METHOD FOR THE CONTROL OF A SWITCHABLE WATER PUMP IN AN INTERNAL COMBUSTION ENGINE

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ABSTRACT
A method is provided for the control of a switchable water pump for a water cooling circuit in an internal combustion engine. The method includes, but is not limited to monitoring a parameter representative of the cylinder head temperature and, in case the temperature is below a predetermined value, perform at least an on-off cycle for the switchable water pump. The on-off cycle, includes, but is not limited to at least a first phase in which the water pump is switched OFF for a time period T1 and a second phase in which the water pump is switched ON for a time period T2.
FIG. 2
METHOD FOR THE CONTROL OF A SWITCHABLE WATER PUMP IN AN INTERNAL COMBUSTION ENGINE

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims priority to British Patent Application No. 0919561.1, filed Nov. 9, 2009, which is incorporated herein by reference in its entirety.

TECHNICAL FIELD

[0002] The technical field invention relates to a method for the control of a switchable water pump in an internal combustion engine.

BACKGROUND

[0003] In modern internal combustion engines cooling systems for the engine usually comprise a water pump and a suitable water cooling circuits. Such water pumps may be switchable water pumps, namely pumps that can be shut off in order to save energy and to warm up faster the engine. However, the following problems usually arise in the use of switchable water pumps: switching off the pump for a long time could lead to excessive temperatures in the cylinder head. Also switching off the pump for too long may lead to excessive NOx emissions if a water cooled EGR cooler is used. Finally, switching on the pump for too long may lead to excessive energy consumption.

[0004] At least one object of the invention is to devise a method for the control of a switchable water pump in an internal combustion engine that achieves an optimal compromise between low energy consumption and high motor performance. At least another object is to provide a control strategy for the switchable water pump without using complex devices and by taking advantage from the computational capabilities of the Electronic Control Unit (ECU) of the vehicle. At least another object of the present invention is to meet these goals by means of a simple, rational and inexpensive solution. In addition, other objects, desirable features, and characteristics will become apparent from the subsequent summary and detailed description, and the appended claims, taken in conjunction with the accompanying drawings and this background.

SUMMARY

[0005] A method is provided for the control of a switchable water pump for a water cooling circuit in an internal combustion engine. The method includes, but is not limited to monitoring a parameter representative of the cylinder head temperature and, in case the temperature is below a predetermined value, perform at least an on-off cycle for the switchable water pump, the on-off cycle comprising at least a first phase in which the water pump is switched OFF for a time period T1 and a second phase in which the water pump is switched ON for a time period T2. Preferably the OFF period T1 of the water pump is longer than the ON period T2 of the water pump. Preferably the ratio between time period T2 and time period T1 is inferior to 1/30. Also above a predetermined value of cylinder head temperature the switchable water pump is always ON.

[0006] The method can be realized in the form of a computer program comprising a program-code to carry out all the steps of the method of the invention and in the form of a computer program product comprising means for executing the computer program. The computer program product comprises, according to a preferred embodiment of the invention, a control apparatus for an IC engine, for example the ECU of the engine, in which the program is stored so that the control apparatus defines the invention in the same way as the method. In this case, when the control apparatus executes the computer program all the steps of the method according to the invention are carried out.

[0007] The method can be also realized in the form of an electromagnetic signal, said signal being modulated to carry a sequence of data bits which represent a computer program to carry out all steps of the method of the invention.

[0008] The invention further provides an internal combustion engine specially arranged for carrying out the method of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] The present invention will hereinafter be described in conjunction with the following viewing figures, wherein like numerals denote like elements, and:

[0010] FIG. 1 is an experimental graph concerning a comparison between the strategy of an embodiment of the present invention and other pump strategies on several motor parameters;

[0011] FIG. 2 is an experimental graph concerning the effect of the invention on NOx emissions and cumulative NOx emissions and also the effect of an embodiment of the invention on fuel consumption and cumulative fuel consumption.

DETAILED DESCRIPTION

[0012] The following detailed description is merely exemplary in nature and is not intended to limit application and uses. Furthermore, there is no intention to be bound by any theory presented in the preceding background or summary or the following detailed description.

[0013] The method for the control of a switchable water pump in an internal combustion engine comprises a phase in which the temperature of the cylinder head is monitored. If the temperature the cylinder head is below a predetermined value the switchable water pump is actuated upon for a series of on-off cycles, said cycles having at least a phase in which the water pump is switched OFF for a period T1 and a phase in which the water pump is switched ON for a period T2. Preferably the period T1 is longer than the period T2. It has been found beneficial to use OFF periods T1 that are substantially longer than ON periods T2.

[0014] More specifically, it has been found beneficial that the ratio between time period T2 and time period T1 is equal or inferior to 1/30. As an example, time period T2 in which the water pump is ON may be 2 seconds or less and time period T1 in which the water pump is OFF may be 60 seconds or more. Other time values may be used according to circumstances. Preferably, when the temperature of a cylinder head rises above a predetermined value the switchable water pump is always ON.

