

Description

The invention relates to a method for removing substances adhering on a surface of the type mentioned in the preamble of the patent claim 1 and further relates to a nozzle structure for use in the method (preamble of claim 4).

With such a method known from the DE-A-3 234 419 the water pressure to be supplied to each of the unit nozzles is 1000 bar.

Furthermore from the CH-A-567 907 a nozzle structure for use in a spraying apparatus is known which comprises a nozzle tip formed with an opening having a reduced diameter portion and a tapering portion, nozzle tip holding members fitted in a recess formed in a nozzle head for holding the nozzle tip and a nut for fixing the nozzle tip in a position within the recess.

The external wall of a building gets dirt or contaminated by dust contained in air or rain with the passage of time. In general, the wall is needed to be renovated, for example by re-painting, every ten years or so. In case of a special kind of wall such as a so-called curtain wall, the wall should be washed every two or three years to remove dirt thereon. Or, as the case may be, there is a need for stripping a coating on the wall to expose a surface thereof.

Washing of the wall is generally carried out by using water or washing chemicals. When water is used, relatively high-pressure water of about 40 to 200 kp/cm² is jetted through a nozzle having a diameter of about 2 mm at a flow rate of 25 to 45 l/min.

Stripping or peeling of the coating of the wall is carried out by using a sander, a chip-cleaner or a concrete-planer. Alternatively, chemicals are also used for stripping or peeling.

However, these conventional methods have various disadvantages. When chemicals are used in washing, there is no problem of dusting, but the chemicals usually contain acids and they give undesirable influence upon plants on the ground and possibly deteriorate or change the properties of the surface of the wall.

Sanding or planing can effectively remove dirt or contaminant on the wall together with a surface thereof, but it has such a fatal defect that it makes dust, compromising the safety of the operator and contaminating the surroundings. If water is used in sanding or planing to prevent dusting, the sander or planer will be clogged and the operation efficiency will be lowered.

In contrast, the method using high-pressure water is free from the problems as described above and it is advantageous in that water can be easily obtained at low cost. However, the conventional method of this type is not satisfactory in that water is only jetted from a single nozzle and therefore washing or stripping is only made linearly when the nozzle is moved. Thus, the operation efficiency is extremely low.

It is therefore the object of the present invention to provide a method for removing substances adhering of a surface of the type mentioned in the preamble of the patent claim 1 which is excellent in operation efficiency and free from dusting which assures the safety of the operator.

According to the present invention this is obtained by the steps mentioned in the characterizing part of the patent claim 1.

Preferred embodiments of the method according to the present invention are subject matter of the patent claims 2 and 3. A nozzle structure for use in an apparatus for removing substances adhering on a surface in the method of the invention is subject matter of claim 4.

The present invention may be applied to washing of an outer wall of buildings or the like for removal of dirt or contaminant, stripping or peeling of coatings such as Lithine or paints, removing of deteriorated sprayed tiles, removing of concrete dust or removing of scale or rust of steel plates. The invention may further be applied to removal of burr on an inner wall of a tank.

Fig. 1 is a longitudinal sectional view of an apparatus embodying the present invention;

Fig. 2 is a sectional view of a nozzle head employable in the present invention;

Fig. 3 is a left side elevational view of the nozzle head of Fig. 2;

Fig. 4 is a detailed sectional view of a nozzle provided in the nozzle head;

Fig. 5 shows loci of nozzles when the nozzle head is held at a position;

Fig. 6 shows loci of nozzles when the nozzle head is moved sidewardly;

Figs. 7 and 8 are front side elevational views of alternative nozzle heads, respectively; and

Figs. 9 and 10 are graphs showing the relationships between the nozzle diameter and the flow rate.

The invention will be described in detail referring to the drawings.

The structure of an apparatus embodying the present invention will be first described.

10 is a holder which is substantially cylindrical. The holder 10 comprises a front portion 10A and a rear portion 10B which are coupled by a bolt 12 in a position for use but they are disengageable from each other according to necessity, for example, when the holder is required to be repaired. The front portion 10A has a handle 14 provided integrally therewith at a lower portion thereof. Within the front portion 10A, a revolving follower gear 16 is supported by bearings 18A and 18B and adapted to be rotated around its axis. The revolving follower gear 16 is provided with a liquid feed pipe 20 having an axis C2 at a position deviated for example by 5 mm from the axis C1 of the holder 10 and the liquid feeding pipe 20 is supported by bearings 22 and 24. An attachment 26 is integrally secured to the forward end of the liquid feeding pipe 20 through a thrust bearing 28. A nozzle head 30 as will be described in detail later is connected integrally with the attachment 26 in such a manner that its axis may be aligned with the axis C2.

