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(54) **METHOD AND SYSTEM FOR DETERMINING SULFUR POISONING STATE OF SELECTIVELY CATALYTIC REDUCTION DEVICE**

VERFAHREN UND VORRICHTUNG ZUR BESTIMMUNG DER SCHWEFELVERGIFTUNG EINES SCR KATALYSATORS

MÉTHODE ET SYSTÈME POUR LA DÉTERMINATION DE L'EMPOISONNEMENT AU SOUFRE D'UN CATALYSEUR SCR.

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(56) References cited:
EP-A1- 2 770 178
WO-A1-2018/132059
CN-A- 109 707 494
US-A1- 2014 331 644
US-A1- 2017 167 352
US-B1- 9 856 773

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Description

FIELD

[0001] The present disclosure relates to the technical field of vehicle post-treatment, and in particular to a method and a system for determining a sulfur poisoning state of a SCR device.

BACKGROUND

[0002] A selective catalytic reduction (SCR) device is used to perform treatment for processing nitrogen oxides (NOx) in diesel vehicle exhaust gas, which is to inject reducing agent of ammonia or urea to reduce the NOx in the exhaust gas into nitrogen and water under the action of catalyst.

[0003] The copper based SCR, which has a good low-temperature performance, is widely used in SCR systems in the current market. However, the copper based SCR may have a serious sulfur poisoning problem, which may seriously decrease the efficiency of reducing NOx. Therefore, in practices, it is required to monitor the sulfur poisoning state of the copper based SCR and perform desulfurization regularly.

[0004] Currently, whether a vehicle post-treatment system is in a sulfur poisoning state is determined according to the deterioration of a light-off characteristic of a Diesel Oxidation Catalyzator (DOC), and a diesel particulate filter (DPF) regeneration method is used for recovery. Such a method is disclosed in the publication WO2018/132059A1. These methods however result in a low accuracy of determining the sulfur poisoning state of the vehicle post-treatment system.

SUMMARY

[0005] To solve the above technical problem, a method and a system for determining a sulfur poisoning state of an SCR device are provided according to the present disclosure to realize the purpose of improving the accuracy of determining a sulfur poisoning state of a SCR device.

[0006] To achieve the above objectives, the following technical solutions are provided according to the embodiment of the present disclosure.

[0007] A method for determining a sulfur poisoning state of a selective catalytic reduction (SCR) device of a vehicle post-treatment system is provided. The vehicle post-treatment system includes the SCR device and a urea injector. The method includes:

> determining whether the SCR device and the urea injector meet a predetermined triggering condition; if it is determined that the SCR device and the urea injector meet the predetermined triggering condition, controlling the urea injector to stop urea injection; and detecting a first actual reduction efficiency of the SCR device after the urea injection is stopped and calculating accumulated consumption amount of stored ammonia for a first predetermined time period after the urea injection is stopped; and
>
> determining whether the first actual reduction efficiency of the SCR device is less than a first predetermined efficiency value, and whether the accumulated consumption amount of stored ammonia is less than or equal to a consumption limit value; if it is determined that the first actual reduction efficiency of the SCR device is less than the first predetermined efficiency value and the accumulated consumption amount of stored ammonia is less than or equal to the consumption limit value, monitoring a low-temperature efficiency of the SCR device; if it is determined that the first actual reduction efficiency of the SCR device is not less than the first predetermined efficiency value, or the accumulated consumption amount of stored ammonia is greater than the consumption limit value, returning to the step of determining whether the SCR device and the urea injector meet the predetermined triggering condition.

[0008] The determining whether the SCR device and the urea injector meet a predetermined triggering condition includes: monitoring a reduction efficiency of the SCR device in a first predetermined temperature range and a concentration of urea in the urea injector; and determining that the SCR device and the urea injector meet the predetermined triggering condition when the reduction efficiency of the SCR device in the first predetermined temperature range is less than a second predetermined efficiency and the concentration of urea is in a predetermined concentration range.

[0009] The monitoring a low-temperature efficiency of the SCR device includes:

> controlling the urea injector to perform urea injection with a fixed ammonia-nitrogen mole ratio, and monitoring a second actual reduction efficiency of the SCR device in a second predetermined temperature range;
>
> determining, in a state that the second actual reduction efficiency of the SCR device, an ammonia storage setting value and an ammonia storage value calculated by an ammonia storage model are all stable, whether a difference value between a theoretical reduction efficiency of the SCR device and the second actual reduction efficiency is greater than a difference threshold value; and
>
> determining that the SCR device is in the sulfur poisoning state if the difference value between the theoretical reduction efficiency of the SCR device and the second actual reduction efficiency is greater than the difference threshold value.

[0010] In some embodiment, the calculating accumulated consumption amount of stored ammonia for a first predetermined time period after the urea injection is stopped includes:

integrating a nitrogen oxides (NOx) mass flow in upstream gas of the SCR device for the first predetermined time period to determine a first integral value;
integrating a NOx mass flow in downstream gas of the SCR device for the first predetermined time period to determine a second integral value; and
multiplying a value of the first integral value minus the second integral value by a molar mass ratio of ammonia to nitrogen oxide in reaction, to determine the accumulated consumption amount of stored ammonia for the first predetermined time period after the urea injection is stopped.

[0011] In some embodiments, the predetermined concentration range is 32.5%±2.5%.

[0012] In some embodiments, after determining that the SCR device is in the sulfur poisoning state, the method further includes sending a stationary regeneration request.

[0013] In some embodiments, the consumption limit value is determined according to an aging factor and an average temperature of the SCR device.

[0014] A system for determining a sulfur poisoning state of a selective catalytic reduction (SCR) device of a vehicle post-treatment system, where the vehicle post-treatment system includes the SCR device and a urea injector, and the system for determining the sulfur poisoning state includes:

an trigger determining module, configured to determine whether the SCR device and the urea injector meet a predetermined triggering condition, and trigger an ammonia storage determination module if it is determined that the SCR device and the urea injector meet the predetermined triggering condition;
the ammonia storage determination module, configured to: control the urea injector to stop urea injection; detect a first actual reduction efficiency of the SCR device after the urea injection is stopped and calculate accumulated consumption amount of stored ammonia for a first predetermined time period after the urea injection is stopped; determine whether the first actual reduction efficiency of the SCR device is less than a first predetermined efficiency value, and whether the accumulated consumption amount of stored ammonia is less than or equal to a consumption limit value; trigger a low-temperature efficiency monitoring module if it is determined that the first actual reduction efficiency of the SCR device is less than the first predetermined efficiency value and the accumulated consumption amount of stored ammonia is less than or equal to the consumption limit value; and trigger the trigger determining module, if it is determined that the first actual reduction efficiency of the SCR device is not less than the first predetermined efficiency value, or the accumulated consumption amount of stored ammonia is greater than the consumption limit value; and
the low-temperature efficiency monitoring module, configured to monitor a low-temperature efficiency of the SCR device by controlling the urea injector to perform urea injection with a fixed ammonia-nitrogen mole ratio, and monitoring a second actual reduction efficiency of the SCR device in a second predetermined temperature range; determining, in a state that the second actual reduction efficiency of the SCR device, an ammonia storage setting value and an ammonia storage value calculated by an ammonia storage model are all stable, whether a difference value between a theoretical reduction efficiency of the SCR device and the second actual reduction efficiency is greater than a difference threshold value; and determining that the SCR device is in the sulfur poisoning state if the difference value between the theoretical reduction efficiency of the SCR device and the second actual reduction efficiency is greater than the difference threshold value;
where the trigger determining module is configured to determine whether the SCR device and the urea injector meet the predetermined triggering condition by: monitoring a reduction efficiency of the SCR device in a first predetermined temperature range and a concentration of urea in the urea injector; and determining that the SCR device and the urea injector meet the predetermined triggering condition, when the reduction efficiency of the SCR device in the first predetermined temperature range is less than a second predetermined efficiency and the concentration of urea is in a predetermined concentration range.

[0015] In some embodiments, the ammonia storage determination module is configured to:

integrate a nitrogen oxides (NOx) mass flow in upstream gas of the SCR device for the first predetermined time period to determine a first integral value;
integrate a NOx mass flow in downstream gas of the SCR device for the first predetermined time period to determine a second integral value; and
multiply a value of the first integral value minus the second integral value by a molar mass ratio of ammonia to nitrogen oxide in reaction, to determine the accumulated consumption amount of stored ammonia for the first predetermined time period after the urea injection is stopped.

[0016] In some embodiments, the predetermined concentration range is 32.5%±2.5%.

[0017] In some embodiments, the low-temperature efficiency monitoring module is further configured to send a stationary regeneration request after determining that the SCR device is in the sulfur poisoning state.

[0018] In some embodiments, the consumption limit value is determined according to an aging factor and an average temperature of the SCR device.

[0019] It can be seen from the above technical solution, the method and the system for determining a sulfur poisoning state of a SCR device are provided according to the embodiments of the present disclosure. In the method for determining a sulfur poisoning state of a SCR device, if the reduction efficiency of the SCR device and the concentration of urea meet the predetermined triggering condition, the ammonia storage capacity is detected. In the process of detecting ammonia storage capacity, the urea injection is stopped and the accumulated consumption amount of stored ammonia is calculated. If the accumulated consumption amount of stored ammonia is greater than the consumption limit value, it is determined that there is large ammonia storage. Therefore the subsequent detection is not performed, and the process of sulfur poisoning determination ends. If the accumulated consumption amount of stored ammonia is less than or equal to the consumption limit value, since the ammonia storage of the SCR is continuously consumed by NOx in upstream gas of SCR, and the first actual reduction efficiency of the SCR device will be gradually decreased. In a case that the accumulated consumption amount of stored ammonia is less than or equal to the consumption limit value and the first actual reduction efficiency of the SCR device is less than the first predetermined efficiency value, it is determined that ammonia is not leaked, and the problem of low reduction efficiency of the SCR device may be caused by sulfur poisoning or insufficient ammonia storage. In this case, the low-temperature efficiency of the SCR is required to be monitored. In the process of monitoring low-temperature efficiency of the SCR device, if the difference value between the theoretical reduction efficiency of the SCR device and the second actual reduction efficiency is greater than the difference threshold value, it is determined that the SCR device is in the sulfur poisoning state. It can be seen from the above process, whether the SCR device is in the sulfur poisoning state can be accurately determined by the method without being effected by other facts such as ammonia leakage, aging, ammonia storage control accuracy.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020] The drawings to be used in the description of the embodiments or the conventional technology will be described briefly as follows, so that the technical solutions according to the embodiments of the present disclosure or according to the conventional technology will become clearer. It is apparent that the drawings in the following description only illustrate some embodiments of the present disclosure. For those skilled in the art, other drawings may be obtained according to these drawings without any creative work.

