Title of the Invention: **Improved tractive power at low speeds**

Abstract Title: **Method of operating an engine to reduce a heating effect on an engine coolant**

The method is for operating an internal combustion engine and comprising the steps of: determining a coolant temperature of an engine coolant of the engine 'S2'; comparing the coolant temperature with a predetermined threshold temperature 'S3'; and reducing a thermal input into the engine coolant by changing at least one operating parameter of the engine if the coolant temperature is higher than the predetermined threshold temperature. Ideally the at least one parameter is a charge pressure of charging air admitted to the engine, whereby the charging pressure is increased if the sensed charge air temperature 'S5' is lower than a maximum charge air temperature 'S6', 'S7'. If the charge air temperature exceeds the maximum charge air temperature then the charging pressure is not increased and the method is either repeated after a time delay or alternative measures for preventing overheating of the engine are taken such as reducing engine power. The method is particularly suitable for when vehicles are towing loads up a hill or incline where a load placed on the engine is high but there is reduced air flow over a cooling radiator of the engine.
Improved tractive power at low speeds

The invention relates to a method for operating an internal combustion engine, to an internal combustion engine which operates according to the method, and to a motor vehicle having such an internal combustion engine.

An internal combustion engine such as a combustion engine of a motor vehicle generates a considerable quantity of heat during operation, which heat has to be conducted away from the internal combustion engine so that the operating temperature of the internal combustion engine does not increase above a maximum permissible temperature. If the maximum permissible temperature is exceeded, the engine power of the internal combustion engine must be lowered or the internal combustion engine must be stopped completely. In order to conduct away the heat from the internal combustion engine, the internal combustion engine is cooled with an engine coolant. The engine coolant, frequently water, is for this purpose pumped in a closed circuit through lines in the wall of the internal combustion engine where it absorbs some of the operational heat and in the process heats up. The heated engine coolant is subsequently conducted through a radiator where it outputs the absorbed heat into the surroundings. The radiator is usually arranged in a motor vehicle in such a way that there is a flow of relative wind through it, which flow is heated in the process and outputs the excess heat in this way to the surroundings.

In this context there is a problem that the cooling power of the radiator is variable. The cooling power of the radiator is determined not only by the difference between the respective variable temperatures of the engine coolant and of the ambient air but, in particular, by the velocity of the motor vehicle and therefore by the air mass flow rate through the radiator. The slower a motor vehicle travels, the less air flows through the radiator and therefore the lower the cooling power thereof. If, despite the low speed, the motor vehicle travels under high load, for example when traveling uphill with a heavy cargo as a result of a trailer, the radiator can no longer conduct away
the operational heat which is produced, even with additional forced cooling by a radiator fan. This leads, as described above, to engine power having to be reduced or the internal combustion engine having to be stopped. As a result, the capability of the motor vehicle to move a heavy trailer load is thereby restricted.

The invention therefore has the object of disclosing a method and a device which permit a motor vehicle to move a larger trailer load.

The invention therefore discloses a method for operating an internal combustion engine. The method comprises at least the following steps:

- determining a coolant temperature of an engine coolant of the internal combustion engine;
- comparing the coolant temperature with a predetermined threshold temperature; and
- reducing a thermal input into the engine coolant by changing at least one operating parameter of the internal combustion engine if the coolant temperature is higher than the predetermined threshold temperature.

The invention has the advantage that the thermal input from the internal combustion engine into the engine coolant is reduced by virtue of the fact that the internal combustion engine is operated according to changed operating parameters. The at least one operating parameter is changed here in such a way that less heat is produced in the internal combustion engine, wherein the engine power of the internal combustion engine is maintained at least virtually without modification. The instantaneous engine power may fall or rise as a result of the change in the at least one operating parameter but this can be compensated by changing another operating parameter or by a control measure of a driver of the motor vehicle, with the result that the engine power remains approximately the same.
The thermal input into the engine coolant is preferably reduced by raising a charging pressure of the internal combustion engine. However, the raised charging pressure also results in raising of mass flow through the internal combustion engine since the combustion air is compressed to a greater degree and therefore a larger mass of air enters the internal combustion engine and correspondingly applies a greater cooling effect to the internal combustion engine. Therefore, when the charging pressure is raised the temperature of the exhaust gas is also lowered.