The rear end of the liquid feeding pipe 20 is coupled through a semi-spherical seat 20a to a flexible tube 32 which is in turn connected to an external pump (not shown) for high-pressure water W. 34 is a holding member for holding the coupling portion. The rear end of the flexible tube 32 is fixed in a protection pipe 36 mounted on the rear portion 10B of the holder 10 through a bush 38 and a securing nut 40.

42 is an air motor driven by air ai. The air motor is adapted to be held by a right hand of an operator and cooperates with the handle 14 to be held by a left hand of the operator to support the entire structure of the holder 10. The air motor 42 includes a switch 44 and it is coupled to the protection pipe 36 by a mounting bracket 46. There remains a space 48 between the front portion 10A and the rear portion 10B of the holder 10. Within the space 48 is rotatably supported a prime gear 50 by bearings 52 and 54. The output shaft of the air motor 42 and the prime gear 50 are coupled by a connecting rod 56 and the prime gear 50 is in mesh with the follower gear 16.

The front end of the holder 10 is protected by a flexible cover 58 made of a flexible material such as rubber for preventing rebound of dust from the surface being treated. The nozzle head 30 is also protected by a cover 60.

With this arrangement, when high-pressure water W is fed to the flexible tube 32 through the pump, the water W passes through the liquid feeding pipe 20 to the nozzle head 30 through which water is jetted onto the surface to be treated. At this time, the air motor 42 is rotated and the follower gear 16 is rotated through the prime gear 50. Since the follower gear 16 has the liquid feeding pipe 20 at a position deviated from the axis C1 of the holder 10, the nozzle head 30 is revolved around the axis C1 as illustrated in Fig. 5. The forward portion of the flexible shaft 32 is revolved following the revolution of the nozzle head 30. The shaking of the nozzle head caused at this time is absorbed by the bearings 22 and 24.

According to the present invention, a plurality of nozzles 70A, 70B ..., for example, seven nozzles are provided on the nozzle head as illustrated in Figs. 2 and 3. In the nozzle head as illustrated, one nozzle is at a center and the remaining six nozzles are disposed at angular intervals of 60 so as to surround the center one. The nozzle head 30 has, at a central portion thereof, an inlet 71 communicating with the liquid feeding pipe 20, communicating passages 72 extending radially therefrom and introducing passages 73 communicating therewith. Thus, each of the nozzles 70A, 70B ... is communicated with the liquid feeding pipe 20 forming a liquid feeding path.

The details of each of the nozzles are illustrated in Fig. 4. For example, the nozzle comprises a nozzle tip 70a of diamond fitted in a hole 30a which is formed on the nozzle head 30 made of a titanium alloy. The nozzle tip 70a is held by holding pieces 70b, 70c made of a monel metal and fixed in a position by a nut 74 made of stainless steel and having a hexagonal hole.

The thickness T of the nozzle tip 70a is, for example, 0.5 to 2 mm and more preferably 0.5 to 1.5 mm and it has an opening having a reduced diameter portion where the diameter D is about 0.15 mm and a tapering portion where the opening has an angle θ of 25 to 55°, preferably 35 to 45°. The length l of the reduced diameter portion is preferably $1/2T \leq l \leq 2/3T$. In case the length l is larger than $2/3T$, there may be caused turbulent flow and in case the length l is smaller than $1/2T$, the nozzle tip 70a is liable to be worn out. When the angle θ of the opening is larger than 55°, water jetted through the nozzle is atomized and the energy of water per unit area is lowered. When the angle is smaller than 25°, not only water jetted through the nozzle becomes turbulent, but the operation efficiency is lowered.

