

Automatic cleaning system and method for vehicle wheels

5 Technical Field

The invention relates to a cleaning system and a cleaning method thereof, more specifically to a system and a method for cleaning vehicle wheels. The system and the method can be mainly used to clean wheels of the vehicles entering into a dusty or
10 dirty site, such as a construction site, so as to prevent the surrounding region from being polluted by dust, dirt or the like.

Background

15 Development of cities depends on construction projects. However, a huge amount of dust, dirt or the like inevitably exists in different building and construction sites. Therefore, a variety of engineering vehicles that frequently drive in and out of the construction site will take the dust and dirt therein to outside places. To maintain a clean environment in cities, governments will generally stipulate that wheels of the
20 vehicle from a construction site have to be cleaned before the vehicle leaves the construction site. Currently, in some construction sites, the wheels are cleaned by a high-pressure squirt gun operated by hand, without any dedicated devices. This method needs manpower and is also time consuming. Also, used water, always being dirty after cleaning, will be discharged out of the cleaning place freely, thus negatively
25 influencing on the environment inside the construction sites. In some other construction sites, a cleaning system with rollers is used. However, this roller-type cleaning system needs a long cleaning time, and the vehicle to be cleaned has to be in an idle state during cleaning in order that the wheels and the rollers can be both freely rotary when cleaning. If the driver forgets to keep the vehicle into the idle state, the
30 components of the cleaning system will be harmed. If so, the maintenance fee for the cleaning system will be increased, and the cleaning procedure will be also interrupted, thus reducing the cleaning efficiency. Meanwhile, both of the above-mentioned methods need a large amount of water, which is disadvantageous in view of environmental protection.

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Summary

To solve the defects in the prior arts, the invention aims to provide an automatic

cleaning system for vehicle wheels and a method thereof, with which the cleaning time is shortened, the structure is simple and easily maintained and the amount of water used is reduced.

5 According to the invention, an automatic cleaning system for vehicle wheels is provided, including a cleaning trough to which a vehicle to be cleaned can drive in and out, a water pump, a plurality of high pressure water nozzles for cleaning vehicle wheels, and an automatic cleaning control circuit. The cleaning trough and the high pressure water nozzles connect to a water circulating system, the high pressure water
10 nozzles being arranged at both sides of the cleaning trough and directing at the wheels at both sides of the vehicle to be cleaned in the cleaning trough along a plurality of corresponding directions. The automatic cleaning control circuit includes a microcontroller, a vehicle-in-position sensor connecting to the signal input of the microcontroller and an actuator connecting to the signal output of the microcontroller,
15 wherein the vehicle-in-position sensor collects information on whether or not the vehicle enters into the cleaning trough, and the microcontroller receives and processes the information collected by the vehicle-in-position sensor, and then controls the actuator to open or close the water pump and the high pressure nozzles at an appropriate time.

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The water circulating system includes a sedimentation tank for receiving used, dirty water from the cleaning trough, a dirty water treatment device and a circulating water storing box, wherein the inlet and outlet of the dirty water treatment device connect to the sedimentation tank and the circulating water storing box via corresponding pipes
25 respectively, and the outlet of the circulating water storing box connects to the water pump and the high pressure water nozzles in sequence through a water pipe.

A lateral drainage trench communicating to the sedimentation tank is provided in front of the cleaning trough, and is used to collect water being discharged when the vehicle
30 leaves the cleaning trough.

A sand filtering layer is provided in the upper portion of the sedimentation tank. The sedimentation tank has a water outlet, which leads to the dirty water treatment device and is arranged above the sand filtering layer. In this manner, the purification
35 efficiency can be increased.

The vehicle-in-position sensor is a plurality of pairs of infrared transmitting assemblies located at both sides of the cleaning trough, each infrared transmitting

assembly including an infrared transmitter and an infrared receiver that are cooperated with each other in pair, wherein the infrared transmitter and the infrared receiver are arranged respectively at both sides of the cleaning trough opposite to each other.

- 5 The left and right side walls of the cleaning trough are both provided with a fence and a retaining plate, wherein the infrared transmitting assemblies are mounted on the fence at both sides of the cleaning trough.

10 The spraying angle of the plurality of high pressure water nozzles mounted on both sides of the cleaning trough can be adjusted so as to obtain an optimal cleaning angle. Two adjacent high pressure water nozzles are spaced from each other at a distance of 250-330 mm.

15 The cleaning trough has a vertical cross section of an inverted trapezoidal shape, the bottom face of which being lower than the road surface 400-500 mm. The water discharging port arranged on the left or right side wall of the cleaning trough has a diameter of 100-200 mm.

