MODULE - 1

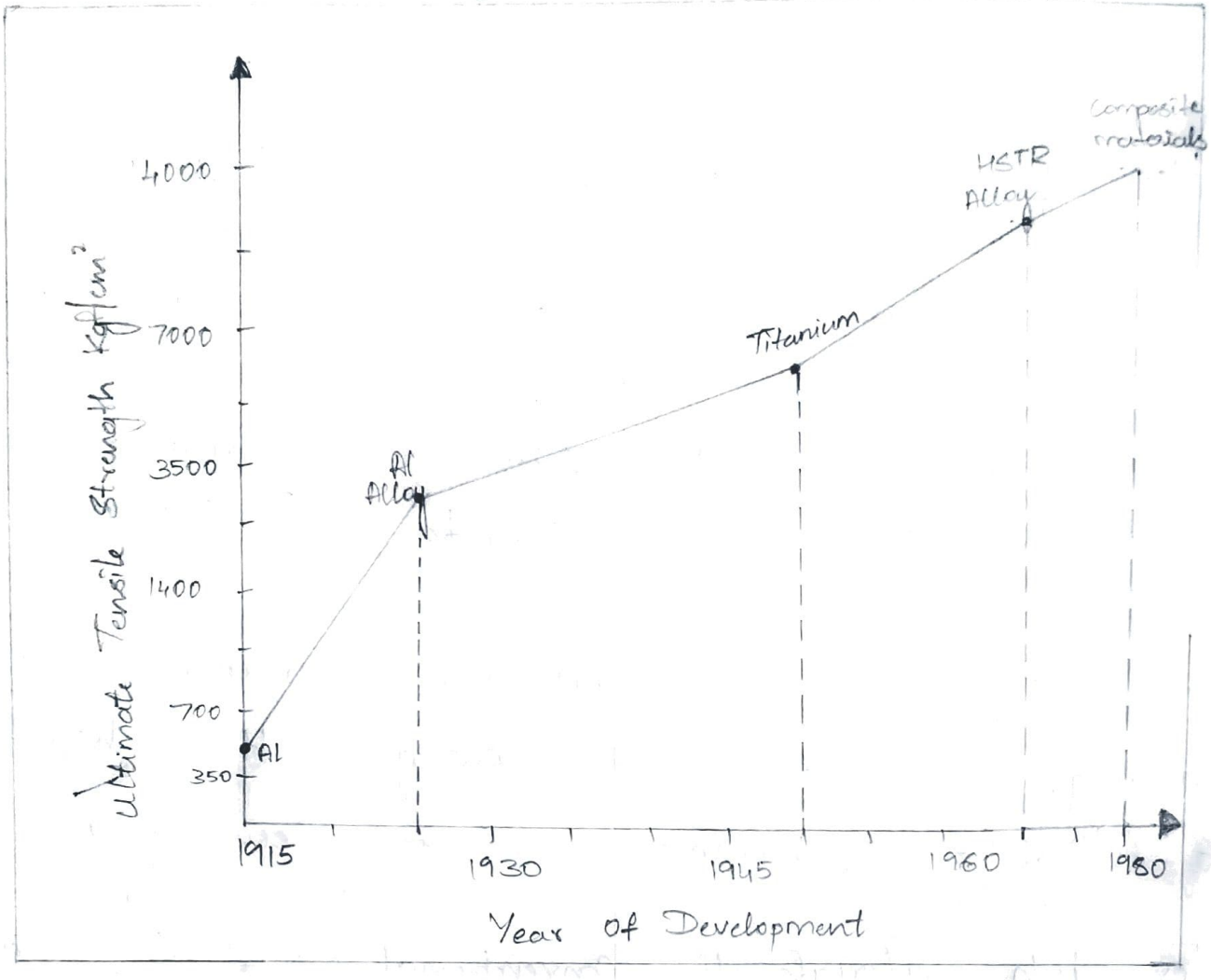
INTRODUCTION

History :- From the past few decades, Engineering industries have withnessed a rapid growth in the development of harden and difficult to machine materials such as nitralloy, waspalloy, nimonics, Carbides, Stainless Steels, Heat Resisting Steels and many other high-Strength - Temperature - Resistant [HTR] alloys.

