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To Study Sustainability and Implementation of Green Manufacturing on Various Manufacturing Processes

Natish Patyal[1], Abhijeet Saini[2], Varun Dutta[3]
[1-2]Assistant Professor, Mechanical Department, MBSCET, Jammu, India-181101
[3]Assistant Professor, Mechanical Department, SMVD University, Katra, India- 182320
Email address: patyal.natish450@gmail.com[1], abhijitsaini@gmail.com[2], varun221984@yahoo.co.in[3]

***Abstract*—**Manufacturing plays an essential role in an organisation, especially to build a competitive advanced and improved performance product. Due to concern of carbon emission and expected rise of electricity prices, eliminate the use of hazardous substances in the design, different techniques are devised to reduce energy demand in the manufacturing processes. Green manufacturing deals with the degree of automation, manufacturing environment, transportation, material inputs and facility input. It is a method for manufacturing that minimizes waste and pollution. These goals are often achieved through product and process design, for green manufacturing, energy efficiency plays a vital role for productivity, cost and flexibility of the manufacturing system such as machine tools. In this paper a study have been made that how production and machine tools can be assessed together for energy efficient approach, Moreover, this paper also encompasses the problems which can arise while working on the manufacturing of an energy efficient system. This study also focuses on the challenges in both the technology as well as conventional manufacturing system.

***Keywords*—** Energy consumption, green manufacturing, sustainability.

I. INTRODUCTION

Manufacturing is the basic step with which an efficient and usable product can be achieved; it involves the transformation of a raw product into final product which can be used to fulfil the basic human needs. However the transformation of the product from initial stage to a final product involves various manufacturing processes, which primarily loses energy and causes environmental pollution. The final product is not that much sustainable in the present market that it can meet all public and environmental requirements. To achieve sustainability, green manufacturing is implemented which is a newly emerged energy efficient technique. It involves machine tool design, process planning and machine operations. In the process of manufacturing wastes are produced through which pollution is caused directly and indirectly by the use of energy which is needed to run those processes. Manufacturing waste involves various group substances which depends on the technology, raw material and quantity at the end of the end of the processes [1]. Increasing demand of goods creates a negative impact on the natural resources and energy. Due to the high goods demand they are being manufactured irrespective of the technology, which turns a good product unsustainable to human. The lesser availability and increased price hike of energy is becoming a noticeable issue which can affect the whole life of the product with its production technology as well. [2] Conventionally the performance of the production system is considered by watching its four major classes of manufacturing which are as: cost, time, quality and flexibility. Manufacturing industries has always taken forward steps to improve the technology for manufacturing. However they may at high energy consumption systems with more installation prices. The major four edge parameters while manufacturing which are considered for a key towards sustainability which was proposed by chryssolouris [4].

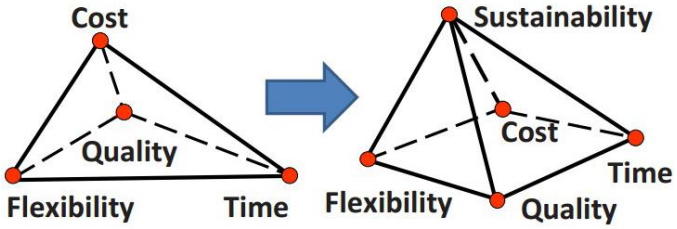

Fig. 1. Manufacturing edge parameters.

Bunse et al studies that energy can be reduced by increasing its consumptions at various levels and utilising it by most and established key performance indicator for the manufacturers .the cost of the product deals with various factors such as the equipments, facility input, material cost and labour etc and these can be monitored through KPI. As same the quality of the product also encompasses with the surface roughness, dimensions of the product, cost for quality etc. And these definitions are misleading by the manufactures while taking sustainability into consideration on the other hand. Duflou *et al* has presented in his paper that for a energy efficient system it is necessary to take control both for energy demand for machine tools and for manufacturing system levels and described that how energy can be efficient by dividing the efficiency into different levels such five levels are as device/process level, line/cell level, line/cell/multimachine system ,facility, multi factory system and enterprises and said that these each levels have their different parameters ,inputs and various assumptions depending upon the conditions[5]. This review paper incorporates with the different levels for efficiency for green manufacturing and putting sustainability together by studying conventional methods of manufacturing.

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II. SUSTAINABILITY

Sustainability involves more efficient manufacturing processes in order to achieve maximum gain from minimum capital or maximum gain from minimum resources. Sustainability becomes very popular in recent years. Development which meets the needs of the present market without compromising with the future generations to meet with their own needs Sustainable is the best outcomes for modern enterprises. Only those can survive in present market who can meet the demands from all these three phases – which takes them into concern with economic, social and environmental performance of the product.

