ISSN (Online) 2394-2320

International Journal of Engineering Research in Computer Science and Engineering (IJERCSE)
Vol 4, Issue 9, Septemeber 2017

Effective Technologies for Reducing Emissions and Saving Energy in Mechanical Industries

[1]Jayant Singh

[1]Department of Mechanical Engineering, Galgotias University, Yamuna Expressway Greater Noida, Uttar Pradesh

[1]jayant.singh@galgotiasuniversity.edu.in

Abstract: This paper proposes production techniques and facilities for sustainable development in the mechanical equipment sector, based on an analysis of the current situation in the mechanical equipment industry. The paper would address eight aspects: digital technology, new material, near-net shaping technology, fast manufacturing process technology, safe manufacturing technology, waste-free manufacturing technology, automatic control technology, and reusing and remanufacturing technology. It is also important to consider that one should grow technology and equipment as a strong manufacturing nation in such a way as to conserve biodiversity and encourage sustainable development of the environment. In this way, the support can be provided that helps in building the society which is eco-friendly in nature.

Keywords: Mechanical Equipment, Green Manufacturing, Sustainable Development, Manufacturing process, Industries. Environment.

INTRODUCTION

The "mechanical equipment industry" has a direct impact on achieving the goals of saving energy and reducing emissions in all industries and occupations, such as electrical power, metallurgy, petrochemical and other fields. Nevertheless, there are many issues in the mechanical sector, such as high energy usage, low precision in manufacturing, high machining allowance, high waste rate, low efficiency in output, high waste pollution, etc. Much energy consumption and pollution is produced in thermal processes such as spinning, welding, and heat treatment, where energy consumption and contaminants in the mechanical industry account for 50~70 per cent [1].

It is therefore imperative that the use of renewable manufacturing technology is investigated and extended to save electricity and reduce emissions. This will provide support for the manufacturing industry for technology and equipment, while at the same time allowing sustainable development. Reducing environmental impact and resource consumption in the manufacturing process would allow both the economic and social benefits of the business to be balanced. Emissions mitigating production and energy saving innovations in the machinery sector consist of three types: conserving resource, environmentally friendly, and energy saving. These primarily apply to the simplification of process system components; the avoidance of auxiliary and raw material consumption; the reduction of energy consumption; and the minimisation or complete elimination of produced ammonia, wastewater, waste gas, noise and other substances that impact or harm the environment and the user during the usage, build, manufacture and remanufacturing phase [2].

With the rapid development of electromechanical interface technology, computer technology, information technology, control technology, etc. in recent years, all the excellent developments of these innovations are constantly consumed to boost manufacturing technology progress. A part of that process is the patterns in digitization, accuracy, versatility, intellectualization and greening. Some architecture, production and control innovations have arisen, and these have been introduced slowly

ISSN (Online) 2394-2320

International Journal of Engineering Research in Computer Science and Engineering (IJERCSE)
Vol 4, Issue 9, Septemebr 2017

to the manufacturing equipment market. Types include digital technology, safe manufacturing technology, new material, near-net shaping technology, waste-free manufacturing technology, fast manufacturing process technology, reusing and remanufacturing technology, and technology of automatic control. Those are actively encouraging sustainable industrial development [3].

Digital Technology in Manufacturing process and Design of Equipment:

Digital design and engineering have become an essential solution to developing the hardware manufacturing industry and strengthening enterprises' central productivity with the rapid development of the IT field. Project digitization, which involves content sourcing and product design, has advanced the production and management cycle. Product development and manufacturing has increased, the number and weight of the components was reduced. Through refining the design process the raw material utilization rate will reach the highest point. All the above steps successfully encourage energy conservation and elimination of pollution during manufacturing [4].

In Boeing Co., the new product development period has been shortened from 7 years to 4 years through the latest product development system; the innovation rework duration has been lowered by 40%. Toyota Motor in Japan has nine months into the development cycle. In 2005, the development evaluation time was shortened by 64 per cent during the R&D phase of the latest Kamei vehicle. The conventional pouring tube, riser and construction concepts in the foundry industry are improved by visual casting technology, which has streamlined the pouring mechanism and the sizes of the pouring device and the riser method. Various analogue simulation techniques will incorporate the virtual reality. Modelling technologies allow models for the entire process in the early stage of equipment construction, which include material management, product design, process design, use and recycle, and so on. It involves numerical modelling, manufacturing and process shaping simulation in multiple physical environments, integrated digital product creation, simulation of high speed and high precision processing equipment, etc. At the same period, consideration is given to environmental factors and emission prevention measures [5].

