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CRYOGENIC CHEMICAL DEBURRING

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ABSTRACT OF THE DISCLOSURE

Process for chemically deburring machined or molded parts including the steps of refrigerating the part to a sufficiently low temperature such that it will form and retain a protective layer of ice on its principal surfaces during the deburring operation.

BACKGROUND OF THE INVENTION

In the process of chemical deburring, a burr-containing part is immersed in a corrosive medium which attacks the burr and either consumes it or weakens it to the point where it readily falls off. For purposes of this discussion and the claims of this application the term "burr" is intended to include such things as shavings, clinging chips or the like resulting from machining operations and flash or the like which is characteristically formed on molded parts usually along the parting lines of the mold. An example of one chemical deburring situation for zinc based die castings is found in U.S. Pat. No. 2,955,0227. In most instances chemical attack of the entire surface of the part is undesirable and some protection for these surfaces is needed. It is common practice to mask-off those portions of the part which are to be protected from the corrosive solution leaving only the unmasked portions, i.e. burrs, exposed to corrosive attack. The masking and unmasking of selected portions of a part is a time consuming and expensive operation especially in the case of intricate complex parts.

It is an object of the present invention to provide a process for chemically deburring parts without substantially corroding the remainder of the part's surface and without the resort to expensive complicated masking and unmasking techniques. This and other objects of this invention will become more readily apparent from the detailed discussion which follows.

The present invention comprehends the in situ formation of a masking layer of ice on the surfaces of parts to be chemically deburred. More specifically, the part is refrigerated to a sufficiently low temperature so that an ice film forms over the entire surface of the part. During the deburring operation, the ice film is retained on the large mass portions of the parts yet quickly dispelled from the low mass portions, i.e. the burrs. In this regard, the ice film may be formed by exposing the refrigerated part to a sufficiently humid environment to condense moisture onto the surfaces, or, in the alternative, immediately immersing the refrigerated part into the corroding medium and allowing the ice film to form therein. The burrs, which have a comparatively low mass, quickly lose their ice film while the bulk of the part which has a larger mass retains it. As a result, the burrs are immediately attacked by the corroding medium while the ice-protected surfaces remain substantially unaffected. Still further, the gassing and heat generated by the local reaction accelerates the removal of the burr and contributes to an even shorter immersion time.

The process of this invention comprehends a wide variation in treatment times, temperatures, and corroding media, all of which will vary according to the specific deburring problem encountered. In this regard, larger parts will require a colder refrigeration environment or a longer exposure time to achieve the same low temperatures as a smaller part. Larger burrs will require either stronger corrosive media or longer immersion times for complete removal. I prefer to use a stronger media and a shorter exposure time where possible in order to ensure retention of the protective ice film. Still further the specific heat and thermal conductivities of the different metals have an effect on both the refrigeration time and the deburring immersion time. The precise combination of time, temperature and corroding medium for any given deburring situation will vary with the composition and size of the metal part, as well as the precise nature of the burr requiring removal. Likewise, the available in-plant processing time and equipment will to some extent dictate the selection of the most desirable combination of parameters for a given application. These parameters can readily be derived in short order by one having skill in this art.

This process is useful with any metal or alloy which can be chemically corroded. Among the possible metal and corroding media combinations are:

(1) sodium hydroxide (8%–20%) which is useful with the aluminums;
(2) ferric chloride (e.g., 36° Baumé), which is useful with aluminum, beryllium-CU, brass, chromium, Constantan, copper, Hastelloys, Havar, Invar, Ivar, Inconels, lead, moly Permalloy, Nichrome, nickel, nickel silver, Phosphor bronze, stainless 300 (LO), steels, tin. Adding about 1% muriatic acid to the $FeCl_3$ will increase its etching speed;
(3) chromic-sulfuric acid, which is useful with beryllium CU, brass, copper and Kovar;
(4) hydrochloric acid, which is useful with chromium and manganese;
(5) hydrofluoric acid, which is useful with germanium and titanium;
(6) hydrofluoric-nitric acid which is useful with silicon steel, germanium, tantalum and titanium;
(7) nitric acid, which is useful with cast iron, magnesium, molybdenum, silver, tellurium, zinc and steels;
(8) nitric-hydrochloric acid (incl. aqua regia) which is useful with molybdenum, gold, platinum, stainless steel 300 (hi), and titanium;
(9) United States patents 3,057,764 and 3,057,765 for stainless steel, nickel-base and cobalt-base alloys; and
(10) nitric acid-ammonium bifluoride, which is useful for 400 series stainless steels.

Many other metal-corroding media combinations are useful for purposes of this invention and particularly those which are the more active at low temperatures (e.g. about room temperature). These more active media will not heat the larger mass of the past too quickly during the deburring immersion step.

The following is a specific example of a deburring operation in accordance with this invention. An SAE 8620 steel gear blank having an outside diameter of 2.654 inches, a through-hole hub inside diameter of 1.313 inches and a thickness of 1.640 inches is placed in a

hobbing machine and 19 teeth cut therein to a depth of 0.294 inch. The hobbing operation leaves a plurality of burrs between the teeth on the trailing face of the blank fed into the hob. The burrs average about 0.020 inch in length, about 0.375 inch in width and vary between about 0.005 inch to about 0.010 inch in thickness. The thusly machined gear is refrigerated to a temperature of about —200° F. by immersion in liquid nitrogen maintained at or below its boiling point. The gear is next transferred to a deburring tank containing a 180° F., 20% by volume solution of 42° Baumé nitric acid. During the transfer operation, moisture from the air condenses on the chilled part and forms a protective layer of ice over it. As the gear begins to warm in the deburring tank, the low mass burrs quickly lose their ice film and are quickly attacked by the acid leaving the remainder of the part virtually unscathed. About 90 secs. to 120 secs. is required to completely remove these burrs.

Although this invention has been described in connection with certain specific examples thereof, no limitation is intended thereby except to the extent hereinafter set forth in the claim which follows.

I claim:

1. A method for chemically deburring metal comprising the steps of refrigerating the metal to a temperature substantially below the freezing point of water, forming a corrosion resisting layer of ice over the surface of the metal, and treating the metal with a warmer, aqueous, metal-corroding medium to selectively melt the protective layer of ice from the burrs and to selectively attack and remove the burrs while retaining the protective ice layer over the remainder of the metal.

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