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METHOD FOR COOLING AN ENDURANCE BRAKING ARRANGEMENT IN AN ELECTRIC VEHICLE

Abstract

The present disclosure relates to a method for cooling an endurance braking arrangement of an electric vehicle, the vehicle comprising an electrical power storage device and the endurance braking arrangement, the vehicle comprising a cabin and a fifth wheel for connection of a trailer to the vehicle, the cabin and the fifth wheel being located at an initial distance from each other; wherein the vehicle comprises a cooling system configured to receive cooling air from a position between the cabin and the fifth wheel for cooling the endurance braking arrangement of the vehicle wherein the method comprises arranging the cabin and the fifth wheel such that an increased distance between the cabin and the fifth wheel is obtained as compared to the initial distance for increasing air flow to the cooling system.

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Background/Summary

RELATED APPLICATIONS

[0001] The present application claims priority to European Patent Application No. 21180962.9, filed on Jun. 22, 2021, and entitled "METHOD FOR COOLING AN ENDURANCE BRAKING ARRANGEMENT IN AN ELECTRIC VEHICLE," which is incorporated herein by reference in its entirety.

FIELD OF THE DISCLOSURE

[0002] The present disclosure relates a method for cooling an endurance braking arrangement for an electric vehicle. Also, the disclosure relates to a method for endurance braking an electric vehicle. The disclosure also relates to a system, a computer program, a computer readable medium, and a control unit for implementing the methods, and to an electric vehicle.

BACKGROUND

[0003] Braking of vehicles, in particular heavy duty vehicles, in downhill slopes is necessary when performing transport missions. In increased braking demand situations, i.e. where frequent braking during a relatively long period of time is necessary, such as in terrain where there are long and/or frequent downhill slopes, use of the service brakes of the vehicle is generally to be avoided, because of the risk for overheating and/or wear of the service brakes.

[0004] Instead, endurance braking is preferred as the method for braking a vehicle in such increased braking demand situations.

[0005] For combustion engine vehicles, various endurance braking methods have been developed to deliver sufficient braking power to enable avoiding use of the service brakes in increased braking demand situations.

[0006] However, for electric vehicles, the availability of endurance braking is restricted.

[0007] Endurance braking in electric vehicles may comprise regenerative endurance braking and energy dissipating endurance braking.

[0008] Since the regenerative endurance braking in electric vehicles provides a regenerative braking force while charging the electric power storage device of the vehicle, the capacity for regenerative endurance braking may be dependent on e.g. the charge status of the electric power device. When the electric power device is completely charged or close to completely charged, regenerative endurance braking is no longer available.

[0009] Further, the energy dissipating endurance braking, wherein a braking force is provided while dissipating energy, is also restricted due to the risk of overheating the endurance braking arrangement. It may be noted that in combustion engine vehicles, heat dissipated while endurance braking may be removed via the exhaust pipe, a solution which is not available for electric vehicles.

[0010] In view of the above, there is a need for alternatives and/or improvements relating to endurance braking arrangements in electric vehicles, in particular as regards increased braking demand situations.

SUMMARY

[0011] An object of the invention is to provide an alternative and/or an improvement relating to

endurance braking arrangements in electrical vehicles, which may be useful in increased braking demand situations.

[0012] The object is achieved by a method for cooling an endurance braking arrangement. Thus, there is provided a method for cooling an endurance braking arrangement of an electric vehicle, the vehicle comprising an electrical power storage device and the endurance braking arrangement. The vehicle further comprises a cabin and a fifth wheel for connection of a trailer to the vehicle, the cabin and the fifth wheel being located at an initial distance from each other. The vehicle comprises a cooling system configured to receive cooling air from a position between the cabin and the fifth wheel for cooling the endurance braking arrangement of the vehicle. The method comprises [0013] arranging the cabin and the fifth wheel such that an increased distance between the cabin and the fifth wheel is obtained as compared to the initial distance for increasing air flow to the cooling system as compared to the initial distance.

[0014] The step of arranging the cabin and the fifth wheel such that an increased distance between the cabin and the fifth wheel is obtained implies that an air flow of cooling air to the cooling system receiving cooling air from a position between the cabin and the fifth wheel may be increased.