In the present invention, the pressure of water fed to each of the nozzles 70A, 70B ... is above 800 kg/cm² and preferably 1000 kg/cm² or more. When high-pressure water is jetted from each of the nozzles while the nozzle head 30 is being revolved as illustrated in Fig. 5, the loci of jetted water are as shown in Fig. 5. In this state, when the nozzle head 30 is moved sidewardly, the loci become as illustrated in Fig. 6. In the figure, the loci of the nozzles 70F and 70G are omitted. Thus, the high-pressure water acts all over the surface to be treated and washing and peeling of the substances adhering thereto may be attained over a wide area.

The number of the nozzles on the nozzle head is not critical and it may be selected according to necessity. It may, for example, be seven as illustrated in Fig. 3, twelve as illustrated in Fig. 7 and twenty as illustrated in Fig. 8. However, the positions of the nozzles may be selected in relation with the distance of the deviation so that the locus of each of the nozzles may overlap as illustrated in Fig. 6.

The diameter D of the nozzles, the pressure P of water, the amount q of jet flow per nozzle, the amount Q of total jet flow and the number R of revolutions of the nozzle head are selected so as to be within the following ranges. The optimum ranges are denoted within the parentheses.

$$\begin{aligned} D &= 0.05 \text{ to } 0.5 \text{ mm (0.1 to 0.3 mm)} \\ 0.1 \text{ l/min (0.2)} &\leq q \leq 4.3 \text{ l/min (3.0)} \\ 1.5 \text{ l/min (2.0)} &\leq Q \leq 12 \text{ l/min (8.0)} \\ 800 \text{ kg/cm}^2 \text{ (1000)} &\leq P \leq 5000 \text{ kg/cm}^2 \text{ (3000)} \\ 800 \text{ rpm (1000)} &\leq R \leq 4000 \text{ rpm (2500)} \end{aligned}$$

The diameter D of the nozzle, the jet flow q per nozzle and the total jet flow Q have relationships as shown in Figs. 9 and 10. In case the nozzle diameter D is smaller than the specified limit, the jet energy is too small to obtain sufficient washing and peeling effects even if the pressure of water is raised. In addition, clog may possibly be caused at a nozzle, especially at a nozzle tip. In case the diameter D is larger than the

specified limit, the flow q and Q become too large for an operator to hold the apparatus by hand and too large to drain without a draining system. In case the pressure P is small, the washing and peeling effects are insufficient and in case the pressure P is large, desired washing and peeling effects can be obtained. However, in the latter case, there are such disadvantages that the wearing of the nozzle tip is large and therefore the material of the nozzle tip should be selected so as to have sufficient strength to tolerate the wearing. If the number R of revolutions is small, each of the nozzles stays at one position long, which results in harming the surface and lowering of operation efficiency. Whereas, if the number R of the revolutions is too large, the strength of the member for eccentrically holding the water feeding pipe cannot be assured.

However, if Q or P is raised, the reacting force caused by jetting of water onto the surface to be treated acts on the holder 10. When the nozzle head has seven nozzles each having a diameter $D = 0.2$ mm, Q is about 5 l and the reaction force is about 9.5 kg. The weight of the apparatus is about 5 kg. In this connection, it is to be noted that the weight including the reaction which the operator can hold safely is about 15 kg. Thus, there is a limit in weight which the operator can support with safety and therefore the total weight should be considered. However, if the holder 10 is mounted on a machine or the holder itself is a part of the machine, the reaction may be larger.

As described above, according to the present invention, the nozzle head having a plurality of unit nozzles is revolved eccentrically, whereby washing or peeling can be effected over a wide area at a time as shown in Fig. 6. This feature is different from the conventional technique in which washing or peeling is effected only linearly.

Another characteristic feature of the present invention lies in that a small amount of water is jetted at an extremely high pressure. In a conventional technique, a large amount of water is jetted through a nozzle of large diameter at a pressure of 40 to 200 kg/cm². However, the effect of washing, especially effect of peeling is rather small for the amount of water used. The consumption of large amount of water brings further disadvantages that the operation efficiency is lowered and that water drainage system is needed.

In contrast, according to the present invention, small amount of water is jetted at an extremely high pressure, so that the jet stream from each of the nozzles strongly taps the surface to be treated. Thus, large effect of washing and peeling can be obtained. Furthermore, plurality of such jet streams are provided from the nozzle head which is rotated at a rate as high as 800 to 4000 rpm. As a result, the washing and peeling effects can be easily spread all over the surface. Thus, operation efficiency can be improved.

