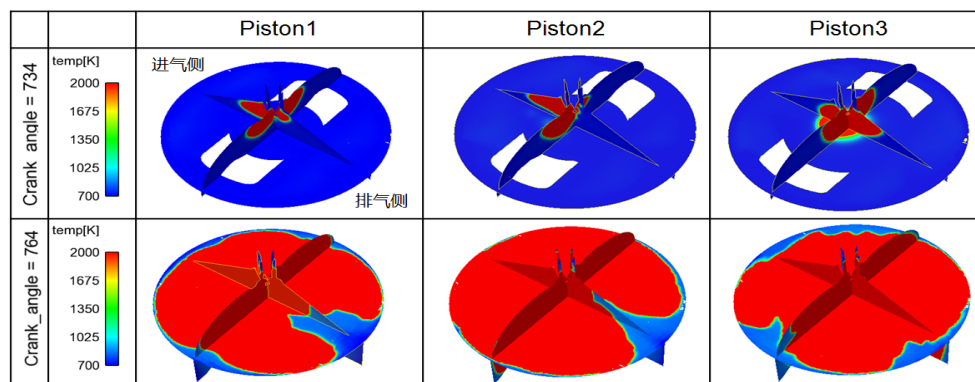
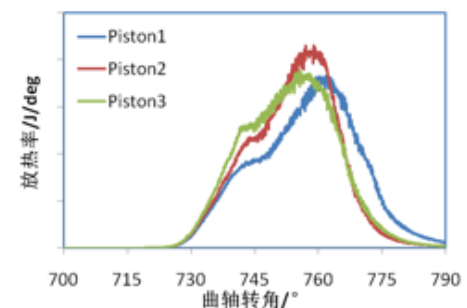
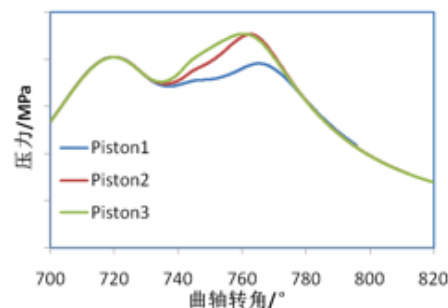
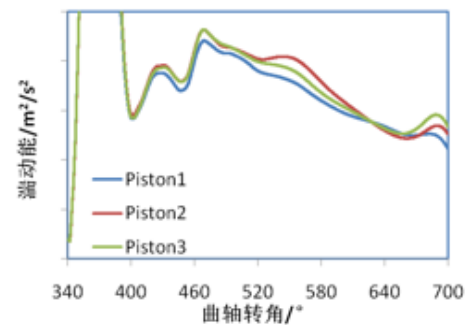
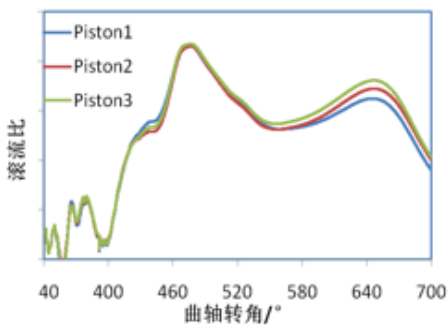
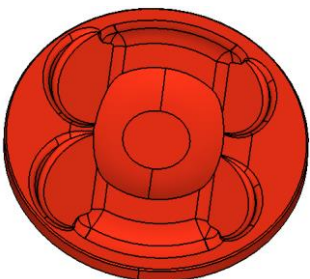
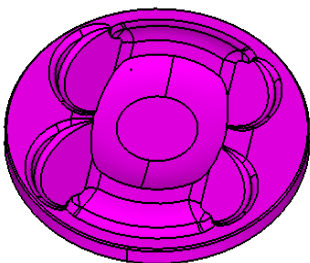
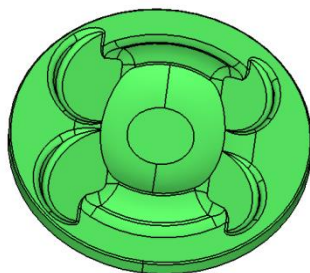
➤ 进气道





