

The characteristics of eco-friendly materials are.

Unit - 5

① (48)

1. They are recyclable or reusable, subsequent to their disposal.
2. They are energy efficient i.e., promotes energy conservation or enhances energy efficiency of Processes.
3. These materials are safer and non-toxic in nature, thereby prevents adverse effects on environment and living beings.
4. They are highly reliable and possess good stability under variable working conditions.
5. They are resource efficient i.e., optimizes the utilization of resources, by enhancing the material performance and efficiency of resources.

Sustainable manufacturing.

The manufacturing strategy which involves consideration of social, environment and economic aspects is known as sustainable manufacturing. It is require to adopt sustainable manufacturing in order to overcome Problems arising due to the factors such as environment aspects, Increased consumption of fossil fuels, rising world population, Unrestricable worldwide globalization etc. Development of technologies to obtain manufacturing with minimized waste generation, toxic emissions, greenhouse gas emissions and energy consumption is the ultimate objective of the sustainable manufacturing.

Environmental friendly machining.

It is defined as a machining which involves use of environment friendly materials and energy efficient Processes. Usually, the machining Processes may involve use of harmful and polluting lubricants or coolants, which causes adverse effects on living beings and environment upon disposal. And, the byproducts obtained during machining may also be harmful to be environment. Also, the improper machining may lead to high energy consumption, which thereby causes environmental pollution. Therefore, environmental friendly machining is implemented in order to overcome the above mentioned drawbacks of general machining methods. And it aims at optimizing the energy consumption as well as prevent the use of

harmful materials, by replacing them with eco-friendly materials.

Alternate casting techniques with respect to sustainable green production systems

Alternate casting techniques deals with the development of energy efficient, resource efficient, and environmental friendly methods of producing a casting. The primary consideration of an alternate casting method is to recycle the moulding sand. The moulding sand can be recycled and used in other forms such as filling material, while, it can also be reused for preparation of cores. Hence, these kind of alternatives in casting, reduces the environmental impact to a great extent and also leads to effective usage of resources.

zero waste manufacturing

zero waste manufacturing refers to the manufacturing process, which involves zero or negligible wastage of resources required for manufacturing. it is made possible by efficient use of products and recycling or alternative usage of byproducts obtained during manufacturing. It deals to environment friendly manufacturing, since it aims at effective management of industrial waste as well as raw material. Different waste assessment process and strategies of reduction or alternate use of waste are implemented, in order to achieve the objectives of zero waste manufacturing. Also, the undesired expenses of waste disposal, surplus scrap and raw material are reduced, due to this type of manufacturing process.

Environmental impact of manufacturing system

Man, material and machine are the basic inputs of a manufacturing firm. Also, energy and water are required for carrying out manufacturing. Impact of manufacturing on environment mainly depends on the consumption of energy, water and materials. manufacturing parameters which are grouped as major factors causing environmental impacts are,

1. Waste generation.
2. TOXIC materials.
3. Green house gas emissions.
4. Energy consumption

Impact of these factors are discussed in detail as follows.

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1. Waste generation.

Most of the manufacturing industries leaves very large quantity of wastage. Form of wastage left may be either liquid or solid type. The quantity of wastes from manufacturing industries is much higher than that of other industrial sectors such as oil and gas, agriculture, mining, hazardous, coal ash etc., even the sum of quantity of wastage from these industries is less than wastage quantity from manufacturing industries. Therefore, waste generated by manufacturing industry produces significant impact on the environment. Thus, it became an important aim for green manufacturing industry produces significant impact on the environment. Thus, it became an important aim for green manufacturing research to minimize the amount of waste from manufacturing industry and thereby reduction in its environmental impact.

2. Toxic chemicals.

Almost all manufacturing industries make use of wide variety and huge amount of toxic materials for development and processing of the components during manufacturing. The manufacturing operations such as cleaning, etching, catalyzing etc., are performed using toxic materials. Thus, these processes leaves toxic waste which causes damage to human health and significant environmental impacts.

3. Greenhouse Gas emissions.

In addition to the solid and liquid wastes, emissions of greenhouse gases are the byproduct of manufacturing industries. Manufacturing requires huge amount of fossil fuels for both in-plant combustion and generation of electricity used in the plant. Thus, as a result large quantity of greenhouse gases are emitted throughout the job. These emissions produces significant impact on environment and leads to global warming, climate change etc.