Claims

1. A method for removing substances adhering on a surface comprising a nozzle head (30) with a plurality of nozzles (70A, B ...) and disposed at different positions thereon, held by a holder (10) in such a manner that it may continuously revolve around a center (C2), while jetting high-pressure water from the nozzles (70A, B ...) onto the surface, characterized in that the nozzles (70A, B ...) open on the front face of the nozzle head (30), the center (C2) around which the nozzle head (30) revolves is deviated from the axis (C1) of the nozzle head (30), the nozzle head (30) is moved substantially in parallel with the surface to be treated, the diameter of each of the unit nozzles (70A, B ...) is selected to be 0.05 to 0.5 mm, the water pressure to be supplied to each of the unit nozzles (70A, B ...) is 800 kp/cm² or more, the total amount of water jetted from each of the nozzles (70A, B ...) is 12 l/min or less and the number of revolutions of the nozzle head (30) is 800 to 4000 rpm.

2. A method according to claim 1, wherein the amount of water jetted from each of the nozzle (70A, B ...) is 0.1 to 12 l/min.

3. A method according to claim 1, wherein the water pressure is 800 to 5000 kp/cm² and the total amount of water jetted from the nozzles (70A, B ...) is 1.5 to 12 l/min.

4. A nozzle structure for use in an apparatus for removing substances adhering on a surface in the method according to any of the preceding claims, comprising a nozzle tip (70a) made of diamond and formed with an opening having a reduced diameter portion and a tapering portion,

a nozzle tip holding member (70b, 70c) fitted in a recess for holding the nozzle tip (70a) and a nut (74) having a hole for fixing the nozzle tip (70a) in position within the recess, characterized in that the recess is formed in the nozzle head (30) and the nut (74) fixing the nozzle tip (70a) within the recess has a hexagonal hole,

that the reduced portion of the opening of the nozzle tip (70a) has a length corresponding to 1/2 to 2/3 of the thickness of the nozzle tip (70a) and

that the nozzle tip holding members (70b, 70c) are made of monel metal, the nut (74) is made of stainless steel and the nozzle head (30) is made of titanium alloy.

Patentansprüche

1. Verfahren zum Entfernen von an einer Oberfläche haftenden Substanzen mit einem Düsenkopf (30) und einer Vielzahl von an unterschiedlichen Stellen auf diesen angeordneten Düsen (70A, B ...), wobei der Düsenkopf (30) durch einen Halter (10) derart gehalten wird, daß er sich kontinuierlich um ein Zentrum (C2) dreht, während unter hohem Druck stehendes Wasser aus den Düsen (70A, 70B ...) auf die Oberfläche

specified limit, the flow q and Q become too large for an operator to hold the apparatus by hand and too large to drain without a draining system. In case the pressure P is small, the washing and peeling effects are insufficient and in case the pressure P is large, desired washing and peeling effects can be obtained. However, in the latter case, there are such disadvantages that the wearing of the nozzle tip is large and therefore the material of the nozzle tip should be selected so as to have sufficient strength to tolerate the wearing. If the number R of revolutions is small, each of the nozzles stays at one position long, which results in harming the surface and lowering of operation efficiency. Whereas, if the number R of the revolutions is too large, the strength of the member for eccentrically holding the water feeding pipe cannot be assured.

However, if Q or P is raised, the reacting force caused by jetting of water onto the surface to be treated acts on the holder 10. When the nozzle head has seven nozzles each having a diameter $D = 0.2$ mm, Q is about 5 l and the reaction force is about 9.5 kg. The weight of the apparatus is about 5 kg. In this connection, it is to be noted that the weight including the reaction which the operator can hold safely is about 15 kg. Thus, there is a limit in weight which the operator can support with safety and therefore the total weight should be considered. However, if the holder 10 is mounted on a machine or the holder itself is a part of the machine, the reaction may be larger.

As described above, according to the present invention, the nozzle head having a plurality of unit nozzles is revolved eccentrically, whereby washing or peeling can be effected over a wide area at a time as shown in Fig. 6. This feature is different from the conventional technique in which washing or peeling is effected only linearly.