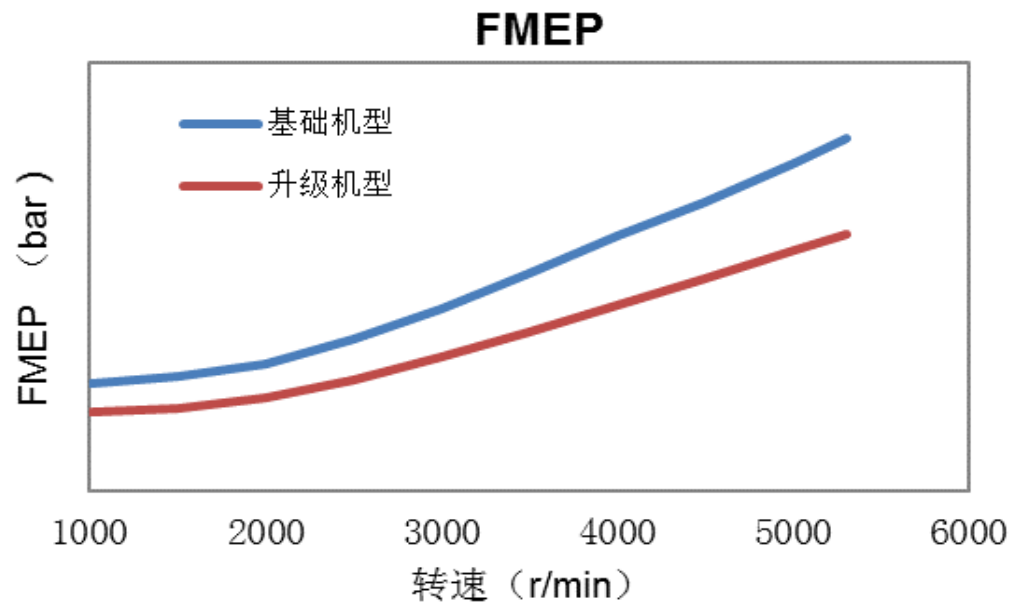
■ 燃烧优化

➤ 活塞

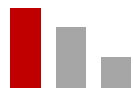


■ 部分负荷

- 废气残余限制
- 中大负荷爆震限制

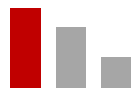


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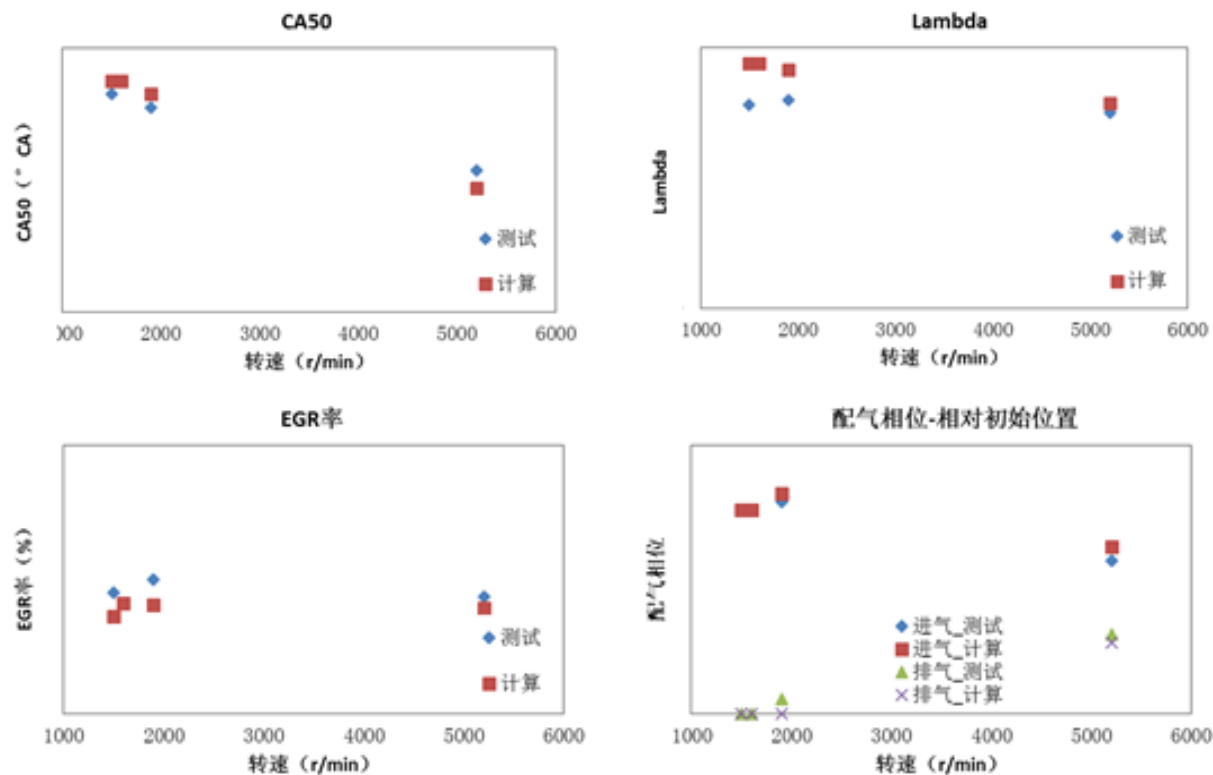


■ WOT

转速 (r/min)	1500	1600	1900	5200
CR10.5_预测	-11.0%	-4.7%	-7.0%	-2.5%
CR10.5_未优化燃烧	-5.3%	-6.7%	-0.6%	-3.6%
CR10.5_优化燃烧	+2.0%	0.0%	+0.6%	-3.6%



■ WOT



■ 部分负荷

转速	r/min	1000	1000	1500	1500	1500	1500	2000	2000	2000	2000	2000	2500	2500	2500	3000
负荷	bar	2	4	2	3.5	4	6	2	4	5	6	8	6	8	10	11
预测与目标差距	%	1.4	1.1	-1.1	-5.3	2.9	2.5	0.5	3.1	1.2	3.4	-0.5	2.4	0	0.6	-1.7
实测与目标差距	%	-2.1	-0.6	-3.4	-4.6	0	0.6	-0.6	0.5	-1.4	1.9	-0.7	1.1	0.5	-2.9	-0.1
预测误差	%	3.6	1.8	2.4	-0.7	2.9	1.9	1	2.6	2.7	1.5	0.2	1.3	-0.5	3.6	-1.6

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- 通过以下措施，实现了动力性保持，油耗降低10%的开发目标
 - D-VVT
 - 低压EGR
 - 提高压缩比
 - 优化燃烧：气道+活塞
 - 降低摩擦：活塞+滚针平衡轴+高效水泵+前段轮系+配气机构
- CAE分析精度高，起到了关键作用

引领未来车生活



北京汽车
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行有道·達天下
Your Wish · Our Ways

坚韧

执着

专注

极致