4. Energy consumption.

Energy is the one of the major input to the manufacturing industry and its consumption in large amounts for manufacturing processes produces significant impact on environment. Because major amount of energy used in manufacturing plants is generated from fossil fuels. While energy generation, fossil fuel combustion results in emission of sulfur dioxide, carbon dioxide and nitrogen oxide as fossil fuels mainly consists of sulfur, carbon and nitrogen.

These emissions mainly include abnormal environmental conditions such as smog, acidification and global warming.

Environmental Friendly materials in manufacturing

Prior to the concept of environment friendly materials, scientists are developed new materials, only focussing on the performance during service. But they ignored the resource utilization and energy consumption for processing of these materials, environmental impact caused during complete life cycle. In order to overcome the problem of environmental friendly materials is to consider the environment impact of the material during its life cycle along with the performance. Environmental consciousness is required during every stage of a material life cycle. There is a huge demand for the eco materials, as these materials leads to the development of advanced materials, sustainable development of global environment and social development. Research on environment friendly materials led to the development of new material technology, that has less impact on environment. Less energy consumption, better resource utilization, recyclability, reusability, non-poisonous, greater reliability and stability human effort etc., are the important characteristics of environmental friendly materials.

Sustainable Production by environmental friendly machining.

The Process which make use of cutting tools to obtain removal of excess material from the component is called machining process. It is one of the manufacturing process, employed for finishing and fabrication of the products. Most of the machining processes make use of cutting tools fluids for cooling and lubrication of workpart and the tool. Various problems arising due to usage of cutting fluids in machining are as follows.

1. Occurrence of environmental hazards in machining area.
2. Health hazards, which operators directly gets exposed to them.
3. Recycling of the chips which are exposed to cutting fluids is difficult.
4. Non-value adding process such as post cleaning is required for the workparts which undergone machining using cutting fluids.

In order to overcome these problems and to make the machining eco-friendly various alternate machining methods are adopted. These methods mainly concerns with prevention or minimization of cutting fluid usage. They

Include dry machining near dry machining cryogenic machining and machining with aid of high pressure jet. (50)

1. Dry machining.

A Metal removal Process which deals with cutting of metals with help of cutting tools in the absence of cutting fluids is called dry machining. For this Process, appropriate development in materials of cutting tool is made and corresponding changes is done in design of machine tools and chip handling aspect. The cutting tool used for dry machining is of high performance coated type or it makes use of tools of self lubricated type which are provided with the micro holes on both flank and rake to accommodate a solid lubricant, usually molybdenum disulfide. It is difficult to employ this Process for high speed cutting and for machining of new materials such as titanium alloys, nickel alloys etc., which are used for aircraft components.

2. Near dry machining.

If a machining Process is carried out by making use of very small amount of lubricant, then such Process is called near dry machining. In this Process lubricant is supplied to contact area of workpart and cutting tool in the form of a mist, and quantity of lubricant used, usually ranges from 10 to 150 ml/h.

3. Cryogenic machining.

The Process in which cryogenic cutting fluids are employed to carry out machining is called cryogenic machining. Such type of cutting fluids enables tool wear reduction, cooling of chip-tool interface, enhancement of machining performance and does not alter material properties. Various cryogenic approaches available are indirect cryogenic cooling, direct cryogenic cutting tool treatment, workpart pre-cooling and cryogenic jet spraying. As this machining Process is safe, clean and eco-friendly, it is considered as a sustainable machining Process.

4. Machining with Aid of High Pressure Jet.

The cases in which avoiding cutting fluid is completely is not possible, an alternative method to conventional cutting is "High Pressure jet assisted machining" and abbreviated as HPJAM. This Process enables rise in machining

Performance by using small amount of cutting fluid comparatively. In this process, water based or oil based cutting fluids are pressurised to a pressure of range 80 to 360 MPa. Then, fluid under pressure is allowed to fall at workpart-tool interface through nozzles of diameter ranging from 0.15 to 0.25 mm. This fluid jet directly hits the area under interest thereby effective use of cutting fluid becomes possible.

Need of vegetable Based cutting fluids:

Cutting fluids such as synthetic, semi-synthetic and mineral type are widely employed for conventional machining. These cooling lubricating fluids are advantageous in manufacturing plants but their usage leads to environmental impact and health hazards. In order to overcome these problems, researches have been carried out and resulted in development of bio based cutting out and resulted in development of bio based cutting fluids which are extracts of vegetables. Such cutting fluids are known as vegetable based cutting fluids and they are replacing the existing cutting fluids in most of the machining cases.