Fig. 2. Drivers for sustainability.

The initiative to have a sustainable operation in this vast sense is becoming more important. As they are the key drivers for sustainable manufacturing in Asian countries. Key drivers facing Asian countries manufacturers include:

- International standards and protocols. The United Nations Global Sustainability Protocol is developing binding international targets for pollution control, resource efficiency and deep institutional, economic and industrial restructuring. Manufacturing firms will be prime targets for controls.
- Compliance with regulations. The need for cleaner production is becoming more critical in particular with the imminent implementation of a carbon emissions trading scheme. Without a change in practice and behaviour some manufacturing enterprises will be either pressured or legislated out of business.
- Community expectations of the impact of production and energy use on ecosystems. Consumers and customers will continue to opt for environmentally friendly products. Employees will also vote with their feet – presenting further challenges for manufacturing industries already facing skill shortages.
- Risks and liabilities associated with investments. Companies are coming under greater scrutiny from financial analysts with respect to environmental performance.
- Costs associated with meeting regulatory constraints. The amount of environmental legislation is expected to increase. Monitoring, verifying and reporting on environmental performance will become a function of manufacturing enterprises.
- Market-competitive, environmentally-benign technologies. The need to be sustainable will lead to new inventions in product and process technologies, providing opportunities for innovative enterprises.

The implications of these drivers for manufacturing are that we need to change our processes, our materials and our thinking at all levels of our organisations. We need a broad understanding of sustainability that permeates everything we do and that involves everyone in the organisation including managers, employees and stakeholders. Managing for sustainability requires leadership, commitment and planning to a sustainability strategy that is nested within the core values of the business.

III. ENERGY EFFICIENCY FOR MACHINE TOOL

A number of studies have been done with the energy efficiency for manufacturing processes, but the most of these studies are being done while monitoring of the energy consumption for machine tools [9] or on the monitoring of specific components, such as the spindle speed, kinetic energy recovery system(KERS) [9].some of the other methods have been published such as the "unit process energy" method by Kara and Li [6] and the "energy blocks" method by Weinert et al. [7]. Moreover up given studies have being focused on energy measurements been conducted in advance so that at last efficiency of the system can enhanced. Gutowski et al studies that how modern tools can be assessing for energy consumption of machine tools and manufacturing processes e.g. to model environment as a thermodynamic system, and studied that how energy exchange is done in these systems [8]. The main barrier for using this approach generates in its results when a very complex energy problem which can solved with the use of energy or "available work". Moreover, the existence of such approach exists in difficult and complex experimentation. And that had been proved in the when the energy consumed by machine tools during machining is sufficiently greater than the estimated energy required in chip formation as stated by Dahmus and Gutowski [14] .Salonitis et. al. Studied that for a movement, that the specific cutting energy consumed is less than 15% of the total energy consumed by a modern automatic machine tool during machining. [5] And as konstantinos et.al. studied that it is very important that accurate energy should be measured while the consumption of energy by the system and its subsystem and compare it with other theoretical results and it showed that the peripherals of the system consume same amount of energy as the energy consumed by the process which is being carried out. Similar results came for the case of grinding and milling machine tools [3]

$$E_{total} = E_{process} + E_{peripherals}$$

Where E process is the energy which is being consumed by the actual process being carried out E peripherals is the energy which is being consumed by the subsystems in the machine other than machine tool e.g.:- coolant pump, bulb, rooms other appliances etc. This energy consumed is estimated by specific cutting speed and it also depends with which mechanism the process is being carried out and also on the process parameters

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.This study also showed us that at idle time of the machine tool the peripheral energy is being continuously consumed and if those also are being shut down the total energy consumptions can be reduced.

E peripherals =E background +E load

The background energy also depends upon the coolant pump energy the HVAC energy (heat ventilation Airconditioning) and control unit energy consumption etc. As described by Daiz Nancy [10].

IV. Energy Efficiency on Manufacturing System

Energy efficiency within a manufacturing system can be tackled at a number of levels. Improvements at each level will derive benefits and each benefit will plays its own role in energy conservation. Hence benefits from machine tool level enhance manufacturing system also. So concentration at particular level will miss opportunities at other levels. The application of lean has focused on the primary material flow to improve the product delivery to customer. More recently lean tools have been credited with achieving energy savings through direct application or the use of 'lean and green' toolsets [11]. One key principle of Lean production is the reduction of waste materials and labour in a continuously improving culture [12].This makes a very powerful statement that Lean companies are embracing Green objectives and suggests that Lean manufacturers are transcending to Green manufacturing as a natural extension of their culture of continuous waste reduction. While it may be questioned whether the main motivation was for economic or environmental improvement, it is clear that energy efficiency gains can be achieved throughout the manufacturing systems. It focuses on the flow between value-adding operations and the removal of waste from non-value activities and contrasts with earlier scientific management which focused primarily on the improvement of the value-adding operations. There is an interesting theory therefore with energy efficiency savings can be achieved through better value additive activities and technology in isolation as well as considering the activities as part of a wider manufacturing system flows.

