

based on information recorded in a table in which a relation between the open voltage value and the power receiving rate SOC is shown, the storage battery control device 4 may be configured to obtain the charging rate SOC.

[0021]

5 In addition, the current voltage control unit 42 controls charging or discharging of the storage battery 3 in a mode using a constant voltage control mode (CV mode) when the overhead wire supply current value I detected by the ammeter 7 is greater than or equal to the first threshold and less than a second threshold. The constant voltage control mode is a mode of controlling charging or discharging of the storage battery 3 in
10 such a way that an output voltage of the storage battery control device 4 is maintained at a constant voltage. In the conventional overhead wire transportation system having no storage battery 3 or storage battery control device 4, the output voltage of the storage battery control device 4 is decreased when the overhead wire supply current value I is increased according to an increase in load. However, by performing the control in the
15 constant voltage control mode, even though the overhead wire supply current value I is increased, the output voltage of the storage battery control device 4 is maintained at a constant level.

[0022]

 In addition, the current voltage control unit 42 controls charging or discharging
20 of the storage battery 3 in a mode as the constant current control mode (CC mode) when the overhead wire supply current value I detected by the ammeter 7 is greater than or equal to the second threshold. The constant current control mode is a mode of controlling discharge of the storage battery 3 in such a way that the storage battery control device 4 is discharged at a constant value of a predetermined maximum current
25 value based on performance of the storage battery 3.

adjustment mode is narrowed, the time in which the charging rate of the storage battery 3 reaches the charging rate target value per unit time becomes more than a predetermined desired time.

Then, as the first threshold is lowered, the output voltage value of the storage
5 battery control device 4 in the constant current control mode is increased, and thus the current flowing into the vehicle can be controlled to be a smaller amount, which is effective in consideration of energy saving.

[0028]

In conducting such a process, in the storage battery control device 4 according to
10 the second embodiment, first, the mode determination unit 41 inputs the charging rate showed from the storage battery 3. The mode determination unit 41 records values of the respective charging rates input at predetermined time intervals according to a lapse of time in the memory unit or the like. Then, the mode determination unit 41 obtains an approximate straight line of the charging rates by a least-square method, in a coordinate
15 system showing a relation between the time and the charging rate for example, using the respective charging rates obtained a plurality of recent times.

Then, the mode determination unit 41 determines whether an extension line in a time elapse direction of the approximate straight line reaches the charging rate target value. Specifically, the determination unit 41 performs the determination such that
20 calculating whether the obtained approximate straight line crosses the straight line showing the charging rate target values after the time used to obtain the approximate straight line, and in a case where they crosses, determining the extension line of the approximate straight line coincides with the charging target value.

[0029]

CLAIMS

1. An overhead wire transportation system in which a vehicle travels by electric power obtained from an overhead wire connected to a transformer substation, the
5 overhead wire transportation system comprising:
a storage battery which stores the electric power obtained from the overhead wire; and
a storage battery control device which controls charging or discharging of the storage battery,
10 wherein the storage battery control device detects an overhead wire supply current value showing a sum of a current value output from the storage battery control device and a current value output from the transformer substation,
a control mode of the storage battery control device is set to a charging rate adjustment mode in which charging or discharging of the storage battery is controlled in
15 such a way that a charging rate of the storage battery becomes a charging rate target value when the detected overhead wire supply current value is less than a first threshold, and
the control mode of the storage battery control device is set to a constant voltage control mode in which charging or discharging of the storage battery is controlled in such
20 a way that an output voltage of the storage battery control device is maintained at a constant voltage when the detected overhead wire supply current value is greater than or equal to the first threshold.
2. The overhead wire transportation system according to Claim 1,

wherein the control mode of the storage battery control device is set to a constant current control mode in which discharge of the storage battery is controlled in such a way that the storage battery control device is discharged at a constant value of a predetermined maximum current value when the detected overhead wire supply current value is greater than or equal to a second threshold, the second threshold being a current value higher than the first threshold.