Figure 1 is a flow chart of a method for determining a sulfur poisoning state of a SCR device according to an embodiment of the present disclosure;

Figure 2 is a flow chart of a method for determining whether a SCR and a urea injector meet a predetermined triggering condition according to an embodiment of the present disclosure;

Figure 3 is a flow chart of a method for monitoring a low-temperature efficiency of a SCR device according to an embodiment of the present disclosure;

Figure 4 is a schematic structural diagram of a vehicle post-treatment system according to an embodiment of the present disclosure;

Figure 5 is a flow chart of a method for determining a sulfur poisoning state of a SCR device according to another embodiment of the present disclosure; and

Figure 6 is a flow chart of a method for monitoring a low-temperature efficiency of a SCR according to another embodiment of the present disclosure.

DETAILED DESCRIPTION

[0021] Hereinafter, the technical solutions of the present disclosure are explained clearly and in further detail in conjunction with the drawings and specific embodiments. It is apparent that the embodiments in the following description are only some embodiments of the technical solution of the present disclosure, rather than all of the embodiments. Based on the embodiment of the present disclosure, other embodiments obtained by those skilled in the art without any creative work all fall within the scope of protection of the present disclosure.

[0022] Referring to Figure 1, a method for determining a sulfur poisoning state of a SCR device is provided according to an embodiment of the present disclosure. The method is used for determining whether an SCR device of a vehicle post-treatment system is in a sulfur poisoning state. The post-treatment system includes the SCR device and a urea injector. The method for determining a sulfur poisoning state of a SCR device includes the following steps S101 and S102.

[0023] In step S101, it is determined whether the SCR device and the urea injector meet a predetermined triggering condition. If it is determined that the SCR device and the urea injector meet the predetermined triggering condition, the urea injector is controlled to stop urea injection, A first actual reduction efficiency of the SCR device is detected after the urea injection is stopped, and accumulated consumption amount of stored ammonia for a first predetermined time period after the urea injection is stopped is calculated.

[0024] In step S102, it is determined whether the first actual reduction efficiency of the SCR device is less than a first predetermined efficiency value, and whether the accumulated consumption amount of stored ammonia is less than or equal to a consumption limit value. If it is determined that the first actual reduction efficiency of the SCR device is less than the first predetermined efficiency value, and the accumulated consumption amount of stored ammonia is less than or equal to the consumption limit value, a low-temperature efficiency of the SCR is monitored, else the process returns to step of determining whether the SCR and urea injector meet the predetermined triggering condition.

[0025] Referring to Figure 2, the process of determining whether the SCR device and the urea injector meet the predetermined triggering condition includes steps S1011 and S1012.

[0026] In step S1011, a reduction efficiency of the SCR device in a first predetermined temperature range and a concentration of urea in the urea injector are monitored.

[0027] In step S1012, when the reduction efficiency of the SCR device in the first predetermined temperature range is less than a second predetermined efficiency, and the concentration of urea is in a predetermined concentration range, it is determined that the SCR device and the urea injector meet the predetermined triggering condition.

[0028] Referring to Figure 3, the process of monitoring the low-temperature efficiency of the SCR device includes steps S1021 to S1023.

[0029] In step S1021, the urea injector is controlled to perform urea injection with a fixed ammonia-nitrogen mole ratio.

[0030] In step S1022, the second actual reduction efficiency of the SCR device for a second predetermined temperature range is monitored.

[0031] In step S1023, in a state that the second actual reduction efficiency of the SCR device, an ammonia storage setting value and an ammonia storage value calculated by an ammonia storage model are all stable, it is determined whether a difference value between a theoretical reduction efficiency of the SCR device and the second actual reduction efficiency is greater than a difference threshold value, and if the difference value between the theoretical reduction efficiency of the SCR device and the second actual reduction efficiency is greater than the difference threshold value, it is determined that the SCR device is in the sulfur poisoning state.

[0032] The ammonia storage setting value is determined by searching an ammonia storage mapping table according to a current space velocity and a current average temperature. The ammonia storage mapping table stores a correspondence between the space velocity, the average temperature and the ammonia storage setting value. The average temperature of the SCR device refers to an average temperature of various parts of the SCR device at a same time. Since the SCR material has a relatively large specific heat capacity, the temperature at an outlet of the SCR device may be changed later than a change in the temperature at an inlet of the SCR device. Therefore, the average temperature of various parts in the SCR device is taken as the average temperature of the SCR device.

[0033] The ammonia storage value calculated by the ammonia storage model is calculated according to a one-dimensional physical model of the SCR device. The ammonia storage, an internal temperature, a NOx concentration in downstream gas of the SCR device and other state parameters are calculated by the model in real time according to NOx quantity in upstream gas of the SCR device, exhaust gas volume, urea injection amount, temperature and other conditions.

[0034] The theoretical reduction efficiency of the SCR device is calculated by using the one-dimensional physical model of the SCR device, which is equal to one minus a ratio of a NOx value in downstream gas of the SCR model to a NOx value in upstream gas of the SCR model.

[0035] Figure 4 is a schematic structural diagram of a vehicle post-treatment system. Referring to Figure 4, the post-treatment system includes a turbocharger (TC), a hydrocarbon (HC) injector, a urea injector, a diesel oxide catalyst (DOC) device, a diesel particulate filter (DPF), a selectively catalytic reduction (SCR) device, and multiple temperature sensors and NOx sensors. The urea injector is arranged with a high-precision urea concentration sensor to accurately detect the urea concentration. In Figure 4, reference sign 10 represents the turbocharger, reference sign 20 represents the diesel oxide catalyst device, reference sign 30 represents the diesel particulate filter, reference sign 40 represents the selectively catalytic reduction device, reference sign 50 represents the NOx sensors, reference sign 60 represents the urea injector and reference sign 70 represents the temperature sensor. In Figure 4, the direction of the arrow indicates the direction of vehicle exhaust emission. The upstream gas of the SCR device refers to the vehicle exhaust inputted into the SCR device, and the downstream gas of the SCR device refers to the vehicle exhaust outputted from the SCR device (as the direction indicated by the arrow).

[0036] In the method for determining a sulfur poisoning state of a SCR device according to the embodiment of present disclosure, it is first determined whether the SCR device and the urea injector meet the predetermined triggering condition. The predetermined triggering condition involves SCR low-temperature efficiency monitoring and urea concentration monitoring. The SCR low-temperature efficiency monitoring is to monitor the reduction efficiency of the SCR device in a first predetermined temperature range, and determine whether the reduction efficiency of the SCR device in the first predetermined temperature range is less than a second predetermined efficiency. If the reduction efficiency of the SCR device in the first predetermined temperature range is less than the second predetermined efficiency, it is determined that the SCR device meets the predetermined triggering condition.

[0037] The first predetermined temperature range may be determined according to the type of the SCR. For the copper based SCR, the first predetermined temperature range may be a range of 220 Celsius degree to 260 Celsius degree.

[0038] The monitoring of the urea concentration range is to determine whether the concentration of urea in the urea injector is in a predetermined concentration range. If the concentration of urea is in a predetermined concentration range, it is determined that the urea injector meets the predetermined triggering condition.

[0039] In some embodiments, the predetermined concentration range may be 32.5%±2.5%.

[0040] If the SCR device and the urea injector meet the predetermined triggering condition, detection of ammonia storage capacity is performed. If the SCR device or the urea injector does not meet the predetermined triggering condition, the detection of ammonia storage capacity is not performed.

[0041] In the detection of ammonia storage capacity, the urea injector is controlled to stop urea injection, the first actual reduction efficiency of the SCR device after the urea injection is stopped is detected, and the accumulated consumption amount of stored ammonia for the first predetermined time period after the urea injection is stopped is calculated.

[0042] It is determined whether the first actual reduction efficiency of the SCR device is less than a first predetermined efficiency value, and whether the accumulated consumption amount of stored ammonia is less than or equal to a consumption limit value. In the detection of ammonia storage capacity, if the accumulated consumption amount of stored ammonia is greater than the consumption limit value, it is determined that the catalyst of SCR is not affected by sulfur, and the problem that the reduction efficiency of the SCR device in the first predetermined temperature range is less than the second predetermined efficiency is not caused by the sulfur poisoning. In this case, the process returns to the step of determining whether the SCR device and the urea injector meet the predetermined triggering condition. If the accumulated consumption amount of stored ammonia is less than or equal to the consumption limit value, since ammonia storage of the SCR is continuously consumed by NOx in upstream gas of SCR device, the first actual reduction efficiency of the SCR device will be gradually decreased. In a case that the first actual reduction efficiency of the SCR device is less than the first predetermined efficiency, and the accumulated consumption amount of stored ammonia is less than or equal to the consumption limit value, it is determined that the ammonia is not leaked and the low efficiency may be caused by sulfur poisoning or insufficient ammonia storage. In this case, the SCR low-temperature efficiency monitoring is performed.

[0043] In some embodiments, the predetermined efficiency value may be 0.5, 0.55 and 0.45, but is not limited thereto.

[0044] The consumption limit value is determined according to an SCR aging factor and the average temperature of the SCR device. The SCR aging factor is determined according to temperature levels experienced by the SCR device. In a case that the aging factor and the average temperature of the SCR device are determined, the consumption limit value may be determined by searching a predetermined mapping table including the correspondence between the SCR aging factor, the average temperature of the SCR device and the consumption limit value.

[0045] The SCR low-temperature efficiency monitoring is to monitor the reduction efficiency under a condition that the average temperature of the SCR device is in a second predetermined temperature range. The second predetermined temperature range is a low operating temperature range for the SCR device. Similarly, the second predetermined temperature range is determined according to the type of SCR. For the copper based SCR, the second predetermined temperature range may be the same as the first predetermined temperature range. That is, the second predetermined temperature range may be the range of 220 Celsius degree to 260 Celsius degree. The second preset temperature range certainly may be different from the first predetermined temperature range, which is not limited in the present disclosure, and depends on the actual situation.

[0046] In the process of monitoring the low-temperature efficiency of the SCR device, the urea injector is controlled to perform urea injection with a fixed ammonia-nitrogen mole ratio. For example, the fixed ammonia-nitrogen mole ratio may be equal to 1:1. The second actual reduction efficiency of the SCR device is monitored in the process of urea injection. In a state that the second actual reduction efficiency of the SCR device, an ammonia storage setting value and an ammonia storage value calculated by an ammonia storage model are all stable, it is determined whether a difference value between a theoretical reduction efficiency of the SCR device and the second actual reduction efficiency is greater than a difference threshold value. If the difference value between the theoretical reduction efficiency of the SCR device and the second actual reduction efficiency is greater than the difference threshold value, it is determined that the ammonia storage is not low and the SCR is in a sulfur poisoning state. If the difference value between the theoretical reduction efficiency of the SCR device and the second actual reduction efficiency is less than or equal to the difference threshold value, it is determined that the actual ammonia storage is low, and the process returns to the step of determining whether the SCR device and the urea injector meet the predetermined triggering condition.

