

Chemical Machining Process - An Overview

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Abstract - Chemical machining (CHM) is the material removal process for the production of desired shapes through selective or overall of material by controlled chemical attack with acids or alkalis. This is one of the oldest nontraditional machining processes and also has some drawbacks. The main issues face by chemical machining process is the reduced material removal rate when compared to other nontraditional machining techniques. Accuracy of machine should also paid attention. Apart of this, since we are using chemical etchant for the process, it also has some environmental issues. The machining quality of chemical machining is comparatively less. So it is necessary to think of an idea to improve the quality. So in this paper we discussed below about working principle, need, procedure, application of chemical machining process.

Keywords: Chemical Machining, Types, Needs, Maskant, Etchant, Process Parameters, Non Traditional Machining.

I. INTRODUCTION

Chemical machining is well known as nontraditional machining process and is controlled by chemical dissolution of the machines work piece material by contact with a strong chemicals reagent. It is also known as a chemical etching .mostly all the material from metal to ceramics can be chemically machined. Chemical machining process is employed where metal removal is difficult. Chemical machining is a controlled dissolution of the work material by

means of contact with a strong acidic or alkaline chemical reagent. The major characteristics of chemical machining are material removal rate, accuracy and surface finish.

The main challenges for this process are the same as is characteristics. Material removal rate is dependent on the selected etchant. Accuracy of the process may be affected by the under cutting behavior in simple contouring.

II. WORKING PRINCIPLE OF CHEMICAL MACHINING

The working principle of chemical machining is based on chemical etching .the part of the work piece metal where material is to be removed is brought into contact with a strong corrosive chemical called etchant. The etchant react with the workpiece in the material to be cut and causes the solid material to be removed. Thus the metal is removed by the chemical attack of the etchant.

The portion of the work material where material is not to be removed is protected from chemical attack by means special coating called as maskants. So by this chemical machining process from all metal to ceramic substance can be machined with chemical machining process. This process of chemical reaction between the material of the work piece and some chemical reagent use to produce a reaction between then so that it can be removed easily .thus the surface of the workpiece is etched away, exposing the lower layers, and the process is continued until the desired amount of material is removed.

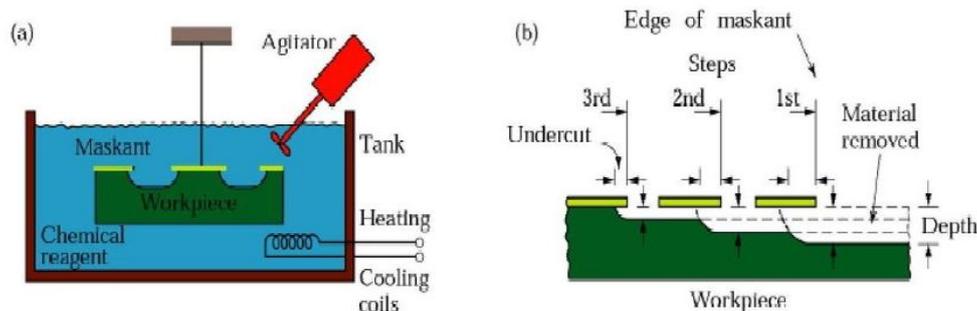


Figure 1(a): Brief illustration of the chemical machining process, Figure 1(b): Stages of producing a profiled cavity by the help of machine called agitator

Need For Chemical Machining

Hard and difficult to shape metals cannot be easily machined by conventional machining methods .further, thin work parts with complex configuration or delicate parts fail to withstand the forces of cutting tool. Although some nontraditional process can be used in such conditions, they are not economical due to high capital and tooling costs involved. These disadvantages are overcome with the use of chemical machining process.

Types of Chemical Machining Process

There are two type of chemical machining:

- Chemical blanking method
- Chemical milling or contour machining method

III. PROCEDURE FOR CHEMICAL MACHINING

Workpiece pre cleaning process: The surface of workpiece metal is cleaned thoroughly, degreased and pickled by acid or alkalis. Pre cleaning is the most important method to remove oil, grease, dirt, rust, or any foreign substance from the work surface to produce a good adhesion of masking material.

Masking and scribing mask: Masking involves covering the portion of the workpiece metal where material is not to be removed by the chemical action .masking with adhesive types or paints is a common practice although rubber (elastomers) and plastics are also used. Since it is difficult to apply maskant on small surface, the maskant is initially applied on a large surface

Etching: The unmasked surface of the workpiece is machined chemically with selected etchant. Etching is carried out by immersing the work material in a tank of agitated etchant. The process is carried out at high temperature depending on the etched material. Temperature control and agitation during chemical machining. Erosion of the work material takes place from the exposed surface. The work piece is converted into metallic salt, which is then dissolved and carried away in the etchant solution.

Damasking: When etching is completed the mask is removed either through mechanical or chemical means. any etchant on the work material is also removed by cold water to clean. A deoxidizing bath may also be required in order to remove the oxide coating or films left on the surface of the work material.

Process Characteristics of Chemical Machining

- Metal removal rate
- Accuracy

- Surface finish

Maskants

Masking material is known as Maskant which is used to protect workpiece surface from chemical etchant. In another words maskants protect the portion of workpiece metal where material is not to be removed by chemical action of the etchant. Polymer or rubber based materials are generally used as a maskant material. Various maskant application methods can be used such as dip, brush, spray, roller, and electro coating as well as adhesive tapes.

The type of maskant to be selected for machining is based on the following factors

- Be inert to the chemical reagent used
- Chemical resistance required
- Be tough enough to withstand handling
- Adhere well to the work piece
- Allow itself to be scribed easily
- Be removed easily after etching
- Be inexpensive after etching
- Be able to withstand the heat generation by etching
- Availability and low cost

TABLE 1
Masking material for various work material

Work material	Maskant
Aluminium & Alloys	Polymer, butyl rubber & neoprene
Copper & alloys	Polymer
Iron based alloys	Polymer, poly vinyl chloride, polyetilien butyl rubber
Nickel	Neoprene
Magnesium	Polymer
Titanium	Polymer

Etchants

Etchants are acid or alkaline solutions maintained within a controlled range of chemical composition and temperature. The workpiece material to be removed is sprayed or immersed in a suitable etchant .various etchant are available for machining different material as listed in table 2. The type of etchant to be selected for machining is based on following factor:

- Type of workpiece metal that is being etched
- Rate of metal removal
- Surface finish required
- Type of maskant used
- Depth of etch required
- Ability to regenerate the etchant solutions
- Un harmful Or non toxic to human operator
- Availability at low cost

TABLE 2
Etchant characteristics

Work material	Etchant	Etchant temperature
Aluminum & alloys	Ferric Chloride	49
Copper & alloys	Cupric Chloride	49
Steel	Ferric Chloride	54
Nickel	Ferric Chloride	49
Magnesium	Nitric acid	49
Titanium	Hydrogen fluoride	-
Glass	Hydrogen fluoride	-

IV. CONCLUSIONS

Material removal rate, accuracy, surface finish and environmental issues are the major challenges what chemical machining face. Rate of removal of material is depended on the type of etchant we are using for machining process. Etchant which remove metal in a faster manner will have many side effects including surface finish, higher heating etc. So the etchant should be selected in such a way that it should balance among all these problems. Undercutting is the issue which reduces the accuracy of machining. Hydrogen embrittlement also causes alterations. The surface produced by CHM process is otherwise stress free and show no thermal effects. Chemical machining greatly affects the environment since it make use of chemical etchants. To improve the material removal rate of chemical machining is to combine both laser machining and chemical machining.

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