Structure of vegetable based cutting fluids:

This type of cutting fluids are prepared by using vegetable oils which comprises of triglycerides. These triglycerides consists of hydroxyl groups and molecules of glycerol having three fatty acids in the form of long chain, hydroxyl groups and glycerol molecules are connected by ester linkages. Unsaturation level of each fatty acid present in the oil is different but they possess similar length and lies within 14 to 22 carbons long. vegetable based cutting fluids possess high viscosity index and lubricating capability due to their triglyceride structure. But they are limited in the aspects of oxidation and thermal stability.

Advantages of vegetable Oils over other oils:

1. They possess high lubrication ability. Thus leads to minimization of wear and friction.
2. vegetable oil possess good viscosity property. comparatively they remain more fluidic with decreasing temperature and as temperature raises they possess higher viscosity.
3. They have higher value of flash point. thereby, they can be employed for high temperature applications, and they enables reduction in occurrence

of fire hazards and generation of smoke.

4. Molecules of vegetable oils possess homogeneity in size due to which oil parameters such as boiling point and viscosity are less susceptible to change. (51)

5. Loss of these oils from misting and vaporisation is less. As they possess larger molecules weight and higher boiling temperature.

Need of Alternate joining Techniques

Different conventional methods are available to obtain joint between sheet plank and tube, and between the tubes. They are joining by welding process, structural adhesive bonding and joining with fasteners. The process of joining by these methods are different from one other and their area of application is highly intensive to mechanical, physical and chemical requirements. Usage of these methods also arises problems with respect to environmental and aesthetic aspects.

Problems related to corrosion undesirable aesthetic features and functional limitations due to permissible load on bolts, rivets, nuts and weld beads are commonly found in both welding and fastener joining methods. In addition to these problems, difficulty in joining dissimilar metals, generation of unwanted smokes and fumes, and difficulties with respect to heat-cooling cycle also arise in welding method. Usage of structural adhesive bonding enhances aesthetic of joint and enables joining of dissimilar materials. But, limitations of this method are performance of such bonded components is joining environment is hostile and surfaces upon which adhesive are applied, requires precise preparation.

In order to overcome these problems, a new environmental friendly joining technique based on compression beading is developed as an alternate joining method to that of conventional methods. This technique enables joining of tubes of thin walls and joining of a sheet plank with the tube.

Advantages of Environmental Friendly joining Technique.

Advantages of the proposed alternate joining method in comparison with conventional joining techniques are as follows.

1. It is a flexible technique as it is able to handle any type comparison of different types.
2. Repetability of Production is very high.
3. Energy consumption is low.
4. Enables joint between tubes or between sheet panel and tube of different materials.
5. It is an economic joining technique.

Environmental friendly joining of tubes and tube with sheet plate.

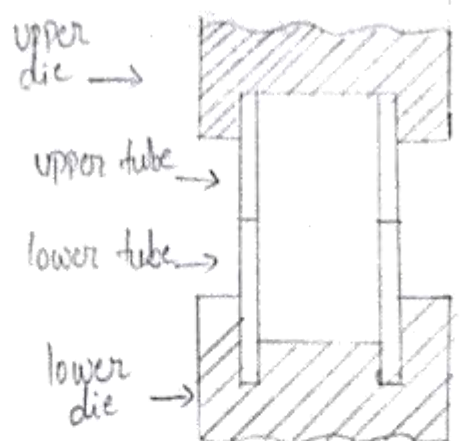
A Proposed technique called compression bending is an environment friendly tube forming process. And is performed based on the local buckling mode of plastic instability mechanism.

Plastic Instability Mechanism:

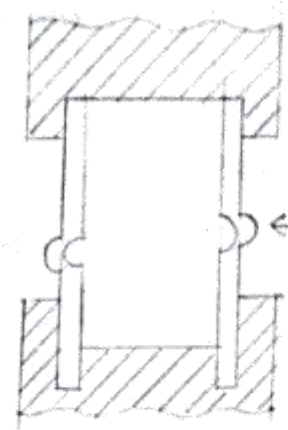
When a tube is subjected to axial compression, deformation of tube occurs due to its plastic instability. In this particular case there exists two modes of deformation, namely local and global buckling. Local buckling occurs in the thin walled tubes. It produces compression beads i.e., axisymmetric wrinkles along axis of tubes. Global buckling usually takes place in the tubes which are thick and long. It leads to complete failure of the tube similar to that of column buckling. Thus, it is evident that global buckling is undesirable and compression beads are generated, only as a result of local buckling mode of plastic instability.