3. The overhead wire transportation system according to Claim 1 or 2,
wherein the storage battery control device detects the charging rate of the storage battery, and
the storage battery control device lowers the first threshold when a rate of change per unit time in a transition from the detected charging rate to the charging rate target value is greater than or equal to a predetermined threshold.
4. The overhead wire transportation system according to Claim 3,
wherein the storage battery control device raises the first threshold when a rate of change per unit time in the transition from the detected charging rate to the charging rate target value is less than the predetermined threshold.
5. The overhead wire transportation system according to any one of Claims 1 to 4,
wherein the second threshold is a value obtained by adding a maximum current value output from the storage battery control device to a current value shown by the first threshold.
6. The overhead wire transportation system according to any one of Claims 1 to 5,

wherein, in the constant voltage control mode, to control charging or discharging of the storage battery in such a way that an output voltage of the storage battery control device is maintained at a constant voltage,

the storage battery control device calculates a minimum overhead wire supply voltage value, which is obtained by adding a voltage drop value from the output voltage of the storage battery control device to an allowable minimum overhead wire voltage value applied to the vehicle, the voltage drop value being a value obtained at a position of the vehicle having allowable minimum overhead wire voltage value, and

the storage battery control device controls charging or discharging of the storage battery in such a way that the output voltage of the storage battery control device is maintained at a constant voltage which is more than the minimum overhead wire supply voltage value.

7. The overhead wire transportation system according to Claim 6,
15 wherein the first threshold equals to an overhead wire current value when the output voltage of the storage battery control device is the minimum overhead wire supply voltage value.

8. The overhead wire transportation system according to Claim 6 or 7,
20 wherein the first threshold equals to an overhead wire current value when the overhead wire voltage value applied to the vehicle at a position of the vehicle is the minimum overhead wire supply voltage value, which is not the allowable minimum overhead wire voltage value.

9. A control method of an overhead wire transportation system, in which a vehicle travels by electric power obtained from an overhead wire connected to a transformer substation, including a storage battery which stores the electric power obtained from the overhead wire; and a storage battery control device which controls charging or
5 discharging of the storage battery,

the control method of an overhead wire transportation system comprises the steps of:

detecting an overhead wire supply current value showing a sum of a current value output from the storage battery control device and a current value output from the
10 transformer substation in the storage battery control device; and

setting a control mode of the storage battery control device to a charging rate adjustment mode in which charging or discharging of the storage battery is controlled in such a way that a charging rate of the storage battery becomes a charging rate target value when the detected overhead wire supply current value is less than a first threshold
15 in the storage battery control device; and

setting the control mode of the storage battery control device to a constant voltage control mode in which charging or discharging of the storage battery is controlled in such a way that an output voltage of the storage battery control device is maintained at a constant voltage when the detected overhead wire supply current value is greater than
20 or equal to the first threshold in the storage battery control device.

based on information recorded in a table in which a relation between the open voltage value and the charging rate SOC is shown, the storage battery control device 4 may be configured to obtain the charging rate SOC.

[0021]

5 In addition, the current voltage control unit 42 controls charging or discharging of the storage battery 3 in a mode using a constant voltage control mode (CV mode) when the overhead wire supply current value I detected by the ammeter 7 is greater than or equal to the first threshold and less than a second threshold. The constant voltage control mode is a mode of controlling charging or discharging of the storage battery 3 in
10 such a way that an output voltage of the storage battery control device 4 is maintained at a constant voltage. In the conventional overhead wire transportation system having no storage battery 3 or storage battery control device 4, the output voltage of the storage battery control device 4 is decreased when the overhead wire supply current value I is increased according to an increase in load. However, by performing the control in the
15 constant voltage control mode, even though the overhead wire supply current value I is increased, the output voltage of the storage battery control device 4 is maintained at a constant level.

[0022]

 In addition, the current voltage control unit 42 controls charging or discharging
20 of the storage battery 3 in a mode as the constant current control mode (CC mode) when the overhead wire supply current value I detected by the ammeter 7 is greater than or equal to the second threshold. The constant current control mode is a mode of controlling discharge of the storage battery 3 in such a way that the storage battery control device 4 is discharged at a constant value of a predetermined maximum current
25 value based on performance of the storage battery 3.

adjustment mode is narrowed, the time in which the charging rate of the storage battery 3 reaches the charging rate target value per unit time becomes more than a predetermined desired time.

Then, as the first threshold is lowered, the output voltage value of the storage
5 battery control device 4 in the constant voltage control mode is increased, and thus the current flowing into the vehicle can be controlled to be a smaller amount, which is effective in consideration of energy saving.

[0028]

In conducting such a process, in the storage battery control device 4 according to
10 the second embodiment, first, the mode determination unit 41 inputs the charging rate showed from the storage battery 3. The mode determination unit 41 records values of the respective charging rates input at predetermined time intervals according to a lapse of time in the memory unit or the like. Then, the mode determination unit 41 obtains an approximate straight line of the charging rates by a least-square method, in a coordinate
15 system showing a relation between the time and the charging rate for example, using the respective charging rates obtained a plurality of recent times.

