题　目　2.4T天然气发动机的增压器匹配及优化研究

摘 要

近年来，天然气以其低污染的特性逐渐成为汽油的替代品，但由于天然气为气体燃料，在进气过程中体积占有较大比例，从而导致进入气缸的空气量减少，充量系数降低，因此使发动机效率降低。本文将运用 GT-Power 来建立一台 2.4T 天然气发动机的仿真模型，并根据已有数据对其进行标定，在此基础上进行了增压器的匹配研究，选定了与之匹配的增压器，并对增压后的发动机进行性能研究。

首先，运用 GT-Power 2016 建立了一台 2.4T 天然气发动机仿真模型，并根据已知发动机外特性数据对仿真模型进行了标定，可以得到仿真模型的最大误差为 3.51%。

在标定的基础上，对仿真模型进行了增压器的匹配，使用该模型对两种压气机 1、2 和两种涡轮机 1、2 两两组合成的四种方案分别进行了模拟计算，通过分析四种方案的压气机与发动机联合运行曲线及外特性曲线图，确定了由压气机 1 和涡轮机 1 组合成的方案 1 为最佳方案。接着使用方案 1 对涡轮增压发动机模型进行了进一步试验，试验结果表示增压器匹配后扭矩的最大误差为 4.65%,燃气消耗率的最大误差为 4.89%，功率的最大误差为 4.53%，均小于 5%，在误差允许范围内。

最后，使用 GT-Power 中的 DoE(DesignofExperiment)工具对发动机仿真模型的进气提前角、排气门迟闭角及点火提前角进行了性能优化。 对进气提前角的优化使发动机的扭矩增加了 13.95%，对排气门迟闭角的优化使发动机的扭矩增加了 1%，对点火提前角的优化使发动机的扭矩增加了 1%。

关 键 词：天然气发动机；标定；增压器；性能优化

ABSTRACT

In recent years, natural gas has gradually become a substitute for gasoline due to its low pollution characteristics. However, as a gas fuel, natural gas occupies a large proportion of the volume in the intake process, leading to a reduction in the amount of air entering the cylinder and a reduction in the charging coefficient, thus reducing the efficiency of the engine. This paper will use GT-Power to build a simulation model of 2.4T natural gas engine, and calibrate it according to existing data. On this basis, the matching research of supercharger is conducted, the matched supercharger is selected, and the performance research of the supercharged engine is conducted.

Firstly, a 2.4T natural gas engine simulation model was established by using GT-Power 2016, and the simulation model was calibrated according to the known data of engine external characteristics. The maximum error of the simulation model was 3.51%.

On the basis of the calibration of the simulation model of the turbocharger matching, using the model of two kinds of compressor 1, 2 and two types of turbine 1， 2 combined into four kinds of solutions respectively simulated calculation, through the analysis of four kinds of solutions of the compressor and engine joint operation curve and external characteristic curve, identified by the compressor 1 and turbine 1 is the best solution scheme. Then the turbocharged engine model was further tested with scheme 1. The test results showed that the maximum error of torque, gas consumption rate and power was 4.89% and 4.53% after the turbocharger was matched, which were all less than 5% and within the allowable error range.

Finally, the intake advance angle, exhaust advance angle and ignition advance angle of the engine simulation model were optimized by using the DoE(Design of Experiment) tool in GT-Power. The optimization of inlet advance Angle increased engine torque by 13.95%, the optimization of exhaust gate late closing Angle increased engine torque by 1%, and the optimization of ignition advance Angle increased engine torque by 1%.

Key words: Natural gas engine; Calibration; The compressor; Performance Optimization