Joining of tubes:

Environmental friendly tube joining process is carried out in an appropriate pair of dies provided with cavities to accommodate the tubes. Initially tubes which are positioned one above other placed in the die cavities as shown in fig. A sufficient space is provided in between the dies so as to allow tube bending. Axial compressive force is applied either by forcing ends of two tubes one over the other or by pushing the axial compressive force is applied on the tubes, they collapse into the space between the dies and thereby results in formation of beads.



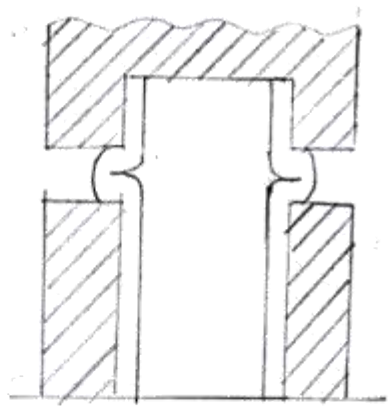
Before start the Process



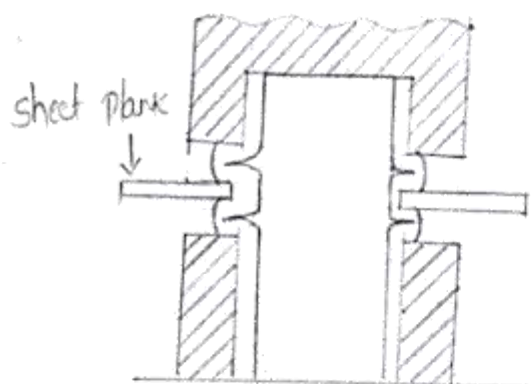
During the Process

Joining of tube with sheet plank:

This Process is similar to that of tubes joining Process until obtaining single compressive bead. Then after metal plank is placed on the bead and compressive force is applied to form another bead on sheet plank. and such Process is called two stage axisymmetric compression beading. joint can also be obtained by performing tube end flaring after completion of axisymmetric compression beading as shown in figure.

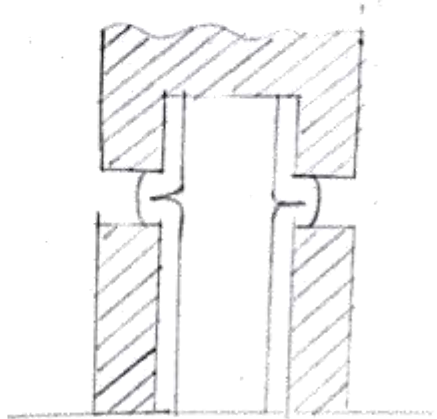


Producing first bead

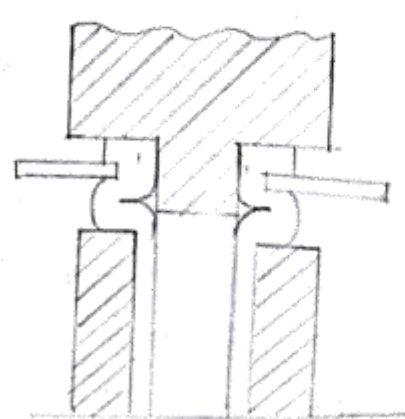


Producing second Bead upon the sheet plank

Joining of tubes sheet plank by tube end flaring compression beading.



Producing first bead



Producing tube End flaring upon the sheet plank

Steps Involved in minimizing the solid waste during manufacturing.