In this context, a charge air temperature of a charge air of the internal combustion engine is preferably determined and the raising of the charging pressure of the internal combustion engine is also carried out as a function of the charge air temperature. By determining the charge air temperature, it is possible to detect how far the charge air temperature is below a maximum desired charge air temperature. By compressing the sucked-in air, the temperature of the air is raised. Accordingly, the charge air temperature is also increased when the charging pressure of the internal combustion engine is raised. In order to avoid increasing the charge air temperature to an undesirably large degree, it is therefore advantageous to determine the charge air temperature and to carry out the raising of the charging pressure as a function of the determined charge air temperature.

In this context, a difference in charging pressure is determined as a function of the charge air temperature, and the charging pressure of the internal combustion engine is raised by the difference in charging pressure. The difference in charging pressure can be, for example, the difference between the maximum desired charge air temperature and the determined charge air temperature. The maximum desired charge air temperature can be a predetermined constant, but in other embodiments it can also depend on a requested engine power or a requested torque and on the rotational speed of the internal combustion engine. This is due to the knowledge that the maximum torque which an internal combustion engine can apply for a determined rotational speed depends on the charge air temperature and drops as the charge air temperature increases. The cause of this is the lower
density of the charge air and therefore the smaller mass of air passing into
the internal combustion engine per charge cycle owing to the relatively high
charge air temperature. Therefore, it may be the case that comparatively high
requested engine power levels or requested torque levels can only be made
available if the charge air temperature does not increase above a determined
charge air temperature, the maximum desired charge air temperature. In
such a case, the charging pressure should not be raised to such an extent
that the charge air temperature increases above the maximum desired
charge air temperature.

However, in particular the degree to which the charging pressure is raised
can also be determined as a function of the determined charge air
temperature. A first difference in charging pressure is preferably determined
for a first charge air temperature, and a second difference in charging
pressure is preferably determined for a second charge air temperature which
is higher than the first charge air temperature. The second difference in
charging pressure is smaller here than the first difference in charging
pressure. The difference in charging pressure can be, in particular,
proportional to a difference between the charge air temperature and the
maximum desired charge air temperature.

It is also possible to determine an instantaneous engine power of the internal
combustion engine. The at least one operating parameter of the internal
combustion engine is changed here only when the instantaneous engine
power of the internal combustion engine is greater than a threshold engine
load. This provides the advantage that the response of the internal
combustion engine is not changed if the instantaneous engine power is
relatively low. The threshold engine load is preferably selected here in such a
way that there is no risk of the internal combustion engine overheating
because of the low instantaneous engine power. The threshold engine load
can be determined as a function of an instantaneous cooling power of the
radiator. The instantaneous cooling power of the radiator can be derived, for
example, from the temperature of the surrounding air, the velocity and the
rotational speed of the fan, which together determine the air mass flow rate.
A second aspect of the invention relates to an internal combustion engine having a sensor for determining a coolant temperature of an engine coolant of the internal combustion engine, and a control unit which is connected to the sensor and has the purpose of controlling the internal combustion engine. In this context, the control unit is designed to carry out the method according to the invention.

A further aspect of the invention relates to a motor vehicle having such an internal combustion engine.

The invention will be described in more detail below on the basis of illustrations of exemplary embodiments, of which:

figure 1 shows an exemplary embodiment of a motor vehicle according to the invention; and

figure 2 shows an exemplary embodiment of a method according to the invention for operating an internal combustion engine.

Figure 1 shows an exemplary embodiment of a motor vehicle 1 according to the invention. The motor vehicle 1 is only partially shown in figure 1 and has an internal combustion engine 2 which drives the motor vehicle 1 and can have, for example, four cylinders 15. The internal combustion engine 2 can be embodied, for example, as a diesel engine of a known type and is cooled by an engine coolant which is fed through the internal combustion engine 2 and a radiator 3 from a coolant reservoir 4 by a coolant pump 5. In the process, the engine coolant heats up as it flows through the internal combustion engine 2 and outputs the absorbed heat again via the radiator 3. The arrangement of the specified components within the cooling circuit can be selected differently here. Furthermore, a sensor 6 is provided with which a coolant temperature of the engine coolant can be determined by measurement. However, the coolant temperature can also be determined
indirectly from one or more other measurement variables and by using mathematical models.

