10th Edition

SPECTROMECH

2024

NOVEMBER 2024

TECHNIQUE POLYTECHNIC INSTITUTE

DEPT: MECHANICAL ENGINEERING

Vision of the Institution

- To be a premier institute in pursuit of excellence in technical education and skill development committed to serve the society

Mission of the Institution

- To promote excellence in learning, teaching and technology transfer
- To improve the quality of skilled workforce through a structured programmed and professional skills training
- To inspire students to learn and facilitate their overall development with social orientation and values

Vision of the Department

- To be a centre of excellence in Mechanical Engineering to impart technical & professional skills to cater industrial requirements while considering environmental aspects fulfilling societal obligations

Mission of the Department

- To impart the necessary technical skills among students
- To enhance the interaction with industry
- To produce competitive& employable Diploma Engineers
- To inculcate ethical & professional values among students

Program Educational Objectives (PEOs)

- **Successful career (PEO #1):** To provide students strong foundation of technological fundamentals, necessary to analyze, design, manufacture using modern technological tools to become successful professional in real life world

- **Adaptability with new learning environment (PEO #2):** To build up the aptitude for an understanding of requirement analysis, ability to adopt new working environment and solves complex problem especially in multidisciplinary in nature
- **Keeping pace with developing world (PEO #3):** To provide adequate exposure to promising radical change in technology, training and opportunity to work as teams in cross functions project with effective communication skill and leadership qualities

- **Integration with the society (PEO #4):** To promote student awareness on the life sustained learning by bringing them to their professional principles of practice based on professional ethics of codes so as to achieve the ability to integrate in to the world of practicing professionals for collaborations, mutual support and representing the profession to society.

Faculty & staff members of Mechanical Department

1. Mr. S. N. Basu, Advisor (Academic & Administration)
2. Mr. Sujay Biswas, In-Charge
3. Mr. Sujit Kumar Garai, Lecturer (Selection Grade-I)
4. Mr. Arijit Kumar Dey, Course Co-ordinator
5. Mr. Debjit Kumar, Lecturer
6. Mr. Bhaskar Chakraborty, Lecturer
7. Mr. Kalyan Biswas, Workshop Superintendent
8. Mr. Tarak Kundu, Workshop Instructor
9. Mr. Tarun Chakraborty, Workshop Instructor
10. Mr. Prabir Kumar Naskar, Workshop Instructor

Published by

DEPARTMENT OF MECHANICAL ENGINEERING

TECHNIQUE POLYTECHNIC INSTITUTE, HOOGHLY

WEST BENGAL-712102.

FOREWORD

Heartily welcome to our tenth edition of Mechanical Engineering Technical magazine 'SPECTRO MECH' in 2024. We excited to report that the Department of Mechanical Engineering continues to grow to meet our vision of the department which is analyze by Faculty Course Assessment Report (FCAR). Mechanical Engineering is one of the largest enrolled department in the collage with more than 631 under graduate student over the period of 2010-2024 & more than 55 students are already placed at various companies as well as higher studies within the academic session 2023-24. All the initiatives are possible by the efficient contributions of alumni, friends, faculty members and staffs.

I would like to express my appreciation to all the authors of the article in this issue of the Magazine. Our goal is to create quality education for the student of the twenty first century. The success of 'SPECTRO MECH' depends on energetic and joint effort of all stake holders of the Institution. I would appreciate your feedback and any suggestion for improvement.

Soumendra Nath Basu
Advisor (Academic & Administration)
Technique Polytechnic Institute

CONTENT

Semi-Automatic Cleaning Machine

SUJIT KUMAR GARAI
Lecturer (Selection Grade-I)
Department of Mechanical Engineering
Technique Polytechnic Institute

1. ABSTRACT:
Cleaning is the main basic need for all human beings, and it is necessary for daily routine process. The conventional road and floor cleaning machine is most widely used in many applications such as example roads, railway stations, airports, hospitals, bus stands, in multi-buildings, colleges etc. also this machine uses human energy for its working operation. It is user-friendly as well as eco-friendly. In our project we aim to use easily available material at low cost, and it can be easily fabricated and easy to use and control. It is the better alternative for conventional machines. The manually operated eco-friendly road and floor cleaner can work very efficiently with respect to covering area, time and cost of road cleaning process compared with the existing machinery. Also, it is economical to use.
Key Words: cleaning, design, ecosystem, economical.

2. INTRODUCTION:
Objectives:
Open defecation free behaviours are sustained, and no one is left behind. Solid and liquid waste management facilities are accessible and reinforcing ODF behaviours and focus on providing interventions for safe management of solid and liquid waste in villages. To encourage cost effective and appropriate technologies for ecologically safe and sustainable sanitation. To develop, wherever required, community managed sanitation systems focusing on scientific Solid & Liquid Waste Management systems for overall cleanliness in the rural areas. To create significant positive impact on gender and promote social inclusion by improving sanitation especially in marginalized communities.

Stop the litter. Keep clean. Keep safe. Be clean.
Cleanliness starts from your home, God gave us green. Now, let's keep it clean, don't litter. It makes the world bitter, Wash your hands, spread the word and stop the germs
Cleaning is a necessary factor of daily routine process. Effective cleaning and sanitizing help and protect the health of human beings directly and indirectly. The Road cleaner is used to keep our surroundings clean. So that we feel fresh while walking on the streets. Generally, in the era of modern technology, different devices such as electric motors, diesel engines, and robots are being used to clean the floor and road. But such processes create

abundant pollution, maintenance and are very tough to carry out. So, to save energy and save nature, there is a need to develop user-friendly road and floor cleaning machines. A machine which should be operated manually so that it can be used as an alternative for conventional electric cleaning machine. The dust cleaning machine system is fixed with a pair of wheels which relate to the help of shaft. The shaft makes the wheels connected to one and other. The wheels are moved to the desired position with the help of manual force, which can handle is provided to move. The handle can be adjusted for a required height and are provided three adjusting holes for it. A chain drive is connected to the wheels and gear at each side. The chain is moved according to the wheel and gear. The brush moving the alternative direction of the wheels move and the brush brooms the waste present on the road also it dumps the waste into the waste-collecting box. The waste collection box is removed to dump the waste into desired places.

The agro-food sector is of major importance in many economies worldwide. In many countries the food and drink industry is a leading industrial sector. Food is a serious component of everybody daily life activities and it is recognized the contribution of safe food to a healthy life. For this reason, food safety and the protection of end consumer health is of increasing concern not only for the consumers but also for governments, professional associations and all organizations involved in the food chain from the primary production to retailers and other food businesses that put food products at the disposal of the population. Food safety is used as a scientific discipline describing the handling, preparation, and storage of food in ways that prevent food-borne illness. This includes a number of routines that should be followed to avoid potential hazards. Food safety considerations include among others, the origins of food, the practices related with food labelling, food hygiene, food additives, control of hazards and good manufacturing practices. The prevention of the multiple type of hazards with very distinctive origins requires a comprehensive and integrated approach to food safety in order to address food safety risks in every day more complex and globalized food chains. All actors in a food chain have a responsibility to ensure the safety of food products at the stages of intervention, irrespective of the nature of the activities they carry out. This book is one of a collection that aims to facilitate to the users the understanding of relevant issues related with food safety

Food handlers have legal obligation to keep food premises clean same as all food equipment, contact area, and if it necessary used, disinfected. Hazard must be controlled. Food handlers shall ensure appropriate standards cleaning and disinfection during all times and throughout all the stages of processing and distribution of food. The legal obligation of all government, including European Union and wider is concern to make sure that the food we eat is same high standard for all its citizens, whether the food is home-grown or comes from another country, inside or outside the EU. Food handlers must be aware of the specific risks associated with their operations and how they can control risk. Those who are responsible for managing the cleaning and disinfection process in the food processing often do not fully understand the reasons for the high hygienic standards or scientific principles and effective cleaning technology. This is necessary to meet the legal and technical standards and ensure control food hazards. All workers in the food industry must have the necessary skills for effective cleaning programs, including cleaning the grounds, principles of disinfection, equipment and methods, application and monitoring of hygiene. In food processing operations, soils and deposits originate from the ingredients used in the preparation of the product. Accumulated soils on food equipment and in the food environment can support the growth of pathogenic microorganisms that can contaminate foods and potentially harm consumers. Food contact surfaces must be constantly cleaned and disinfected to minimize potential contamination. Cleaning in the food industry is not an easy task. However, it is a critical step within food production since it is crucial to maintain and guarantee food safety. To ensure a safe hygienic product and manufacturing environment food handlers and workers must understand why they clean and how detergents and disinfectants work. Food safety management systems often put HACCP in the centre to control the hazard of food that can identify the specific risk associated with adverse impacts consumers. This requires a program of basic controls that deal with the general hazards, many of which can identified as Good Manufacturing Practice (GMP), Good Hygiene Practices (GHP), Prerequisite Programs (PRP) and a Control Point (CP), etc... They represent the basic requirement for good practice necessary to provide a safe environment for food production. Among the most important of them is cleaning and sanitizing plant and equipment for the production of food without physical, allergic, chemical and microbiological hazards. In addition, it is important that employees understand the reasons why “everything must be clean.” Only order to workers is not enough to maintain high standards - they need to understand the reasons why and how they do it only way to ensure a safe, healthy, high quality product and mutual trust between manufacturers and customers. All these standards ensure that risks of food poisoning and contamination are minimized, comply with local and international legislation, meet the specific requirements of customers and food safety standards and act in accordance.

