Metal Spraying

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1. Introduction

Metal spraying started in Switzerland in 1910 but it became a commercial process only in 1923. Since then the process had made a phenomenal headway and now it is an industry of considerable importance. There are three types of metal spraying.

1. The system using molten metal. The metal to be sprayed is melted in a furnace and poured into the tool from which it is sprayed. The process is only suitable for metals of comparatively low melting point, that is, lead, tin, zinc and aluminium alloys.

2. The system using powdered metals which are sucked through the tool heated in a flame, and sprayed. This method again finds its greatest outlet for such metals as zinc.

3. The system using the metal to be sprayed in the form of wire. This method is responsible for the largest percentage of metal spraying, and is the only one suitable for reclamation by using metals such as steel, nickel, stainless steel and for protective coatings on metal surfaces.

2. Reclamation of worn parts

The reclamation of worn parts is of considerable interest. Many parts may be reclaimed by welding, electrodeposition and metal spraying. Metal spraying has two distinct advantages :

1. The process is nearly cold and is therefore free from the difficulties inherent in welding.

2. The apparatus used is comparatively mobile and does not necessitate the use of chemicals in vats which are required for electro-deposition.

3. Principle of the process

Metallisation consists of bombarding the prepared surface to be metallised with thousands of tiny particles of molten metal in the form of a spray by a stream of compressed air which atomises a small globule of molten metal forming continuously at the end of a wire. This dual process is accomplished by a special tool known as the metal spraying pistol weighing approximately 1.5 to 2 kgms. The principle of the pistol is simple, although its mechanism is somewhat complicated. A wire of the metal or alloy is passed at a steady speed through the pistol. The feeding of the wire is automatic, being actuated by rollers in the pistol body which in turn are driven by gears connected to a small air turbine also contained in the pistol case. The wire feeds into the hot zone of a blow pipe flame, which is surrounded by a cone of the compressed air. As soon as the metal becomes molten it is atomized by the air and the particles are driven forward on to the surfaces to be coated. The flame of the pistol is always fed with oxygen but the combustible gas may be hydrogen, coal gas, propane or acetylene under pressure. Owing to the cooling action of air stream there is very little heat effect at the surface being metallised. Even wood, paper, textiles etc. can be metallised satisfactorily but it is essential that the surface shall not be glazed. It is a *sine qua non* of the process, that the surface sprayed must have an open texture, and with metallic surfaces this is obtained by blasting with angular steel grit or other suitable abrasive.

4. Types of metal deposit

Sprayed coatings can be applied to any desired thickness from 0.025 mm. upwards, it being merely the time of application of the spray. The coating, as applied, is matte, but "Satin" and bright surfaces may be obtained by wire brushing and polishing. The process is therefore applicable for coating any article from celluloid to steel and the sprayed layer may be of any metal or alloy which can be drawn into wire and which is capable of being melted in the blow-pipe flame.

There is no alloying with the base even if it be metallic, and careful examinations under the microscope will prove that there is no chemical bond. The adhesion of the coating is not fully understood but it is probably due to a mechanical interlocking of the particles of the coating with the interstices of the rough base, the interlocking, of course, being on a microscopic scale. Recent scientific work has shown that adhesion of metal-sprayed coatings is not weakened until the base metal is strained beyond its elastic limit and as this state of strain is never present in engineering structures it will be seen the adhesion of metal sprayed coating is extremely satisfactory.

The layer consists of tiny saucer-shaped particles sintered together by momentary plasticity on impact.

In transverse section under the microscope the structure is seen as a mass of wavy formation. In horizontal section the coating is found to be a mass of interlocking irregular shaped particles about 1100th mm diameter. The structures of the coatings sprayed from wire is uniform throughout. Irregular deposits produce highly porous and oxidised coatings with very weak mechanical properties.

The oxidation due to spraying by the wire process is comparatively small. The total amount of element oxygen picked up during spraying varies from 0.2% to 0.9% according to the metal spraying and the conditions of spraying. This fact is extremely important because it assures the user, that so long as a pure metal wire is used, the composition of the coating is known to exactitude and coatings of high purity are obtained. In some cases where extra pure metals are used the coatings have very great resistance to corrosive conditions.

5. Surface preparation before spraying

The usual method of preparing a surface for spraying when applying a protective coating is by shot blasting in order to obtain (i) a clean surface and (ii) a surface of sufficient roughness to obtain the adherence of the coating. Quite good adhesion is possible by this method. For this purpose the article is cleaned by heavily shotblasting with angular steel grit at a pressure of 2.5 to 5 kg/sq. cm. The part should be degreased by means of an organic solvent before shot blasting. Also steel grit may with advantage be replaced occasionally by an aluminous abrasive i.e., carborundum or blastyte especially when dealing with case hardened parts. Metal sprayed coatings of steel or other hard metal are now used for the repair of worn parts and in this case the surface preparation may take the form of a rough screw-thread. The thread is cut by the use of a suitable tool so that it is as rough as possible.

