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(54) **Method of cleaning surfaces.**

(57) Surfaces, for example, metal surfaces, especially parts of engines, turbines and aeroplane bodies, are cleaned by blasting the surface with an aqueous slurry of particulate urea.

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METHOD OF CLEANING SURFACES

The present invention relates to processes for cleaning surfaces, in particular to the use of jets of aqueous slurries of particulate abrasive material in such processes.

It is well known to abrade surfaces by blasting the surfaces with abrasive particles entrained in water or gas, generally air. Typical abrasive particles that are used include inorganic materials such as alumina, sand, silicon carbide, powdered glass and metal particles and organic materials such as rice husks, wood flour, crushed plum, apricot and peach stones and crushed almond, hazelnut, walnut or other nut shells, or synthetic resin particles such as particles of urea-formaldehyde resin.

A potential problem with all such abrasive blasting methods is that the abrasive may become trapped in complex areas of the article being blasted or in apparatus associated with that article. For instance when cleaning complex shaped articles such as pistons, crank shafts and bearings in motor assemblies or hollow blades or other components of jet engines contamination of such articles with abrasive clearly could cause serious wear and blocking of narrow passages. However even when cleaning much larger articles, such as removing the paint from aircraft bodies, problems can arise from abrasive becoming trapped in crevices in the surface and from the abrasive entering critical areas such as flight control components eg pitot heads and undercarriage components. Organic abrasive materials are often highly inflammable and thus very dangerous to use. The slurry of insoluble abrasive in water is difficult to dispose of or to recycle. Suring blasting with air and/or water conventional abrasive particles tend to rebound back off the surface and strike the operator which is obviously unpleasant.

Despite these problems there are circumstances where dry abrasive blasting is used. Very powerful paint strippers may be capable of softening all the paint on an aircraft body sufficient that it can be removed by gentle scraping but such paint strippers tend to be environmentally toxic and may cause damage to certain substrates, for instance corrosion or embrittlement of the substrate. The use of milder paint strippers has less effect on the underlying paint coatings. Removal by scraping is liable to result in damage of the underlying substrate and so dry abrasive blasting has been used.

The paint stripper may make the surface very sticky and this may render the abrasive ineffective. Accordingly in practice it is necessary to wash the paint stripper from the surface and to dry it before initiating the abrasive blasting.

Dry abrasive blasting creates a serious dust problem. This can be reduced, but not prevented, by spraying water in the area of abrasive blasting. In practice it is necessary to conduct the dry abrasive blasting in a confined space or to use a blast cabinet. It is necessary to surround the area by a vacuum collector for collecting the dust. As a result the method is impracticable for uniformly abrading large surface areas. In addition the operator of the blasting apparatus is exposed to dust and requires special protective gear and breathing apparatus.

Dry abrasive blasting within a blast cabinet is suitable for small articles but this is impracticable for the treatment of large articles.

It is known to remove residual water soluble abrasive from a treated article by rinsing the surface after abrasion with water. For example in US 3778938 in the internal surfaces of a nuclear reactor are blasted with dry boron trioxide sand and subsequently rinsed with water to dissolve the abrasive. The method may be of some use in confined spaces but water-soluble particles tend to give an even greater dust problem since they often shatter on impact to create tiny particles. The use of urea as the abrasive in a dry blasting process is described in British Patent Specification No. 2119298.

It has also been suggested, for instance in FR-A-2475425, to use small particles of ice in an air blasting process, the particles being formed by spraying fine droplets of water into a cold air stream. The ice melts after impact. The process requires special apparatus and a large amount of extra energy to cool the air stream.

Blasting with an aqueous slurry of abrasive particles avoids the dust problem but the risk of contamination by residual abrasive still remains.

In GB-A-1538433 there is described a process in which sodium silicate and/or sodium chloride are used as the abrasives in a water-jet blasting process. Both compounds are quite readily soluble in water and are fed into the water supply immediately before the nozzle. The process is apparently similar to other wet abrsion processes, that is using a large volume of water in the ject. The ratio of abrasive to water in these processes is probably in the range 1:1 to 1:10. The large volumes involved create serious effluent disposal problems. There is no disclosure of the use of air as part of the carrier medium. Sodium silicate forms strongly alkaline aqueous solutions which are environmentally hazardous, dangerous for the operator of the process and corrosive to metals and other substrates. Sodium chloride is highly corrosive towards all but the most chemically resistant metals in the presence of water.

In the invention a surface is abraded by blasting with a mixture of water and water-soluble particulate abrasive and is characterised in that the abrasive comprises urea.