The combustion air for the internal combustion engine 2 is sucked in through an air filter 11 and compressed to a predefinable charging pressure by a compressor 9. The compressor 9 is driven here, for example, by an exhaust turbine 10, which is arranged in an exhaust gas flow of an exhaust manifold 8 and is connected to the compressor 9 by a shaft 14 to form a turbocharger. However, it is also conceivable to drive the compressor 9 directly by the internal combustion engine 2 or electrically. A charge air sensor 12, which measures a temperature of the charge air compressed by the compressor 9, can optionally be arranged in an intake manifold 7. The charge air temperature can, however, also be derived from a measurement of the ambient temperature, the charge air and, if appropriate, further measurement variables. The sensor 6 and the charge air sensor 12 are connected to a control unit 13 which also controls the internal combustion engine 2, wherein the control unit 13 carries out the method according to the invention, for example that in figure 2.

Figure 2 shows an exemplary embodiment for a method according to the invention for operating an internal combustion engine. The method starts in a step S1. In a step S2 a coolant temperature of an engine coolant of the internal combustion engine is subsequently determined. This can be done, for example, by measurement with a temperature sensor. In step S3 the determined coolant temperature is compared with a predetermined threshold temperature which can be, for example, 110 degrees Celsius. In the subsequent step S4 it is decided whether the determined coolant temperature is higher than the threshold temperature. If this is not the case, the system either returns to step S2, for example after a waiting time period or the method is ended until it is carried out again later. However, if the determined coolant temperature is higher than the threshold temperature, in step S5 a charge air temperature of a charge air of the internal combustion engine is determined and in step S6 it is compared with a maximum desired charge air temperature. In step S7 branching occurs as a function of a result
of the comparison. If the determined charge air temperature is lower than the maximum desired charge air temperature, the system continues with step S8 where a difference in charging pressure is determined. The difference in charging pressure can be, for example, proportional to a difference between the maximum desired charge air temperature and the determined charge air temperature. In step S9 the charging pressure of the internal combustion engine 2 is increased by the difference in charging pressure determined in this way, which can be carried out, for example, by correspondingly actuating the compressor, and the method is subsequently ended again or the system branches back to step S2 directly or after a waiting time period. In contrast, if it was detected in step S7 that the determined charge air temperature reaches or exceeds the maximum desired charge air temperature, the charging pressure is not increased. Instead it is possible, if appropriate after a waiting time period, to branch back to step S2 and the method to be aborted or alternative measures for avoiding overheating of the internal combustion engine to be taken. These alternative measures can comprise, for example, a reduction in the engine power of the internal combustion engine.

The invention has the advantage that overheating of the engine coolant under a large load when the cooling power is low can be prevented or at least delayed, with the result that a motor vehicle can, for example, tow a large trailer load for a relatively long time, as is the case when traveling uphill with the trailer at a low velocity and therefore when the cooling power is low.

Although the invention has been illustrated and described in detail by means of examples of preferred embodiments, the invention is not restricted by the disclosed examples. Variations of the invention can be derived by a person skilled in the art from the exemplary embodiments shown without departing from the scope of protection of the invention as defined in the claims.
List of reference numerals

1. Motor vehicle
2. Internal combustion engine
3. Radiator
4. Coolant reservoir
5. Coolant pump
6. Sensor
7. Intake manifold
8. Exhaust manifold
9. Compressor
10. Exhaust turbine
11. Air filter
12. Charge air sensor
13. Control unit
14. Shaft
15. Cylinder
Patent claims

1. A method for operating an internal combustion engine (2), comprising the steps:
   5 -- determining a coolant temperature of an engine coolant of the internal combustion engine (2);
   -- comparing the coolant temperature with a predetermined threshold temperature; and
   -- reducing a thermal input into the engine coolant by changing at least one
   10 operating parameter of the internal combustion engine (2) if the coolant temperature is higher than the predetermined threshold temperature.