Another characteristic feature of the present invention lies in that a small amount of water is jetted at an extremely high pressure. In a conventional technique, a large amount of water is jetted through a nozzle of large diameter at a pressure of 40 to 200 kg/cm². However, the effect of washing, especially effect of peeling is rather small for the amount of water used. The consumption of large amount of water brings further disadvantages that the operation efficiency is lowered and that water drainage system is needed.

In contrast, according to the present invention, small amount of water is jetted at an extremely high pressure, so that the jet stream from each of the nozzles strongly taps the surface to be treated. Thus, large effect of washing and peeling can be obtained. Furthermore, plurality of such jet streams are provided from the nozzle head which is rotated at a rate as high as 800 to 4000 rpm. As a result, the washing and peeling effects can be easily spread all over the surface. Thus, operation efficiency can be improved.

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1. A method for removing substances adhering on a surface comprising a nozzle head (30) with a plurality of nozzles (70A, B ...) and disposed at different positions thereon, held by a holder (10) in such a manner that it may continuously revolve around a center (C2), while jetting high-pressure water from the nozzles (70A, B ...) onto the surface, characterized in that the nozzles (70A, B ...) open on the front face of the nozzle head (30), the center (C2) around which the nozzle head (30) revolves is deviated from the axis (C1) of the nozzle head (30), the nozzle head (30) is moved substantially in parallel with the surface to be treated, the diameter of each of the unit nozzles (70A, B ...) is selected to be 0.05 to 0.5 mm, the water pressure to be supplied to each of the unit nozzles (70A, B ...) is 800 kp/cm² or more, the total amount of water jetted from each of the nozzles (70A, B ...) is 12 l/min or less and the number of revolutions of the nozzle head (30) is 800 to 4000 rpm.

2. A method according to claim 1, wherein the amount of water jetted from each of the nozzle (70A, B ...) is 0.1 to 12 l/min.

3. A method according to claim 1, wherein the water pressure is 800 to 5000 kp/cm² and the total amount of water jetted from the nozzles (70A, B ...) is 1.5 to 12 l/min.

4. A nozzle structure for use in an apparatus for removing substances adhering on a surface in the method according to any of the preceding claims, comprising a nozzle tip (70a) made of diamond and formed with an opening having a reduced diameter portion and a tapering portion,

a nozzle tip holding member (70b, 70c) fitted in a recess for holding the nozzle tip (70a) and a nut (74) having a hole for fixing the nozzle tip (70a) in position within the recess, characterized in that the recess is formed in the nozzle head (30) and the nut (74) fixing the nozzle tip (70a) within the recess has a hexagonal hole,

that the reduced portion of the opening of the nozzle tip (70a) has a length corresponding to 1/2 to 2/3 of the thickness of the nozzle tip (70a) and

that the nozzle tip holding members (70b, 70c) are made of monel metal, the nut (74) is made of stainless steel and the nozzle head (30) is made of titanium alloy.

Patentansprüche

1. Verfahren zum Entfernen von an einer Oberfläche haftenden Substanzen mit einem Düsenkopf (30) und einer Vielzahl von an unterschiedlichen Stellen auf diesen angeordneten Düsen (70A, B ...), wobei der Düsenkopf (30) durch einen Halter (10) derart gehalten wird, daß er sich kontinuierlich um ein Zentrum (C2) dreht, während unter hohem Druck stehendes Wasser aus den Düsen (70A, 70B ...) auf die Oberfläche



ausgebracht wird, dadurch gekennzeichnet, daß die Düsen (70A, 70B ...) sich auf der Vorderseite des Düsenkopfes (30) öffnen, daß das Zentrum (C2) um das sich der Düsenkopf (30) dreht, gegen dessen Achse (C1) versetzt ist, daß der Düsenkopf (30) im wesentlichen parallel zu der zu behandelnden Oberfläche bewegt wird, und daß der Durchmesser der Einheitsdüsen (70A, 70B ...) zu 0,05 bis 0,5 mm, der Druck des den Einheitsdüsen (70A, 70B ...) zugeführten Wassers zu 800 kp/cm² oder mehr, die Gesamtmenge des aus jeder Düse (70A, 70B ...) ausgebrachten Wassers zu 12 l/min oder weniger und die Drehzahl des Düsenkopfes (30) zu 800 bis 4000 Umdrehungen pro Minute gewählt ist.