The process does not suffer from the problems created by the dust in dry abrasion processes and the abrasive is easily removed from the substrate after cleaning, generally dissolving entirely in the water used in the process after impact with the surface. Urea is, in contrast to other water-soluble abrasives non-toxic and thus not hazardous for operators of the process, practically neutral and generally non-corrosive to substrates, non-hazardous to the environment and so easy and cheap to dispose of. Urea particles are relatively soft, having a mohs hardness of about 1 or 2 and urea is thus suitable for use on soft metals such as aluminium and its alloys but is effective in removing most types of surface dirt, paint or the like.

In contrast, other water-soluble materials that might be proposed as substitutes for urea, such as sodium chloride, sugars, sodium benzoate, citric acid and other crystalline acids and other organic and inorganic salts, such as ammonium bifluoride and sodium silicate, have serious disadvantages. Many of the materials are highly acidic or highly alkaline when dissolved in water and therefore tend to cause corrosion of the surfaces and/or effluent discharge problems. Examples are citric acid and sodium silicate. Many of the materials accelerate corrosion of metal surfaces even though they may not be acidic or alkaline when dissolved in water. For instance metal surfaces of aluminium, magnesium, steel, titanium, nickel and cobalt based alloys may tend to be corroded when sodium chloride is used as the abrasive and is subsequently washed. Further it is well known that the specialised metals and metal alloys that are often used in components, of, for instance, turbine engines and other devices should not be brought in to contact with certain elements which many water soluble materials do contain. Thus compounds containing elements such as sulphur, chlorine, fluorine, bromine, iodine, sodium, lead, antimony, bismuth and zinc should not be brought into contact with such components. These criterial alone render unsuitable many water soluble abrasive particulate materials.

Another problem arises from effluent disposal in that many water soluble materials create a solution that is toxic by ingestion and/or is harmful to the environment. Examples are sodium choride, silicate or hydroxide, sodium cyanide and oxalic acid.

Finally, many water soluble materials which in theory might be suitable in practice are not commercially available in a particulate form having the desired particle size or powder rheology. Examples include some grades of sugar and sodium laurate.

The particles of urea tend to shatter on impact with the surface, thereby accelerating their dissolution into the water of the jet after they have served as an effective abrasive, and any particles that are not dissolved by the water of the slurry during blasting can easily be removed by subsequent washing. The shattering also reduces the tendency of the particles to rebond off the surface and hit the operator.

It is essential that the particles remain as abrasive particles in the mixture during the blasting and so the mixture must not be formed sufficiently early that a substantial proportion of the particles dissolve into the water before blasting. The blasting generally requires forcing the slurry out of a jet and preferably the mixture is formed in the nozzle or immediately prior to it.

The force used for blasting the mixture can be provided primarily by pressurised water, in which event the abrasive particles can be entrained in the water immediately before blasting, for instance by venturi pick-up of the abrasive by a high pressure wash rig lance, but such methods use large volumes of water in the slurry and result in a great amount of effluent for disposal.

Although the effluent is relatively non-hazardous it is preferred to minimise the amount of water used in the process and to use gas, usually air, to force the slurry out of the nozzle.

The amount of water used in the process usually enough to wet the surface of the urea particles but is generally much less than would normally be used in a wet abrasion process. The ratio of water to urea is usually in the rang 1:1 to 1:10/ The amount of water is to some extent dependent upon the specific surface area of the urea and thus the size of the particles. For micropill urea (particle size in the range 0.1 to 1mm) the ratio of water to urea is suitable in the range 1:2 to 1:5.

The nozzle is suitably one having independently controllable gas and water input and which may be suitable for providing air or water or air and water jets. Typical apparatus comprises a nozzle, a duct for supplying air or other gas to the nozzle at, for instance, at least 3 kg/cm^2 and generally 5 to 10 kg/cm^2 and a water supply for feeding a relatively low amount of water into the air stream either in the nozzle or immediately prior to it. For instance the water supply to a standard nozzle having an opening with a diameter of about 13mm may be from 0.5 to 5, often 1 to 2, litres per minute.

In the invention the abrasive particles are preferably fed into the high pressure air supply so that they are contacted with the water only during blasting. For instance the abrasive particles may be supplied from a pressurised container through a metering device by which their flow can be regulated. It is often preferred that, using a single nozzle, it should be possible to control the supply of abrasive so that the blasting can be interchanged between pressurised water alone and pressurised aqueous slurry of abrasive.

For instance after application of paint stripper or other cleaner the surface to be cleaned may initially be washed solely with a jet of water to remove most of the contamination and then resistant contamination can be abraded by blasting aqueous slurry onto the surface, generally from the same nozzle. After abrading with aqueous slurry, the supply of particles can be discontinued and the surface can then be washed solely with pressurised water, again using the same nozzle.

Suitable apparatus is described in British Patent Specifications Nos. 1,491,259, 1,491,596 and 1,524,769.

