VEHICLE CHARGING SYSTEM

FIELD OF THE INVENTION

[0001]

The present invention relates to a vehicle charging system, especially a vehicle charging system capable of simultaneously charging a plurality of vehicles.

BACKGROUND OF THE INVENTION

[0002]

There has been a vehicle charging system that includes a plurality of chargers for charging vehicles mounted with storage batteries, such as automobiles (see JP-A No. 2007-66278, for example).

[0003]

By including a plurality of chargers as described above, the waiting time for charging could be reduced to correspond with an increasing number of electrical vehicles.

[0004]

However, when a plurality of vehicles are charged using the conventional system including a plurality of chargers, the total quantity of charging current may exceed a set value such as a demand value. In such cases, a priority order is decided according to the order of connection, and a vehicle with low priority must wait to be charged in some cases. Thus, efficient charging has not been possible.

SUMMARY OF THE INVENTION

[0005]

Therefore, in consideration of the problems, it is an object of the present invention to

provide a vehicle charging system that allows even a vehicle with low priority to begin to be charged without waiting, and furthermore, ensures that the total charging current does not exceed a predetermined value.

[0006]

In order to solve the above-described problem, a vehicle charging system according to a first aspect of the invention is provided. The vehicle charging system includes a plurality of chargers for charging vehicles, and a charge control device that controls the chargers. When a plurality of vehicles are connected to the chargers, the charge control device sets a priority order according to the order of connection and charges the vehicle with first priority at a predetermined first current value. Then, the charge control device charges the vehicles with second or lower priority at a smaller current value than the current value of the vehicle with the first priority. The charge control device sets an upper-limit value of a current usable for charging vehicles based on power information received from a system, controlling the total vehicle-charging current so that the total charging current has a smaller current value than the upper-limit value.

With the above configuration, the priority order of the vehicle charging is set according to the connected order. A vehicle whose charging has started the earliest is charged with the highest priority, and another vehicle whose charging has started later is also started to be charged. Thus, a user who started charging later is spared from feeling discomfort by the charging being delayed.

Further, since the total charging current is controlled not to exceed the set upper-limit value irrespective of the number of vehicles being charged, the total charging current can be controlled not to exceed a contracted power of commercial power, demand value, or breaker capacitance.

[0007]

In the vehicle charging system according to the second aspect of the invention, which is in the configuration recited in the first aspect, when a charged amount of the vehicle with the first priority reaches a predetermined power amount, the charge control device changes the priority order of the vehicle from the first to the lowest, and allows the vehicle with second priority to be assigned first priority to be charged at the first current value. A charging of a vehicle that has reached the predetermined power amount and has not reached full charge is continued at a smaller current value than a charging current used for a vehicle whose charged amount has not reached the predetermined power amount.

With the configuration, since the charging of a vehicle whose charged amount has not reached the predetermined power amount is prioritized, the charging can reach the predetermined power amount in a short time. Further, since the charging continues even after the charged amount reaches the predetermined power amount, the charging can be continued until full charge.

Note that, the predetermined power amount is, for example, a power amount that allows a vehicle to run for a certain distance.

[0008]

In the vehicle charging system according to the third aspect of the invention, which is in the configuration recited in the first or the second aspect, when the charged amount of every vehicle to be charged reaches the predetermined power amount, the upper-limit value is equally divided to continue charging the respective vehicles.

With the configuration, when the charged amount of every vehicle being charged reaches the predetermined power amount, the priority order ceases to exist, and the current of the upper-limit value is equally distributed to continue the charging. Therefore, the power usable for the charging is effectively available, and even a vehicle with low priority can reach full charge.

[0009]

According to the fourth aspect of the invention, there is provided a vehicle charging system including a plurality of chargers and a charge control device that controls the chargers. The charge control device sets an upper-limit value of a current that is usable for vehicle charging based on received power information from a system. When there are a plurality of vehicles connected to the chargers whose charged amounts have not reached a predetermined power amount, the charge control device divides the upper-limit value for the plurality of vehicles, and charges the respective vehicles at the same current value.

With the above configuration, since a vehicle whose charging has started later and has not reached the predetermined power amount is charged at the same current as the other vehicles, a user who started charging later is spared from feeling discomfort by the charging being delayed.