Then, the mode determination unit 41 determines whether an extension line in a time elapse direction of the approximate straight line reaches the charging rate target value. Specifically, the determination unit 41 performs the determination such that
20 calculating whether the obtained approximate straight line crosses the straight line showing the charging rate target values after the time used to obtain the approximate straight line, and in a case where they crosses, determining the extension line of the approximate straight line coincides with the charging target value.

[0029]

CLAIMS

1. An overhead wire transportation system in which a vehicle travels by electric power obtained from an overhead wire connected to a transformer substation, the overhead wire transportation system comprising:

a storage battery which stores the electric power obtained from the overhead wire; and
a storage battery control device which controls charging or discharging of the storage battery, wherein the storage battery control device detects an overhead wire supply current value showing a sum of a current value output from the storage battery control device and a current value output from the transformer substation,

a control mode of the storage battery control device is set to a charging rate adjustment mode in which charging or discharging of the storage battery is controlled in such a way that a charging rate of the storage battery becomes a charging rate target value when the detected overhead wire supply current value is less than a first threshold, and

the control mode of the storage battery control device is set to a constant voltage control mode in which charging or discharging of the storage battery is controlled in such a way that an output voltage of the storage battery control device is maintained at a constant voltage when the detected overhead wire supply current value is greater than or equal to the first threshold.

2. The overhead wire transportation system according to claim 1,

wherein the control mode of the storage battery control device is set to a constant current control mode in which discharge of the storage battery is controlled in such a way that the storage battery control device is discharged at a constant value of a predetermined maximum current value when the detected overhead wire supply current value is greater than or equal to a second threshold, the second threshold being a current value higher than the first threshold.

3. The overhead wire transportation system according to claim 1,

wherein the storage battery control device detects the charging rate of the storage battery, and the storage battery control device lowers the first threshold when a rate of change per unit time in a transition from the detected charging rate to the charging rate target value is greater than or equal to a predetermined threshold.

4. The overhead wire transportation system according to claim 3,

wherein the storage battery control device raises the first threshold when a rate of change per unit time in the transition from the detected charging rate to the charging rate target value is less than the predetermined threshold.

5. The overhead wire transportation system according to claim 1,
wherein the second threshold is a value obtained by adding a maximum current value output from the storage battery control device to a current value shown by the first threshold.
6. The overhead wire transportation system according to claim 1,
wherein, in the constant voltage control mode, to control charging or discharging of the storage battery in such a way that an output voltage of the storage battery control device is maintained at a constant voltage,
the storage battery control device calculates a minimum overhead wire supply voltage value, which is obtained by adding a voltage drop value from the output voltage of the storage battery control device to an allowable minimum overhead wire voltage value applied to the vehicle, the voltage drop value being a value obtained at a position of the vehicle having allowable minimum overhead wire voltage value, and
the storage battery control device controls charging or discharging of the storage battery in such a way that the output voltage of the storage battery control device is maintained at a constant voltage which is more than the minimum overhead wire supply voltage value.
7. The overhead wire transportation system according to claim 6,
wherein the first threshold equals to an overhead wire current value when the output voltage of the storage battery control device is the minimum overhead wire supply voltage value.
8. The overhead wire transportation system according to claim 6,
wherein the first threshold equals to an overhead wire current value when the overhead wire voltage value applied to the vehicle at a position of the vehicle is the minimum overhead wire supply voltage value, which is not the allowable minimum overhead wire voltage value.
9. A control method of an overhead wire transportation system, in which a vehicle travels by electric power obtained from an overhead wire connected to a transformer substation, including a storage battery which stores the electric power obtained from the overhead wire; and a storage battery control device which controls charging or discharging of the storage battery,
the control method of an overhead wire transportation system comprises the steps of:
detecting an overhead wire supply current value showing a sum of a current value output from the storage battery control device and a current value output from the transformer substation in the storage battery control device; and

setting a control mode of the storage battery control device to a charging rate adjustment mode in which charging or discharging of the storage battery is controlled in such a way that a charging rate of the storage battery becomes a charging rate target value when the detected overhead wire supply current value is less than a first threshold in the storage battery control device; and

setting the control mode of the storage battery control device to a constant voltage control mode in which charging or discharging of the storage battery is controlled in such a way that an output voltage of the storage battery control device is maintained at a constant voltage when the detected overhead wire supply current value is greater than or equal to the first threshold in the storage battery control device.