3. LITERATURE REVIEW:

The global concern for environmental sustainability has led to a growing interest in eco-friendly technologies across various industries. Road cleaning machines play a crucial role in maintaining cleanliness and hygiene in urban and rural areas. This literature review explores existing research and developments in eco-friendly road cleaner machines, emphasizing their environmental impact, energy efficiency, and technological innovations.

Environmental Impact of Traditional Road Cleaners:

Traditional road cleaning machines often rely on fossil fuels and generate emissions, contributing to air pollution and environmental degradation. Studies (Smith et al., 2018; Green Baum & Johnson, 2019) highlight the adverse effects of conventional road cleaning methods, emphasizing the need for sustainable alternatives.

Transition to Eco-Friendly Technologies:

Researchers have explored alternative technologies to reduce the environmental impact of road cleaning. Electric-powered Road sweepers have gained attention, with studies (Chen et al., 2020; Kumar & Singh, 2021) showcasing their potential to decrease carbon emissions and reliance on non-renewable energy sources.

Innovations in Eco-Friendly Road Cleaning:

Solar-Powered Road Cleaners: Recent developments have focused on integrating solar panels into road cleaning machines, allowing them to harness renewable energy for operation (Wang & Li, 2022). This approach aligns with the global shift towards sustainable energy solutions.

Advanced Filtration Systems: Efficient waste separation and filtration systems are critical for eco-friendly road cleaners. Advances in filtration technology (Gupta et al., 2020) contribute to improved waste management and recycling, minimizing the environmental impact of waste disposal.

Smart Sensor Integration: Some studies (Zhao et al., 2021) have explored the incorporation of smart sensors to optimize the cleaning process. These sensors can detect and target specific areas, reducing energy consumption and improving overall cleaning efficiency.

Challenges and Opportunities:

While progress has been made in developing eco-friendly road cleaners, challenges persist. Limited infrastructure for renewable energy charging stations, initial costs of adopting new technologies, and the need for standardized regulations are areas that require attention (Li & Wang, 2023).

ABOUT SWACHH BHARAT MISSION:

To accelerate the efforts to achieve universal sanitation coverage and to put focus on sanitation, the Prime Minister of India had launched the Swachh Bharat Mission on 2nd October 2014. The mission was implemented as nation-wide campaign/Janandolan which aimed at eliminating open defecation in rural areas during the period 2014 to 2019 through mass scale behavior change, construction of household-owned and community-owned toilets and establishing mechanisms for monitoring toilet construction and usage.

Under the mission, all villages, Gram Panchayats, Districts, States and Union Territories in India declared themselves "open-defecation free" (ODF) by 2 October 2019, the 150th birth anniversary of Mahatma Gandhi, by constructing over 100 million toilets in rural India.

To ensure that the open defecation free behaviours are sustained, no one is left behind, and that solid and liquid waste management facilities are accessible, the Mission is moving towards the next Phase II of SBMG i.e ODF-Plus. ODF Plus activities under Phase II of Swachh Bharat Mission (Grameen) will reinforce ODF behaviours and focus on providing interventions for safe management of solid and liquid waste in villages.

Vision

The aim of Swachh Bharat Mission (Gramin) phase II is to ensure the open defecation free behaviours are sustained.

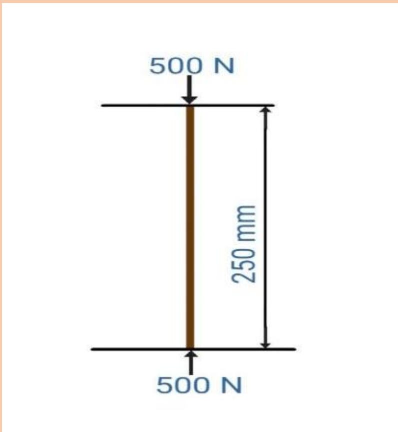
Objectives

Open defecation free behaviours are sustained, and no one is left behind. Solid and liquid waste management facilities are accessible and reinforcing ODF behaviours and focus on providing interventions for safe management of solid and liquid waste in villages. To encourage cost effective and appropriate technologies for ecologically safe and sustainable sanitation. To develop, wherever required, community managed sanitation systems focusing on scientific Solid & Liquid Waste Management systems for overall cleanliness in the rural areas. To create significant positive impact on gender and promote social inclusion by improving sanitation especially in marginalized communities.

4. Problem Statement & Solution: Design, cost estimation & fabrication of eco-friendly semi-automatic road & floor cleaning machine with less human effort.

Design procedure of automatic road cleaning machine:

1) Frame:



Total Load Assumed = 1000 N

Consider Euler's formula :

$L = \frac{500}{2}$ $\quad\quad$ $l_e = \frac{L}{\sqrt{2}}$

$= 250$ mm $\quad\quad$ $= 176.77$mm

$P_E = 500$ N $\quad\quad$ E = 200 Gpa

$= 200 * 10^3$ N/mm^2

So, **Euler's critical load:**

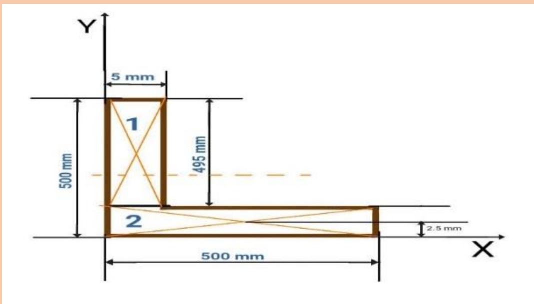
$P_E = \frac{\pi E I}{le}$

$500 = \frac{\pi * 200 * 10^2 * I}{176.77}$

$\mathbf{I = \frac{500 * 176.77}{\pi * 200 * 10^2}}$

$\mathbf{I = 7.915 mm^4}$

(I = least moment of inertia)



$a_1 = l * b$ $\quad\quad$ $a_2 = l * b$

$= 495 * 5$ $\quad\quad$ $= 500 * 5$

$= 2475 mm^2$ $\quad\quad$ $= 2500 mm^2$

$X_1 = \frac{5}{2}$ $\quad\quad$ $X_2 = \frac{500}{2}$

$= 2.5$mm $\quad\quad$ $= 250$mm

$Y_1 = 5 + \frac{495}{2}$ $\quad\quad$ $Y_2 = \frac{5}{2}$

$= 252.5$mm $\quad\quad$ $= 2.5$mm

$\bar{X} = \frac{(a_{1*x_1})+(a_{2*x_2})}{a_1+a_2}$

$= \frac{(2475*2.5)+(2500*250)}{2475+2500}$

=123.88

$\bar{Y} = \frac{(a_{1*y_1})+(a_{2*y_2})}{a_1+a_2}$

$= \frac{(2475*252.5)+(2500*2.5)}{2475+2500}$

=126.88

$h_1 = Y_1 - \bar{Y}$

$= 252.5 - 126.88$

=125.63

$h_2 = \bar{Y} - Y_2$

$= 126.88 - 2.5$

=124.37

$I_{XX} = I_1 + I_2$

$I_1 = I_{G_1} + a_1 * h_1^2$

$= \frac{b*d^3}{12} + 2475 * (125.63)^2$

$= \frac{5*495^3}{12} + 2475 * (125.63)^2$

$= 89599076.08$

$I_2 = I_{G_2} + a_2 * h_2^2$

$= \frac{b*d^3}{12} + 2500 * (124.37)^2$

$= \frac{500*5^3}{12} + 2500 * (124.37)^2$

$= 38674950.58$

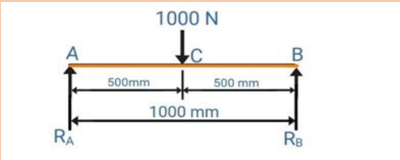
$\therefore I_{XX} = I_1 + I_2$

$= 89599076.08 + 38674950.58$

=128274026.7 mm

CONSIDERING COLUMN THE CROSS-SECTION IS SAFE

CONSIDER AS A BEAM:



$R_A = R_B = 500N$

$M_e = \frac{\omega l}{4}$ $= \frac{1000*1000}{4}$

=2,50,000 N-m

$\frac{M}{I} = \frac{\sigma_b}{y} = \frac{E}{R}$ $\frac{M}{I} = \frac{\sigma_b}{y}$ $I = \frac{My}{\sigma_b}$ $= \frac{250000*(500-126.88)}{120}$ $=777333.33 \text{ mm}^4$

Considering beam the cross-section is safe

Considering load carrying capacity is 100N [considering factor of safety 10 times]

So, design consideration is safe

DESIGN OF TRANSMISSION SHAFT:

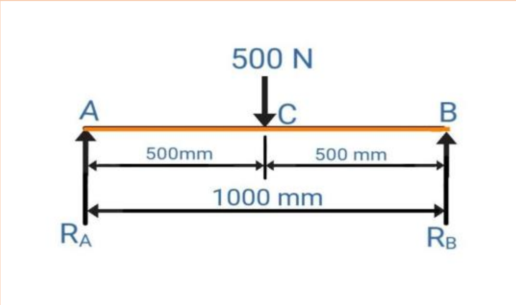
Motor Power = 5 KW

P= $\frac{2\pi N T_m}{60 \ X \ 1000}$ KW

5= $\frac{2\pi \ X \ 100 \ X \ T_m}{60 \ X \ 1000}$

Mean Torque (T_m) = $\frac{5 \ X \ 60 \ X \ 1000}{2\pi \ X \ 100}$ = 477.46 N-m

Keyway factor = 25%, T_{max} = 1.25 X 477.46 = 596.82 N-m



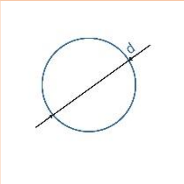
Maximum bending moment- **$R_A = R_B$ = 250N**

$M_{max} = \frac{wl}{4} = \frac{500\ X\ 1}{4} = 125\ N - m$

Equivalent Torque-

$T_e = \sqrt{M^2 + T^2} = \sqrt{125^2 - 600^2}$ = 612.88 N-m

=

$\frac{T}{J} = \frac{\tau}{d/2}$  $J = \frac{\pi}{32} d^4$

$T = \frac{J\ X\ \tau}{d/2}$

$= \frac{\frac{\pi}{32} d^4\ X\ \tau}{d/2} = \frac{\pi\ X\ 2}{32} X \frac{d^4}{d} X\tau$

$T = \frac{\pi}{16} d^3 X\ \tau$

τ = 40 N/mm^2 (for M.S)

613 X 1000 = $\frac{\pi}{32} d^4\ X\ 40$

d = $\sqrt[3]{\frac{16\ X\ 613\ X\ 1000}{\pi\ X\ 40}}$

d = 42.735 mm = 45 mm

For Hollow Shaft -

$T_H = \pi/16\ X\ \frac{D_o^4 - d_t^4}{D_o}\ X\ \tau_H$

$T_s = \frac{\pi}{16}\ X\ \frac{D_o^4 - d_t^4}{D_o}\ X\ \tau_H$

$T_s = \frac{\pi}{16}\ X\ d^3 X \tau_H$

$T_H = T_s$

$= \frac{D_o^4 - d_i^4}{D_o} = d^3$ [**Assume**, D_o = 2di, D_o=2Xd_i = 2X23 =46= 45mm]

$= \frac{2di^4 - di^4}{2di} = d^3$

$= \frac{15di^4}{2di} = d^3$

$= \frac{15di^3}{2} = 45^3$

= di = 22.98 = 23 mm

Weight of solid shaft (Inner Dia & outer Dia ratio = 1:2)

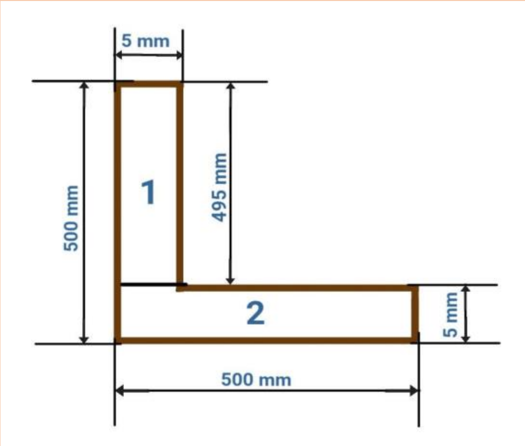
$= \frac{W_S - W_H}{W_S}$ X 100 %

$= \frac{\left(\frac{\pi}{4}d^2\right) - [\frac{\pi}{4}(D_o^2 - d_i^2)]}{(\frac{\pi}{4}d^2)} X\ 100\%$

$= \frac{\left(\frac{\pi}{4}X\ 45^2\right) - [\frac{\pi}{4}(45^2 - 23^2)]}{(\frac{\pi}{4}X\ 45^2)}\ X\ 100\%$

$= \frac{23^2}{45^2} = 26\%$

MATERIALS COST ANALYSIS:



$A_1 = 495$ X 5 $A_2 = 500$ X 5

$A_1 + A_2 = 2475 + 2500$

$= 4975\ mm^2$

Volume of Frame = Area X Length

= (4975 X 6000) mm^3

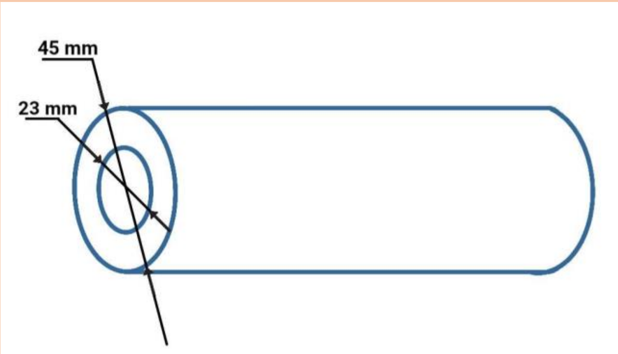
= 29850000 mm^3

= 29850 cm^3

Density of M.S = 7.3 gm/cc

Weight of Frame = (218 X 50) = Rs. 10900/- =Rs. 11000/-

Weight of Shaft:



Area = $\frac{\frac{\pi}{4}(4.5^2 - 2.3^2) X\ 200\ X\ 7.3}{100}$ kg

= 17.15 kg

Cost = 17.15 X 50 = Rs. 857.71/- = Rs. 1000/-

(Frame + Shaft Cost) = Rs. 12000/-

COST OF MATERIAL:

SL No.	NAME OF THE COMPONENT	QUANTITY	PRICE
1.	Frame	1	12000/-
2.	Shaft	2	1000/-
3.	Rear Wheel	2	400/-
4.	Font Wheel	2	100/-
5.	Collector Tray	1	50/-
6.	Sprockets	2	200/-
7.	Chain	1	100/-
8.	Swiper	1	500/-
9.	Bearing	6	600/-
10.	Screw, Nut Bolt	-	50/-
11.	Paint	-	200/-
12.	Fabrication Work Cost	-	100/-
TOTAL		18	15300/-

CONCLUSION:

From this paper a sound information about health & hygiene, design procedure & cost analysis and manufacturing process of the automatic road cleaner can be obtained. There are more future scope to develop modern machine in this field for researchers, for human.

REFERENCES:

1. Ashish Patil, Pranav Patil, Jaywant Patil, Rohit Ingawale, Sanket Nalawade, Amar Patil (2018). **"Design & Development of Roadside Cleaning Machine"**, International research journal of engineering and technology, **ISSN: 2395-0056, Volume 05, Issue 4.**
2. Meshram, S., & Mehta, G. (2016). **"Design and development of tricycle operated street cleaning machine"**, Journal of information, knowledge, and research in mechanical engineering, **4(1), 702-706.**
3. Akshay nighot, Yogesh jadhav, Pritam jagadale, Ishwar jadhav, Avinas hbharate (2019). **"Design & Development of Low Cost Manually Operated Sweeping Machine",** International research journal of engineering and technology, **ISSN: 2395-0056, Volume 06, Issue 6.**
4. Shuzaib kalam, Jatin Sekhri, Twinkle Bauddh, Shivam Kumar, Sarthak Jha (2018). **"Roadside Dust Collector Machine",** International research journal of engineering and technology, ISSN: 2395-0056, Volume 05, Issue 3.
5. Muhammad I. Taiwo. Mohammed A. Namadi. and James, B. Mokwa (16)**."Design and analysis of cyclone dust separator",** American Journal of Engineering Research (AJER),ISSN: **2320-0847, Volume-5, Issue-4.**
6. Muhammad Kashishaikh Ghaffar, M.Aadril Arshad ,Nanadkishor S. Kale, Prof. D.M.Ugle (IJAERD,April 2018), **Design & development floor cleaning machine.**
7. V.Kaliaselavn, P.Jagadeseswaran, M.Gopi, B. Rahulraj (Nexgen Technologies, jan 2018), Fabrication of modern road cleaning vehicle. 32
8. https://sustainablereview.com/top-10-green-technology-innovations-2/
9. https://chat.openai.com/c/86f69129-0186-4975-bb7d-95bf7938c8ea
10. SJIF Impact Factor (2023): 8.574| ISI I.F. Value: 1.241| Journal DOI: 10.36713/epra2016 ISSN: 2455-7838(Online) EPRA International Journal of Research and Development (IJRD)Volume: 8 | Issue: 5 | May 2023 - Peer Reviewed Journal.