20 The automatic cleaning control circuit further includes an alerting device connecting to the microcontroller for indicating the cleaning is finished, wherein the alerting device can be in form of a visual alarm and/or a sound alarm.

25 The cleaning system according to the invention further includes a manual switch for controlling the actuator. Even in the case that the automatic cleaning control circuit fails, it is ensured that the system can be controlled in a manual way.

The invention further provides a method for automatically cleaning vehicle wheels with the above mentioned automatic cleaning system, including the following steps:

30 Step A: Switching on the system, so that the microcontroller of the automatic cleaning control circuit inquires about the state of the vehicle-in-position sensor unintermittently;

35 Step B: When a vehicle to be cleaned enters in the cleaning trough, the microcontroller collects information about the vehicle enters in the cleaning trough and sends the information to the microcontroller, which, after receiving the signal indicating the vehicle enters in the cleaning trough, controls the actuator to switch on the water pump, so that wheels of the vehicle entering in the cleaning trough are cleaned by the high pressure water nozzles arranged at both sides of the cleaning trough;

Step C: After a predetermined cleaning time passes through, the microcontroller controls the alerting device to send out an alert signal informing the cleaning is finished; when the driver drives the vehicle away from the cleaning trough after receiving the alert signal, the vehicle-in-position sensor transmits information about the vehicle is no longer in the cleaning trough to the microcontroller, which controls the actuator to switch off the water pump, so that the spraying and cleaning operation of the high pressure water nozzles at both sides of the cleaning trough is ended.

In the above cleaning method, the cleaning water can be reused after being treated by the water circulating system. Therefore, the method further includes the following steps:

Step D: Discharging the used, dirty water from the cleaning trough to the sedimentation tank through the water discharging port, the dirt and dust in the dirty water residing in the bottom portion of the sedimentation tank by means of a preliminary sedimentation;

Step E: Filtering the water after sedimentation by means of the sand filter layer arranged at the upper portion of the sedimentation tank, and then delivering the filtered water to the dirty water treatment device for treatment, so that a circulating water that can meet the requirement of cleaning the wheel is obtained;

Step F: Storing the circulating water from the dirty water treatment device in a circulating water storing box, and allowing the circulating water flows to the water pump and the high pressure water nozzles for reuse in cleaning of wheels.

The vehicle-in-position sensor is a plurality of infrared transmitters and receivers located at both sides of the cleaning trough respectively, wherein a signal indicating the vehicle enters in the cleaning trough is sent to the microcontroller when the vehicle to be cleaned enters in the cleaning trough and thus blocks the signal transmission of one pair of the infrared transmitters and receivers.

Compared with the prior arts, the cleaning system for vehicle wheels has the following advantages: 1) the whole system detects the information about the vehicle to be cleaned drives in and out by means of a sensor, and controls the actuator to automatically switch on or off the water pump and the high pressure water nozzles with the microcontroller; therefore, the whole procedure is completed automatically without manual operation, thus significantly saving labor cost; 2) the whole cleaning system is of a simple and durable structure, thus reducing the daily maintenance fee; 3) the cleaning water can be reused by means of the water circulating system; therefore, it can reduce the water cost and save water, thus is environmentally friendly; and 4)

the cleaning time is short; for example, it costs only 2-3 minutes for cleaning one vehicle; thus the system has a high cleaning efficiency.

Brief Description of Drawings

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Fig. 1 schematically shows the vehicle wheel cleaning system according to the invention.

Fig. 2 is the vertical cross-sectional view of the cleaning trough.

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Fig. 3 schematically shows the structure of the sedimentation tank.

Fig. 4 is the block diagram showing the principle of the automatic cleaning control circuit.

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Preferred Embodiments of the Invention

In the following the invention will be discussed in details with reference to embodiments and the attached drawings.

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As shown in Figs. 1 and 2, the automatic cleaning system for vehicle wheels according to the invention mainly includes: a cleaning trough 1 to which the vehicle to be cleaned can drive in and out, a water circulating system, a water pump 6, a plurality of high pressure water nozzles 22 for cleaning vehicle wheels, an automatic
25 cleaning control circuit, and a vehicle-in-position sensor 32. The water circulating system further includes a sedimentation tank 51 for receiving used water from the cleaning trough 1, a dirty water treatment device 52 and a circulating water storing box 53. The inlet and outlet of the dirty water treatment device 52 connect to the sedimentation tank 51 and the storing box 53 via corresponding pipes respectively,
30 and the outlet of the circulating water storing box 53 connects to the water pump 6 and the high pressure water nozzles 22 in sequence through a water pipe 23.

