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微粒捕集器再生背压阈值**MAP**图建立及其应用

Establishment and application of MAP for regeneration back-pressure threshold value of diesel particulate filter

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中文关键词：柴油机,微粒,捕集器,再生,背压,MAP图

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中文摘要:

为获得柴油机微粒捕集器（diesel particulate filter，DPF）再生背压阈值以提供再生时机判断基准，针对该文设计的喷油助燃再生系统，提出以总油耗量法为基础DPF再生时机背压判断法。基于AVL-BOOST平台建立装有DPF发动机的仿真模型，并试验验证其油耗、功率、转矩、排气温度及DPF背压变化模拟值，对比结果表明，该模型具有较好的实用性，为获得较高密度和精度的测点值创造条件。沿发动机纵、横向工况分布面上采用最小二乘拟合法与区间分段线性插值法，借助MATLAB对装有干净DPF的发动机等油耗曲面进行拟合。通过设置仿真模型中DPF模块微粒层厚度，记录各工况油耗，并从中筛选出较干净过滤体发动机油耗超过5%时所对应的DPF背压值作为背压阈值，进一步建立DPF再生背压阈值脉谱图（map of arterial pressure, MAP）。从应用试验来看，相同控制策略下采用该MAP判断再生时机可保证DPF再生过程在5～10 min内完成，过滤体内峰值温度及最大温度梯度均低于安全阈值1400 K、75 K/cm，表明该MAP具有较好的实用性，这为实现微粒捕集器的快速、安全再生提供了依据和技术参考。

英文摘要:

Abstract: In order to obtain the regeneration back-pressure threshold value of a diesel particulate filter (DPF) to provide the estimated criterion of regeneration time, the working principle of a burner-type DPF was introduced, and the estimated method of DPF exhaust back-pressure was put forward based on the total fuel consumption rate. A simulation model of a diesel engine with DPF was built by AVL-BOOST software. Through reasonable simplification, setting its parameters, and defining the boundary conditions, the working performances were simulated and DPF's back-pressure under the allowed total fuel consumption rate of different working conditions was calculated, then verified the simulation values of fuel consumption rate, power, torque, exhaust gas temperature and DPF's back-pressure on the DPF regeneration test bench. It shows that the results of the simulation are in close agreement with the experiments. Under diesel engine's full load working condition, the maximum error and the relative error of power was 3.9 kW and 7.83%, respectively, and that of fuel consumption rate was 12.3g/(kW.h) and 4.82%, and the error of DPF's back-pressure between the simulations and the experiments was less than 2.5kPa. Under the diesel engine's partial load working conditions, changes of power, fuel consumption rate, torque, exhaust gas temperature and DPF's back-pressure were consistent with those of full load working conditions, and likewise the simulation value agreed with the experimental data. It showed that the simulation model was valid and able to supply high density and precision measure values instead of the test bench. Based on the multivariate linear regression analysis theory, with the least square fitting method and piecewise linear interpolation technology along the vertical and horizontal direction distribution of the engine's working conditions, respectively, the values of fuel consumption rate were obtained under the diesel engine's all working conditions, and with the help of MATLAB software's powerful mathematics function and graph disposal capability, the curve surface of equal fuel consumption rate was simulated for the diesel engine with clean DPF. To set up the soot layer thickness with 0.0025mm increments in the DPF module of simulation and to record the fuel consumption rate of each working condition, the back-pressure was taken as the threshold value with the fuel consumption rate at 5% more than that of the diesel engine with clean DPF; further, the threshold value MAP of DPF regeneration back-pressure was built. From test results of the MAP application, it shows that DPF regeneration can be completed in 5-10 minutes. Through embedding three temperature measure probes in equal intervals along the axis of DPF's central inlet channels, real-time monitoring on temperature and its gradient were carried out on each measuring point. From the selected four regeneration cases, the peak value and maximum gradient of temperature was 1230, 1180, 1085, 1047K and 26.3, 24.6, 21.5, and 20 K/cm, respectively, which was below the safe threshold value. It indicated that the back-pressure threshold value MAP is very practical. It provides technology references on fast and safe regeneration for DPF.

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