"Courage is like a muscle. We strengthen it by use." **—Ruth Gordo**

HOW AI HELPING FOR EASE OF MANUFACTURING PROCESS

Rajdeep Modak
2024 Pass out

I am Rajdeep Modak, a passionate mechanical engineer with a deep fascination for technology, machinery, and manufacturing industry. My interest lies in understanding the intricate mechanics behind powerful machines and exploring advancements in engineering that drive innovation. With a strong foundation in mechanical principles, I am keen on applying my knowledge to develop efficient and high-performance systems. My enthusiasm for cutting-edge technology and precision engineering fuels my commitment to continuous learning and problem-solving in the ever-evolving world of mechanical engineering.

CREDENTIALS:

Educational background:
Primary school: Anandamarg Primery School (2011)
High School: Haripal Gurudayal Institution (2020)
Diploma in Mechanical Engineering: Technique Polytechnic Institute (2024)
Bachelor of technology in mechanical engineering: Hooghly Engineering and Technology (Pursuing)

Projects and research:
1. Eco-friendly machine,
2. Home automation,
3. Motorcycle rebuild,
4. Electronic automated toys,
5. Mini metal furnace

WHAT IS ARTIFICIAL INTELLIGENCE (AI):

AI (Artificial Intelligence) in simple words is the ability of machines to mimic human intelligence by learning from data, recognizing patterns, solving problems, and making decisions with minimal human intervention. It powers technologies like voice assistants, self-driving cars, and smart manufacturing systems, making processes faster, more efficient, and intelligent

GOALS:

The general problem of simulating (or creating) intelligence has been broken into sub problems. These consist of particular traits or capabilities that researchers expect an intelligent system to display. The traits described below have received the most attention and cover the scope of AI research.

Reasoning and problem-solving:

Early researchers developed algorithms that imitated step-by-step reasoning that humans use when they solve puzzles or make logical deductions, by the late 1980s and 1990s, methods were developed for dealing with uncertain or incomplete information, employing concepts of probability and economics

Many of these algorithms are insufficient for solving large reasoning problems because they experience a "combinatorial explosion": They become exponentially slower as the problems grow even humans rarely use the step-by-step deduction that early AI research could model. They solve most of their problems using fast, intuitive judgments. Accurate and efficient reasoning is an unsolved problem.

Knowledge representation:
An ontology represents knowledge as a set of concepts within a domain and the relationships between those concepts. Knowledge flow of a knowledge engineering allow AI programs to answer questions intelligently and make deductions about real-world facts. Formal knowledge representations are used in content-based indexing and retrieval, scene interpretation, clinical decision support, knowledge discovery (mining "interesting" and actionable inferences from large data), and other areas.
A knowledge base is a body of knowledge represented in a form that can be used by a program. An ontology is the set of objects, relations, concepts, and properties used by a particular domain of knowledge. Knowledge bases need to represent things such as objects, properties, categories, and relations between objects and situations, events, states, and time; causes and effects; knowledge about knowledge (what we know about what other people know); default reasoning (things that humans assume are true until they are told differently and will remain true even when other facts are changing); and many other aspects and domains of knowledge.
Among the most difficult problems in knowledge representation are the breadth of common sense knowledge (the set of atomic facts that the average person knows is enormous); and the sub-symbolic form of most common sense knowledge (much of what people know is not represented as "facts" or "statements" that they could express verbally). There is also the difficulty of knowledge acquisition the problem of obtaining knowledge for AI applications. AI save time on administrative processes and increase productivity by automating routine tasks. Free up employees to focus on more strategic and skill-dependent activities by taking over labor-intensive tasks. Optimize resource usage by automatically modifying production in response to demand fluctuations.
HOW AI ENTER IN MANUFACTURING INDUSTRYS:
In manufacturing, optimization is crucial for every aspect of the business from maximizing productivity while enforcing rigorous quality control to minimizing costs and compliance risks while ensuring smooth, uninterrupted manufacturing processes. To succeed in these and stay competitive, manufacturers use automation and other innovative manufacturing solutions. Artificial intelligence (AI) can be used to empower both, which is why more and more companies are using AI in manufacturing.
In this comprehensive guide, you'll learn about practical use cases, challenges, and benefits of AI, as well as find out how to start using AI in manufacturing.

Why do companies use artificial intelligence in manufacturing?

Though artificial intelligence can be used in just about every aspect of life and work, AI and manufacturing are particularly compatible thanks to an important shared element: data. Manufacturers generate and own vast volumes of data, including machine performance, logistics, process, and external data; AI technologies require data to train machine learning algorithms and provide accurate output specific to each business. This means that AI can help manufacturing companies put their structured and unstructured data to good use. So, how is AI used in manufacturing?

AI's versatility is one of the reasons it's playing such a huge role in the business world: leaders across industries find countless uses for AI, and manufacturing is no exception. It helps to streamline manufacturing processes, maximize efficiencies, reduce errors, improve the quality of products, empower employees, support operational excellence, and ultimately—gain a competitive edge.

How to use AI in manufacturing: Examples and use cases:

There's a very wide variety of use cases for AI in manufacturing, applicable in different ways across different types of manufacturing: from high-volume or customizable product manufacturing in industrial and automotive industries—to the continuous process manufacturing in the chemistry and energy sectors, or batch processes in pharmaceutical and food production. So, rather than trying to come up with an exhaustive list of all AI use cases, let's break down some of the key applications.

Predictive maintenance and AI-assisted quality control:

Thanks to computer vision, cameras and trackers monitoring the manufacturing processes, and AI models used for advanced analytics, artificial intelligence can:

- Help predict required asset and equipment maintenance, which allows human workers to avoid issues rather than respond reactively once they arise (that's why it's called "predictive maintenance")
- Identify anomalies and quality control issues faster and automatically trigger alerts or take prescribed actions to prevent defects
- Anticipate potential failures of equipment by using digital twins
- Optimize maintenance processes to reduce costs and extend equipment life

Supply chain management and machine learning algorithms:

Machine learning algorithms can analyze vast volumes of supply chain data and identify patterns, which enables AI to:

- Provide real-time insights to improve demand forecasting and inventory management
- Flag potential risks and supply chain disruptions early, which helps manufacturers mitigate risks by making the necessary adjustments quickly
- Help assess supplier quality and reliability
- Identify opportunities to reduce ecological footprint of materials used and deliveries
- Optimize warehouse management and logistics and reduce idle time

Data-driven process optimization:

By analyzing performance and real-time data from sensors on the factory floor, AI technologies can identify areas for improvement in the existing manufacturing processes and equipment layout, which allows companies to:

- Identify bottlenecks and inefficiencies and get recommendations for improvement
- Monitor and analyze resource usage, as well as occupancy and production patterns, for opportunities to reduce carbon footprint and save energy
- Optimize resource allocation to improve output and reduce costs and downtime

Task and process automation:

Many innovative manufacturing solutions have been designed to automate repetitive manufacturing tasks, and this is something artificial intelligence can help with too. AI can:

- Save time on administrative processes and increase productivity by automating routine tasks
- Free up employees to focus on more strategic and skill-dependent activities by taking over labor-intensive tasks
- Optimize resource usage by automatically modifying production in response to demand fluctuations

Product development and customization:

AI can analyze both internal and external data, which includes market trends, sales data, and customer preferences. With that and rapid prototyping capabilities, AI can:

- Help develop or customize products to meet customer demands and tastes
- Speed up development by quickly generating and evaluating design iterations based on input parameters and constraints
- Carry out virtual testing to ensure optimal product performance by simulating various conditions, which lets manufacturers address possible design flaws even before physical prototypes are produced

Employee empowerment:

The use of artificial intelligence in manufacturing can benefit the manufacturer's employees too:

- AI can monitor and analyze data from sensors to improve workplace safety by detecting potential hazards and alerting employees to take appropriate action
- AI-assisted learning can help employees acquire new skills to adapt to change in job roles and technologies
- AI-enhanced visual inspection helps quality control specialists spot issues and production flaws, alleviating the burden of responsibility and chance of human error
- AI can provide employees with insights and recommendations that help make data-driven decisions—for example, about production planning and forecasting
- Due to developments in generative AI, many AI technologies now support conversational capabilities, which allows employees at various levels of technical proficiency to benefit from the use of AI in manufacturing (AI copilots, such as Joule, are a great example)

Benefits of AI in manufacturing:

The three key benefits of using AI in manufacturing are that it serves as a catalyst for productivity, efficiency, and operational excellence. In other words, with artificial intelligence, manufacturers can do more, better, and in less time. For companies that produce goods, especially those in the field of industrial manufacturing, this opportunity alone makes AI worthwhile. But the uses cases described above make it clear that there are even more benefits to incorporating AI into any smart factory strategy:

Better product quality:

AI-assisted quality control helps manufacturers reduce the number of products with defects and provides real-time feedback for root cause analysis, while rapid prototyping makes it easier to spot design flaws early in the product development process.