Further, since a total charging current is controlled not to exceed the upper-limit value even when the number of vehicles being charged increases, the total charging current can be controlled not to exceed a contracted current of commercial power, demand value, or breaker capacitance.

[0010]

With the present invention, when the charging is controlled based on the priority order, since a vehicle whose charging has started the earliest is charged with the highest priority and a vehicle whose charging has started later is also beginning the charge, a user who started charging later is spared from feeling discomfort by the charging being delayed.

When charging with equal powers without setting a priority order, since a vehicle whose charging has started later is charged with the same current as the other vehicles, a user who started charging later is spared from feeling discomfort by the charging being delayed.

Further, since the total charging current is controlled not to exceed the upper-limit

value regardless of a charging form or an increase in the number of vehicles being charged, the total charging current can be controlled not to exceed a contracted power of commercial power, demand value, or breaker capacitance.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011]

FIG. 1 is a configuration diagram illustrating an exemplary vehicle charging system of the present invention.

FIG. 2 is a block diagram of a charge control device.

FIG. 3 is a flowchart illustrating a procedure of the charge control.

FIG. 4 is a flowchart illustrating a procedure of the charge control.

FIG. 5 is a table diagram illustrating a relation between a priority order and a charging current in case of a rotational charge control.

FIG. 6 is a flowchart illustrating a procedure of an equal charge control.

DETAILED DESCRIPTION OF THE INVENTION

[0012]

The following describes embodiments of the present invention in detail with reference to the drawings. Fig. 1 is a configuration diagram illustrating an exemplary vehicle charging system according to the present invention. As illustrated in Fig. 1, the vehicle charging system includes a plurality of chargers (a charger) 1, and a charge control device 2 that controls the individual chargers 1. Further, reference numeral 3 denotes a commercial power source that is a received power from a system, reference numeral 4 denotes an energy meter including a smart meter, 5 indicates a switch including a breaker that opens and closes an electric circuit L, reference numeral 6 denotes a chargeable vehicle, such as an EV, and

reference numeral 7 denotes a load that receives power from the commercial power source 3 other than the chargers 1.

The charge control device 2 is connected to the energy meter 4 via a communication line L1. Each of the charger 1 receives power supplied from the commercial power source 3, and is connected to the charge control device 2 via a communication line L2.

[0013]

Fig. 2 is a block diagram illustrating the charge control device 2. The charge control device 2 includes a first communication unit 21 that obtains power information (current information) from the energy meter 4 via the communication line L1, a plurality of second communication units 22 communicating with the individual chargers 1 via the communication lines L2, a storage unit 23 storing an upper-limit value described later and the like, an operation unit 24 that sets a charge control method, a charge control device CPU 25 that controls the chargers 1 and the charge control device 2, and the like.

[0014]

Note that, an upper-limit value is a maximum value of a current usable for vehicle charging, and is a current value set to prevent or reduce a received power from exceeding a set maximum power such as a demand value. The current value is subjected to change according to the power supplied to another load 7.

[0015]

The vehicle charging system thus configured operates as follows. First, a charging method is set by the operation of the operation unit 24. The charging method includes a rotational charging method that prioritizes a charging of a vehicle 6 whose charging has started first, an equal charging method that does not depend on a charge start order, and the like.

For example, when the rotational charging method is set, the vehicle charging system

operates as follows. In the following description, it is assumed that, in the power facility, the largest current value usable for the vehicle charging is the upper-limit value, a current value suppliable to one of the vehicles 6 is the maximum current set value (first current value), the smallest current value set for charging per vehicle is the minimum current set value, and a charged amount that enables running a predetermined distance, such as 20 km, is a predetermined power amount (which is also referred as predetermined value or predetermined amount).

[0016]

The upper-limit value is a value affected by a power supplied to the load 7, and the maximum value of a current that is usable for the vehicle charging is calculated by the charge control device CPU 25 based on the received power information from the energy meter 4 and is set. Further, the first current value is set to be, for example, 30 amperes, and is changed according to a fluctuation of the upper-limit value. Meanwhile, the predetermined value is calculated according to the running distance of the vehicle 6 per unit amount of power, and is calculated by the charge control device CPU 25, for example, when the charger 1 is connected and information is obtained from the vehicle 6.