[0047] It can be seen from the above process, with the method for determining a sulfur poisoning state of a SCR device, it can be accurately determined whether the SCR device is in the sulfur poisoning state without being effected by other facts such as ammonia leakage, aging and ammonia storage control accuracy.

[0048] Based on the above embodiment, referring to Figure 5, a method for determining a sulfur poisoning state of a SCR device according to another embodiment of the present disclosure includes steps S201 to S204.

[0049] In step S201, it is determined whether the SCR device and the urea injector meet a predetermined triggering condition. If the SCR device and the urea injector meet the predetermined triggering condition, the urea injector is controlled to stop urea injection. A first actual reduction efficiency of the SCR device is detected after the urea injection is stopped and a NOx mass flow in upstream gas of the SCR is integrated for a first predetermined time period to determine a first integral value.

[0050] In step S202, the NOx mass flow in downstream gas of the SCR is integrated for a first predetermined time period to determine a second integral value.

[0051] In step S203, a value of the first integral value minus the second integral value is multiplied by a molar mass ratio of ammonia to nitrogen oxide in reaction to determine accumulated consumption amount of stored ammonia for the first predetermined time period after the urea injection is stopped.

[0052] In step S204, it is determined whether the first actual reduction efficiency of the SCR device is less than a first predetermined efficiency value and whether the accumulated consumption amount of stored ammonia is less than or equal to a consumption limit value. If the first actual reduction efficiency of the SCR device is less than the first predetermined efficiency value and the accumulated consumption amount of stored ammonia is less than or equal to the consumption limit value, a low-temperature efficiency of the SCR is monitored. If the first actual reduction efficiency of the SCR device is not less than the first predetermined efficiency value or the accumulated consumption amount of stored ammonia is greater than the consumption limit value, the process returns to the step of determining whether the SCR device and the urea injector meet the predetermined triggering condition.

[0053] The process of determining whether the SCR device and the urea injector meet the predetermined triggering condition includes: monitoring the reduction efficiency of the SCR device in a first predetermined temperature range and a concentration of urea in the urea injector, and determining that the SCR device and the urea injector meet the predetermined triggering condition when the reduction efficiency of the SCR device in the first predetermined temperature range is less than a second predetermined efficiency and the concentration of urea is in a predetermined concentration range.

[0054] Referring to Figure 6, the process of monitoring the low-temperature efficiency of the SCR device includes step S2041 to S2043.

[0055] In step S2041, the urea injector is controlled to perform urea injection with a fixed ammonia-nitrogen mole ratio.

[0056] In step S2042, a second actual reduction efficiency of the SCR device in a second predetermined temperature range is monitored.

[0057] In step S2043, in a state that the second actual reduction efficiency of the SCR device, an ammonia storage setting value and an ammonia storage value calculated by an ammonia storage model are all stable, it is determined whether a difference value between a theoretical reduction efficiency of the SCR device and the second actual reduction efficiency is greater than a difference threshold value. If the difference value between the theoretical reduction efficiency of the SCR device and the second actual reduction efficiency is greater than the difference threshold value, it is determined that the SCR device is in the sulfur poisoning state, and a stationary regeneration request is sent.

[0058] A method for calculating accumulated consumption amount of stored ammonia for the first predetermined time period after the urea injection is stopped is provided according to the embodiment of the present disclosure. Furthermore, when it is determined that the SCR device is in the sulfur poisoning state, the stationary regeneration request is sent for regeneration and desulphurization to restore the performance of SCR catalyst.

[0059] Hereinafter, a system for determining a sulfur poisoning state of a SCR device according to an embodiment of the present disclosure is described. The above method for determining a sulfur poisoning state of a SCR device may be referred to for details of the system for determining a sulfur poisoning state of a SCR device.

[0060] The system is used for determining whether the SCR of a vehicle post-treatment system is in a sulfur poisoning state. The post-treatment system includes the SCR device and the urea injector. The system for determining a sulfur poisoning state of a SCR device includes a trigger determining module, an ammonia storage determination module and a low-temperature efficiency monitoring module.

[0061] The trigger determining module is configured to determine whether the SCR device and the urea injector meet a predetermined triggering condition, and trigger the ammonia storage determination module if it is determined that the SCR device and the urea injector meet the predetermined triggering condition.

[0062] The ammonia storage determination module is configured to control the urea injector to stop urea injection, detect a first actual reduction efficiency of the SCR device after the urea injection is stopped and calculate accumulated consumption amount of stored ammonia for a first predetermined time period after the urea injection is stopped.

[0063] The ammonia storage determination module is configured to determine whether the first actual reduction efficiency of the SCR device is less than a first predetermined efficiency value and whether the accumulated consumption amount of stored ammonia is less than or equal to a consumption limit value, trigger the low-temperature efficiency monitoring module if determining that the first actual reduction efficiency of the SCR device is less than the first predetermined efficiency value, and the accumulated consumption amount of stored ammonia is less than or equal to the consumption limit value, and trigger the trigger determining module if determining that the first actual reduction efficiency of the SCR device is not less than the first predetermined efficiency value, or the accumulated consumption amount of stored ammonia is greater than the consumption limit value.

[0064] The low-temperature efficiency monitoring module is configured to monitor the low-temperature efficiency of the SCR device by controlling the urea injector to perform urea injection with a fixed ammonia-nitrogen mole ratio, and monitoring a second actual reduction efficiency of the SCR device in a second predetermined temperature range, and determining, in a state that the second actual reduction efficiency of the SCR device, an ammonia storage setting value and an ammonia storage value calculated by an ammonia storage model are all stable, whether a difference value between a theoretical reduction efficiency of the SCR device and the second actual reduction efficiency is greater than a difference threshold value, and determining that the SCR is in a sulfur poisoning state if the difference value between the theoretical reduction efficiency of the SCR device and the second actual reduction efficiency is greater than the difference threshold value.

[0065] The trigger determining module is configured to determine whether the SCR device and the urea injector meet the predetermined triggering condition by monitoring a reduction efficiency of the SCR device in the first predetermined temperature range and a concentration of urea in the urea injector, and determining that the SCR device and the urea injector meet the predetermined triggering condition when the reduction efficiency of the SCR device for the first predetermined temperature range is less than the second predetermined efficiency, and the concentration of urea is in a predetermined concentration range.

[0066] In some embodiments, the ammonia storage determination module is configured to calculate the accumulated consumption amount of stored ammonia for the first predetermined time period after the urea injection is stopped, by integrating a NOx mass flow in upstream gas of the SCR device for the first predetermined time period to determine a first integral value; integrating a NOx mass flow in downstream gas of the SCR device for the first predetermined time period to determine a second integral value; and multiplying a value of the first integral value minus the second integral value by a molar mass ratio of ammonia to nitrogen oxide in reaction to determine the accumulated consumption amount of stored ammonia for the first predetermined time period after the urea injection is stopped.

[0067] In some embodiments, the predetermined concentration range may be 32.5%±2.5%.

[0068] In some embodiments, the low-temperature efficiency monitoring module may be further configured to send a stationary regeneration request when determining that the SCR device is in the sulfur poisoning state.

[0069] In some embodiments, the consumption limit value may be determined according to an aging factor and an average temperature of the SCR device.

[0070] In summary, the method and the system for determining a sulfur poisoning state of a SCR device are provided according to the embodiments of the present disclosure. In the method for determining a sulfur poisoning state of a SCR device, if the reduction efficiency of the SCR device and the concentration of urea meet the predetermined triggering condition, the ammonia storage capacity is detected. In the process of detecting ammonia storage capacity, the urea injection is stopped and the accumulated consumption amount of stored ammonia is calculated. If the accumulated consumption amount of stored ammonia is greater than the consumption limit value, it is determined that there is large ammonia storage. Therefore the subsequent detection is not performed, and the process of sulfur poisoning determination ends. If the accumulated consumption amount of stored ammonia is less than or equal to the consumption limit value, since the ammonia storage of the SCR is continuously consumed by NOx in upstream gas of SCR, and the first actual reduction efficiency of the SCR device will be gradually decreased. In a case that the accumulated consumption amount of stored ammonia is less than or equal to the consumption limit value and the first actual reduction efficiency of the SCR device is less than the first predetermined efficiency value, it is determined that ammonia is not leaked, and the problem of low reduction efficiency of the SCR device may be caused by sulfur poisoning or insufficient ammonia storage. In this case, the low-temperature efficiency of the SCR is required to be monitored. In the process of monitoring low-temperature efficiency of the SCR device, if the difference value between the theoretical reduction efficiency of the SCR device and the second actual reduction efficiency is greater than the difference threshold value, it is determined that the SCR device is in the sulfur poisoning state. It can be seen from the above process, whether the SCR device is in the sulfur poisoning state can be accurately determined by the method without being effected by other facts such as ammonia leakage, aging, ammonia storage control accuracy.

[0071] The embodiments in the present disclosure are described in a progressive manner, each of which emphasizes differences from others. The same or similar parts among the embodiments can be referred to each other.

[0072] Based on the above description of the disclosed embodiments, those skilled in the art can implement or use the present disclosure.

Claims

1. A method for determining a sulfur poisoning state of a selective catalytic reduction (SCR) device of a vehicle post-treatment system, wherein the vehicle

post-treatment system comprises the SCR device (40) and a urea injector (60), and the method comprises:

determining whether the SCR device and the urea injector meet a predetermined triggering condition; if it is determined that the SCR device and the urea injector meet the predetermined triggering condition, controlling the urea injector to stop urea injection; and detecting a first actual reduction efficiency of the SCR device after the urea injection is stopped and calculating accumulated consumption amount of stored ammonia for a first predetermined time period after the urea injection is stopped; and

determining whether the first actual reduction efficiency of the SCR device is less than a first predetermined efficiency value, and whether the accumulated consumption amount of stored ammonia is less than or equal to a consumption limit value; if it is determined that the first actual reduction efficiency of the SCR device is less than the first predetermined efficiency value and the accumulated consumption amount of stored ammonia is less than or equal to the consumption limit value, monitoring a low-temperature efficiency of the SCR device; if it is determined that the first actual reduction efficiency of the SCR device is not less than the first predetermined efficiency value, or the accumulated consumption amount of stored ammonia is greater than the consumption limit value, returning to the step of determining whether the SCR device and the urea injector meet the predetermined triggering condition;

wherein the determining whether the SCR device and the urea injector meet a predetermined triggering condition comprises:

monitoring a reduction efficiency of the SCR device in a first predetermined temperature range and a concentration of urea in the urea injector; and determining that the SCR device and the urea injector meet the predetermined triggering condition when the reduction efficiency of the SCR device in the first predetermined temperature range is less than a second predetermined efficiency and the concentration of urea is in a predetermined concentration range; and

wherein the monitoring a low-temperature efficiency of the SCR device comprises:

controlling the urea injector to perform urea injection with a fixed ammonia-nitrogen mole ratio, and monitoring a second actual reduction efficiency of the SCR device in a second predetermined temperature range;

determining, in a state that the second actual reduction efficiency of the SCR device, an ammonia storage setting value and an ammonia storage value calculated by an ammonia storage model are all stable, whether a difference value between a theoretical reduction efficiency of the SCR device and the second actual reduction efficiency is greater than a difference threshold value; and

determining that the SCR device is in the sulfur poisoning state if the difference value between the theoretical reduction efficiency of the SCR device and the second actual reduction efficiency is greater than the difference threshold value.