The sequence of steps involved in minimizing the solid waste generation during manufacturing are explained as follows

1. In this step, a well structured solid waste minimization team is established and some specific goals are defined. Clear responsibilities and activities are given to each member to accomplish the defined goals.
2. In this step, the existing records of solid waste and recycling methods are reviewed, so that it is possible to get a complete information about the amount and type of waste produced in a process, methods employed for recycling data related to raw material etc.
3. An hierarchical flow chart of the process is prepared in this step. so that, all the processes are clearly analyzed, and this data is used for developing new alternative techniques to minimize the solid waste generation.
4. This step, discuss about the composition present in this step. so that, of organisation This analysis also. Above data is provided by the "solid waste costs".
5. This step provides a complete analysis about the waste produced from an organisation. This analysis also answers the questions such as type and amount of waste generation, type of input materials producing waste, efficiency of process used etc.
6. In this step, the assessment team identifies the components of waste stream and some common waste minimization alternatives are implemented for the reduction, recycle or reuse of these components.
7. A screening process is carried out to evaluate the waste minimization alternatives for economic and operational feasibility of various options provided by the alternatives. so that, it is possible to select a best waste minimization alternatives.
8. The selected waste minimization alternatives are implemented for waste minimization. This step also provides an implementation plan, deployment plan, funding details etc.
9. The developed deployment plan is executed correctly. A regular supervision is necessary to meet the established goals within the time line.
10. This step validates the implemented programs. so that, it is possible to ensure, whether these programs have met the established goals or not and the operating costs are within the limits or not etc.
11. After implementing solid waste minimization program, a regular monitoring of the program is necessary to ensure that the performance of the program is not deviating from the predefined plan, and a continuous improvement of minimization program is required to accomplish the established goals.

Strategies of Zero waste.

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The main concept of zero waste manufacturing is to reduce the amount of solid waste produced and use of materials during manufacturing by developing ecofriendly machining process, alternate casting and joining methods and by using a recyclable and ecofriendly materials. This can be achieved by employing the following strategies.

(i) Identification of Recyclable Products.

An assessment is necessary to identifying the recyclable and reusable products and appropriate methods for recycling and reusing. Thus, it is possible to reduce the solid waste by identifying the recyclable products at source.

Examples of Recyclable.

Aluminium cans, amber glass, antifreeze, batteries, bottles, buckets, CFL bulbs, carpets, Paper, high density polythene plastics, Polycarbonates, Polystyrene etc.

(ii) Paper Product Reduction

Excessive use of paper is minimized by implementing new policies or rules, and these should be followed by all the employees in an organisation. Creating awareness among the customers about the 'going green' also minimize the use of paper.

Eliminate Paper Use:

- a. Using electronic media, instead of paper printing.
- b. Printing on two sides of paper and using recyclable papers etc.
- c. Paper use is completely eliminated by sharing information, paying bills through digital media only.

(iii) Collection Station.

Collecting the recyclable and reusable products such as cell phones, computers, CFL bulbs, outdated products, pens, plastic bags, batteries etc. from all sources.

(iv) Source Reduction.

It is the process of minimizing the production of by-products at source itself. Thus, it is possible to reduce and eliminate the waste, and the need of innovative disposal techniques. Quantity of waste generation is significantly reduced by employing energy efficient lighting, using water-based paints, reusing

old equipment, refillable bottles etc.

(V) Reduction in waste Generation During Packing.

Reusing the Packaging materials such as envelopes, mailing boxes and using returnable containers for shipping etc.

(Vi) minimization of food waste.

Production of food waste is minimized by donating excess food to food banks, metal Programs etc., Producing bio-diesel from used oils, composting cafeteria's bi-Products etc.

(Vii) Purchasing Green Products and Developing Green Partnerships.

For sustainable development, Purchasing green Products and building green Partnerships are necessary irrespective of the profits or cost. Examples of green Products are recyclable Plastics, Paints that are free from volatile, Organic compounds, biodegradable Plastics and Cleaning Products, green building materials etc.

(Viii) minimizing the need of Delivery and transportation Systems.

By minimizing the use of delivery and transportation Systems, it is possible to reduce the cost involved. This is achieved by implementing following initiatives.

1. Using locally available Products
2. Rebuilding Pallets at working site
3. disposing of waste onsite.
4. implementing work-from-home Programs.

(ix) Alternative usage of Products.

It is the Process of reusing the Outdated Products for other purposes, both internally and externally. This is the best way to reducing the waste at source.

(x) zero-land Filling methods.

Employing zero-land Filling methods such as mini-MRF and landscaping Process like zeniscape, grass cycling etc.

(xi) implementing HR strategies for Green Development.

Educating and assigning duties to the employees, customers and other stakeholders in an organisation for sustainable green development.