EUROPEAN PATENT SPECIFICATION

MODULATING AIR/FUEL RATIO

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References cited:
- WO-A-92/02721
- US-A-4 617 794
- PATENT ABSTRACTS OF JAPAN vol. 008, no. 094 (M-293), 28 April 1984 & JP,A,59 007724 (TOYOTA JIDOSHA KOGYO KK), 14 January 1984,

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Description

[0001] This invention relates to electronic engine control of internal combustion engine operation. Prior technology modulates air to fuel ratio peak to peak amplitude as a function of engine rpm and mass air flow only. It would be desirable to control air to fuel ratio so as to improve engine and catalyst operation. SAE paper 940935 entitled “Performance and Durability of Palladium Only Metallic Three-Way Catalyst” by Matti Harkonen, Matti Kivioja, Pekka Lappi, Paivi Mannila, Teuvo Maunula and Thomas Slotte teaches that adjusting the air to fuel ratio can lower catalyst light-off temperatures.

US Patent No 4 617 794 discloses a method of controlling the air to fuel ratio peak to peak amplitude in the operation of an internal combustion engine having a catalyst, the method including the steps of:

- determining whether the engine is at idle;
- if yes, setting the standard peak to peak amplitude equal to an idle calibrateable constant multiplied by a first function of catalyst temperature; and
- if no, setting the standard peak to peak amplitude equal to a non-idle calibrateable constant multiplied by a second function of catalyst temperature.

Vehicle data has indicated that the conversion efficiency of the catalyst changes for different air to fuel ratio peak to peak amplitudes. If the peak to peak amplitude is too high, the driveability of the vehicle will suffer due to engine rpm surges. If the peak to peak amplitude is too low, the emissions may be unfavourably altered. Making the peak to peak amplitude a function of catalyst temperature, for HC, CO, NOx, respectively.

Figs. 1, 2, and 3 show graphical representations of catalyst conversion efficiencies versus catalyst temperature and engine load as inputs and air fuel peak to peak amplitude multiplier as an output; and Figs. 4A, 4B, and 4C are graphical representations of HC, CO, NOx conversion percentages with respect to catalyst temperature, respectively.

[0003] The air fuel ratio applied to an internal combustion engine is modulated to improve the operation of a catalyst receiving exhaust gas from the engine. Referring to Fig 1, logic flow starts at a block 20 where electronic engine control operation begins. Logic flow then goes to a block 21 to determine whether the engine is at idle. If a flag, ISCFLG, is greater than 0, the engine is not at idle, and logic flow goes to a block 23 wherein a standard peak to peak amplitude is determined according to standard a look up table which is based on engine RPM and load.

[0004] From block 23 logic flow goes to a block 25 where a final peak to peak amplitude is calculated by multiplying the standard peak to peak amplitude by the output of a peak to peak multiplier lookup table which is based on the temperature of the catalyst and load. Load is the instantaneous airflow that is moving through the engine divided by the maximum airflow that could be moving through the engine. From block 25, the process ends at a block 26.

[0005] If, at block 21, ISCFLG is not greater than 0, the engine is at idle, and logic flow goes to a block 22 wherein the standard air fuel peak to peak amplitude is set equal to a calibrateable constant that has been determined to be the most efficient peak to peak amplitude at idle.

[0006] From block 22 logic flow goes to a block 24 where a final peak to peak amplitude is calculated by multiplying the standard peak to peak amplitude by the output of an at idle peak to peak multiplier function that is based on catalyst temperature. From block 24, the process ends at block 26.

[0007] Fig. 2 is a graphical representation of the idle air to fuel ratio peak to peak multiplier function. Catalyst temperature is the input and the idle air to fuel ratio peak to peak multiplier is the output.

[0008] Referring to Fig. 3, a table shows non-idle peak to peak air to fuel ratio multiplier values for inputs of catalyst temperature and engine load (i.e. mass air flow).