2. The method for determining a sulfur poisoning state of a SCR device according to claim 1, wherein the calculating accumulated consumption amount of stored ammonia for a first predetermined time period after the urea injection is stopped comprises:

integrating a nitrogen oxides (NOx) mass flow in upstream gas of the SCR device for the first predetermined time period to determine a first integral value;

integrating a NOx mass flow in downstream gas of the SCR device for the first predetermined time period to determine a second integral value; and

multiplying a value of the first integral value minus the second integral value by a molar mass ratio of ammonia to nitrogen oxide in reaction, to determine the accumulated consumption amount of stored ammonia for the first predetermined time period after the urea injection is stopped.

3. The method for determining a sulfur poisoning state of a SCR device according to claim 1, wherein the predetermined concentration range is 32.5%±2.5%.

4. The method for determining a sulfur poisoning state of a SCR device according to claim 1, wherein after determining that the SCR device is in the sulfur poisoning state, the method further comprises: sending a stationary regeneration request.

5. The method for determining a sulfur poisoning state of a SCR device according to claim 1, wherein the consumption limit value is determined according to an aging factor and an average temperature of the SCR device.

6. A system for determining a sulfur poisoning state of a selective catalytic reduction (SCR) device of a vehicle post-treatment system, wherein the vehicle post-treatment system comprises the SCR device (40) and a urea injector (60), and the system for determining the sulfur poisoning state comprises:

an trigger determining module, configured to determine whether the SCR device and the urea injector meet a predetermined triggering condition, and trigger an ammonia storage determination module if it is determined that the SCR device and the urea injector meet the predetermined triggering condition;
the ammonia storage determination module, configured to

control the urea injector to stop urea injection;
detect a first actual reduction efficiency of the SCR device after the urea injection is stopped and calculate accumulated consumption amount of stored ammonia for a first predetermined time period after the urea injection is stopped;
determine whether the first actual reduction efficiency of the SCR device is less than a first predetermined efficiency value, and whether the accumulated consumption amount of stored ammonia is less than or equal to a consumption limit value;
trigger a low-temperature efficiency monitoring module if it is determined that the first actual reduction efficiency of the SCR device is less than the first predetermined efficiency value and the accumulated consumption amount of stored ammonia is less than or equal to the consumption limit value; and
trigger the trigger determining module, if it is determined that the first actual reduction efficiency of the SCR device is not less than the first predetermined efficiency value, or the accumulated consumption amount of stored ammonia is greater than the consumption limit value; and

the low-temperature efficiency monitoring module, configured to monitor a low-temperature efficiency of the SCR device by controlling the urea injector to perform urea injection with a fixed ammonia-nitrogen mole ratio, and monitoring a second actual reduction efficiency of the SCR device in a second predetermined temperature range; determining, in a state that the second actual reduction efficiency of the SCR device, an ammonia storage setting value and an ammonia storage value calculated by an ammonia storage model are all stable, whether a difference value between a theoretical reduction efficiency of the SCR device and the second actual reduction efficiency is greater than a difference threshold value; and determining that the SCR device is in the sulfur poisoning state if the difference value between the theoretical reduction efficiency of the SCR device and the second actual reduction efficiency is greater than the difference threshold value;
wherein the trigger determining module is configured to determine whether the SCR device and the urea injector meet the predetermined triggering condition by: monitoring a reduction efficiency of the SCR device in a first predetermined temperature range and a concentration of urea in the urea injector; and determining that the SCR device and the urea injector meet the predetermined triggering condition, when the reduction efficiency of the SCR device in the first predetermined temperature range is less than a second predetermined efficiency and the concentration of urea is in a predetermined concentration range.

7. The system for determining a sulfur poisoning state of a SCR device according to claim 6, wherein the ammonia storage determination module is configured to:

integrate a nitrogen oxides (NOx) mass flow in upstream gas of the SCR device for the first predetermined time period to determine a first integral value;
integrate a NOx mass flow in downstream gas of the SCR device for the first predetermined time period to determine a second integral value; and
multiply a value of the first integral value minus the second integral value by a molar mass ratio of ammonia to nitrogen oxide in reaction, to determine the accumulated consumption amount of stored ammonia for the first predetermined time period after the urea injection is stopped.

8. The system for determining a sulfur poisoning state of a SCR device according to claim 6, wherein the predetermined concentration range is 32.5%±2.5%.

9. The system for determining a sulfur poisoning state of a SCR device according to claim 6, wherein the low-temperature efficiency monitoring module is further configured to send a stationary regeneration request after determining that the SCR device is in the sulfur poisoning state.

10. The system for determining a sulfur poisoning state of a SCR device according to claim 6, wherein the

consumption limit value is determined according to an aging factor and an average temperature of the SCR device.

Patentansprüche

1. Verfahren zum Bestimmen eines Schwefelvergiftungszustands einer Vorrichtung zur selektiven katalytischen Reduktion (SCR) eines Fahrzeugnachbehandlungssystems, wobei das Fahrzeugnachbehandlungssystem die SCR-Vorrichtung (40) und eine Harnstoffeinspritzdüse (60) umfasst, und das Verfahren umfasst:

    Bestimmen, ob die SCR-Vorrichtung und die Harnstoffeinspritzdüse eine vorbestimmte Auslösebedingung erfüllen; wenn bestimmt wurde, dass die SCR-Vorrichtung und die Harnstoffeinspritzdüse die vorbestimmte Auslösebedingung erfüllen, Steuern der Harnstoffeinspritzdüse, um die Harnstoffinjektion zu stoppen; und Detection einer ersten tatsächlichen Reduktionseffizienz der SCR-Vorrichtung nach dem Stoppen der Harnstoffinjektion und Berechnen der akkumulierten Verbrauchsmenge an gespeichertem Ammoniak für einen ersten vorbestimmten Zeitraum nach dem Stoppen der Harnstoffinjektion; und

    Bestimmen, ob die erste tatsächliche Reduktionseffizienz der SCR-Vorrichtung kleiner als ein erster vorbestimmter Effizienzwert ist, und ob die akkumulierte Verbrauchsmenge an gespeichertem Ammoniak kleiner oder gleich einem Verbrauchsgrenzwert ist; wenn bestimmt wurde, dass die erste tatsächliche Reduktionseffizienz der SCR-Vorrichtung kleiner als der erste vorbestimmte Effizienzwert ist und die akkumulierte Verbrauchsmenge an gespeichertem Ammoniak kleiner oder gleich dem Verbrauchsgrenzwert ist, Überwachen einer Niedertemperatureffizienz der SCR-Vorrichtung; wenn bestimmt wurde, dass die erste tatsächliche Reduktionseffizienz der SCR-Vorrichtung nicht kleiner als der erste vorbestimmte Effizienzwert ist oder die akkumulierte Verbrauchsmenge an gespeichertem Ammoniak größer als der Verbrauchsgrenzwert ist, Zurückkehren zum Schritt des Bestimmens, ob die SCR-Vorrichtung und die Harnstoffeinspritzdüse die vorbestimmte Auslösebedingung erfüllen;

    wobei das Bestimmen, ob die SCR-Vorrichtung und die Harnstoffeinspritzdüse eine vorbestimmte Auslösebedingung erfüllen, umfasst:

        Überwachen einer Reduktionseffizienz der SCR-Vorrichtung in einem ersten vorbestimmten Temperaturbereich und einer Konzentration von Harnstoff in der Harnstoffeinspritzdüse;

        und Bestimmen, dass die SCR-Vorrichtung und die Harnstoffeinspritzdüse die vorbestimmte Auslösebedingung erfüllen, wenn die Reduktionseffizienz der SCR-Vorrichtung im ersten vorbestimmten Temperaturbereich kleiner als eine zweite vorbestimmte Effizienz ist und die Konzentration von Harnstoff in einem vorbestimmten Konzentrationsbereich liegt; und

        wobei das Überwachen einer Niedertemperatureffizienz der SCR-Vorrichtung umfasst:

            Steuern der Harnstoffeinspritzdüse, um eine Harnstoffinjektion mit einem festen Ammoniak-Stickstoff-Molverhältnis durchzuführen, und Überwachen einer zweiten tatsächlichen Reduktionseffizienz der SCR-Vorrichtung in einem zweiten vorbestimmten Temperaturbereich;

            Bestimmen, in einem Zustand der zweiten tatsächlichen Reduktionseffizienz der SCR-Vorrichtung, in dem ein Ammoniakspeichereinstellwert und ein von einem Ammoniakspeichermodell berechneter Ammoniakspeicherwert alle stabil sind, ob ein Differenzwert zwischen einer theoretischen Reduktionseffizienz der SCR-Vorrichtung und der zweiten tatsächlichen Reduktionseffizienz größer als ein Differenzschwellenwert ist; und

            Bestimmen, dass sich die SCR-Vorrichtung im Schwefelvergiftungszustand befindet, wenn der Differenzwert zwischen der theoretischen Reduktionseffizienz der SCR-Vorrichtung und der zweiten tatsächlichen Reduktionseffizienz größer als der Differenzschwellenwert ist.

2. Verfahren zum Bestimmen eines Schwefelvergiftungszustands einer SCR-Vorrichtung nach Anspruch 1, wobei das Berechnen der akkumulierten Verbrauchsmenge an gespeichertem Ammoniak für einen ersten vorbestimmten Zeitraum nach dem Stoppen der Harnstoffinjektion umfasst:

    Integrieren eines Stickoxide(NOx)-Massenstroms in stromaufwärts fließendes Gas der SCR-Vorrichtung für den ersten vorbestimmten Zeitraum, um einen ersten Integralwert zu bestimmen;

    Integrieren eines NOx-Massenstroms in stromabwärts fließendes Gas der SCR-Vorrichtung für den ersten vorbestimmten Zeitraum, um einen zweiten Integralwert zu bestimmen; und Multiplizieren eines Wertes des ersten Integralwerts minus des zweiten Integralwerts mit einem Molmassenverhältnis von Ammoniak zu Stickoxid in Reaktion, um die akkumulierte Verbrauchsmenge an gespeichertem Ammoniak für den ersten vorbestimmten Zeitraum nach dem Stoppen der Harnstoffinjektion zu bestimmen.