[0015] The electrical power storage device may be any electrical power storage device suitable for an electric vehicle. For example, the electrical power storage device may comprise a battery.

[0016] The endurance braking arrangement may be arranged to charge the electric power storage device during regenerative endurance braking and to dissipate energy during energy dissipating endurance braking.

[0017] Typically, the need for cooling of the endurance braking arrangement is increased during energy dissipating endurance braking.

[0018] Optionally, the cooling system comprises a cooling system portion. Such a cooling system portion may comprise a heat exchanger, located between the cabin and the fifth wheel. Thus, the heat exchanger may be arranged to receive cooling air from a position between the cabin and the fifth wheel for cooling the endurance braking arrangement of the vehicle.

[0019] Optionally, the step of arranging the cabin and the fifth wheel such that an increased distance between the cabin and the fifth wheel is obtained is performed upon determining a present or upcoming need for cooling of the endurance braking arrangement.

[0020] For example, an upcoming need for cooling of the endurance braking arrangement may be assumed in situations which requires endurance braking in such an extent that not only regenerative endurance braking is required, but also energy dissipating endurance braking. For example, this may be the case when the vehicle travels in a terrain involving several and/or long downhill slopes.

[0021] Optionally, the method may further comprise the subsequent step of:

[0022] arranging the cabin and the fifth wheel such that the initial distance is kept or arrived at upon determining that the increased need for cooling of the endurance braking arrangement no longer prevails. This implies that after the distance between the cabin and the fifth wheel has been increased upon determination of a present or upcoming need for cooling, the initial distance may be re-established upon determining that there is no longer an increased need for cooling.

[0023] Optionally, the need for cooling is determined based on the state-of-charge SOC of the electrical power storage device. This implies that the need for cooling may be coupled to the availability of generative endurance braking. Since generative endurance braking implies charging of the electrical power device, a relatively high state-of-charge SOC may indicate that only a limited amount of regenerative endurance braking is available, and that the endurance braking to be performed is energy dissipating endurance braking which might increase the need for cooling.

[0024] Optionally, the need for cooling is determined based on the state-of-charge SOC of the electrical power storage device being above a predetermined threshold.

[0025] Optionally, the need for cooling is determined based on the determination of current terrain or the estimation of upcoming terrain.

[0026] Optionally, the need for cooling is determined based on the determination or estimation of a downhill slope of the terrain of at least a predetermined inclination and/or duration.
[0027] Optionally, need for cooling is determined using historical data for increased need for cooling.
[0028] For example, historical data may be obtained from the vehicle or from other vehicles, e.g. on the same route.
[0029] Optionally, the need for cooling may be determined using static data, for example topographic data.
[0030] Optionally, the need for cooling is determined using real-time data, for example current or predicted weather situation data and/or current or predicted traffic situation data and/or current or predicted vehicle weight or load of the electric vehicle and/or configuration data indicative of the configuration of the electric vehicle.
[0031] Optionally, the increased distance between the cabin and the fifth wheel is achieved by moving the fifth wheel away from the cabin.
[0032] Optionally, the method comprises the step of raising the cabin and/or a chassis of the vehicle for increasing air flow to the cooling system.
[0033] This implies that the cabin and/or a chassis of the vehicle may be raised to further increase the air flow to the cooling system and hence to further increase the cooling of the endurance braking arrangement.
[0034] The raising of the cabin and/or chassis to increase air flow to the cooling system may be performed upon determining the increased need for cooling of the endurance braking arrangement.
[0035] Optionally, the method may comprise lowering the cabin and/or the chassis to decrease air flow to the cooling system upon determining that the increased need for cooling of the endurance braking arrangement no longer prevails.
[0036] Optionally, the cabin comprises one or more air deflectors and/or a trailer comprising one or more air deflectors is arranged to the vehicle, the method further comprising the step of controlling the air deflectors of the cabin and/or the air deflectors of the trailer to increase air flow to the cooling system.
[0037] This implies that the air deflectors may be used to further increase the air flow to the cooling system and hence to further increase the cooling of the endurance braking arrangement.
[0038] The control of the air deflectors to increase are flow to the cooling system may be performed upon determining the increased need for cooling of the endurance braking arrangement.
[0039] Optionally, the method may comprise controlling the air deflectors of the cabin and/or the air deflectors of the trailer to decrease air flow to the cooling system upon determining that the increased need for cooling of the endurance braking arrangement no longer prevails.
[0040] In a second aspect, the object is achieved by a method for endurance braking an electric vehicle. Thus, there is provided a method for endurance braking an electric vehicle the vehicle comprising an electrical power storage device and the endurance braking arrangement, the vehicle comprising a cabin and a fifth wheel for connection of a trailer to the vehicle, the cabin and the fifth wheel being located at an initial distance from each other; wherein the vehicle comprises a cooling system configured to receive cooling air from a position between the cabin and the fifth wheel for cooling the endurance braking arrangement of the vehicle; the endurance braking arrangement being adapted to provide a regenerative braking force while charging the electric power storage device and/or a energy dissipating braking force provided while dissipating energy from the endurance braking arrangement; the method comprising: [0041] determining a current or upcoming endurance braking need; [0042] performing the method for cooling the endurance braking arrangement of the vehicle in accordance with the first aspect of the present invention in response to determining that the available regenerative braking force is insufficient in view of said current or upcoming endurance braking need.
[0043] Optionally the method for endurance braking an electric vehicle may comprise [0044]