[0015] According to a preferred embodiment of the method the switchable water pump is always ON when the cylinder head temperature is at least above 80° C. The value of temperature mentioned is purely indicative, other predetermined values may be set according to circumstances. If, by effect of the continuous ON state of the switchable water pump, the
cylinder head temperature falls below said predetermined value, the OFF-ON phases of the pump may be repeated cyclically as explained above.

[0016] In an embodiment, the temperature of the cylinder head is monitored, but without departing from the inventive concepts hereby described, in the alternative it can be monitored a different motor parameter representative of the temperature. By using the switchable water pump control method of the invention the following results may be achieved.

[0017] As depicted in the experimental graph of FIG. 1, the cylinder head temperature reached with the method is very close to the one that is reached with the condition of water pump always ON. From the experimental graph of FIG. 2 it can be seen that the effect on NOx emissions and on cumulative NOx emissions is that these emissions are substantially at the same level with the condition of water pump always ON and inferior to the condition of water pump always OFF. Finally, from the same experimental graph of FIG. 2 it can be seen that fuel consumption using the inventive strategy of the methods is very close to fuel consumption when water pump is always OFF. These facts are very significant in terms of reduced fuel consumption.

[0018] An additional benefit of the invention is that the it can be performed using a simple on-off switchable water pump (SWP), without the request of residual water circulation when the switchable water pump is OFF to cool the cylinder head, avoiding increase of components costs. Finally, fuel economy in a New European Driving Cycle (NEDC), which is considered to represent the typical usage of a vehicle, has been measured using the method of the invention and is around 2%.

[0019] While at least one exemplary embodiment has been presented in the foregoing summary and detailed description, it should be appreciated that a vast number of variations exist. It should also be appreciated that the exemplary embodiment or exemplary embodiments are only examples, and are not intended to limit the scope, applicability, or configuration in any way. Rather, the foregoing summary and detailed description will provide those skilled in the art with a convenient road map for implementing an exemplary embodiment, it being understood that various changes may be made in the function and arrangement of elements described in an exemplary embodiment without departing from the scope set forth in the appended claims and their legal equivalents.

What is claimed is:

1. A method for control of a switchable water pump for a water cooling circuit in an internal combustion engine, comprising the steps of:
   - monitoring a parameter representative of a cylinder head temperature with a sensor;
   - performing at least an on-off cycle for the switchable water pump with a control apparatus if said cylinder head temperature is below a predetermined value, said on-off cycle comprising at least a first phase in which the switchable water pump is switched OFF for a time period T1 and a second phase in which the switchable water pump is switched ON for a time period T2.

2. The method according to claim 1, wherein the time period T1 is greater than the time period T2.

3. The method according to claim 1, wherein a ratio between a first length of the time period T2 and a second length of the time period T1 less then or equal to approximately 1/30.

4. The method according to claim 1, maintaining the switchable water pump in an ON state if the cylinder head temperature is above the predetermined value.

5. The method according to claim 4, wherein the predetermined value is at least approximately 80° C.

6. An internal combustion engine, comprising:
   - a sensor adapted to measure a cylinder head temperature; and
   - a control unit adapted to:
     - receive a parameter representative of the cylinder head temperature measured by the sensor; and
     - initiate at least an on-off cycle for a switchable water pump if said cylinder head temperature is below a predetermined value, said on-off cycle comprising at least a first phase in which the switchable water pump is switched OFF for a time period T1 and a second phase in which the switchable water pump is switched ON for a time period T2.

7. The internal combustion engine according to claim 6, wherein the time period T1 is greater than the time period T2.

8. The internal combustion engine according to claim 6, wherein a ratio between a first length of the time period T2 and a second length of the time period T1 less then or equal to approximately 1/30.

9. The internal combustion engine according to claim 6, maintaining the switchable water pump in an ON state if the cylinder head temperature is above the predetermined value.

10. The internal combustion engine according to claim 9, wherein the predetermined value is at least approximately 80° C.

11. The internal combustion engine according to claim 6, wherein the internal combustion engine is a diesel engine.

12. A computer readable medium embodying a computer program product, said computer program product comprising:
   - a program for control of a switchable water pump for a water cooling circuit in an internal combustion engine, the program configured to:
     - monitor a parameter representative of a cylinder head temperature with a sensor;
     - performing at least an on-off cycle for the switchable water pump if said cylinder head temperature is below a predetermined value, said on-off cycle comprising at least a first phase in which the switchable water pump is switched OFF for a time period T1 and a second phase in which the switchable water pump is switched ON for a time period T2.

13. The computer readable medium according to claim 12, wherein the time period T1 is greater than the time period T2.

14. The computer readable medium according to claim 12, wherein a ratio between a first length of the time period T2 and a second length of the time period T1 less then or equal to approximately 1/30.

15. The computer readable medium according to claim 12, the program further configured to maintain the switchable water pump in an ON state if the cylinder head temperature is above the predetermined value.

16. The computer readable medium according to claim 15, wherein the predetermined value is at least approximately 80° C.

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