The related design parameters are standardized, thereby reducing the overall effect of the product and its production process on the environment. For starters, by implementing the methodology of virtual reality, the CAMTC has reduced its design process by 10~30 per cent through the design and assessment of its ultra-high strength steel production line. It allows for the estimation of many manufacturing problems, as shown in Fig 1.

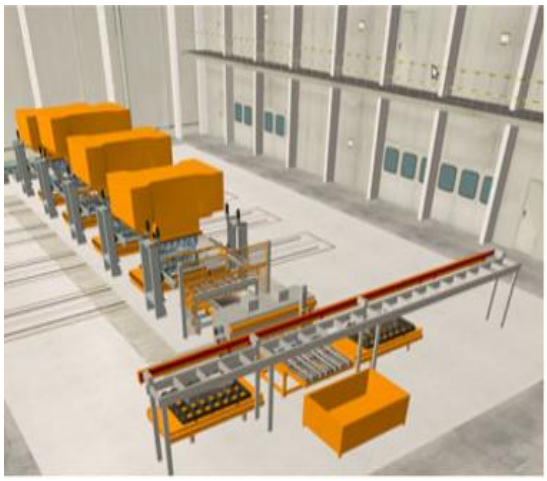

Figure 1: Design and Evaluation of Production line

Introducing New Materials to reduce the weight of Mechanical Equipment:

Innovative technologies encourage the development of new high-tech materials defined by increased strength, durability, temperature tolerance, wear resistance and resistance to corrosion. The development and use of new materials such as composite materials, high temperature alloys and light metals historically used in space and military applications has been expanded to include civilian value-added industries (machine, automotive, communication, electrical appliances, etc.), especially for the automotive industry [6].

By using new materials in building the structure, the efficiency of the new generation of engines and

ISSN (Online) 2394-2320

International Journal of Engineering Research in Computer Science and Engineering (IJERCSE)
Vol 4, Issue 9, Septemebr 2017

aircraft could be increased in 40% to 60%, and the weight of aircraft and engines could be decreased by 60% to 70%. Take a car as an example: if the weight is decreased by 15%, it will increase the fuel economy by 5~7%. CO2 pollution, which has a great influence on energy savings and environmental protection, will also be limited. The weight will rely on the use of modern automobile materials. Magnesium alloy could be made of more than 50 styles of parts on the engine, such as steering wheel, clutch housing, seat brace, transmission housing, and instrument tray system. Through designing and installing ultra-high-strength material, the CAMTC has lightened the door beam weight through 20~40 percent with a greater anti-collision capacity, as shown in figure 2 [7].

Figure 2: Ultra-high strength steel lightweight door beam

Efficient Part Manufacturing:

With growing attention being paid to resource and protection of the environment, the manufacturing process is progressing towards specific creation. It means that the accuracy of the blank's size and shape is modified from comprehensive formation to close net forming or perhaps even net shape forming. The clearance can be smaller and smaller between the blank and the pieces, with some blanks similar to or exceeding the final shapes and sizes. When anchored, these could then be mounted. Raw material use decreased by 14%, energy consumption decreased by 74%, waste fragment production decreased by 80%, and the lifespan of forged shaping dies increased by 10 times in 2020. The gray iron cast flywheel, as shown in Fig 3, decreases the weight by 9~14 per cent when formed by the casting process of the missing form.

(a) Lost pattern **(b) Casting part**

Figure 3: Casting flywheel by lost foam Process

With internal high-pressure forming technology, hollow parts with a segment of round, rectangular or irregular shape which changes along the axis may be formed. Compared with turning and dull components, the hydro shaping hollow shafts can be decreased by 30~40 percent, also up to 73 percent by weight. Hollow structural sections can be raising by weight by 10~20 per cent relative to stamping and welding elements. To use the radiator bracket as an example, the number of welding points will be decreased from 172 to 19, the amount of manufacturing passes from 12 to 5 passes and the quality of output will be improved by 64%. According to mechanically manufactured parts, the development of a hollow crankshaft with two turns saves 85% of the materials and cuts the weight by 54% according to the strong shaft with that same torque [8].