2. Verfahren nach Anspruch 1, bei dem die Menge des aus jeder Düse (70A, 70B ...) ausgebrachten Wassers gleich 0,1 bis 12 l/min ist.

3. Verfahren nach Anspruch 1, bei dem der Wasserdruck 800 bis 5000 kp/cm² und die Gesamtmenge des aus den Düsen (70A, 70B ...) ausgebrachten Wassers 1,5 bis 12 l/min beträgt.

4. Düsenvorrichtung für die Verwendung in einer Einrichtung zum Entfernen von an einer Oberfläche anhaftenden Substanzen beim Verfahren nach den vorhergehenden Ansprüchen, mit

einer aus Diamant hergestellten Düsen Spitze (70a) mit einem Öffnungsteil reduzierten Durchmessers und einem abgeschrägten Teil, und

einem in einer Ausnehmung eingepaßten Düsen Spitzen-Halterungselement (70b, 70c) zur Halterung der Düsen Spitze (70) sowie einer Schraube (74) mit einem Loch zur Fixierung der Düsen Spitze (70a) in einer Stellung in der Ausnehmung, dadurch gekennzeichnet, daß

die Ausnehmung im Düsenkopf (30) ausgebildet ist und die die Düsen Spitze (70a) in der Ausnehmung fixierende Schraube (74) ein sechseckiges Loch besitzt,

daß der reduzierte Öffnungsteil der Düsen Spitze (70a) eine Länge entsprechend von 1/2 bis 2/3 der Dicke der Düsen Spitze (70a) besitzt und

daß die Düsen Spitzen-Halterungselemente (70b, 70c) aus Monel-Metall, die Schraube (74) aus rostfreiem Stahl und der Düsenkopf (30) aus einer Titanlegierung hergestellt sind.

Revendications

1. Procédé d'élimination de substances adhérent à une surface, comprenant une tête de buse (30) munie d'une pluralité de buses (70A, B ...) disposées en différents emplacements sur celle-ci, maintenues par un support (10), de manière à pouvoir tourner de manière continue sur un centre (C2), tout en projetant de l'eau sous haute pression par les buses (70A, B ...) sur la surface, caractérisé en ce que les buses (70A, B ...) débouchent sur la face avant de la tête de buse (30), le centre (C2) autour duquel tournent la tête de buse (30) étant écarté de l'axe (C1) de la tête de buse (30), cette dernière étant déplacée sensiblement parallèlement à la surface à traiter, le diamètre de chaque buse unitaire (70A, B ...) étant choisi dans une plage allant de 0,05 à 0,5 mm, la pression de chaque buse unitaire (70A, B ...) étant de 800 kp/cm², la quantité totale d'eau projetée par chacune des buses (70A, B ...) étant de 12 l/min ou moins et la vitesse de rotation de la tête de buse (30) étant de 800 à 4000 tr/min.

2. Procédé selon la revendication 1, dans lequel la quantité d'eau projetée par chaque buse (70A, B ...) est de 0,1 à 12 l/min.

3. Procédé selon la revendication 1, dans lequel la pression de l'eau est de 800 à 5000 kg/cm² et la quantité d'eau projetée par chaque buse (70A, B ...) est de 1,5 à 12 l/min.

4. Structure de buse pour usage dans un appareil d'élimination de substances adhérent à une surface, par le procédé selon l'une quelconque des revendications précédentes, comprenant un embout de buse (70a) en diamant et formé avec une ouverture présentant une partie de diamètre réduit et une partie conique, un élément de support (70b, 70c) d'embout de buse étant monté dans une cavité afin de maintenir l'embout de buse (70a) et un écrou (74) présentant un trou pour fixer l'embout de buse (70a) en position, à l'intérieur de la cavité, caractérisée en ce que la cavité est formée dans la tête de buse (30) et que l'écrou (74) bloquant l'embout de buse (70a) à l'intérieur de la cavité présente un trou hexagonal, que la partie réduite de l'ouverture de l'embout de buse (70a) présente une longueur correspondant à 1/2 à 2/3 de l'épaisseur de l'embout de buse (70a), et que les éléments de maintien (70b, 70c) de l'embout de buse sont en monel, l'écrou (74) étant en acier inoxydable et la tête de buse (30) étant en alliage de titane.