[0017]

Figs. 3 and 4 are flowcharts illustrating the procedure of the rotational charge control, and the rotational charge control is described with reference to the flowcharts. Since rotational charging is for controlling a case including a plurality of vehicles being charged, a charge control for a single vehicle is omitted here.

When a plurality of the vehicles 6 are connected to the chargers 1, the charging starts according to the control of the charge control device CPU 25. First, it is calculated whether or not a current obtained by subtracting the first current value from the set upper-limit value is larger than the minimum current set value (S11).

In the above calculation, when a current larger than the minimum current set value is determined to be suppliable (YES in S11), first, the vehicle with the first priority (S12 in YES) is charged at the first current value (S13). To each vehicle 6 with the second or lower priority (NO in S12) whose charged amount has not reached a predetermined amount (YES in S14), the remaining current obtained by subtracting the first current value from the upper-limit value is distributed (S15).

[0018]

Meanwhile, among the vehicles whose charged amount have reached the predetermined amount (NO in S14), a vehicle 6 that has reached full charge (YES in S16) is removed from the priority order and its charging is stopped (S17). Further, a vehicle 6 whose charged amount has reached the predetermined amount and has not reached full charge is assigned the lowest priority and, when the remaining current obtained by subtracting the supplied power to a vehicle 6 whose charged amount has not reached the predetermined amount from the upper-limit value (defined as a "difference from the upper-limit value") is equal to or larger than the minimum current set value (YES in S18), the vehicle 6 whose charged amount has reached the predetermined amount and has not reached full charge is charged using the difference from the upper-limit value (S19). When the difference from the upper-limit value is smaller than the minimum current set value, vehicle 6 whose charged amount has reached the predetermined amount is not provided with the charging current and the charging is stopped (S20).

[0019]

Next, a case is described where the remaining current obtained by subtracting the first current value from the suppliable current is equal to or below the minimum current set value (NO in S11). In this case, the vehicle 6 with the first priority (YES in S21) is provided with the current remaining after subtracting from the upper-limit value the total amount of current

used for supplying all the vehicles needing to be charged with the minimum current set value (S22).

A vehicle 6 with the second or lower priority (NO in S21) whose charged amount has not reached the predetermined amount (YES in S23) is charged with the minimum current set value (S24).

[0020]

Meanwhile, among the vehicles 6 that have been charged up to or more than the predetermined amount (NO in S23), the charging of a vehicle that has reached full charge (YES in S25) is stopped (S26).

For a vehicle 6 that has not reached full charge, the difference from the upper-limit value is compared with the minimum current set value (S27), and when the difference from the upper-limit value is equal to or larger than the minimum current set value (YES in S27), the vehicle 6 that has not reached full charge is charged using the current of the difference from the upper-limit value (S28). On the other hand, when the difference from the upper-limit value is smaller than the minimum current set value (NO in S27), the charging current is not supplied and the charging is terminated(S29). Thus, rotational charging is performed.

[0021]

Fig. 5 is a table diagram illustrating a relation between the priority order and the charging current of the rotational charge control in detail, and the relation is described with reference to the table. Here, it is described a case where the upper-limit value is 50 A, the maximum current set value (first current value) is 30 A, the minimum current set value as the minimum current value is 6 A, and four of the vehicles 6 are connected to the chargers 1.

When all four of the vehicles 6 have not reached the predetermined power amount, the first vehicle 6 with the first priority is started to be charged at 30 A while the other three of the vehicles 6 are charged at a current subtracting 30 A from 50 A and equally dividing the

remaining 20 A into three (approximately 6 A).

[0022]

As a result of continuing the charging, when the first vehicle is charged up to the predetermined power amount, the priority order is changed and the second vehicle 6 is assigned the first priority for starting the charging at 30 A. The third and fourth vehicles 6 are charged at 10 A by equally dividing the remaining 20 A into two while the charging of a vehicle 6 that has reached the predetermined power amount is stopped.