Manufacturing process with the clean production:

Clean processing of machine components in the manufacturing process mainly involves clean machining such as laser deburring and dry cutting, clean heat treatment, and clean painting or plating,

ISSN (Online) 2394-2320

International Journal of Engineering Research in Computer Science and Engineering (IJERCSE)
Vol 4, Issue 9, Septemebr 2017

and so on. There are however other pitfalls in the traditional method of manufacturing. For starters, in conventional manufacturing the slathered cutting fluids can not only cause environmental pollution, one of the most important sources of pollution for soils and waterways, but also create micro-cracks on machine surfaces, which can reduce the life of the device. As a consequence, more and more attention is being paid to modern, clean production methods such as dry cutting and close dry cutting [9].

Vacuum coating in vehicle tire hub decoration has been gradually replacing electroplating, and the recycled process known as "organic solvent" is being introduced in the painting of vehicles. Certain types of equipment including the multi-arc ion plating machine, the low frequency magnetron ion plating system, and the magnetron plus multi-arc ion plating machine were also introduced with vacuum coating technology and equipment. Douglas Company of America, for example, has used the drum-type ion plating system to handle contact components. So carbon steel bolts produced from ionized aluminium plating is put into production in Japan, instead of stainless steel. Modern electroplating plants have not been thoroughly updated with these new coating techniques [10].

In fact, the constant emission of thermal radiation, exhaust gases, dusts, waste water, and vibration during heat treatment induces environmental pollution to some degree. The important development directions of heat treatment technologies are high efficiency, energy savings, low distortion and safe production. The demand for high-performance forgings is growing with the fast development of modern automobile manufacturing. Automotive manufacturers are paying growing attention to non-quenched-tempered steels with micro-alloy as they allow lower energy and material use, decreased emissions and a shorter production period.

Reduction of process time period and resource consumption:

Short period production process makes full use of pre-production materials and power, or combines multiple systems to re-engineer the entire production process. Of starters, the high quality complex castings are produced straight from blast furnace with the molten iron smelted. In recent years, work has been carried out at home and abroad on short cycle smelting technologies with blast furnace-medium frequency induction furnace. Hot metal from blast furnace can thus be immediately moved to a medium frequency induction furnace to change the temperature and structure, resulting in a high-quality casting of molten iron. This avoids the cycle of cooling molten iron from the cast iron re-melting and blast furnace compared to conventional melting method, which takes full advantage of molten iron heat from blast furnace. The system has high energy performance in decreasing both emissions and consumption of energy.

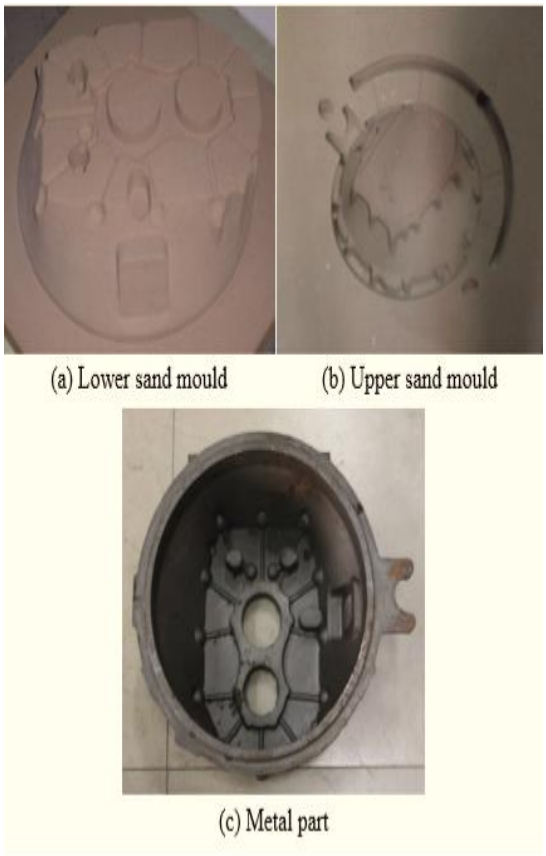

Figure 4 : Sand mould without pattern of automobile parts

Although the low-pressure casting technology was widely adopted in the manufacture of aluminium

alloy wheels for the automotive industry, the forging-spinning composite shaping technology was developed to satisfy this application's requirements. Lightweight (forged aluminium alloy wheel weight is 22 per cent lighter than casting) and high-performance (forged aluminium wheel strength is 4 times greater than steel wheel size) parts are needed for large passenger vehicles, heavy trucks and luxury cars. Steel plates would be quenched and refrigerated directly by the mold in the ultra-high strength steel stamping phase. Some forms of new manufacturing technologies, which are marked by their quick, efficient and clean manufacturing equipment, are commonly used in many countries, and are also used in the machinery and equipment industry itself. Sand CNC machining, for example, a fabrication technique that doesn't use molds or templates, has simplified the production process to a large extent. It is focused on the numerical power, casting, machine, and other multidisciplinary scientific achievements. Compared to traditional manufacturing, processing costs would only be about 1/10 of that, engineering period would be decreased by 40%-70%, and production costs would be reduced by 20%-40%.