3. Verfahren zum Bestimmen eines Schwefelvergiftungszustands einer SCR-Vorrichtung nach Anspruch 1, wobei der vorbestimmte Konzentrationsbereich 32,5 % ± 2,5 % beträgt.

4. Verfahren zum Bestimmen eines Schwefelvergiftungszustands einer SCR-Vorrichtung nach Anspruch 1, wobei nach dem Bestimmen, dass sich die SCR-Vorrichtung im Schwefelvergiftungszustand befindet, das Verfahren ferner umfasst: Senden einer stationären Regenerationsanforderung.

5. Verfahren zum Bestimmen eines Schwefelvergiftungszustands einer SCR-Vorrichtung nach Anspruch 1, wobei der Verbrauchsgrenzwert in Abhängigkeit von einem Alterungsfaktor und einer Durchschnittstemperatur der SCR-Vorrichtung bestimmt wird.

6. System zum Bestimmen eines Schwefelvergiftungszustands einer Vorrichtung zur selektiven katalytischen Reduktion (SCR) eines Fahrzeugnachbehandlungssystems, wobei das Fahrzeugnachbehandlungssystem die SCR-Vorrichtung (40) und eine Harnstoffeinspritzdüse (60) umfasst und das System zum Bestimmen des Schwefelvergiftungszustands umfasst:

ein Auslösebestimmungsmodul, konfiguriert, um zu bestimmen, ob die SCR-Vorrichtung und die Harnstoffeinspritzdüse eine vorbestimmte Auslösebedingung erfüllen, und ein Ammoniakspeicherbestimmungsmodul auslöst, wenn bestimmt wurde, dass die SCR-Vorrichtung und die Harnstoffeinspritzdüse die vorbestimmte Auslösebedingung erfüllen;
das Ammoniakspeicherbestimmungsmodul, konfiguriert zum Steuern der Harnstoffeinspritzdüse, um die Harnstoffinjektion zu stoppen; Detektieren einer ersten tatsächlichen Reduktionseffizienz der SCR-Vorrichtung nach dem Stoppen der Harnstoffinjektion und Berechnen der akkumulierten Verbrauchsmenge an gespeichertem Ammoniak für einen ersten vorbestimmten Zeitraum nach dem Stoppen der Harnstoffinjektion;
Bestimmen, ob die erste tatsächliche Reduktionseffizienz der SCR-Vorrichtung kleiner als ein erster vorbestimmter Effizienzwert ist und ob die akkumulierte Verbrauchsmenge an gespeichertem Ammoniak kleiner oder gleich einem Verbrauchsgrenzwert ist;
Auslösen eines Niedertemperatureffizienz-Überwachungsmoduls, wenn bestimmt wurde, dass die erste tatsächliche Reduktionseffizienz der SCR-Vorrichtung kleiner als der erste vorbestimmte Effizienzwert ist und die akkumulierte Verbrauchsmenge an gespeichertem Ammoniak kleiner oder gleich dem Verbrauchsgrenzwert ist; und
Auslösen des Auslösebestimmungsmoduls, wenn bestimmt wurde, dass die erste tatsächliche Reduktionseffizienz der SCR-Vorrichtung nicht kleiner als der erste vorbestimmte Effizienzwert ist oder die akkumulierte Verbrauchsmenge an gespeichertem Ammoniak größer als der Verbrauchsgrenzwert ist; und
das Niedertemperatureffizienz-Überwachungsmodul ist konfiguriert zum Überwachen einer Niedertemperatureffizienz der SCR-Vorrichtung durch Steuern der Harnstoffeinspritzdüse, um eine Harnstoffinjektion mit einem festen Ammoniak-Stickstoff-Molverhältnis durchzuführen und Überwachen einer zweiten tatsächlichen Reduktionseffizienz der SCR-Vorrichtung in einem zweiten vorbestimmten Temperaturbereich; Bestimmen, in einem Zustand der zweiten tatsächlichen Reduktionseffizienz der SCR-Vorrichtung, in dem ein Ammoniakspeichereinstellwert und ein von einem Ammoniakspeichermodell berechneter Ammoniakspeicherwert alle stabil sind, ob ein Differenzwert zwischen einer theoretischen Reduktionseffizienz der SCR-Vorrichtung und der zweiten tatsächlichen Reduktionseffizienz größer als ein Differenzschwellenwert ist; und Bestimmen, dass sich die SCR-Vorrichtung im Schwefelvergiftungszustand befindet, wenn der Differenzwert zwischen der theoretischen Reduktionseffizienz der SCR-Vorrichtung und der zweiten tatsächlichen Reduktionseffizienz größer als der Differenzschwellenwert ist;
wobei das Auslösebestimmungsmodul konfiguriert ist, um zu bestimmen, ob die SCR-Vorrichtung und die Harnstoffeinspritzdüse die vorbestimmte Auslösebedingung erfüllen, durch: Überwachen einer Reduktionseffizienz der SCR-Vorrichtung in einem ersten vorbestimmten Temperaturbereich und einer Konzentration von Harnstoff in der Harnstoffeinspritzdüse; und Bestimmen, dass die SCR-Vorrichtung und die Harnstoffeinspritzdüse die vorbestimmte Auslösebedingung erfüllen, wenn die Reduktionseffizienz der SCR-Vorrichtung im ersten vorbe-

stimmten Temperaturbereich kleiner als eine zweite vorbestimmte Effizienz ist und die Konzentration von Harnstoff in einem vorbestimmten Konzentrationsbereich liegt.

7. System zum Bestimmen eines Schwefelvergiftungszustands einer SCR-Vorrichtung nach Anspruch 6, wobei das Ammoniakspeicherbestimmungsmodul konfiguriert ist, zum:

Integrieren eines Stickoxide(NOx)-Massenstroms in stromaufwärts fließendes Gas der SCR-Vorrichtung für den ersten vorbestimmten Zeitraum, um einen ersten Integralwert zu bestimmen;
Integrieren eines NOx-Massenstroms in stromabwärts fließendes Gas der SCR-Vorrichtung für den ersten vorbestimmten Zeitraum, um einen zweiten Integralwert zu bestimmen; und
Multiplizieren eines Wertes des ersten Integralwerts minus des zweiten Integralwerts mit einem Molmassenverhältnis von Ammoniak zu Stickoxid in Reaktion, um die akkumulierte Verbrauchsmenge an gespeichertem Ammoniak für den ersten vorbestimmten Zeitraum nach dem Stoppen der Harnstoffinjektion zu bestimmen.

8. System zum Bestimmen eines Schwefelvergiftungszustands einer SCR-Vorrichtung nach Anspruch 6, wobei der vorbestimmte Konzentrationsbereich 32,5 % ± 2,5 % beträgt.

9. System zum Bestimmen eines Schwefelvergiftungszustands einer SCR-Vorrichtung nach Anspruch 6, wobei das Niedertemperatureffizienz-Überwachungsmodul ferner konfiguriert ist, um eine stationäre Regenerationsanforderung zu senden, nach dem Bestimmen, dass sich die SCR-Vorrichtung im Schwefelvergiftungszustand befindet.

10. System zum Bestimmen eines Schwefelvergiftungszustands einer SCR-Vorrichtung nach Anspruch 6, wobei der Verbrauchsgrenzwert in Abhängigkeit von einem Alterungsfaktor und einer Durchschnittstemperatur der SCR-Vorrichtung bestimmt wird.

Revendications

1. Procédé de détermination d'un état d'empoisonnement au soufre d'un dispositif de réduction catalytique sélective (SCR) d'un système de post-traitement de véhicule, dans lequel le système de post-traitement de véhicule comprend le dispositif SCR (40) et un injecteur d'urée (60), et le procédé comprend :

la détermination si le dispositif SCR et l'injecteur d'urée satisfont à une condition de déclenchement prédéterminée ;
s'il est déterminé que le dispositif SCR et l'injecteur d'urée satisfont à la condition de déclenchement prédéterminée, la commande de l'injecteur d'urée pour arrêter l'injection d'urée ; et la détection d'une première efficacité de réduction réelle du dispositif SCR après l'arrêt de l'injection d'urée et le calcul de la quantité de consommation accumulée d'ammoniac stocké pendant une première période de temps prédéterminée après l'arrêt de l'injection d'urée ; et
la détermination si la première efficacité de réduction réelle du dispositif SCR est inférieure à une première valeur d'efficacité prédéterminée, et si la quantité de consommation accumulée d'ammoniac stocké est inférieure ou égale à une valeur limite de consommation ; s'il est déterminé que la première efficacité de réduction réelle du dispositif SCR est inférieure à la première valeur d'efficacité prédéterminée et que la quantité de consommation accumulée d'ammoniac stocké est inférieure ou égale à la valeur limite de consommation, la surveillance d'une efficacité à basse température du dispositif SCR ;
s'il est déterminé que la première efficacité de réduction réelle du dispositif SCR n'est pas inférieure à la première valeur d'efficacité prédéterminée, ou que la quantité de consommation accumulée d'ammoniac stocké est supérieure à la valeur limite de consommation, le retour à l'étape de détermination si le dispositif SCR et l'injecteur d'urée satisfont à la condition de déclenchement prédéterminée ;
dans lequel la détermination si le dispositif SCR et l'injecteur d'urée satisfont à une condition de déclenchement prédéterminée comprend :

la surveillance d'une efficacité de réduction du dispositif SCR dans une première plage de température prédéterminée et d'une concentration en urée dans l'injecteur d'urée ; et la détermination que le dispositif SCR et l'injecteur d'urée satisfont à la condition de déclenchement prédéterminée quand l'efficacité de réduction du dispositif SCR dans la première plage de température prédéterminée est inférieure à une seconde efficacité prédéterminée et que la concentration en urée est dans une plage de concentration prédéterminée ; et
dans lequel la surveillance d'une efficacité à basse température du dispositif SCR comprend :

la commande de l'injecteur d'urée pour effectuer une injection d'urée avec un

rapport molaire d'azote d'ammoniac fixe, et la surveillance d'une seconde efficacité de réduction réelle du dispositif SCR dans une seconde plage de température prédéterminée ;
la détermination, dans un état dans lequel la seconde efficacité de réduction réelle du dispositif SCR, une valeur de réglage de stockage d'ammoniac et une valeur de stockage d'ammoniac calculée par un modèle de stockage d'ammoniac sont toutes stables, si une valeur de différence entre une efficacité de réduction théorique du dispositif SCR et la seconde efficacité de réduction réelle est supérieure à une valeur seuil de différence ; et
la détermination que le dispositif SCR est dans l'état d'empoisonnement au soufre si la valeur de différence entre l'efficacité de réduction théorique du dispositif SCR et
la seconde efficacité de réduction réelle est supérieure à la valeur seuil de différence.