performing the step of determining a current or upcoming endurance braking need; [0045] endurance braking to provide a regenerative braking force while charging the electric power storage device; [0046] performing the method for cooling the endurance braking arrangement of the vehicle in accordance with the first aspect of the present invention in response to determining that the available regenerative braking force is insufficient in view of said current or upcoming endurance braking need, and [0047] initiating and/or continuing endurance braking to provide an energy dissipating braking force while dissipating energy from the endurance braking system.
[0048] In a third aspect, the object is achieved by a system for endurance braking of an electric vehicle. Thus, there is provided a system for endurance braking of an electric vehicle, the electric vehicle comprising an electrical power storage device, preferably a battery, and an endurance braking arrangement arranged to charge the electric power storage device during regenerative endurance braking, the vehicle comprising a cabin and a fifth wheel for connection of a trailer to the vehicle; and an actuator system enabling at least two different distances to be obtained between the cabin and the fifth wheel; wherein a cooling system configured to receive cooling air for cooling the endurance braking arrangement of the vehicle is arranged between the cabin and the fifth wheel;
[0049] the system being adapted to perform a method according to the first or second aspect in the above using the actuator system.
[0050] In a fourth aspect, the object is achieved by a computer program. Thus, there is provided a computer program comprising program code means for performing the steps of the method according to the first or second aspect of the invention when the program is run on a computer.
[0051] In a fifth aspect, the object is achieved by a computer readable medium. Thus, there is provided a computer readable medium carrying a computer program comprising program code means for performing the steps of the method according to the first of second aspect in the above when the program product is run on a computer.
[0052] In a sixth aspect, the object is achieved by a control unit. Thus, there is provided a control unit for controlling an endurance braking arrangement in a vehicle, the control unit being configured to perform the steps of the method according to the first or second aspect in the above.
[0053] In a seventh aspect, the object is achieved by an electric vehicle. Thus, there is provided an electric vehicle comprising an electrical power storage device and an endurance braking arrangement arranged to charge the electric power storage device during regenerative endurance braking, the vehicle comprising a cabin and a fifth wheel for connection of a trailer to the vehicle; and an actuator system enabling at least two different distances to be obtained between the cabin and the fifth wheel; wherein a cooling system configured to receive cooling air for cooling the endurance braking arrangement of the vehicle is arranged between the cabin and the fifth wheel; comprising or being operatively connected to a system in accordance with the third aspect in the above.
[0054] Features and advantages as described in relation to one of the aspects of the disclosure are equally applicable to the other aspects of the disclosure.
[0055] Further, although particularly useful for cooling an endurance braking arrangement in accordance with what is disclosed in the above, the method as disclosed herein may in other applications be used for cooling other vehicle arrangements than an endurance braking arrangement. Such vehicle arrangements could be in an electric vehicle, or in a combustion engine vehicle. Hence, there is provided a method for cooling a vehicle arrangement of a vehicle, the vehicle comprising the vehicle arrangement, the vehicle comprising a cabin and a fifth wheel for connection of a trailer to the vehicle, the cabin and the fifth wheel being located at an initial distance from each other; wherein the vehicle comprises a cooling system configured to receive cooling air from a position between the cabin and the fifth wheel for cooling the vehicle arrangement of the vehicle wherein the method comprises: [0056] arranging the cabin and the fifth wheel such that an increased distance between the cabin and the fifth wheel is obtained as