Improved decision-making:

By providing data-derived insights and advanced analytics, AI helps human workers make informed decisions faster and more confidently, which makes their lives easier and, ultimately, leads to better business outcomes.

Smart manufacturing and productivity

Thanks to AI-enabled automation and optimization, manufacturers can be more efficient in their use of resources and time. This smart manufacturing approach, in turn, raises productivity, allowing companies to produce goods at a faster rate without compromising quality.

Cost reduction:

AI can improve cost-effectiveness through more than just automation. The digital twin technology and AI-driven predictive maintenance can extend the life of equipment, which translates into savings in the long run—as does the conservation of energy, time, water, and other resources. The same is true for optimized supply chain management: AI-assisted data analysis helps make demand planning and inventory management more cost-efficient and risk-resilient.

Environmental sustainability:

Through AI-optimized management of resources, logistics, and warehouses, manufacturers can reduce energy and material waste, lessening the ecological footprint. This positive environmental impact is important for sustainable manufacturing.

The current state and future of AI in the manufacturing industry:

Given the potential benefits of artificial intelligence in manufacturing, it's not hard to see why manufacturers are interested in it. But when it comes to the actual adoption of AI in manufacturing, there's still room for improvement. For example, not all manufacturers' AI strategies are both linked to business objectives and supported by a measurement approach to evaluate success with ERP.

ERP is essential to innovative manufacturing solutions, so manufacturers need to ensure compatibility and synergy of their existing IT landscape and ERP portfolio—with the AI capabilities they want to incorporate. However, despite the adoption lag, the industry is likely to continue embracing the use of artificial intelligence. Two factors have converged to make the use of AI in manufacturing more viable than ever before, which gives us reason to think this trend is here to stay:

Smart factory processes generate valuable data:

The increasingly widespread use of cameras, sensors, and other technologies that track manufacturing processes 24/7, which started with smart factory and industry 4.0 initiatives, allows manufacturers to feed AI vast amounts of data in real time. This helps maximize the value manufacturer's gain from their data and supports certain use cases of AI. In fact, some of the key applications of artificial intelligence in manufacturing, such as predictive maintenance, digital twin technology, and AI-assisted visual inspection, are impossible without this data. What's more, by connecting this wealth of data with AI used for specific business objectives, manufacturers can drive customer value and empower employees to gain experience and skills faster, mitigating talent shortages.

Conversational AI makes artificial intelligence more accessible:

At the same time, thanks to recent advancements in machine learning (such as breakthroughs in generative AI), conversational AI is now a reality. What does it mean? It means that humans can communicate—and work—with artificial intelligence using natural language rather than code. This is important because it makes AI accessible to employees at various levels of technical proficiency: everyone in the company, from operations and supply chain management to the factory floor, can use AI tools to be more effective and productive. This exponentially raises the value of AI as a catalyst for human potential and operational efficiency.

The growing adoption of AI in manufacturing raises the bar of excellence, as higher productivity, more flexible manufacturing processes, and maximized efficiency become the norm. At the same time, artificial intelligence offers a strong competitive advantage, so we can expect further widespread AI adoption across the manufacturing industry.

Adoption of AI in manufacturing: Challenges and concerns:

Despite the benefits, some companies still have concerns about implementing AI in manufacturing processes, for example:

Shortages of skilled labour:

To implement and operate AI-assisted capabilities, companies need talent with the right skills. Thankfully, AI itself can be a part of the solution.

- AI can help hire people with the right skills
- Existing employees can use AI-enabled HR solutions, such as learning and development software, to gain new skills

- Assistive technologies can help improve worker safety on the factory floor by providing instructions and helping manufacturers enforce necessary compliance and safety procedures
- Generative AI enables AI assistants and copilots to understand natural language prompts, which makes it easier for all employees, not just IT staff, to access AI capabilities that help—for example, to configure complex solutions for customers without needing years of experience
- Many software providers integrate AI into business solutions they offer. For example, at SAP, we embed AI on multiple layers across our solutions, so customers using, say, the SAP cloud ERP portfolio already have access to AI features

Safety, security, and responsible use of AI:

As with many innovative manufacturing solutions, the use of artificial intelligence requires regulation and guardrails, especially because AI handles potentially sensitive data. There are two important steps in addressing this concern.

Firstly, manufacturers should prioritize implementing ethical and responsible AI practices and opt for selecting third-party software providers that do the same. Secondly, to ensure the protection of business and customer data, it's best to work with AI solution providers who are committed to ethical, transparent, compliant, and secure handling of your data. This is especially important, given the cyber security risks, sabotage, and IP theft that threaten manufacturing companies.

Here are some green flags to look for when selecting a security-minded provider:

- AI provider doesn't share your data with third parties for the purpose of training their AI models
- AI solutions are developed responsibly and with rigorous standards
- AI provider employs advanced data security measures to protect your data at all times
- AI provider is committed to transparency and explain ability

Large-scale business transformation for complex enterprise architecture:

Smart manufacturing often involves vast IT infrastructures. And after going through multiple mergers and acquisitions, many companies end up with a patchwork of legacy systems. A large-scale AI adoption across such a complex enterprise architecture can seem challenging. The good news is that manufacturers don't have to tackle this challenge alone: they can work with a software provider on developing a clean core strategy and AI-ready enterprise architecture.

How to get started with AI in manufacturing:

The same sensible steps that apply to most innovative manufacturing solutions are applicable to introducing AI in manufacturing:

- **Get informed.** Explore the state and capabilities of artificial intelligence, familiarize yourself with use cases, and look at results others have already achieved.
- **Assess the benefits.** Consider the specific nature of your manufacturing business: what challenges is your company facing, and can they be addressed by AI? Do you have a large volume of data that's underutilized? How would AI benefit your manufacturing processes?
- **Formulate the goals.** Like many tools, AI is most impactful when used purposefully and strategically. Working from your business goals, create an AI adoption strategy that clearly delineates what benefits you are expecting to get and how.
- **Research providers.** Security, compliance, and data protection must be at the core of AI solutions you're using. To protect yourself and your customers, thoroughly evaluate the prospective AI providers: make sure their data security practices are transparent and up to standard.
- **Get professional input.** Many software providers, especially in the ERP and business optimization space, are already up to speed on all things AI—they can help strategize and even carry out the introduction of AI in manufacturing companies. If you're already using an ERP portfolio that supports AI capabilities, introducing artificial intelligence in your company might be even easier than it seems. Embedded AI allows manufacturers to take advantage of artificial intelligence without the need to build, maintain, and iterate their own models.

Conclusion:

Artificial Intelligence (AI) is revolutionizing the manufacturing industry, bringing unparalleled efficiency, precision, and innovation. By leveraging AI for predictive maintenance, supply chain optimization, process automation, and quality control, manufacturers can enhance productivity, reduce costs, and improve product quality.

AI-driven insights empower decision-making, while automation streamlines operations, ultimately driving smarter and more sustainable manufacturing practices.

Despite challenges such as talent shortages, cyber security concerns, and integration complexities, the growing adoption of AI in manufacturing proves its immense value. With advancements in machine learning, data analytics, and conversational AI, companies can now implement AI solutions more seamlessly than ever before. By strategically adopting AI and collaborating with trusted technology providers, manufacturers can future-proof their operations, gain a competitive edge, and shape the future of industrial production.

Artificial Intelligence (AI) is transforming the manufacturing industry by optimizing processes, improving efficiency, and enhancing product quality. From predictive maintenance and supply chain management to automation and data-driven decision-making, AI enables manufacturers to reduce operational costs, minimize errors, and increase overall productivity. The integration of AI-driven solutions, such as machine learning algorithms, digital twins, and smart automation, allows businesses to stay competitive in an increasingly fast-paced and technology-driven world.