Here, while the charging of the first vehicle 6 that has reached the predetermined power amount is stopped, when the charging currents of the third and fourth vehicles 6 are 6 A instead of 10 A, the charging of the first vehicle also continues at 6 A.

[0023]

Subsequently, when the charged amount of the second vehicle reaches the predetermined power amount, the third vehicle is assigned the first priority for starting the charging at 30 A, and the fourth vehicle is charged at 20 A. The charging of the first and second vehicles are stopped.

Even in this case, when the charging current of the fourth vehicle is 6 A, the first and second vehicles can continue to be charged at 6 A.

[0024]

When the charged amount of the third vehicle reaches the predetermined power amount, the fourth vehicle is assigned the first priority to be charged at 30 A. In this case, since none of the vehicles 6 are assigned with the second priority, the first to third vehicles are equally charged at 6 A.

When the charged amount of every vehicle 6 reaches the predetermined power amount, the upper-limit value of 50 A is equally distributed, and the charging of every vehicle 6 is continued at 12 A until being stopped when reaching full charge.

[0025]

Thus, the priority order of the vehicle charging is set according to the order of connection. A vehicle 6 whose charging has started the earliest is charged with the highest priority, and charge is beginning for even a vehicle 6 whose charging started later. Thus, a user who started charging later is spared from feeling discomfort from the charging being delayed.

Moreover, since the total charging current is controlled not to exceed the upper-limit value regardless of the number of the vehicles 6 being charged, the total charging current can be controlled not to exceed a contracted current of commercial power, demand value, or breaker capacitance.

Further, since the charging of the vehicle 6 whose charged amount has not reached the predetermined power amount is prioritized, the charging can reach the predetermined power amount in a short time, and since the charging continues even after the charged amount reaches the predetermined power amount, the charging can be continued until full charge.

In addition, since the priority order ceases to exist when the charged amount of every vehicle 6 being charged reaches the predetermined power amount, and the current of the upper-limit value is equally distributed to continue with the charging, the power usable for charging is efficiently available, and even a vehicle with low priority can reach full charge.

[0026]

Fig. 6 is a flowchart illustrating the procedure of another charge control. Fig. 6 illustrates a procedure of performing a charge control without assigning priority orders to the vehicles 6. A charge control of a single vehicle is omitted here, and a charge control for a case involving a plurality of vehicles is described.

A vehicle 6 whose charged amount has not reached the predetermined amount (YES in S31) is charged by equally distributing the upper-limit value to each vehicle 6 whose

charged amount has not reached the predetermined amount (S32).

Among the vehicles 6 whose charged amount have reached the predetermined amount (NO in S31), the charging of a vehicle 6 that has reached full charge (YES in S33) is stopped (S34), and a vehicle 6 that has not reached full charge (NO in S33) is charged at a difference from the upper-limit value (S36) when the difference from the upper-limit value is larger than the minimum current set value (YES in S35).

When the difference from the upper-limit value does not reach the minimum current set value (NO in S35), the procedure is terminated without charging (S37).

[0027]

Thus, since a vehicle 6 whose charging has started later is charged at the same current as the other vehicles 6 if the charging has not reached the predetermined charged amount, a user who started charging later is spared from feeling discomfort by the charging being delayed.

Since the total charging current is controlled not to exceed the upper-limit value regardless of the number of the vehicles 6 being charged, the total charging current can be controlled not to exceed a contracted current of commercial power, demand value, or breaker capacitance.

[0028]

While in the above-described embodiment, the predetermined power amount is set according to the information obtained from the vehicles 6 being charged, the predetermined power amount may be set uniformly regardless of the information obtained from the vehicles 6.

REFERENCE SIGNS LIST

[0051]

1... Charger

2... Charge control device

6... Vehicle

23... Storage unit

25... Charge control device CPU

CLAIMS

1. A vehicle charging system comprising:

a plurality of chargers; and

a charge control device that controls the chargers, wherein

the charge control device sets an upper-limit value of a current that is usable for vehicle charging based on received power information from a system, and when a plurality of vehicles are connected to the chargers whose charged amounts have not reached a predetermined power amount, the charge control device divides the upper-limit value for the plurality of vehicles , and charges the respective vehicles at the same current value.