These materials find wide application in aerospace, nuclear, engineering, and other industries owing to their high-strength -to- weight ratio, hardness, and heat resisting qualities.

For such materials the conventional edged tool machining, in spite of recent technological advancement is highly ~~uneco~~ -en uneconomical and the degree of accuracy and surface finish attained are poor. Besides, machining of these materials into complex shapes is difficult, time-consuming and sometimes impossible.

These processes are non-traditional or unconventional in the sense that they do not employ a convensional or traditional tool for metal removal, insted they directly utilize some form of energy for metal machining.



Need for Non-traditional machining Process

The instances led to the development of new machining method - NTM are :-

1. Machining of hard workpiece materials like ~~xxxxx~~, Carbides Stainless Steels, heat resisting Steels and Similar Such materials Tool wear and failure becomes a Serious problem in machining Such materials. Further, the high cost of tools and the damage generated during machining made it practically or economically impossible to machine Such materials using Conventional machining pro s.
2. Machining of Very Small diameter holes, deep Cavities a complex geometrical Shape.

3. Workpiece is too flexible or slender (thin) to withstand the high cutting forces during machining.

4. A very high surface finish with close dimensional accuracy of the product is required.

Comparison between traditional and non-traditional machining

Conventional Machining	Non-Conventional Machining
1. There is direct contact between tool and workpiece.	There is no direct contact between tool and workpiece.
2. Since there is contact between tool and workpiece, transfer media is not necessary.	Since there is no contact between tool and workpiece, transfer media is necessary.
3. It is difficult to perform machining operations and complicated shape.	Complicated shapes can be easily machined.
4. Tool gets worn out and tool life goes on reducing due to contact between tool and workpiece.	Tool wear does not exist since no contact between tool and workpiece.
5. Initial investment for equipment is less compared to non-traditional machining.	Initial investment for equipment is high.
6. Skilled labour is not necessary to perform machining operation.	Skilled labour are required to perform machining operations.
7. Metal removal rate is more when compared to NTM process.	Metal rate is less, when compared to conventional machining.

8.	Hard materials are difficult to machine in conventional machining process.	Hard materials are easy to machine in non-conventional machining process.
9.	Time required for machining operation is less.	Time required for machining is more.
10.	Surface finish is poor	Surface finish is good (1.5μm).
11.	Cost of production is less.	Cost of production is more.
12.	Rate of production is more when compare to NTM.	Rate of production is less. when compare to conventional machining.
13.	Economical	Un-economical.
14.	Stress induced on workpiece machining.	Stress free machining is possible.
15.	Precision machining is not possible by conventional machining.	High precision machining is possible by non-conventional machining.

General Classification Non-traditional Machining Process.

The non-traditional machining process are classified on the basis of :

1. Type of Energy Used.
2. Mechanism of material removal
3. Media for energy transfer.

1) Based on Type of Energy Used.

Type of Energy	Mechanism of metal removal	Transfer media	Energy Source	Process
Mechanical	Shear	Physical Contact	Cutting tool	conventional machining
	Erosion	High Velocity particles	Hydraulic/pneumatic pressure	USM, WJM, AJM.
Electro chemical	Ion Displacement	Electrolyte	High Current	ECM, ECG
chemical	Ablative Fusion relation	Reactive environment	Corrosive agent	CHM
thermo Electric.	Vaporisation	Radiation ion Steam	Amplified light ionised material	IBM, PAM EDM
	Fusion	Hot gases Electrons	Ionised material High Voltage	IBM, PAM EDM.

2) Based on Mechanism of Material Removal.

i). Erosion - Mechanical Energy based processes.

ii) Electric Discharge - Electrical Energy based processes.

iii) Chemical Etching - Chemical Energy based processes.

iv) Melting and Vaporization - Thermal based processes.

v) Ion Displacement - Thermal based processes.

3). Based on the media for energy transfer.

i) Electrons - EBM.

ii) Pressurized gas - AJM

iii) water - WJM

iv) Ultrasonic waves - USM

Classification of Non Traditional Machining Process

Mechanical Metal removal Processes

It is characterized by the fact that the material removal is due to the application of mechanical energy in the form of high frequency vibrations or kinetic energy of an abrasive jet.