compared to the initial distance for increasing air flow to the cooling system as compared to the initial distance.
[0057] Arranging the cabin and the fifth wheel such that an increased distance between the cabin and the fifth wheel is obtained as recited above may be performed in response to the determination of a cooling need by said cooling system exceeding a predetermined cooling need threshold.
[0058] Features and advantages as described in relation to the disclosure in the above will be equally applicable to the application of the method for other vehicle arrangements than an endurance braking arrangement.
[0059] Further advantages and advantageous features of the invention are disclosed in the following description and in the dependent claims.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
[0060] With reference to the appended drawings, below follows a more detailed description of embodiments of the invention cited as examples.
[0061] In the drawings:
[0062] FIG. **1** schematically illustrates a variant of a vehicle as disclosed herein;
[0063] FIGS. **2***a* and **2***b* schematically illustrate a variant of a vehicle as disclosed herein, wherein the methods as disclosed herein are implemented;
[0064] FIG. **3***a* is a flow chart illustrating a variant of a method for cooling an endurance braking arrangement in a vehicle;
[0065] FIG. **3***b* is a flow chart illustrating another variant of a method for cooling an endurance braking arrangement in a vehicle; and
[0066] FIG. **4** illustrates a variant of a method for endurance braking a vehicle.
DETAILED DESCRIPTION
[0067] FIG. **1** illustrates a variant of an electric vehicle **1** as disclosed herein for which the methods as disclosed herein may be implemented.
[0068] The vehicle **1** comprises a cabin **30** and a fifth wheel **40** for connection of a trailer **80** to the vehicle. The illustrated vehicle **1** is a truck. It is understood that the disclosure is not limited to the particular vehicle **1** as illustrated, but could be any kind of vehicle **1** comprising a fifth wheel **40** for connection to any type of trailer **80**.
[0069] The vehicle **1** comprises an electrical power storage device **20**. The electrical power storage device **20** may be any electrical power storage device **20** suitable for a vehicle, for example, the electrical power storage device **20** may comprise one or more fuel cell. In another example, the electrical power storage device **20** may comprise one or more batteries. In another example, the electrical power storage device **20** may comprise one or more fuel cells and one or more batteries. In embodiments of the vehicle **1**, the electrical power storage device **20** may comprise at least one unit, such as a battery, being arranged to be charged during operation of the vehicle.
[0070] The vehicle **1** further comprises an endurance braking arrangement **10**. The endurance braking arrangement **10** may be configured to enable regenerative endurance braking during which the electrical power storage device is charged, and to enable energy dissipating endurance braking during which energy is dissipated, and the electrical power storage device is generally not charged.
[0071] The vehicle **1** further comprises cooling system **50** arranged for cooling the endurance braking arrangement **10** of the vehicle. To this end, the cooling system **50** is configured for receiving cooling air from a position between the cabin **30** and the fifth wheel **40**.
[0072] The cooling system **50** may be any kind of cooling system suitable for receiving cooling air and to use the cooling air for cooling the endurance braking arrangement **10**.
[0073] To this end, the cooling system **50** may comprise a cooling system portion, located between

the cabin **30** and the fifth wheel **40**. For example, the cooling system portion may comprise a heat exchanger.

[0074] Further, the vehicle **1** may comprise an actuator system **70** enabling at least two different distances to be obtained between the cabin **30** and the fifth wheel **40**. For example, the actuator system **70** may be a mechanic actuator system **70** (such as a screw actuator) or the actuator system **70** may be a hydraulic actuator system. Purely by way of example, the actuator system **70** may enable a variation, e.g. a stepped or stepless variation, of the distance between the cabin **30** and the fifth wheel **40**.