2. Procédé de détermination d'un état d'empoisonnement au soufre d'un dispositif SCR selon la revendication 1, dans lequel le calcul de la quantité de consommation accumulée d'ammoniac stocké pendant une première période de temps prédéterminée après l'arrêt de l'injection d'urée comprend :

l'intégration d'un débit massique d'oxydes d'azote (NOx) dans un gaz en amont du dispositif SCR pendant la première période de temps prédéterminée pour déterminer une première valeur d'intégrale ;
l'intégration d'un débit massique de NOx dans le gaz en aval du dispositif SCR pendant la première période de temps prédéterminée pour déterminer une seconde valeur d'intégrale ; et
la multiplication d'une valeur de la première valeur d'intégrale moins la seconde valeur d'intégrale par un rapport masse molaire d'ammoniac sur masse molaire d'oxyde d'azote dans la réaction, pour déterminer la quantité de consommation accumulée d'ammoniac stocké pendant la première période de temps prédéterminée après l'arrêt de l'injection d'urée.

3. Procédé de détermination d'un état d'empoisonnement au soufre d'un dispositif SCR selon la revendication 1, dans lequel la plage de concentration prédéterminée est de 32,5 % $\pm$ 2,5 %.

4. Procédé de détermination d'un état d'empoisonnement au soufre d'un dispositif SCR selon la revendication 1, dans lequel après avoir déterminé que le dispositif SCR est dans l'état d'empoisonnement au soufre, le procédé comprend en outre :
l'envoi d'une demande de régénération stationnaire.

5. Procédé de détermination d'un état d'empoisonnement au soufre d'un dispositif SCR selon la revendication 1, dans lequel la valeur limite de consommation est déterminée en fonction d'un facteur de vieillissement et d'une température moyenne du dispositif SCR.

6. Système de détermination d'un état d'empoisonnement au soufre d'un dispositif de réduction catalytique sélective (SCR) d'un système de post-traitement de véhicule, dans lequel le système de post-traitement de véhicule comprend le dispositif SCR (40) et un injecteur d'urée (60), et le système de détermination de l'état d'empoisonnement au soufre comprend :

un module de détermination de déclenchement, configuré pour déterminer si le dispositif SCR et l'injecteur d'urée satisfont à une condition de déclenchement prédéterminée, et pour déclencher un module de détermination de stockage d'ammoniac s'il est déterminé que le dispositif SCR et l'injecteur d'urée satisfont à la condition de déclenchement prédéterminée ;
le module de détermination de stockage d'ammoniac, configuré pour
commander l'injecteur d'urée pour arrêter l'injection d'urée ;
détecter une première efficacité de réduction réelle du dispositif SCR après l'arrêt de l'injection d'urée et calculer la quantité de consommation accumulée d'ammoniac stocké pendant une première période de temps prédéterminée après l'arrêt de l'injection d'urée ;
déterminer si la première efficacité de réduction réelle du dispositif SCR est inférieure à une première valeur d'efficacité prédéterminée, et si la quantité de consommation accumulée d'ammoniac stocké est inférieure ou égale à une valeur limite de consommation ;
déclencher un module de surveillance d'efficacité à basse température s'il est déterminé que la première efficacité de réduction réelle du dispositif SCR est inférieure à la première valeur d'efficacité prédéterminée et que la quantité de consommation accumulée d'ammoniac stocké est inférieure ou égale à la valeur limite de consommation ; et
déclencher le module de détermination de déclenchement, s'il est déterminé que la première efficacité de réduction réelle du dispositif SCR n'est pas inférieure à la première valeur d'efficacité prédéterminée, ou que la quantité de con-

sommation accumulée d'ammoniac stocké est supérieure à la valeur limite de consommation ; et

le module de surveillance d'efficacité à basse température, configuré pour surveiller une efficacité à basse température du dispositif SCR par la commande de l'injecteur d'urée pour effectuer une injection d'urée avec un rapport molaire d'azote d'ammoniac fixe, et la surveillance d'une seconde efficacité de réduction réelle du dispositif SCR dans une seconde plage de température prédéterminée ; la détermination, dans un état dans lequel la seconde efficacité de réduction réelle du dispositif SCR, qu'une valeur de réglage de stockage d'ammoniac et qu'une valeur de stockage d'ammoniac calculée par un modèle de stockage d'ammoniac sont toutes stables, si une valeur de différence entre une efficacité de réduction théorique du dispositif SCR et la seconde efficacité de réduction réelle est supérieure à une valeur seuil de différence ; et la détermination que le dispositif SCR est dans l'état d'empoisonnement au soufre si la valeur de différence entre l'efficacité de réduction théorique du dispositif SCR et la seconde efficacité de réduction réelle est supérieure à la valeur seuil de différence ;

dans lequel le module de détermination de déclenchement est configuré pour déterminer si le dispositif SCR et l'injecteur d'urée satisfont à la condition de déclenchement prédéterminée par : la surveillance d'une efficacité de réduction du dispositif SCR dans une première plage de température prédéterminée et d'une concentration en urée dans l'injecteur d'urée ; et la détermination que le dispositif SCR et l'injecteur d'urée satisfont à la condition de déclenchement prédéterminée, quand l'efficacité de réduction du dispositif SCR dans la première plage de température prédéterminée est inférieure à une seconde efficacité prédéterminée et que la concentration en urée est dans une plage de concentration prédéterminée.

7. Système de détermination d'un état d'empoisonnement au soufre d'un dispositif SCR selon la revendication 6, dans lequel le module de détermination de stockage d'ammoniac est configuré pour :

intégrer un débit massique d'oxydes d'azote (NOx) dans un gaz en amont du dispositif SCR pendant la première période de temps prédéterminée pour déterminer une première valeur d'intégrale ;

intégrer un débit massique de NOx dans le gaz en aval du dispositif SCR pendant la première période de temps prédéterminée pour déterminer une seconde valeur d'intégrale ; et

multiplier une valeur de la première valeur d'intégrale moins la seconde valeur d'intégrale par un rapport masse molaire d'ammoniac sur masse molaire d'oxyde d'azote dans la réaction, pour déterminer la quantité de consommation accumulée d'ammoniac stocké pendant la première période de temps prédéterminée après l'arrêt de l'injection d'urée.

8. Système de détermination d'un état d'empoisonnement au soufre d'un dispositif SCR selon la revendication 6, dans lequel la plage de concentration prédéterminée est de 32,5 % $\pm$ 2,5 %.

9. Système de détermination d'un état d'empoisonnement au soufre d'un dispositif SCR selon la revendication 6, dans lequel le module de surveillance d'efficacité à basse température est configuré en outre pour envoyer une demande de régénération stationnaire après avoir déterminé que le dispositif SCR est dans l'état d'empoisonnement au soufre.

10. Système de détermination d'un état d'empoisonnement au soufre d'un dispositif SCR selon la revendication 6, dans lequel la valeur limite de consommation est déterminée en fonction d'un facteur de vieillissement et d'une température moyenne du dispositif SCR.

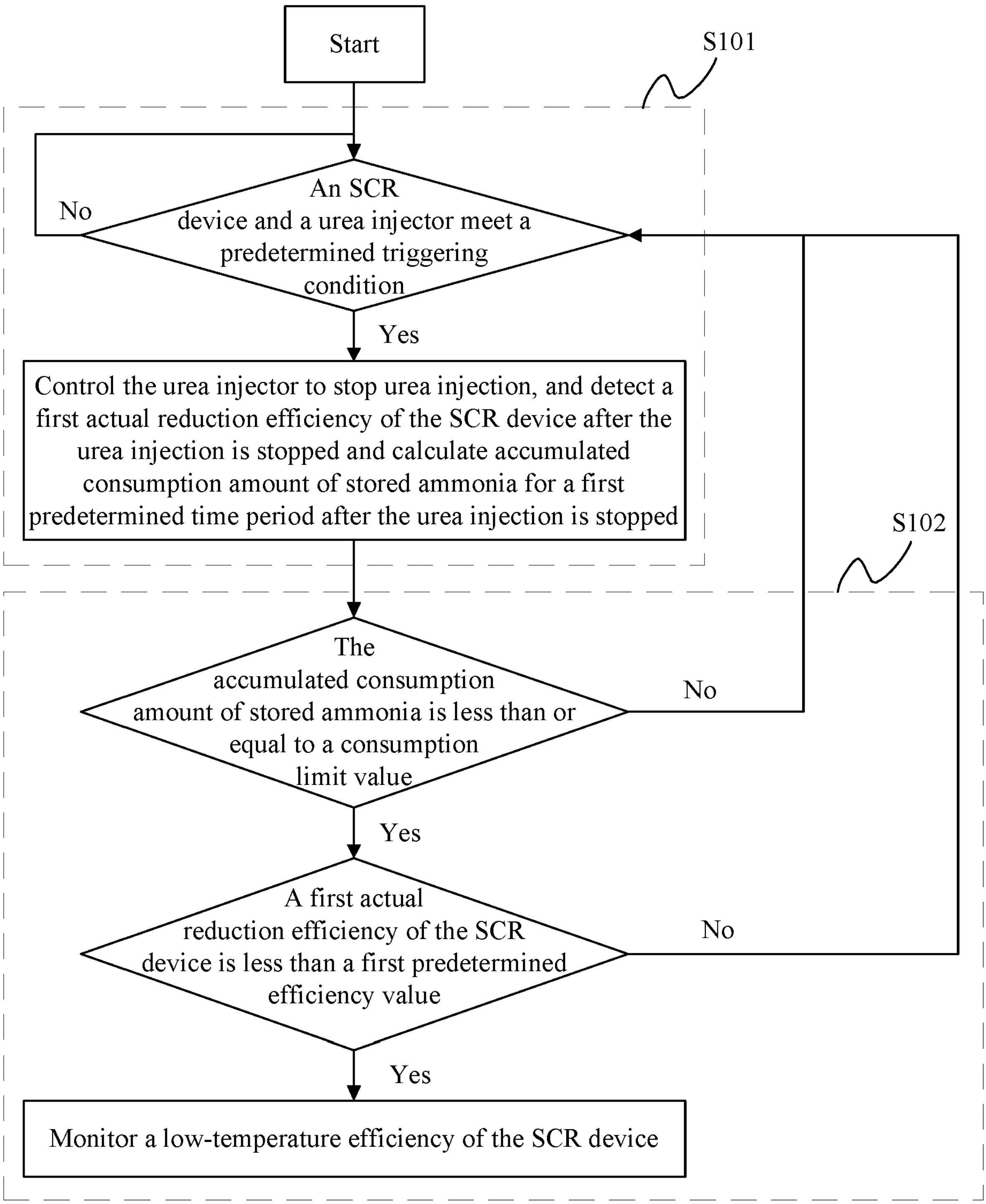
Start
S101
An SCR device and a urea injector meet a predetermined triggering condition
No
Yes
Control the urea injector to stop urea injection, and detect a first actual reduction efficiency of the SCR device after the urea injection is stopped and calculate accumulated consumption amount of stored ammonia for a first predetermined time period after the urea injection is stopped
S102
The accumulated consumption amount of stored ammonia is less than or equal to a consumption limit value
No
Yes
A first actual reduction efficiency of the SCR device is less than a first predetermined efficiency value
No
Yes
Monitor a low-temperature efficiency of the SCR device

