Title of Invention: Method for suctioning braking particles

Technical field

The invention relates to braking particle suction systems in friction braking systems. Such friction braking systems can be fitted to road or rail vehicles. Such friction braking systems can also be fitted to stationary rotor-based machines such as wind turbines or industrial machines.

Context and Prior Art

In such systems, as described for example in document DE4240873, a suction turbine and a particle collection filter are provided. Particles from abrasion are thus gradually accumulated in the collection filter. This results in a progressive clogging of the filter and the pneumatic lines which lead to the filter. When friction pads are used, suction grooves can be provided in the friction material as taught by the applicant, for example in document FR3057040.

Document FR3088395 provided a control solution adapted to optimize turbine control during braking and to indicate a clogged state of the filter.

The inventors, however, noticed that the pneumatic lines tended to become clogged over time, due to a small deposit of braking particles which gradually accumulate therein.

The object of the present invention is to propose an improved solution for maintaining pneumatic lines in a satisfactory state.

Summary

For this purpose, according to an aspect, the present disclosure refers to a method for controlling a braking particle suction system of a friction braking system, the braking particle suction system comprising:

at least one negative pressure source, at least one suction mouth arranged close to a friction interface or inside a friction part and connected by at least one pneumatic line to the negative pressure source, a control unit configured to control the negative pressure source, and a means of supplying current braking activation information,

the method providing that the control unit is configured to:

a- control the negative pressure source, for a braking suction sequence, according to the current braking activation information, in order to ensure suction is applied as soon as braking is activated,

b- establish at least one cleaning suction condition, outside of any braking sequence,

c- as soon as the at least one cleaning suction condition satisfies a predetermined criterion, control the negative pressure source for a cleaning sequence for the at least one pneumatic line, for a predetermined duration,

the method providing that, in step **b-**, the determination of the cleaning suction condition is a logical/algorithmic calculation which takes into account at least one of the following variables:

- a current speed of the vehicle, in particular if the current speed of the vehicle is above a first speed threshold,
- a time elapsed since a last cleaning sequence,
- a distance traveled since the last cleaning sequence,
- a number of dynamic braking actions carried out since the last cleaning sequence,
- a prevalence of a maintenance mode.

In an aspect, the present disclosure refers to a braking particle suction system of a friction braking system, the suction system comprising at least one negative pressure source, at least one suction mouth arranged close to a friction interface or inside a friction part and connected by at least one pneumatic line to the negative pressure source, a control unit configured to control the negative pressure source, and a means of supplying current braking activation information, the suction system being configured to implement the method according to the above aspect.

In an example, a method is proposed for controlling a braking particle suction system of a friction braking system, the suction system comprising:

at least one negative pressure source, at least one suction mouth arranged close to a friction interface or inside a friction part and connected by at least one pneumatic line to the negative pressure source, a control unit configured to control the negative pressure source, and a means of supplying current braking activation information,

the method providing that the control unit is configured to:

a- control the negative pressure source (for example the rotation of the turbine), for a braking suction sequence, according to the current braking activation information, in order to ensure suction is applied as soon as (and as long as) braking is activated,

b- establish at least one cleaning suction condition, outside of the braking sequences,

c- as soon as the at least one cleaning suction condition satisfies a predetermined criterion, control the negative pressure source (for example the rotation of the turbine) for a cleaning sequence for the at least one pneumatic line, for a predetermined duration (TN).

By means of these arrangements, a sequence with high pneumatic flow can be

provided, which makes it possible to clean the pneumatic line(s). While driving, any whistling noise due to this operation is covered by the rolling noise, given that this

operation is carried out when the vehicle is traveling above a threshold speed. A cleaning sequence could also be called upon for maintenance reasons or in diagnostic conditions.

One will note that the braking suction sequences are carried out at a low flow rate, while conversely the cleaning sequences are carried out at a high flow rate, by having increased the airflow-limiting cross-sectional area at the suction mouth.

The term “friction interface” designates a [pad against disc] interface surface or a [pad against rim] interface surface, and all friction braking configurations are covered. Furthermore, “close to” means that the suctioning occurs in proximity to the interface surfaces mentioned above.

One will also note that if friction pads are used, the suction grooves made in the friction material form the suction mouth, which is then arranged inside the friction part that constitutes the friction pad.

In various examples of the disclosure relating to the method, it is possible to additionally make use of one or more of the following arrangements, individually or in combination.

According to one example, in step **b-**, the determination of the cleaning suction condition is a logical/algorithmic calculation which takes into account at least one of the following variables:

- the current speed of the vehicle, in particular above a first speed threshold (V1),
- the time elapsed since the last cleaning sequence,
- the distance traveled since the last cleaning sequence,
- the number of dynamic braking actions carried out since the last cleaning sequence,
- the prevalence of a maintenance mode (garage mode or diagnostic mode).

Such a multi-parameter, multi-criteria condition is used in order to decide to trigger the cleaning sequence in the most optimized manner possible; in other words, the number of cleaning sequences relative to the desired efficiency in maintaining the lines in good condition is minimized.

Dynamic braking is understood to mean braking carried out while the vehicle is not at zero speed.

According to one example, it may be provided that in step c-, the negative pressure source (e.g. the rotation of the turbine) is activated to maximum power. This maximizes the effect of high-flow suctioning in removing particles that may have been deposited inside the lines.

According to one example, it may be provided that the predetermined duration (TN) is selected within a range of between 3 seconds and 15 seconds. This duration is sufficient and necessary to ensuring proper cleaning of the lines.

According to one example, the cleaning sequence is triggered, outside of maintenance

mode, only if the current speed of the vehicle is greater than a first speed threshold. The cleaning sequence is thus unlikely to be heard by a vehicle occupant or a passerby, because its sound level is covered by the rolling noise.

According to one example, the cleaning sequence (52) is triggered in response to a request made by a diagnostic device during maintenance mode. Thus, when exchanging brake pads, with the line disconnected and without pads, the diagnostic tool can be used to generate a suction sequence with no airflow restriction at the pad area.

According to one example, the negative pressure source is formed by a turbine driven by an electric motor (11), the control unit (6) being configured to control the electric motor. This is a flexible solution to use, as the speed of the turbine can be adjusted according to suction requirements.

According to one example, the control unit can be configured to control, during the cleaning sequence, a vent solenoid valve arranged on the pneumatic circuit close to the suction mouth. This makes it possible to further increase air flow inside the pneumatic line during the cleaning sequence. When said vent solenoid valve is activated, there is no longer any airflow-limiting section at the friction interface side.

In an example, the disclosure also relates to a braking particle suction system of a friction braking system, the suction system comprising at least one negative pressure source (1), at least one suction mouth (83) arranged close to a friction interface or inside a friction part and connected by at least one pneumatic line to the negative pressure source, a control unit (6) configured to control the negative pressure source, and a means of supplying current braking activation information, the suction system being configured to implement the method as described above.

According to one example, the system may further comprise at least one filter (2) for collecting the suctioned particles.

According to one example, the system comprises a centralized filter and a centralized turbine, which are connected to four or more suction mouths. In this configuration the pneumatic lines are of some length, hence the advantage of being able to clean them from time to time.

According to one example, a vent solenoid valve (59) may be provided on the pneumatic circuit and close to the suction mouth. Such a solenoid valve allows substantially increasing the airflow inside the pneumatic line during the cleaning sequence, said solenoid valve allowing the pneumatic pipe to communicate with the atmosphere (free air) on the suction mouth side.

Description of the figures

Other aspects, aims, and advantages of the invention will become apparent upon reading the following description of an embodiment of the invention, given as a non-