[0075] Also, the vehicle **1** may comprise or be operatively connected to a control unit **100** for controlling the actuator system **70** in accordance with the methods as described herein. The control unit **100** may be comprised in the vehicle, or the control unit may be remote from the vehicle. The control unit **100** may be arranged to receive and/or transmit signals to/from the endurance braking arrangement **10** and/or the actuator system **70**. The control unit **100** may be arranged to receive and/or transmit signals via wired or wireless connections.

[0076] Turning to FIG. **2***a*, a vehicle **1** such as the vehicle **1** described in relation to FIG. **1** is illustrated when connected to a trailer **8**. In FIG. **2***a*, the cabin **30** and the fifth wheel **40** are located at an initial distance dl from each other. The initial distance dl may be a standard distance of the vehicle **1**, i.e. a distance which is set to be suitable for most situations occurring under operation of the vehicle **1** when connected to a specific trailer **8**.

[0077] In accordance with a method for cooling the endurance braking arrangement **10** of a vehicle **1** as for example the vehicle **1** illustrated in FIGS. **2***a* and **2***b*, a method step **320** is performed comprising:

[0078] arranging the cabin **30** and the fifth wheel **40** such that an increased distance d**2** between the cabin **30** and the fifth wheel **40** is obtained as compared to the initial distance d**1** for increasing air flow to the cooling system **50** as compared to the initial distance d**1**.

[0079] Although the increased distance d**2** can be obtained by changing the distance between the cabin **30** and the fifth wheel **40** it is also envisaged that an increased distance between the cabin **30** and the trailer may be obtained in other ways. Purely by way of example, in embodiments of the present invention, the fifth wheel **40** may be such that it allows the distance between the cabin **30** and the trailer **8** to be changed without necessarily moving the position of the fifth wheel **40** relative to the cabin **30**. As a non-limiting example, the change of the distance between the cabin **30** and the trailer **8** may be achieved by allowing the fifth wheel **40** two have at least two connection points (not shown) at which the trailer connects to the fifth wheel **40** and the method for changing the distance between the cabin **30** and the trailer **8** may involve moving the connection point for the trailer **8**.

[0080] FIG. **2***b* illustrates as an example the vehicle **1** when the method step **320** has been performed, and thus the distance d**2** in FIG. **2***b* is increased as compared to the initial distance d**1** of FIG. **2***a*.

[0081] The increased distance d**2** between the fifth wheel **40** and the cabin **30** of the vehicle **1** results in an increased distance d**2** between the trailer **8** and the cabin **30**. Thus the free volume adjacent the position between the cabin **30** and the fifth wheel **40** where the cooling system **50** is configured to receive cooling air is increased, allowing for a greater air flow to the cooling system **50**.

[0082] With the increased distance d**2**, the turbulence and/or the air flow adjacent the position between the cabin **30** and the fifth wheel **40** and/or the trailer **8** where the cooling system **50** is configured to receive cooling air may bence be increased, resulting in an increased air flow to the cooling system **50** and increased cooling of the endurance braking arrangement **10**.

[0083] As exemplified in FIGS. **2***a* and **2***b*, the increased distance d**2** between the cabin **30** and the fifth wheel **40** is achieved by moving the fifth wheel **40** away from the cabin **30**.

[0084] For example, the increased distance d**2** may be achieved by moving the fifth wheel **40** away

from the cabin **30** along a longitudinal axis L of the vehicle corresponding to an intended direction of travel of the vehicle **1**. Purely by example, the increased distance d**2** may be achieved by moving the fifth wheel **40** away from the cabin **30** along essentially only the longitudinal axis L, i.e. the movement implies that the fifth wheel **40** is moved along a generally horizontal direction while remaining at a constant vertical level, as seen when the vehicle is on horizontal ground.

[0085] According to some variants, the method may, as in the example flow charts of FIGS. **3***a* and **3***b*, comprise a step **310** of determining a present or upcoming need for cooling of the endurance braking arrangement **10**. Thus, the step **320** of arranging the cabin **30** and the fifth wheel **40** such that an increased distance d**2** between the cabin **30** and the fifth wheel **40** is obtained is performed upon determining, i.e. in response to determining, a present or upcoming need for cooling of the endurance braking arrangement **10** (S**310**).