While AI adoption comes with challenges like workforce up skilling, cyber security risks, and integration with legacy systems, these hurdles can be overcome through strategic implementation and collaboration with reliable technology partners. As AI continues to evolve, its role in manufacturing will only expand, fostering innovation, sustainability, and smarter production processes. By embracing AI, manufacturers can future-proof their operations, drive business growth, and set new standards for efficiency and excellence in the industry.

Embracing AI in manufacturing is no longer a choice but a necessity for companies aiming to stay competitive in a rapidly evolving industry. By integrating AI-driven solutions, manufacturers can unlock new levels of efficiency, innovation, and sustainability. As technology advances, those who adapt and invest in AI today will lead the future of smart manufacturing, setting new benchmarks for excellence and redefining industrial success.

ROBOTICS ENGINEERING

ASHIS PAL
2025 Pass out

❖ What is Robotics Engineering?

Robotics engineering is a multidisciplinary field including electrical, mechanical and computer engineering. It deals with designing, building, operating, and engineering robots and robotic systems based on theoretical understanding and practical application.

Robotics engineering covers a broad spectrum of tasks composed of conceptualizing designs, developing systems, and crafting operational algorithms. Robotics engineers play a critical role in every step of the lifecycle of robots and robotic systems. Common tasks include evaluating the performance of robotic systems, identifying areas for enhancement, and conducting rigorous testing protocols to ensure compliance with industry standards prior to widespread deployment and utilization.

Robotics engineering brings together creativity, technical know-how, and problem-solving skills. It's an exciting field that studies the latest and multidisciplinary engineering technology. Whether it's creating autonomous vehicles and drones, robotic systems that work with humans in manufacturing, or cyber-physical humanoid machines, robotics engineering sets the stage for a better tomorrow where humans and machines work together seamlessly.

❖ What Do Robotics Engineers Do?

A **robotics engineer** develops robotic applications across many industries, including automotive, aerospace, manufacturing, defence, agriculture, and healthcare. Robotics engineers work on designing, building, and operating robots and robotic systems.

Designing: - Robotics engineers conceptualize robots and robotic systems, create blueprints and schematics for robots, and determine their physical structure, components, and functionalities.

Building: - Robotic engineers develop robots and robotic systems using a combination of mechanical, electrical, and computer engineering principles and technologies including selection and integration of the necessary components, such as sensors, actuators, motors, and controllers.

Programming: - Robotics engineers write code to control the behaviour and motions of robots and robotic systems. Programming languages, such as C++, Python, or specialized robot operating systems (ROS), are used in this task.

Testing: - Robotic engineers run testing to confirm that robots and robotic systems operate correctly and safely as designed, built, and programmed by simulating possible application scenarios, troubleshooting technical issues, and optimizing algorithms.

Operating and Maintaining: -

Robitics engineers are also responsible for diagnosing problems, replacing faulty components, and implementing modifications to continuously enhance functionality throughout the lifecycle of robots and robotic systems.

❖ What Careers are there in Robotics Engineering?

Many different types of robotics engineering are available for you to choose from, with specialties that fit an individual's interests and skills.

Robotics engineers work in every sector of industry including automotive, aerospace, manufacturing, defence, agriculture, and healthcare. Some examples include but are not limited to:

- Aerospace and space technology
- Automation

- Automotive
- Computer software development
- Consumer electronics
- Control systems
- Cybernetics
- General robotics
- Healthcare
- Intelligent systems and manufacturing
- Medical robotics

Robots and robotic systems are used in various fields, which creates numerous opportunities for robotics engineers.

Robots are used in various fields, creating many opportunities for robotics engineers. You may work in:

- A manufacturing plant building, maintaining, and fixing robots
- A technology company designing personal and domestic robots
- A university performing research on human-machine interaction and robotic advances
- Industrial research developing and building new robotic design concepts

❖ **What Skills Do Robotics Engineers Need?**

Robotics engineers need to have keen interest in working principles of components and systems as they need to be able to design, build, test, and operate robots and robotic systems. It is required that robotics engineers understand electronics, mechanics, control, and software of robotic systems. Additionally, robotics engineers are required to have skills of strong mathematics in design and analysis, computer programming for controlling robotic systems in different environments, and problem solving in operating and troubleshooting robotic systems in real world applications. Creativity is highly valuable, as is the ability to communicate in written and oral forms.

- **Interest in how things work:** As a robotics engineer, you'll be responsible for designing, assembling, testing, and maintaining robots. You must understand mechanics, electronics, sensory feedback systems, and how these complex machines operate.
- **Imagination:** You must be able to visualise how a robot moves and interacts with its environment.

- **Decision-making skills:** Many problems have unclear solutions. In these situations, it's up to you to evaluate different options and make the best decision.
- **Maths skills:** As a robotics engineer, you'll use advanced maths daily as you design and analyse the performance of robots. Algebra, geometry, measurement, and statistics are commonly used while calculus or trigonometry may also be used.
- **Computer skills:** Robotics engineers use computer software to create detailed designs of robots and robotic systems before they're built. They also use specialised software programs to test how robots perform in different environments.
- **A practical focus:** You must use practical and logical thinking to debug machines and get them working correctly. You'll often have to make decisions that compromise performance in one area and be able to ascertain the best path forward.
- **Communication skills:** The ability to communicate your designs to other professionals is essential when you're working as an engineer.

You'll also need domain-specific skills. For example, if you're working on designing robotic brain interfaces, you may need knowledge of flexible conducting metals used as neural probes. If you're working on autonomous robots, you must understand programming languages and artificial intelligence. You can often learn domain-specific technical skills on the job, although some employers want prior experience in the area you'll be working.

❖ **Where does a robotics engineer work?**

A lot of positions conduct advanced robotics research in universities. Here are some industries where you'll find robotics engineering jobs.

- Automotive manufacturers are one of the largest employers of robotics engineers. These companies use robots in manufacturing vehicles and their parts.
- Robotics engineers also work for defence contractors who build military weapons that require remote or automated operations. Military drones and missile systems commonly use robotic technology.
- Aerospace firms employ robotics engineers to design and manufacture spacecraft, satellites, and missiles. Robots also help assemble aircraft and perform maintenance on them.
- Medical equipment manufacturers use robotics engineers to create artificial limbs and prosthetics. Surgical operations have increasingly used robotic surgical systems.
- Robotics engineers can also find employment at research firms that study robotic technology and its possible applications in different industries.

❖ **How to become a robotics engineer: -**

To become a robotics engineer, you'll need a bachelor's degree. If you intend to work in a robotics software role, you'll need a background in computer science. If you want to design robotic components, you'll focus your studies on mechanical or electrical engineering.

❖ **Is robotics engineering right for me?**

Careers in robotics engineering can be very rewarding. Here are some things to remember as you consider this career path:

- You'll need to commit yourself to lifelong learning. The world of technology is always changing and evolving. To remain competitive and relevant, you'll need to devote yourself to staying current with technological advancements.
- Focus on solutions. You may encounter problems from time to time. When you do, you may need to be able to take a step back and focus on finding the solution rather than getting bogged down by the problem.

Robotics engineering could be the right career if:

- You have a solid commitment to lifelong learning.
- You thrive in an intellectually challenging environment.
- You have a high level of initiative, integrity, professionalism, and accountability.
- You can prioritise competing demands, handle multiple projects, and organise your time effectively.
- You have well-developed analytical, organisational, and problem-solving skills.

❖ **The Future of Robotics Engineering: -**

The future of robotics engineering has numerous possibilities that could impact industries, daily life, and society. One critical impact is on automation in manufacturing, mobility, and productivity. Another area for impact is collaborative robotics, where robots work alongside humans and assist human activities, leading to safer and more efficient workflows.

Recent advances in artificial intelligence (AI) and machine learning also drive progress in robotics engineering. AI enables robots and robotic systems to perceive and adapt to given environments and makes them highly intelligent and autonomous. Additionally, there is a growing interest in robots and robotic systems for applications in healthcare and smart home systems. Robotics engineering is anticipated to enhance productivity, improve quality of life, and address societal challenges in the future.