2. The method as claimed in the preceding claim, in which the thermal input into the engine coolant is reduced by raising a charging pressure of the
   15 internal combustion engine (2).

3. The method as claimed in the preceding claim, in which a charge air temperature of a charge air of the internal combustion engine (2) is
   determined, and in which the raising of the charging pressure of the internal
   20 combustion engine is also carried out as a function of the charge air temperature.

4. The method as claimed in the preceding claim, in which a difference in charging pressure is determined as a function of the charge air temperature,
   and in which the charging pressure of the internal combustion engine (2) is
   25 raised by the difference in charging pressure.

5. The method as claimed in the preceding claim, in which a first difference in charging pressure is determined for a first charge air temperature, and a
   second difference in charging pressure is determined for a second charge air temperature which is higher than the first charge air temperature, wherein the
   30 second difference in charging pressure is smaller than the first difference in charging pressure.
6. The method as claimed in one of the preceding claims, in which an engine power of the internal combustion engine (2) is maintained without modification if the at least one operating parameter of the internal combustion engine (2) is changed.

7. The method as claimed in one of the preceding claims, in which an instantaneous engine power of the internal combustion engine (2) is determined, and in which the at least one operating parameter of the internal combustion engine (2) is changed only when the instantaneous engine power of the internal combustion engine (2) is greater than a threshold engine load.

8. An internal combustion engine (2) having a sensor (6) for determining a coolant temperature of an engine coolant of the internal combustion engine (2), and a control unit (13) which is connected to the sensor (6) and has the purpose of controlling the internal combustion engine (2), wherein the control unit (13) is designed to carry out the method as claimed in one of the preceding claims.

9. A motor vehicle (1) having an internal combustion engine (2) as claimed in the preceding claim.
Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

<table>
<thead>
<tr>
<th>Category</th>
<th>Relevant to claims</th>
<th>Identity of document and passage or figure of particular relevance</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>1-2, 6 and 8-9</td>
<td>US 2002/145053 A1 (FORD GLOBAL TECH INC) See paragraphs 0021-0036 and figure.</td>
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<td>X</td>
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<td>JP H0988702 A (TOYOTA MOTOR CORP) 31.03.97 (See EPDOC abstract and figure 1 noting reduction of fuel injection quantity to an internal combustion engine when a temperature sensed by a cooling water temperature sensor 114 exceeds a threshold temperature 'TTH').</td>
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<tr>
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<td>JP S5939942 A (TOYOTA MOTOR CO LTD) 05.03.84 (See EPDOC abstract and figure 1 noting reduction of fuel injection quantity to an internal combustion engine when a coolant temperature 'TC' reaches a reference temperature 'TR').</td>
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<tr>
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<td>1 and 8-9</td>
<td>GB 0931087 A (GRATZMULLER) See figure 13 and the passages spanning from line 123 of page 8 to line 96 of page 9.</td>
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<tr>
<td>A</td>
<td>-</td>
<td>US 2007/261648 A1 (FREIGHTLINER LLC) See whole document noting use of a fan to boost airflow over a radiator of a vehicle when a coolant temperature of an engine of the vehicle reaches a predetermined temperature nearing a maximum coolant temperature.</td>
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Categories:

| X | Document indicating lack of novelty or inventive step |
| Y | Document indicating lack of inventive step if combined with one or more other documents of same category. |
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| A | Document indicating technological background and/or state of the art. |
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| E | Patent document published on or after, but with priority date earlier than, the filing date of this application. |

Field of Search:
Search of GB, EP, WO & US patent documents classified in the following areas of the UKC:

[Table containing the search areas]
Worldwide search of patent documents classified in the following areas of the IPC

F01P; F02B; F02D

The following online and other databases have been used in the preparation of this search report

EPODOC, WPI, TXTE

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<thead>
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<th>Subclass</th>
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<td>01/01/2006</td>
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