[0086] Further, according to some variants, the method may, as in the example flow charges of FIGS. **3***a* and **3***b*, comprise a subsequent step **5330** of arranging the cabin **30** and the fifth wheel **40** such that the initial distance d**1** is kept or arrived at upon determining that the increased need for cooling of the endurance braking arrangement **10** no longer prevails.

[0087] For example, the need for cooling may be determined based on the state-of-charge (SOC) of the electrical power storage device **20**.

[0088] For example, the need for cooling may be determined based on the state-of-charge SOC of the electrical power storage device **20** being above a predetermined threshold. As explained in the above, regenerative endurance braking is in an electrical vehicle generally restricted by the availability of the power storage device **20** to charge to take up braking energy. The predetermined threshold may be set to take the capacity of the power storage device **20** to charge to take up braking energy into account. Hence, purely as an example, the threshold may indicate a completely charged power storage device **20** or a close to completely charged power storage device.

[0089] When the power storage device **20** is unable to take up braking energy to charge the battery, endurance braking will be limited to dissipative endurance braking in which the braking energy is dissipated as heat in the endurance braking arrangement. Accordingly, it may be assumed that in this situation, a need for cooling is present.

[0090] As an alternative, or in addition to the above, in some variants the need for cooling may be determined based on the determination of current terrain or the estimation of upcoming terrain.

[0091] Purely as an example, current or upcoming terrain comprising frequent and/or relatively long downhill slopes may indicate a need for cooling, since such terrain generally requires increased endurance braking demand

[0092] For example, the need for cooling may be determined based on the determination or estimation of a downhill slope of the terrain of at least a predetermined inclination and/or duration. The predetermined inclination and/or predetermined duration of the downhill slope may be set depending on an estimated need for endurance braking.

[0093] As an alternative of in addition, the need for cooling may determined using historical data for increased need for cooling. Historical data may be obtained from the vehicle **1** and/or from other vehicles. Fore example, historical data may be obtained from the vehicle **1** and/or other vehicles travelling the same route.

[0094] Optionally, the need for cooling may determined using static data. With static data is meant data which is static at least for a period of time, such as for example topographic data.

[0095] Optionally, the need for cooling is determined using real-time data, for example current or predicted weather situation data and/or current or predicted traffic situation data and/or current or predicted vehicle weight or load of the electric vehicle and/or configuration data indicative of the configuration of the electric vehicle.

[0096] Static and/or real-time data may be retrieved from onboard or offboard databases and/or controllers.

[0097] In some variants, such as the one exemplified in FIG. **3***b*, the method may comprise a step