CONCLUSION

Developing advanced manufacturing technology allows us to build a resource-saving, environmentally friendly world with the production of electronics, products, knowledge, and new management technologies. One of the big challenges in the context of equipment production is ensuring the sustainable development of the machinery sector. In order to develop and encourage technology for energy saving and reducing emissions, it is necessary to foster sustainable development within the equipment manufacturing industry.

This can be done by using items like digital technology, safe development technology, new material, waste-free manufacturing technology, near-net shape forming technology, fast production process technology, automatic control technology, and remanufacturing and reusing technology during the design, processing, use and remanufacturing processes. Development and implementation of these new green technology and facilities will achieve the goals of energy saving and carbon mitigation. This will encourage sustainable development within the mechanical machinery sector by raising the use of raw materials, energy consumption and environmental pollution.

REFERENCES

[1] Z. Shan, S. Qin, Q. Liu, and F. Liu, “Key manufacturing technology & equipment for energy saving and emissions reduction in mechanical equipment industry,” Int. J. Precis. Eng. Manuf., 2012.
[2] S. R. Vijayakumar and S. Gajendran, “Improvement of Overall Equipment Effectiveness (OEE) in injection moulding process industry,” IOSR J. Mech. Civ. Eng. Spes. Issue, 2014.
[3] I. H. Afefy, “Implementation of Total Productive Maintenance and Overall Equipment Effectiveness Evaluation,” Int. J. Mech. Mechatronics Eng., 2013.
[4] P. K. Paritala, S. Manchikatla, and P. K. D. V. Yarlagadda, “Digital Manufacturing- Applications Past, Current, and Future Trends,” in Procedia Engineering, 2017.
[5] H. Chandrashekhar and J. Rao, “An Overview of fermenter and the design considerations to enhance its productivity,” Pharmacologyon-line, 2010.
[6] M. Colledani et al., “Design and management of manufacturing systems for production quality,” CIRP Ann. - Manuf. Technol., 2014.
[7] Z. Shan, Z. Lin, X. Xu, and F. Liu, “Development and application of patternless casting mould-manufacturing machine,” in IET Conference Publications, 2010.
[8] S. Tabibian, E. Charkaluk, A. Constantinescu, F. Szmytka, and A. Oudin, “TMF criteria for Lost Foam Casting aluminum alloys,” Fatigue Fract. Eng. Mater. Struct., 2013.
[9] N. Tucker, “Clean production,” in Green Composites: Waste and Nature-based Materials for a Sustainable Future: Second Edition, 2017.

[10] B. Mrugalska and M. K. Wyrwicka, "Towards Lean Production in Industry 4.0," in Procedia Engineering, 2017.

[11] Vishal Jain, Gagandeep Singh Narula, "Improving Statistical Multimedia Information Retrieval (MIR) Model by using Ontology and Various Information Retrieval (IR) Approaches", International Journal of Computer Applications 94(2):27-30, May 2014 having ISSN No. 0975-8887.

[12] Vishal Jain, Gagandeep Singh, Dr. Mayank Singh, "Implementation of Multi Agent Systems with Ontology in Data Mining", International Journal of Research in Computer Application and Management (IJRCM) May, 2013 page no. 108-114 having ISSN No. 2231 – 1009.

[13] Balamurugan S, Visalakshi P, "Proposing New Strategy for Privacy Preserving Microdata Publishing With Conditional Functional Dependencies", Asian Journal of Information Technology Vol 15, Issue : 12, 2016

[14] S Balamurugan, K Deepika, RS Venkatesh, R Poornima, Gokul Kruba Shanker, VS Kumar, "SUN Computing: Scalable Ubiquitous Nestle (SUN) Computing for Healing on the IoT", Asian Journal of Research in Social Sciences and Humanities, Volume : 6, Issue : 8, 2016