Figure 1

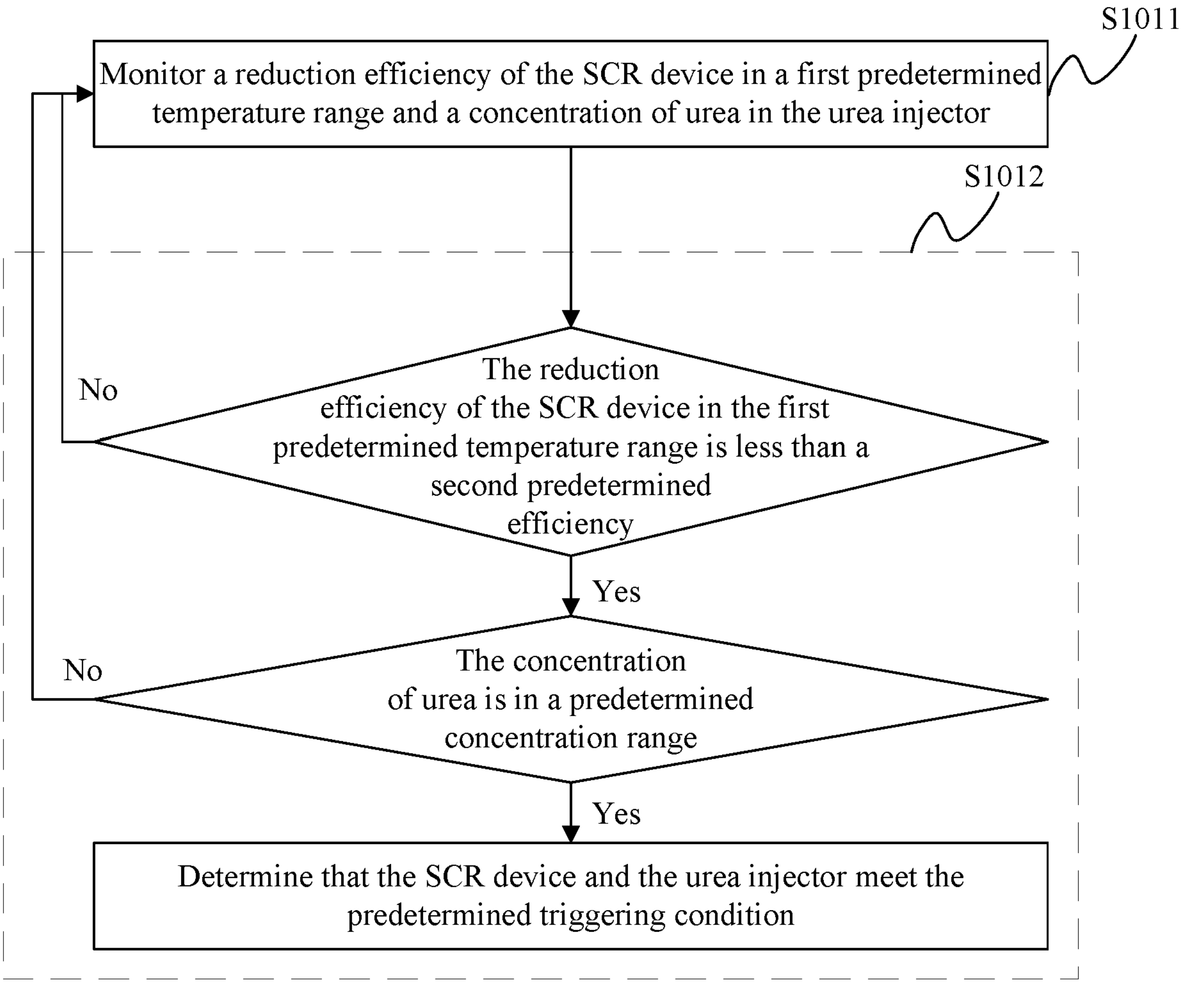
S1011
Monitor a reduction efficiency of the SCR device in a first predetermined temperature range and a concentration of urea in the urea injector
S1012
No
The reduction efficiency of the SCR device in the first predetermined temperature range is less than a second predetermined efficiency
Yes
No
The concentration of urea is in a predetermined concentration range
Yes
Determine that the SCR device and the urea injector meet the predetermined triggering condition

Figure 2

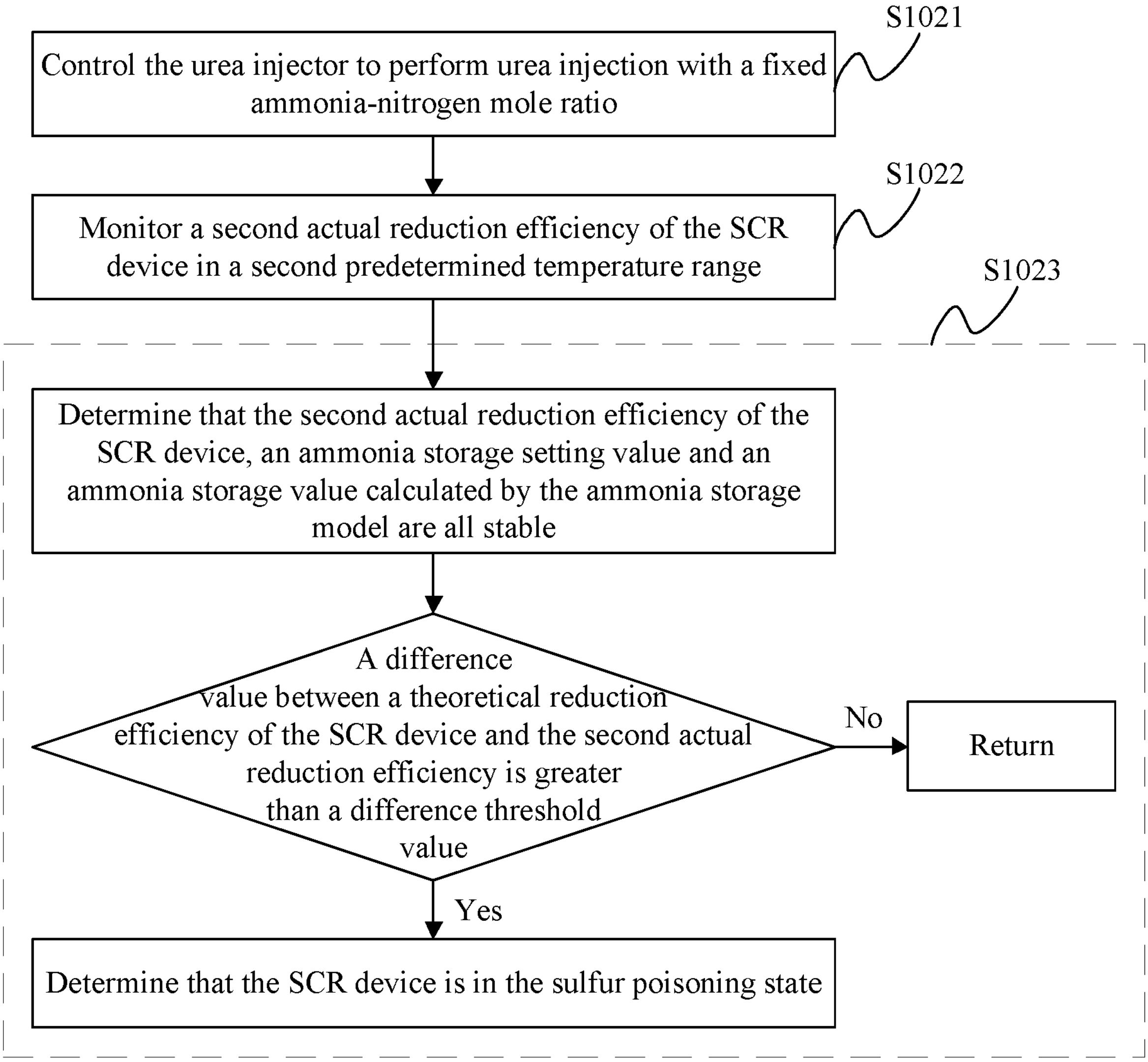
S1021
Control the urea injector to perform urea injection with a fixed ammonia-nitrogen mole ratio
S1022
Monitor a second actual reduction efficiency of the SCR device in a second predetermined temperature range
S1023
Determine that the second actual reduction efficiency of the SCR device, an ammonia storage setting value and an ammonia storage value calculated by the ammonia storage model are all stable
A difference value between a theoretical reduction efficiency of the SCR device and the second actual reduction efficiency is greater than a difference threshold value
No
Return
Yes
Determine that the SCR device is in the sulfur poisoning state

Figure 3

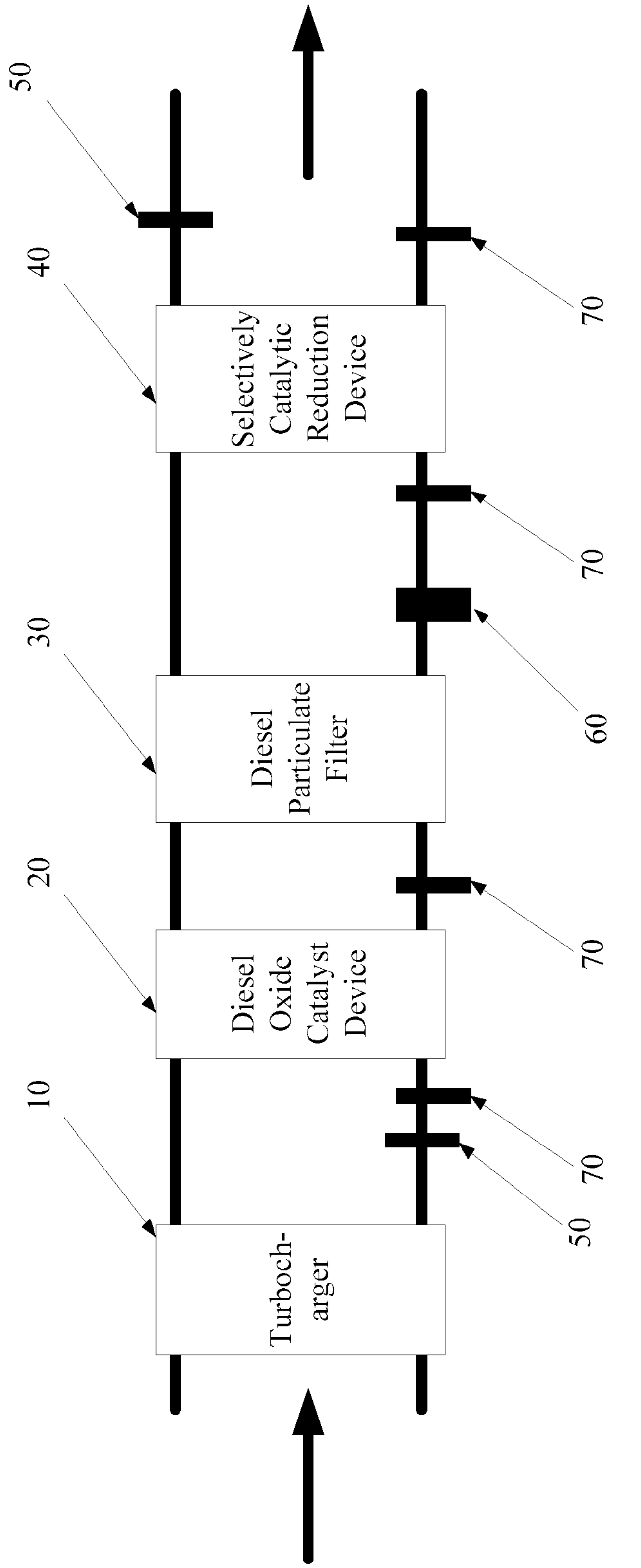
Turboch-
arger
Diesel
Oxide
Catalyst
Device
Diesel
Particulate
Filter
Selectively
Catalytic
Reduction
Device
10
20
30
40
50
50
60
70
70
70
70