1. Ultra sonic Machining (USM).
2. Abrasive Jet Machining (AJM).
3. Water Jet Machining (WJM).

Electro-Chemical

It is based on electro-chemical dissolution of materials by an electrolyte under the influence of an externally applied electrical potential.

1. Electro-Chemical Machining (ECM).
2. Electro-Chemical Grinding (ECG)
3. Electro-Chemical Drilling (ECD)

Thermal Method

The material is removed due to controlled, localized heating of the work piece. It result into material removal by melting and evaporation. The source of heat generation in such cases can be widely different.

1. Electric Discharge Machining (EDM).
2. Plasma Arc Machining (PAM).
3. Electron Beam Machining (EBM)
4. Laser Beam Machining (LBM0

v). Plasma, Laser – PAM, LBM.

vi) Chemical Reagent – CHM, ECM.

USM → Ultrasonic Machining
WJM → water jet Machining
AJM → Abrasive jet Machining
ECM → Electro chemical Machining
ECG → Electro chemical Grinding
CHM → chemical Machining
IBM → Ion Beam Machining
PAM → Plasma Arc Machining
EDM → Electron Discharge Machining
LBM → Laser Beam Machining
EBM → Electron Beam Machining

Selection of Non-traditional machining Processes (or)

In order to make use of the non-traditional machining process efficiently, it is necessary that the exact nature of the machining problem must be known.

The points which should be looked into before the selection of these processes are :-

i) Physical Parameter
ii) Properties of the work materials and the shape to be machine.
iii) Process Capabability (or) machining characteristics.
iv) Economic Considerations.

The non traditional machining processes have relatively wide application to over all metals and alloys and non metals. This is in contrast to the conventional machining process (Eg. ie: their application, depending upon the strength and hardness of the material.

i) Physical Parameter :-

Power, Voltage potential, current, gap between tool and workpiece material, are a few common parameters in NTM process process like USM and EDM consume approximately the same power for machining a particular material, while ECM and CM consume a comparatively greater amount of power. Further, with respect to the gap between tool and workpiece, a small gap results in greater metal removal from the workpiece, however some process conditions restrict the gap and thence a proper choice has to be made therein.

ii) Properties of work material :-

workpiece materials posses different properties. They can be hard or soft, conducting or non-conducting, ductile or brittle etc. USM process is good for machining ceramics. and glasses are non-conductive. on the other hand, ECM and EDM are good for machining steel and super alloy but not with USM.

iii) Process Capabilities :-

Process Capabilities of NTM process include, Metal removal rate, surface finish, tolerance, and other related

parameter, PAM has a higher metal, removal rate Compared to USM and EDM process. BCM results in excellent surface finish, however it causes extensive surface damage. when compared to AJM or USM process.

iv) Economic Considerations :

Economical factors include costs related to capital investment, tooling and fixtures, power requirement and other expenses incured for machining process, AJM, USM and PAM proces require very low capital investment, Compared to EBM, EDM, BCM. and LBM process. Tooling costs are high for EDM and BCM process. the power consumption is very low for USM and LBM process. Economic Consideration is a very important aspect as it determines the final cost for machining a particular component.

Advantages :

1) Material removal without mechanical with the workpiece.
2) Material removal rate is independent of workpiece hardness
3) Cutting forces are independent of workpiece hardness.
4) Tool material need not be harder than workpiece material.
5) Tool wear is not a problem.
6) Ability to machine any material
7) Stress free machining
8) uniform material removal over entire area simultaneously
9) Superior surface Integrity possible.

10) Intricately shaped very hard and fragile material can be machined.
11) Finely focussed micro-machining is possible
12) Micro hole drilling at shallow entrance angles are possible.

LIMITATIONS:

1) All modern machining methods are generally costly
2) Their specific power consumption is quite high
3) work piece and tool must be electrically conductive
4) Recast or heat affected zone or surface produced may troublesome, for this purpose the compatibility of procss with the metallurgical state of the workpiece material can be studied before using a particular NTM procss for production work.
5) The depth of cut is limited.
6) There may be taper in side walls, holes or cavities

Most of these limitations can be overcome & controlled, so that the advantages can be obtained with good product quality assurance.