"I learned a long time ago that there is something worse than missing the goal, and that's not pulling the trigger." — Mia Hamm

Waste Heat Recovery from Domestic Refrigerator

SOURAV MAJUMDAR
2025 Pass Out

I. INTRODUCTION:

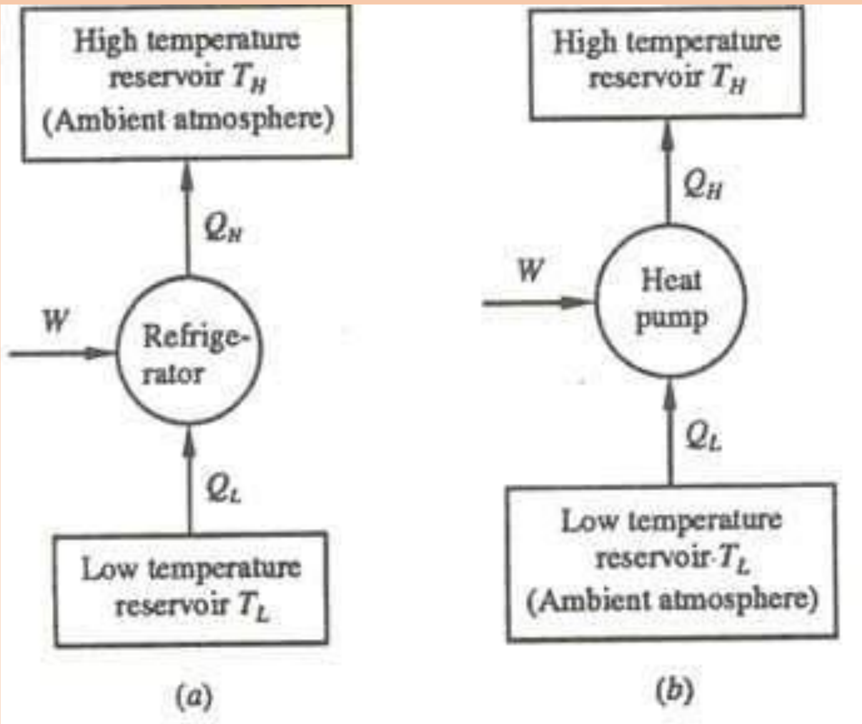
Waste heat is heat, which is generated in a process by way of fuel combustion or chemical reaction, heat removed from thermal system by heat exchanger and then "dumped" into the environment even though it could still be reused for some useful and economic purpose. The essential quality of heat is not the amount but rather its "value". The strategy of how to recover this heat depends in part on the temperature of the waste heat gases and the economics involved. Use of waste heat recovery is an important technique of reducing total energy costs in energy system design. Attachments need to be developed to recover waste heat energy from air conditioning or refrigeration systems. If the heat recovery system is designed optimally and implemented in residential and small-scale commercial systems, the cumulative benefits would be significant

Households need both refrigeration and water heating. Refrigeration at temperatures below 4°C is employed for food preservation, while hot water at temperatures around 55°C is used for bathing and showering. But it is common for refrigeration and water heating to be separated and unconnected, each consuming their own purchased energy. A more efficient use of this electrical energy would be to integrate the refrigeration and hot water systems. This would reduce the electrical power consumed by heating water, by making use of the heat rejected by refrigerators.

A home's single largest electricity expense is water heating, which typically accounts for about 40% of their electricity usage. The total energy consumption by geysers will continue to increase as the population grows. As electricity demand increases, the adverse environmental effects and the economic costs associated with electricity generation will also increase.

The vapor compression refrigeration cycle is a common method for transferring heat from a low temperature to a high temperature.

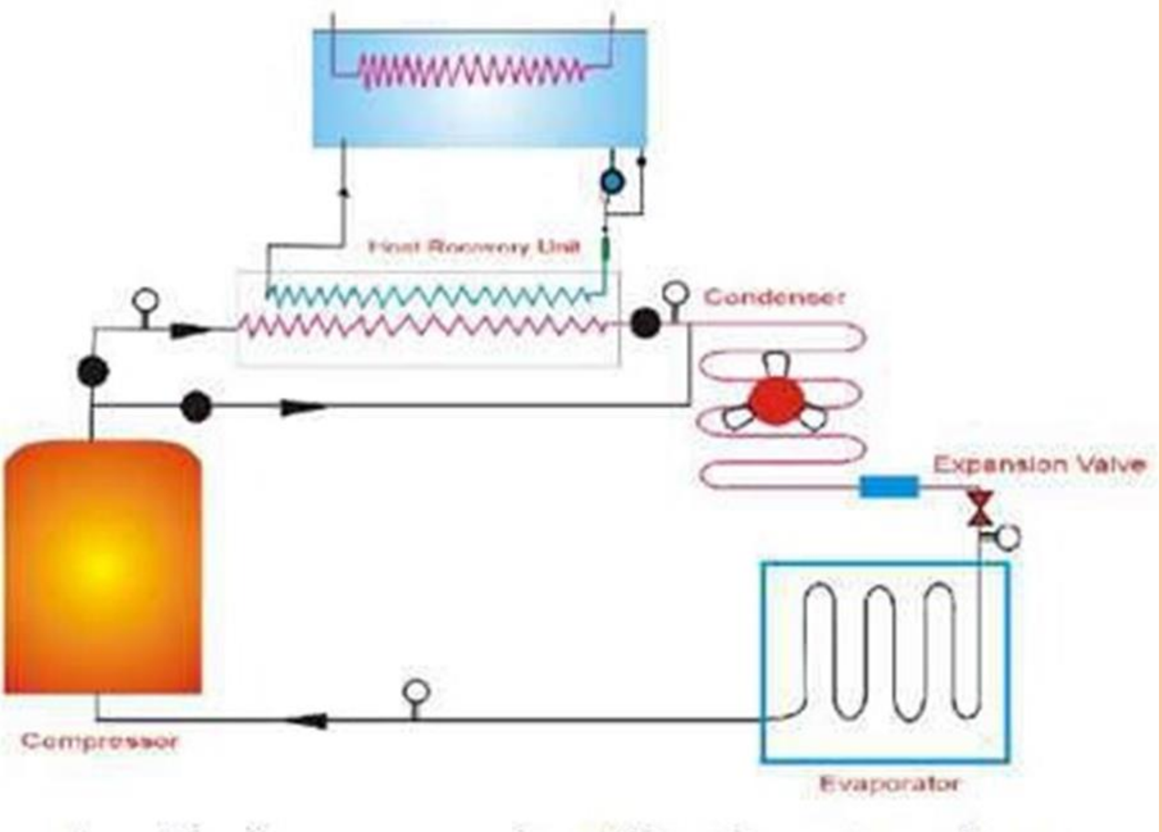
The figure shows the objectives of refrigerators and heat pumps. The purpose of a refrigerator is the removal of heat, called the cooling load, from a low-temperature medium. The purpose of a heat pump is the transfer of heat to a high-temperature medium, called the heating load. When we are interested in the heat energy removed from a low-temperature space, the device is called a refrigerator. When we are interested in the heat energy supplied to the high-temperature space, the device is called a heat pump.



In general, the term heat pump is used to describe the cycle as heat energy is removed from the low-temperature space and rejected to the high-temperature space.

Both refrigerators and heat pumps move heat from a cold thermal reservoir to a warm thermal reservoir. The objective of refrigerators is to remove heat from a cold space whereas the objective of heat pumps is to put heat into a warm space. Both heat pumps and refrigerators use the same thermodynamic cycle and principles.

When a household refrigerator is operating, it rejects heat into the environment at the condenser and in warm climates that heat is usually wasted. In this paper, the feasibility of a new system which used the rejected heat at the condenser of the refrigerator to heat water in the geyser was investigated. Thus, a combined refrigerator/heat exchanger and geyser resulted in a single machine which maintained a certain physical space at cold temperature for storage of food and used the heat rejected by the refrigeration part for water heating. The figure shows that a vapor compression cycle was used with the evaporator in the refrigerator and condenser in the heat exchanger which was connected to the geyser. Cold and low pressure refrigerant gas entered the compressor where its pressure (and temperature) increased. After the compressor, it then passed through the condenser where it gave up heat at approximately constant pressure to the water in the geyser so that the refrigerant's temperature decreased sufficiently for it to condense into a sub cooled liquid.



A combined vapor-compression refrigeration system and geyser

The figure shows that a vapor compression cycle was used with the evaporator in the refrigerator and condenser in the heat exchanger which was connected to the geyser. Cold and low pressure refrigerant gas entered the compressor where its pressure (and temperature) increased. After the compressor, it then passed through the condenser where it gave up heat at approximately constant pressure to the water in the geyser so that the refrigerant's temperature decreased sufficiently for it to condense into a sub cooled liquid. After leaving the condenser it went through an expansion valve (which may be a capillary tube). The decrease in pressure in the expansion process caused the refrigerant to turn back into a mixture of liquid and vapor but at a much lower temperature. Then it went to the evaporator where it absorbed heat at approximately constant pressure from the food in the refrigerator.