As shown in Fig. 4, the automatic cleaning control circuit includes a microcontroller 31, the vehicle-in-position sensor 32 connecting to the signal input of the
35 microcontroller 31, an actuator 33 connecting to the signal output of the microcontroller 31, and an alerting device 34. In this embodiment, the vehicle-in-position sensor 32 is an infrared sensor, which, as shown in Fig.2, includes three pairs of infrared transmitting assemblies located at both sides of the cleaning

trough 1. Each infrared transmitting assembly includes an infrared transmitter and an infrared receiver that are cooperated with each other in use. The infrared transmitter and the infrared receiver are arranged respectively at both sides of the cleaning trough 1 opposite to each other. The alerting device 34, which is used to indicate the cleaning for vehicle wheel is finished, can be in form of a visual alarm and/or a sound alarm, such as a ring tone or a caution light, etc. The vehicle-in-position sensor 32 collects information on whether or not a vehicle enters into the cleaning trough 1. The microcontroller 31 receives and processes the information collected by the vehicle-in-position sensor 32, and then controls the actuator 33 to open or close the water pump 6 and the high pressure water nozzles 22 at an appropriate time. The actuator 33 includes a relay and an electromagnetic valve for controlling opening and closing of the water pump 6 and the high pressure water nozzles 22. In order to manually control the system so as to enable it in normal operation when the automatic control circuit fails, the actuator 33 is provided with a manual switch 35.

As shown in Fig. 2, the cleaning trough 1 has a vertical cross section of an inverted trapezoidal shape, the bottom face 12 of which being lower than the outer road surface 7 about 450 mm. The front end and the rear end of the bottom face 12 connect to the outer road surface through slopes 16. The left or right side wall 13 of the cleaning trough 1 is provided with a water discharging port 11, which connects to the sedimentation tank 51 and has a diameter of 150 mm. Of course, both of the depth of the bottom face 12 and the diameter of the water discharging port 11 can be suitably selected according to the types of most vehicles to be cleaned, and the particular values as mentioned above are exemplary only.

As shown in Figs. 1 and 2, the left and right side walls 13 of the cleaning trough 1 are both provided with a water discharging pipe 21 leading to the water pipe 23 along the longitudinal direction thereof. Each of the water discharging pipes 21 is provided with a plurality of high pressure water nozzles 22, which direct at the wheels at both sides of the vehicle to be cleaned in the cleaning trough 1 along a plurality of corresponding directions. The spraying angle of the plurality of high pressure water nozzles 22 can be adjusted so as to obtain an optimal cleaning angle. Two adjacent high pressure water nozzles 22 are spaced from each other at a distance of 250-330 mm, in particular 300 mm in the example as shown. To prevent the used, dirty water from splashing during cleaning, the left and right side walls 13 of the cleaning trough 1 are both provided with a fence 91 and a retaining plate 92. The infrared transmitting assemblies are mounted on the fence 91 at both side walls 13 of the cleaning trough 1. Moreover, to prevent the dirty water being forced to flow outside when the vehicle

leaves the cleaning trough 1, a lateral drainage trench 15 leading to the sedimentation tank 51 is provided in front of the cleaning trough 1. With the above structures, the surrounding region can be kept in a clean and dry condition during cleaning, and no dirty water will be splashed to the road and cause inconvenience to the pedestrians.

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As shown in Fig. 3, a sand filtering layer 513 is provided in the upper portion of the sedimentation tank 51. The sedimentation tank 51 has a water outlet 512, which leads to the dirty water treatment device 52 and is arranged above the sand filtering layer 513. The water outlet 512 is higher than the water discharging port 11 of the cleaning trough 1, so that a shallow water layer can be maintained at the bottom portion of the cleaning trough 1. The shallow water layer is used to dip with the wheels to be cleaned and thus facilitates the cleaning. The used dirty water discharges from the water discharging port 11, flows into the sedimentation tank 51 through the water inlet 511 and precipitates therein. The relatively clean water in the upper portion of the tank will be preliminarily filtered by the sand filtering layer 513, and then flow to the dirty water treatment device 52 via the water outlet 512. In this manner, the efficiency of water treatment will be enhanced.