At different levels, savings can come from simple prevention activities such as switching off energy consumption when not in use. Switching off lights when not in use is perhaps an simple example but the principle extends to the switching off manufacturing equipment when not in use. Other savings can come from how equipment is managed when in use, for example, the use of sequencing and batching to maximise the energy efficiency during production periods.

The waste hierarchy (Fig.3) is one means but which manufacturing system level energy efficiency actions can be both classified and prioritised. The material waste hierarchy is well established and this can be translated into an energy waste hierarchy [13]. An energy hierarchy for manufacturing systems level would include: prevent, reduce, reuse and dispose. Examples of actions arising from such a hierarchy are as follows:

- Prevention: switching off equipment at end of shift or powering down clean room air handling when not in use at night.
- Reduce: relaxing set points or clustering batches to enable to equipment to run at closer to design load efficiency when in use.
- Reuse: harvesting energy from one process for use by another process
- Dispose: venting to atmosphere and using the environment as a heat sink rather than using power to cool.

Fig. 3. Waste hierarchy.

V. Conclusion

From the above study it is clear that energy efficiency approach and sustainability can achieve by implementing some of the key features like KPI, KERS etc. Lean manufacturing which helps the manufacturers to achieve an energy efficient level which will be profitable to the environment and to the manufactures also to get sustainability it is necessary to concentrate on each level of the manufacturing system so that even from individual level energy is not eliminated and can be utilised again. It is very crucial in the present fast manufacturing essential energy efficiency measures should be adopted, which are acceptable to environment and humans.

References

[1] IEA 2007. Tracking Industrial Energy Efficiency and CO2 emission.
[2] D. Allen, D. Bauer, B. Bras, T. Gutowski, C. Murphy, T. Piwonka, P. Sheng, J. Sutherland, D. Thurston, E, Wolff 1; Environmentally Benign Manufacturing: Trends in Europe, Japan, and the USA, *ASME Journal of Manufacturing Science and Engineering*, 124, pp. 908-920, 2002.
[3] Konstantinos, salonitis. Energy efficiency manufacturing from machine tools to manufacturing systems, 634-639, 2013.
[4] IEA 2008. Worldwide Trends in Energy use and efficiency – Key insights from IEA Indicator Analysis.
[5] K. Salonitis, "Efficient Grinding Processes: An energy efficiency point of view," *Proceedings of the 10th International Conference on Manufacturing Research (ICRM 2012)*, pp. 541-546, 2012.
[6] S. Kara, W. Li., "Unit process energy consumption models for material removal processes," *CIRP Annals - Manufacturing Technology*, 60, pp. 37-40. 2011.
[7] N. Weinert, S. Chiotellis, and G. Seliger, "Methodology for planning and operating energy-efficient production systems," *CIRP Annals - Manufacturing Technology*, 60, pp. 41-44, 2011.

Natish Patyal, Abhijeet Saini, and Varun Dutta, "To study sustainability and implementation of green manufacturing on various manufacturing processes," *International Journal of Scientific and Technical Advancements*, Volume 2, Issue 4, pp. 135-138, 2016.

ISSN: 2454-1532

[8] T. Gutowski, J. Dahmus, and A. Thiriez, "Electrical Energy Requirements for Manufacturing Processes," *In 13th CIRP International Conference on Life Cycle Engineering*, 2006.
[9] T. Behrendt, A. Zeina, S. Min, "Development of an energy consumption monitoring procedure for machine tools," *CIRP Annals - Manufacturing Technology*, 61, pp. 43-46, 2012.
[10] D. Nancy, Machine tool design and operation strategies for green manufacturing, 2010.
[11] G. G. Bergmiller, and P. R. McCright, "Lean manufacturers' transcendence to green manufacturing," *Proceedings of the 2009 Industrial Engineering Research Conference*, 30 May - 3 June,Miami, FL, 2009.
[12] G. G. Bergmiller, and P. R. McCright, "Parallel Models for Lean and Green Operations," *Proceedings of the 2009 Industrial Engineering Research Conference*, Miami, FL, 2009.
[13] P. Lunt, and A. Levers, "Reducing Energy Use in Aircraft Component Manufacture - Applying Best practice in Sustainable Manufacturing," *SAE AeroTech Congress*, Warrendale, PA: SAE International, 2011.

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