Figure 4

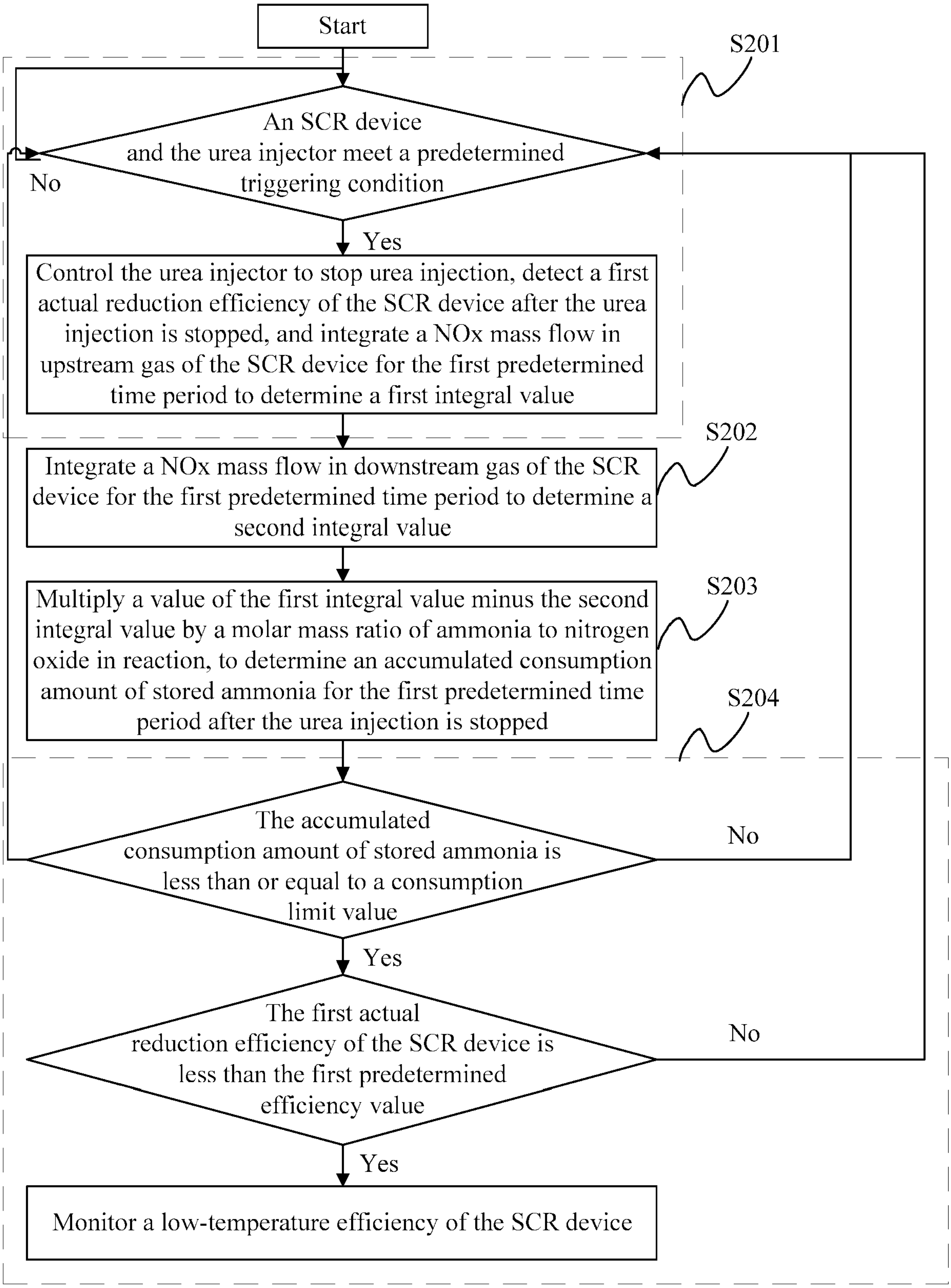
Start
S201
An SCR device and the urea injector meet a predetermined triggering condition
No
Yes
Control the urea injector to stop urea injection, detect a first actual reduction efficiency of the SCR device after the urea injection is stopped, and integrate a NOx mass flow in upstream gas of the SCR device for the first predetermined time period to determine a first integral value
S202
Integrate a NOx mass flow in downstream gas of the SCR device for the first predetermined time period to determine a second integral value
S203
Multiply a value of the first integral value minus the second integral value by a molar mass ratio of ammonia to nitrogen oxide in reaction, to determine an accumulated consumption amount of stored ammonia for the first predetermined time period after the urea injection is stopped
S204
The accumulated consumption amount of stored ammonia is less than or equal to a consumption limit value
No
Yes
The first actual reduction efficiency of the SCR device is less than the first predetermined efficiency value
No
Yes
Monitor a low-temperature efficiency of the SCR device

Figure 5

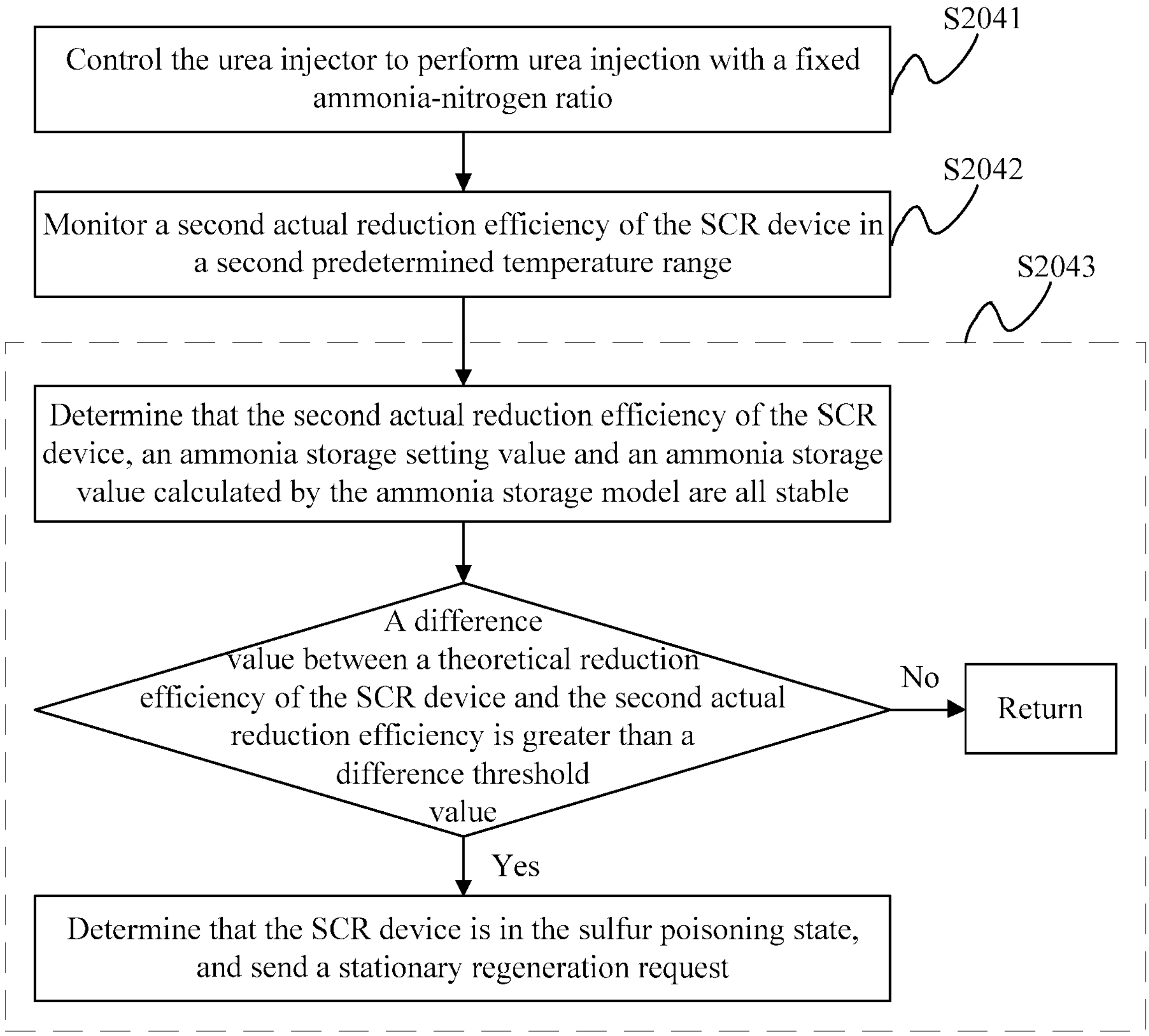
S2041
Control the urea injector to perform urea injection with a fixed ammonia-nitrogen ratio
S2042
Monitor a second actual reduction efficiency of the SCR device in a second predetermined temperature range
S2043
Determine that the second actual reduction efficiency of the SCR device, an ammonia storage setting value and an ammonia storage value calculated by the ammonia storage model are all stable
A difference value between a theoretical reduction efficiency of the SCR device and the second actual reduction efficiency is greater than a difference threshold value
No
Return
Yes
Determine that the SCR device is in the sulfur poisoning state, and send a stationary regeneration request

Figure 6

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- WO 2018132059 A1 **[0004]**