[0009] Figures 4A, 4B, and 4C, are graphical representations of catalyst conversion efficiencies versus catalyst temperature, for HC, CO, and NOx, respectively, at each of three different peak to peak air to fuel ratios. The plots indicate the catalyst converter efficiencies are dependent on the size of the air to fuel ratio peak to peak amplitudes. The catalyst converter dependency on peak to peak amplitude is primarily in the catalyst temperature range of 400-700 degrees Fahrenheit.

[0010] Air to fuel ratio is often desired to be held at a stoichiometric ratio of 14.7. Figs. 4A, 4B, and 4C show...
data at three different air to fuel ratio peak to peak amplitudes: +/- 0.9 A/F; +/- 0.3 A/F; and +/- 0.6 A/F. For example +/- 0.9 A/F indicates an actual A/F ratio varying from 15.6 (i.e. 14.7 + 0.9) to 13.8 (i.e. 14.7 - 0.9). Air to fuel ratio may also be presented in a normalised manner wherein 1 would indicate air to fuel ratio at stoichiometry. An air fuel ratio of 15.6 would be represented in a normalised fashion by 1.06 (i.e. 15.6 divided by 14.7).

[0011] If desired this method can be applied to each bank of a V-type engine so that each bank can have independent peak to peak air to fuel ratio amplitude variation.

Claims

1. A method of controlling air to fuel ratio peak to peak amplitude in the operation of an internal combustion engine having a catalyst, the method including the steps of:

- determining whether the engine is at idle;
- if yes, setting the standard peak to peak amplitude equal to an idle calibrateable constant multiplied by a first function of catalyst temperature; and
- if no, setting the standard peak to peak amplitude equal to a non-idle calibrateable constant multiplied by a second function of catalyst temperature.

2. A method as claimed in claim 1, wherein said first function of catalyst temperature is an idle speed control peak to peak multiplier determined as a function of catalyst temperature.

3. A method as claimed in claim 1 or 2, wherein said second function of catalyst temperature is a peak to peak multiplier determined by the output of a lookup table which is based on inputs of catalyst temperature versus engine load.

Revendications

1. Procédé de régulation de l’amplitude crête-à-crête du rapport air sur carburant lors de la mise en œuvre d’un moteur à combustion interne comportant un catalyseur, le procédé comprenant les étapes consistant à :

- déterminer si le moteur se trouve au ralenti, si oui, fixer l’amplitude crête-à-crête standard égale à une constante pouvant être étalonnée de ralenti multipliée par une première fonction de température de catalyseur, et si non, fixer l’amplitude crête-à-crête égale à une constante pouvant être étalonnée de non ralenti multipliée par une seconde fonction de température de catalyseur.

2. Procédé selon la revendication 1, dans lequel ladite première fonction de température de catalyseur est un multiplicateur crête-à-crête de la régulation du régime de ralenti déterminé en fonction de la température du catalyseur.

3. Procédé selon la revendication 1 ou 2, dans lequel ladite fonction de température de catalyseur est un multiplicateur crête-à-crête déterminé par la sortie d’une table de consultation qui est fondée sur des entrées de températures de catalyseur en fonction de la charge du moteur.
BEGIN ELECTRONIC ENGINE CONTROL OPERATION.

20

IS THE ENGINE AT IDLE? (ISCFLG > 0)

21

Y

THE STANDARD PEAK TO PEAK AMPLITUDE IS SET EQUAL TO A CALIBRABLE CONSTANT.

22

N

THE STANDARD PEAK TO PEAK AMPLITUDE IS DETERMINED ACCORDING TO A LOOKUP TABLE BASED ON ENGINE RPM AND LOAD.

23

24

THE FINAL PEAK TO PEAK AMPLITUDE IS CALCULATED BY MULTIPLYING THE STANDARD PEAK TO PEAK AMPLITUDE AND THE OUTPUT OF THE AT IDLE PEAK TO PEAK MULTIPLIER FUNCTION

25

26

END

FIG. 1

ISC_PTP_MULT (FUNCTION)

PTP_MULT (TABLE)

LOAD

CATALYST TEMPERATURE

INPUT: CATALYST TEMPERATURE
OUTPUT: ISC_PTP_MULT

FIG. 2

INPUT: CATALYST TEMPERATURE, LOAD
OUTPUT: PTP_MULT

FIG. 3