S**321** of raising the cabin **30** and/or a chassis of the vehicle **1** for increasing air flow to the cooling system (S**321**). This implies that the air flow and/or the turbulence adjacent the position between the cabin **30** and the fifth wheel **40** where the cooling system **50** is configured to receive cooling air may be further increased to increase the cooling of the endurance braking system **10**.
[0098] The step **321** of raising the cabin **20** and/or a chassis of the vehicle **1** may be performed simultaneously with the step **320** of providing an increased distance d**2** between the cabin **30** and the fifth wheel **40**, as illustrated in the chart of FIG. **3***b*.
[0099] Alternatively or in addition, the step **321** of raising the cabin **20** and/or a chassis of the vehicle **1** may be performed before and/or after the step **320** of providing an increased distance d**2** between the cabin **30** and the fifth wheel **40**.
[0100] The step S**321** of raising the cabin **30** and/or a chassis of the vehicle **1** for increasing air flow to the cooling system (S**321**) may be performed upon determining an increased need for cooling of the endurance braking arrangement **10**.
[0101] Optionally, and as illustrated in FIG. **3***b*, the method may further comprise a step **5331** of lowering the cabin and/or a chassis of the vehicle upon determining that the increased need for cooling no longer prevails.
[0102] In some variants, such as the one exemplified in FIG. **3***b*, when the cabin **30** comprises one or more air deflectors **60** (See FIGS. **1** to **2***b*) and/or a trailer **8** comprising one or more air deflectors **81** (See FIGS. **1** to **2***b*) is arranged to the vehicle **1**, the method further comprising the step **322** of controlling the air deflectors **60** of the cabin **30** and/or the air deflectors **81** of the trailer **8** to increase air flow to the cooling system **50**.
[0103] The step **321** step **322** of controlling the air deflectors **60** of the cabin **30** and/or the air deflectors **81** of the trailer **8** to increase air flow to the cooling system **50** may be performed simultaneously with the step **320** of providing an increased distance d**2** between the cabin **30** and the fifth wheel **40**, as illustrated in the chart of FIG. **3***b*.
[0104] Alternatively or in addition, step **322** of controlling the air deflectors **60** of the cabin **30** and/or the air deflectors **81** of the trailer **8** to increase air flow to the cooling system **50** may be performed before and/or after the step **320** of providing an increased distance d**2** between the cabin **30** and the fifth wheel **40**.
[0105] The step **322** of controlling the air deflectors **60** of the cabin **30** and/or the air deflectors **81** of the trailer **8** to increase air flow to the cooling system **50** may be performed upon determining an increased need for cooling of the endurance braking arrangement **10**.
[0106] Optionally, and as illustrated in FIG. **3***b*, the method may further comprise a step S**332** of controlling the air deflectors **60** of the cabin **30** and/or the air deflectors **81** of the trailer **8** to restore a standard position upon determining that the increased need for cooling no longer prevails.
[0107] In a second aspect of the disclosure there is provided a method for endurance braking an electric vehicle, using the method for cooling the endurance braking arrangement as described in the above. FIG. **4** is a flow chart of a variant of such a method for endurance braking an electric vehicle **1**.
[0108] As intimated in the above, the endurance braking arrangement **10** may be adapted to provide a regenerative braking force while charging the electric power storage device **20** and/or a energy dissipating braking force provided while dissipating energy from the endurance braking arrangement **10**. The method for endurance braking comprises: [0109] Determining a current or upcoming endurance braking need S**100**; [0110] Determining that the available regenerative braking force is insufficient in view of the current or upcoming endurance braking need S**200**; and [0111] Performing the method for cooling the endurance braking arrangement as disclosed in the above S**300**.
[0112] As such, the method for cooling the endurance braking arrangement is carried out in response to determining that the available regenerative braking force is insufficient in view of said current or upcoming endurance braking need in the above method.

[0113] Optionally, and as illustrated in FIG. **4**, the method for endurance braking an electric vehicle may be comprising: [0114] Performing the step of determining a current or upcoming endurance braking need S**100**; [0115] Endurance braking to provide a regenerative braking force while charging the electric power storage device S**150**; [0116] Performing the step of determining that the available regenerative braking force is insufficient in view of the current or upcoming endurance braking need S**200**; [0117] Performing the step of performing the method for cooling the endurance braking arrangement, and [0118] Continuing endurance braking to provide an energy dissipating braking force while dissipating energy from the endurance braking system **5400**.
[0119] Thus, the method for endurance braking an electric vehicle implies that increased cooling of the cooling arrangement **50** is obtained, allowing the endurance braking to continue by providing an energy dissipating braking force while diminishing the risk for overheating the endurance braking arrangement **10**.
[0120] The disclosure further relates to a control unit **100** for controlling an endurance braking arrangement in a vehicle. As intimated in the above description in relation to FIG. **1**, the control unit **100** may be method for cooling an endurance braking arrangement and/or the method for endurance braking an electric vehicle.
[0121] Other options and alternatives will be available to the person skilled in the art.