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The cleaning method using the cleaning system according to the invention includes the following steps:

Step A: Switching on the system, so that the microcontroller 31 of the automatic cleaning control circuit inquires about the state of the vehicle-in-position sensor 32 unintermittently;

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Step B: When a vehicle to be cleaned enters in the cleaning trough 1 so that the signal transmission of the infrared transmitter and the infrared receiver of the sensor 32 is blocked, the microcontroller 31 receives a signal indicating the vehicle enters in the cleaning trough 1 and then controls the actuator 33 to switch on the water pump 6, so that wheels of the vehicle entering in the cleaning trough 1 are cleaned by the high pressure water nozzles 22 arranged at both sides of the cleaning trough 1;

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Step C: After a predetermined cleaning time passes through, the microcontroller 31 controls the alerting device 34 to send out an alert signal, informing the driver to drive the vehicle away from the cleaning trough 1. When the driver drives the vehicle away from the cleaning trough 1 after receiving the alert signal, the vehicle-in-position sensor 32 transmits information about the vehicle is no longer in the cleaning trough 1 to the microcontroller 31. Then, the microcontroller 31 controls the actuator 33 to

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switch off the water pump 6, so that the spraying and cleaning operation of the high pressure water nozzles 22 at both sides of the cleaning trough 1 is ended.

5 In Step C, the predetermined cleaning time can be suitably adjusted according to the condition of the construction site, the type of vehicle to be cleaned and the like. This can be easily done by one skilled in the art through testing, which is omitted herein for the sake of conciseness.

10 In the cleaning method according to the invention, the cleaning water can be reused after being treated by the water circulating system. Therefore, the method further includes the following steps:

15 Step D: Discharging the used, dirty water from the cleaning trough 1 to the sedimentation tank 51 through the water discharging port 11, the dirt and dust in the used water residing in the bottom portion of the sedimentation tank 51 by means of a preliminary sedimentation (optionally, cleaning the dirt and dust residing in the bottom portion of the sedimentation tank 51 at a regular time);

20 Step E: Filtering the water after sedimentation by means of the sand filter layer 513 arranged at the upper portion of the sedimentation tank 51, and then delivering the filtered water to the dirty water treatment device 52 for treatment, so that a circulating water meeting the requirement of cleaning the wheel is obtained;

25 Step F: Storing the circulating water from the dirty water treatment device 52 in the circulating water storing box 53, and allowing the circulating water to flow to the water pump 6 and the high pressure water nozzles 22 for reuse in cleaning of wheels. Therefore, the water can be reused in wheel cleaning.

30 While the invention has been described in conjunction with the preferred embodiments outlined above, it is evident that many alternatives, modifications and variations will be apparent to those skilled in the art. Various changes may be made without departing from the spirit and scope of the invention as defined in the following claims.

Claims

1. An automatic cleaning system for vehicle wheels, including a cleaning trough (1) to which a vehicle to be cleaned can drive in and out, a water pump (6), a plurality
5 of high pressure water nozzles (22) for cleaning vehicle wheels and an automatic cleaning control circuit,

characterized in that, the cleaning trough (1) and the high pressure water nozzles (22) connect to a water circulating system, the high pressure water nozzles (22) being
10 arranged at both sides of the cleaning trough (1) and directing at the wheels at both sides of the vehicle to be cleaned in the cleaning trough (1) along a plurality of corresponding directions; and

the automatic cleaning control circuit includes a microcontroller (31), a vehicle-in-position sensor (32) connecting to the signal input of the microcontroller (31) and an actuator (33) connecting to the signal output of the microcontroller (31),
15 wherein the vehicle-in-position sensor (32) collects information on whether or not the vehicle enters into the cleaning trough (1), and the microcontroller (31) receives and processes the information collected by the vehicle-in-position sensor (32), and then controls the actuator (33) to open or close the water pump (6) and the high pressure nozzles (22) at an appropriate time.

2. The automatic cleaning system for vehicle wheels according to claim 1,
20 characterized in that, the water circulating system includes a sedimentation tank (51) for receiving used, dirty water from the cleaning trough (1), a dirty water treatment device (52) and a circulating water storing box (53), wherein the inlet and outlet of the dirty water treatment device (52) connect to the sedimentation tank (51) and the circulating water storing box (53) via corresponding pipes respectively, and the outlet
25 of the circulating water storing box (53) connects to the water pump (6) and the high pressure water nozzles (22) in sequence through a water pipe.

3. The automatic cleaning system for vehicle wheels according to claim 2,
30 characterized in that, a lateral drainage trench (15) communicating to the sedimentation tank (51) is provided in front of the cleaning trough (1).

4. The automatic cleaning system for vehicle wheels according to claim 2,
35 characterized in that, a sand filtering layer (513) is provided in the upper portion of the sedimentation tank (51), and the sedimentation tank (51) has a water outlet (512), which leads to the dirty water treatment device (52) and is arranged above the sand filtering layer (513).