The urea particles must have a size of at least 0.01 mm and will usually be at least 0.05 mm and most preferably at least 0.1 mm. Generally the size is below about 2 or 3 mm and 0.1 to 1 mm is generally preferred. The particles may be commercial grade crystalline urea but preferably are urea prills having the desired small particle size, generally known as urea microprills. Suitable material is the product sold by Chemie Linz AG under the name "Biuron" microprill urea.

Although it is generally convenient for any previous or subsequent water wash to be by pressurised water from the same nozzle it is also possible for it to be by, for instance, conventional spray, immersion or flushing.

The method of the invention can follow the application of conventional cleaners and/or paint strippers, depending upon the contamination that is to be removed from the surface. Thus if the process is used to remove paint from a surface it is often found to be advantageous to pretreat the painted surface with a paint stripper of a conventional type. This softens the paint and renders it easily removable by the subsequent jet of aqueous urea slurry. Depending upon the size of the surface to be treated the method can, if desired, be conducted in a blast cabinet or it can be conducted in the open.

Although the invention is of particular value for removing paint or carbon from metal surfaces or for cleaning components of apparatus that involves moving parts in assembled or disassembled form, the method can also be used for cleaning a wide variety of other surfaces, such as glass or walls.

The following are some examples.

EXAMPLE 1

An experiment was carried out using a high pressure wash rig at 140 kg/cm^2 water pressure with ground hazelnut shells being introduced by venturi pick-up into the water stream. A panel of aluminium which had been coated in aircraft quality paint had paint remover applied to it for one hour after which time the primer remained intact. Blasting the surface with the water and hazelnut shells removed the paint but 36 litres of water per minute were deposited on the floor and shells not only rebounded off the surface hitting the operator but also fell to the floor producing an unacceptable brown sludge.

A repeat of the experiment replacing the hazelnut shells with urea microprills had a similar effect on the paint but removed the problem of rebounding abrasive and production of sludge. The large quantity of water remained a problem.

EXAMPLE 2

A similar paint scheme to that used in Example 1 was treated with paint remover and after one hour blasted with microprilled urea at 5.6 kg/cm² in air with late injection of water at 1 litre per minute. The paint was quickly removed down to the substrate which was anodised aluminium. There was no damage of the substrate and very little water was left on the floor. Dust was suppressed by the water, enabling the process to be carried out in the open.

EXAMPLE 3

A helicopter was sprayed with paint remover. It had previously been impossible to strip completely even with the mechanical assistance of scraping because of the resistance of the paint system and the fact that much of the surface was covered with mush headed rivets. Using a 8 mm nozzle and 7 kg/cm² air with late water injection of 2 litres per minute the surface including complex rivet runs could be cleaned down.

EXAMPLE 4

An aircraft wheel which was contaminated with rubber, brake dust and carbon was completely cleaned without damaging the paint by wet blasting with urea after immersion in a mild detergent.

CLAIMS

1. A process in which a surface is cleaned by blasting with a mixture of water and a water-soluble particulate abrasive, characterised in that the abrasive comprises urea.

2. A process according to claim 1 in which the abrasive has a particle size in the range 0.1 to 2mm.

3. A process according to claim 1 or 2 in which the urea is in the form of microprills.

4. A process according to any one of claims 1 to 3 in which the water and the abrasive are mixed together in the nozzle through which they are blasted.

5. A process according to any one of claims 1 to 4 in which the slurry is blasted on to the surface by a jet of gas.

6. A process according to any one of claims 1 to 5 in which the surface is subsequently rinsed with water.

7. A process in which paint is stripped from a metal surface by a process according to any one of claims 1 to 6.

8. A process according to claim 7 in which, before blasting with the slurry, a chemical paint softener or remover is applied to the painted metal surface.

European Patent Office

EUROPEAN SEARCH REPORT

Application number

EP 85 30 7226

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
D,X	GB-A-1 538 433 (LONG & CO.) * Claims 1-5 * ---	1	F 02 B 24C
Y	FR-A-2 127 021 (SIEMENS) * Page 2, line 3 - page 3, line 22 * ---	1	
Y	DE-A-2 638 323 (WACKER-CHEMIE) * Claim 1 * ---	1	
D,A	GB-A-2 119 298 (BRENT) * Claims 1-4,7,8 * ---	3,4,7-9	
A	NL-C- 91 624 (DE BATAAFSCHE PETROLEUM) * Column 1, lines 34-41 * ---	2	TECHNICAL FIELDS SEARCHED (Int. Cl.4)
D,A	FR-A-2 475 425 (REEL) * Claims; figure 1 * ---	5,6	B 24 C
A	US-A-2 605 596 (UHRI) * Claim 1; figures * -----	5,6	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	06-12-1985	ESCHBACH D.P.M.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
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P : intermediate document
T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons
& : member of the same patent family, corresponding document