6. Strength & properties of deposit

In order to demonstrate the strength of bond and the metal as sprayed, collars of sprayed metal 4.76 mm thick and 25.4 mm wide were built up on 25.4 mm diameter steel shafts. The rods were passed through a hole in a steel plate and pulled in a tensile machine until the collar burst. With a collar of sprayed 0.8% C steel, a pull of 22.78 tons was required, 18/8 stainless steel required 21.26 tons, and phosphor bronze 9.51 tons.

It is the very nature of the deposit which gives it its most valuable properties. Hardness in itself is no criterion of wear, and in fact in some cases the soft surface wears less than one of the extreme hardness. Electro-deposited chromium is not always a success as a wearing surface, although its hardness cannot be disputed. In general, most wearing faces should be well-lubricated, and the resistance to wear is therefore a function of retention of the oil film rather than the intrinsic properties of the metals themselves. A very hard, perfectly smooth surface would not retain the necessary oil film. In the case of metal-sprayed surface we have a face containing minute pores which hold oil very tenaciously and such a surface may wear even less than a solid metal face. Hence metal spraying is one of the ideal ways of preparing a lubricating surface.

7. Technique of reclamation

For repairing worn shafts, it is examined, degreased if required, and mounted in the lathe. Its diameter is reduced, if necessary, to allow for deposit thickness, and then rough-threaded while still mounted. The metal spraying tool is then mounted on the tool post and the deposit applied. Finally grinding or turning gives the fine size and finish. It is advisable to spray as soon as possible after preparation of the job, so that oxidation is prevented.

Following jobs may be successfully built-up by making use of metal spraying : 1. Water jackets 2. Cylinder heads 3. Cylinder blocks 4. Pistons 5. Crank cases 6. Gudgeon pins 7. Flywheel details 8. Crank shafts 9. Ball races and housing 10. Shafts 11. Brake drums 12. Road wheels 13. Springs etc.

8. Metallic protective coatings

The coating of iron and steel with zinc by means of metal spraying process is the best form of cheap and efficient rust protection. A sprayed zinc coating 0.10 mm thick gives protection equivalent to the best hot dip galvanising, and, moreover, possesses the following advantages in common with other coatings obtained by this process :

(1) There is no limit to the size article that can be treated.

(2) There is no possibility of distortion, however, large or intricate the article to be treated may be.

(3) Spray can be carried out after final machining operation. there is no clogging of screw threads etc., provided that sufficient tolerance is allowed to compensate for the thickness of the coating.

(4) Coatings are even and regular.

(5) Being of pure metal, this coating gives the maximum protection against the atmospheric and general corrosion.

(6) Metallising can be carried out in situ.

Tin, like other metals, can be applied to almost any thickness and coatings obtained, have found a large field of usefulness in industries concerned with the production of food stuffs and medicines. In recent years, spray coatings of aluminium have been proved satisfactory for the protection of constructional steel works particularly in industrial atmosphere. The resistance of aluminium to attack by hot sulfurous gases and many organic compounds render coating of this metal particularly useful for the protection of chemical plant, food manufacturing equipments. During aluminising a compound coating of iron-aluminium alloys and aluminium oxide is produced, which retards further oxidation of steel. The increase of life obtained by aluminising, depends on the temperature and atmosphere to which the articles are exposed. At 950°C aluminized steel lasts three times as long as untreated steel.

Sprayed nickel has found a field of usefulness for the protection of rollers used in paper making. Coating of nichrome are used for the protection of steel against oxidation where the working temperature exceeds 950°C. Sprayed lead gives a coating which is resistant to acid atmospheres and attack by dilute acids and other chemicals. Coatings of bronze, brass, copper etc. are used for decorative effects on ornamental steel works. Cadmium is preferred to zinc for resistance to marine conditions.

Statement of the membership of The Indian Institute of Welding

Corporate Member	As on 31/12/84	As on 30/6/85 Transfered	New	As on 30/6/85 Total
Industrial Corporate	135	—	2	137
Fellow	20	7	—	27
Member	615	6	45	659
Associate Member	1054	—	72	1120
Non-corporate Member				
Associate	149	—	10	159
Student	160	—	6	166
Total	2133	13	135	2268