5. The automatic cleaning system for vehicle wheels according to any one of claims 1 to 4, characterized in that, the vehicle-in-position sensor (32) is a plurality of pairs of infrared transmitting assemblies located at both sides of the cleaning trough (1), each infrared transmitting assembly including an infrared transmitter and an infrared receiver that are cooperated with each other in pair, wherein the infrared transmitter and the infrared receiver are arranged respectively at both sides of the cleaning trough (1) opposite to each other.

6. The automatic cleaning system for vehicle wheels according to claim 5, characterized in that, the left and right side walls of the cleaning trough (1) are both provided with a fence (91) and a retaining plate (92), wherein the infrared transmitting assemblies are mounted on the fence (91) at both sides of the cleaning trough (1).

7. The automatic cleaning system for vehicle wheels according to any one of claims 1 to 4, characterized in that, the spraying angle of the plurality of high pressure water nozzles (22) mounted on both sides of the cleaning trough (1) can be adjusted so as to obtain an optimal cleaning angle, and two adjacent high pressure water nozzles (22) are spaced from each other at a distance of 250-330 mm.

8. The automatic cleaning system for vehicle wheels according to any one of claims 1 to 4, characterized in that, the cleaning trough (1) has a vertical cross section of an inverted trapezoidal shape, the bottom face (12) of which being lower than the road surface 400-500 mm, and the water discharging port (11) arranged on the left or right side wall of the cleaning trough (1) has a diameter of 100-200 mm.

9. The automatic cleaning system for vehicle wheels according to any one of claims 1 to 4, characterized in that, the automatic cleaning control circuit further includes an alerting device (34) connecting to the microcontroller (31) for indicating the cleaning is finished, wherein the alerting device (34) can be in form of a visual alarm and/or a sound alarm.

10. The automatic cleaning system for vehicle wheels according to any one of claims 1 to 5, characterized in that, the actuator (33) is provided with a manual switch (35).

11. A method for automatically cleaning vehicle wheels using the automatic cleaning system according to any one of claims 1 to 10, including the following steps:

Step A: Switching on the system, so that the microcontroller (31) of the automatic cleaning control circuit inquires about the state of the vehicle-in-position sensor (32) unintermittently;

Step B: When a vehicle to be cleaned enters in the cleaning trough (1), the microcontroller (31) collects information about the vehicle enters in the cleaning trough (1) and sends the information to the microcontroller (31), which, after receiving the signal indicating the vehicle enters in the cleaning trough (1), controls the actuator (33) to switch on the water pump (6), so that wheels of the vehicle entering in the cleaning trough (1) are cleaned by the high pressure water nozzles (22) arranged at both sides of the cleaning trough (1);

Step C: After a predetermined cleaning time passes through, the microcontroller (31) controls the alerting device (34) to send out an alert signal informing the cleaning is finished; when the driver drives the vehicle away from the cleaning trough (1) after receiving the alert signal, the vehicle-in-position sensor (32) transmits information about the vehicle is no longer in the cleaning trough (1) to the microcontroller (31), which controls the actuator (33) to switch off the water pump (6), so that the spraying and cleaning operation of the high pressure water nozzles (22) at both sides of the cleaning trough (1) is ended.

12. The method for automatically cleaning vehicle wheels according to claim 11, characterized in that, the cleaning water can be reused after being treated by the dirty water circulating system, and the method further includes the following steps:

Step D: Discharging the used, dirty water from the cleaning trough (1) to the sedimentation tank (51) through the water discharging port (11), the dirt and dust in the dirty water residing in the bottom portion of the sedimentation tank (51) by means of a preliminary sedimentation;

Step E: Filtering the water after sedimentation by means of the sand filter layer (513) arranged at the upper portion of the sedimentation tank (51), and then delivering the filtered water to the dirty water treatment device (52) for treatment, so that a circulating water meeting the requirement of cleaning the wheel is obtained;

Step F: Storing the circulating water from the dirty water treatment device (52) in a circulating water storing box (53), and allowing the circulating water flows to the water pump (6) and the high pressure water nozzles (22) for reuse in cleaning of wheels.

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13. The method for automatically cleaning vehicle wheels according to claim 11, characterized in that, the vehicle-in-position sensor (32) is a plurality of infrared transmitters and receivers located at both sides of the cleaning trough (1) respectively,

wherein a signal indicating the vehicle enters in the cleaning trough (1) is sent to the microcontroller (31) when the vehicle to be cleaned enters in the cleaning trough (1) and thus blocks the signal transmission of one pair of the infrared transmitters and receivers.

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