Claims

1. A method for cooling an endurance braking arrangement of an electric vehicle, the vehicle comprising: an electrical power storage device, the endurance braking arrangement, a cabin, and a fifth wheel for connection of a trailer to the vehicle, wherein the cabin and the fifth wheel are located at an initial distance from each other, wherein the vehicle comprises a cooling system configured to receive cooling air from a position between the cabin and the fifth wheel for cooling the endurance braking arrangement of the vehicle, and wherein the method comprises: arranging the cabin and the fifth wheel such that an increased distance between the cabin and the fifth wheel is obtained as compared to the initial distance for increasing air flow to the cooling system.
2. The method of claim 1, wherein the cooling system comprises a cooling system portion, preferably the cooling system portion comprising a heat exchanger, located between the cabin and the fifth wheel.
3. The method of claim 1, wherein the step of arranging the cabin and the fifth wheel such that an increased distance between the cabin and the fifth wheel is obtained is performed upon determining a present or upcoming need for cooling of the endurance braking arrangement.
4. The method of claim 3, further comprising the subsequent step of: arranging the cabin and the fifth wheel such that the initial distance is kept or arrived at upon determining that the increased need for cooling of the endurance braking arrangement no longer prevails.
5. The method of claim 3, wherein the need for cooling is determined based on the state-of-charge of the electrical power storage device.
6. The method of claim 3, wherein the need for cooling is determined based on the state-of-charge of the electrical power storage device being above a predetermined threshold.
7. The method of claim 3, wherein the need for cooling is determined based on the determination of current terrain or the estimation of upcoming terrain.
8. The method of claim 3, wherein the need for cooling is determined based on the determination or estimation of a downhill slope of the terrain of at least a predetermined inclination and/or duration.
9. The method of claim 3, wherein the need for cooling is determined using historical data for increased need for cooling.
10. The method of claim 3, wherein the need for cooling is determined using static data, for example topographic data.
11. The method of claim 3, wherein the need for cooling is determined using real-time data, for

example current or predicted weather situation data and/or current or predicted traffic situation data and/or current or predicted vehicle weight or load of the electric vehicle and/or configuration data indicative of the configuration of the electric vehicle.

12. The method of claim 1, wherein the increased distance between the cabin and the fifth wheel is achieved by moving the fifth wheel away from the cabin.

13. The method of claim 1, further comprising the step of raising the cabin and/or a chassis of the vehicle for increasing air flow to the cooling system.

14. The method of claim 1, wherein the cabin comprises one or more air deflectors and/or a trailer comprising one or more air deflectors is arranged to the vehicle, the method further comprising the step of: controlling the air deflectors of the cabin and/or the air deflectors of the trailer to increase air flow to the cooling system.

15. A method for endurance braking of an electric vehicle, the vehicle comprising: an electrical power storage device, the endurance braking arrangement, a cabin, and a fifth wheel for connection of a trailer to the vehicle, wherein the cabin and the fifth wheel are located at an initial distance from each other, wherein the vehicle comprises a cooling system configured to receive cooling air from a position between the cabin and the fifth wheel for cooling the endurance braking arrangement of the vehicle, and wherein the endurance braking arrangement is adapted to provide a regenerative braking force while charging the electric power storage device and/or an energy dissipating braking force provided while dissipating energy from the endurance braking arrangement, the method comprising: determining a current or upcoming endurance braking need, and performing the method for cooling the endurance braking arrangement of the vehicle in accordance with claim 1 in response to determining that the available regenerative braking force is insufficient in view of the current or upcoming endurance braking need.

16. The method of claim 15, the method further comprising: performing the step of determining a current or upcoming endurance braking need, endurance braking to provide a regenerative braking force while charging the electric power storage device, performing the method for cooling the endurance braking arrangement of the vehicle in response to determining that the available regenerative braking force is insufficient in view of the current or upcoming endurance braking need, and initiating and/or continuing endurance braking to provide an energy dissipating braking force while dissipating energy from the endurance braking system.

17. A system for endurance braking of an electric vehicle, the electric vehicle comprising: an electrical power storage device, an endurance braking arrangement arranged to charge the electric power storage device during regenerative endurance braking, a cabin, a fifth wheel for connection of a trailer to the vehicle, and an actuator system enabling at least two different distances to be obtained between the cabin and the fifth wheel, wherein a cooling system configured to receive cooling air for cooling the endurance braking arrangement of the vehicle is arranged between the cabin and the fifth wheel, and wherein the system is adapted to perform the method of claim 1 using the actuator system.

18. An electric vehicle comprising: an electrical power storage device, preferably a battery, and an endurance braking arrangement arranged to charge the electric power storage device during regenerative endurance braking, a cabin, a fifth wheel for connection of a trailer to the vehicle, and an actuator system enabling at least two different distances to be obtained between the cabin and the fifth wheel, wherein a cooling system configured to receive cooling air for cooling the endurance braking arrangement of the vehicle is arranged between the cabin and the fifth wheel, comprising or being operatively connected to a system in accordance with claim **17**.