II.LITERATURE REVIEW:

Clark et al.1996, describe the design, construction, and testing of an integrated heat recovery system which has been designed both to enhance the performance of a residential refrigerator and simultaneously to provide preheated water for an electric hot water heater. A commercial, indirect-heated hot water tank was retrofitted with suitable tubing to permit it to serve as water cooled condenser for a residential refrigerator. This condenser operates in parallel with the air-cooled condenser tubing of the refrigerator so that either one or the other is active when the refrigerator is running. The refrigerator was housed in a controlled-environment chamber, and it was instrumented so that its performance could be monitored carefully in conjunction with the water pre-heating system.

The system has been tested under a variety of hot water usage protocols, and the resulting data set has provided significant insight into issues associated with commercial implementation of the concept. For the case of no water usage, the system was able to provide a 35 "C temperature rise in the storage tank after about 100 hours of continuous operation, with no detectable deterioration of the refrigerator performance. Preliminary tests with simulations of "high water usage," "low water usage,'' and "family water usage" indicate a possible 18-20% energy savings for hot water over a long period of operation. Although the economic viability for such a system in a residential environment would appear to be sub-marginal, the potential for such a system associated with commercial-scale refrigeration clearly warrants further study, particularly for climates for which air conditioning heat rejection is highly seasonal

.

Stinson et al.1987, conducted research in dairy refrigeration by recovering the heat from condenser. A theoretical energy balance was conducted, from which the potential for recovery of refrigeration condenser heat was estimated to be up to 60% of the water heating energy requirements. Preliminary tests with heat exchangers led to the development and testing of a tube-in-tube, counter flow heat exchanger, with fins on the refrigerant side and cores on the water side to improve the heat transfer characteristics. The exchanger, designed to provide 300 1 of water at 60°C from a 2.25 kW refrigeration system which cooled 2100 1 of milk per day, had a surface area on the refrigerant side of 0.84, and an overall thermal conductance of 750 W m-2 C-1.

It was inserted between the compressor and the condenser of the refrigeration plant and tested with two condensing systems (air and water), together with varying conditions of condenser pressure and milk temperatures at inlet and final cooling. In addition, tests on the receiver pressure and suction superheat were performed to determine their effect on the overall system performance. Increasing the condenser pressure from 6.5 bar to 12 bar increased cooling times. In extreme circumstances the system failed to comply with the New Zealand milk cooling regulations. The average coefficient of performance (C.O.P.) of the refrigerator (with the heat exchanger in the circuit) decreased with increasing pressure, varying from 3.0 to 2.3 over this range of pressures for the water cooled condenser system. Values for the air cooled condenser system were 0.3 to 0.4 lower due to fan power consumption.

Sanmati Mirji 2006, presented a multipurpose warming apparatus utilizing the waste heat of domestic refrigerator. The multipurpose apparatus was constructed as an additional part of the refrigerator. It used the waste heat generated by the refrigerator and has several possible household uses like food warming, domestic fermentation purposes such as curd making, fermentation for Indian food. The maximum temperature of the chamber got as high as 50ºC and the average temperature was around 40 ºC. The main advantage of the invention was to keep cooked food warm for a sufficiently long duration before consumption as well as warming the food removed from the refrigerator before consumption. It makes use of the waste heat generated by the domestic refrigerator and does not need any additional power supply.

Mills 1986, investigated several methods of heat recovery as applied to a residence. One of the more interesting approaches involved the reclamation of heat from water after it has been utilized. Waste water is collected in a 454 litre holding tank, which also contains the evaporator for a 1.2 kW water-to-water heat pump. When the water temperature in the holding tank rises above a certain point, the heat pump is activated, transferring heat from the holding tank to the condenser which is mounted inside a 272 liters fresh hot water storage tank. An experimental prototype of this system was constructed and tested using a water usage pattern that was derived from an accepted standard hot water delivery schedule. The tests indicated that an energy savings of up to 60% over a typical 272 liters electric hot water heater was possible.

"Don't worry about failure; you only have to be right once." —Drew Houston

MANUFACTURING PROCESS OF NUTS AND BOLTS

Sujay Biswas

In-Charge, Department of Mechanical Engineering

When the diameter of a piece changes uniformly from one end to the other, the piece is said to be tapered. Taper turning as a machining operation is the gradual reduction in diameter from one part of a cylindrical work piece to another part. Tapers can be either external or internal. If a work piece is tapered on the outside, it has an external taper; if it is tapered on the inside, it has an internal taper.

There are three basic methods of turning tapers with a lathe. Depending on the degree, length, location of the taper (internal or external), and the number of pieces to be done, the operator will use either one of the following methods:

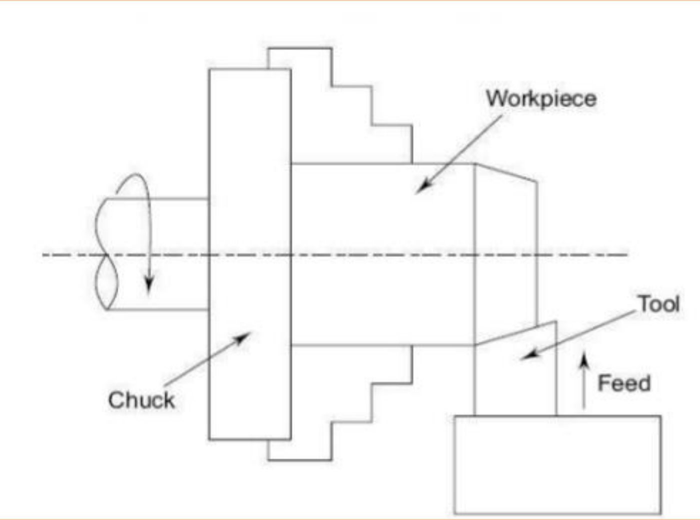
- Form tool method
- Compound slide method
- Tailstock method
- Taper turning attachment

With any of these methods the cutting edge of the tool bit must be set exactly on centre with the axis of the workpiece or the work will not be truly conical and the rate of taper will vary with each cut.

Form tool method:

The tool is ground and shaped at a particular angle which is needed in taper turning. This method is used in mass production for producing a small length of taper where accuracy is not

a criterion. The form tool should be set at right angle to the axis of the work. The carriage should be locked while taper turning by this method.



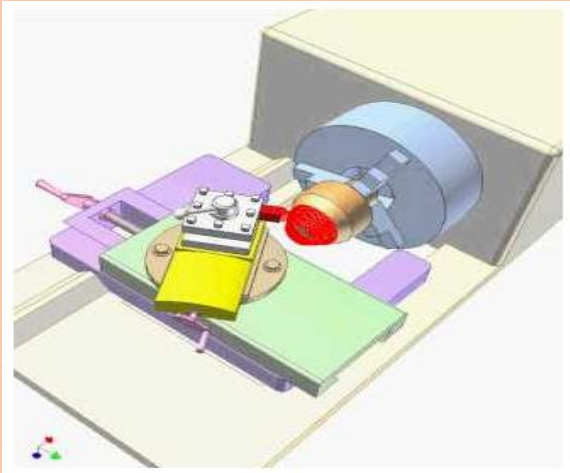
Advantage

- Once the tool is made with cutting edge at particular angle, as long as tool is aligned perpendicular to the axis of the lathe, one can easily turn the jobs at required angle.

Disadvantage

- There is only one angle value possible for the tool to be ground at a time.

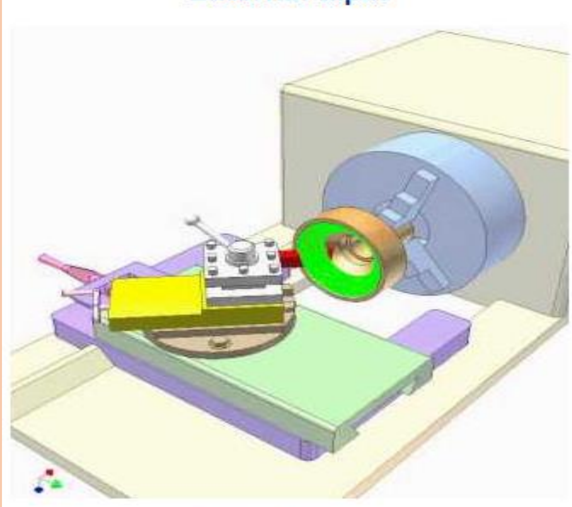
Compound slide method



Generally short and steep taper are produced using this method. In this method the work piece is held in the chuck and it will be rotated about the lathe axis. The compound rest is swivelled to the required angle and then it will be clamped in position.

Advantage:

- Both internal and external taper can be produced
- Steep taper can be produced
- Easy setting of the compound slide



External taper

Internal taper

Disadvantages:

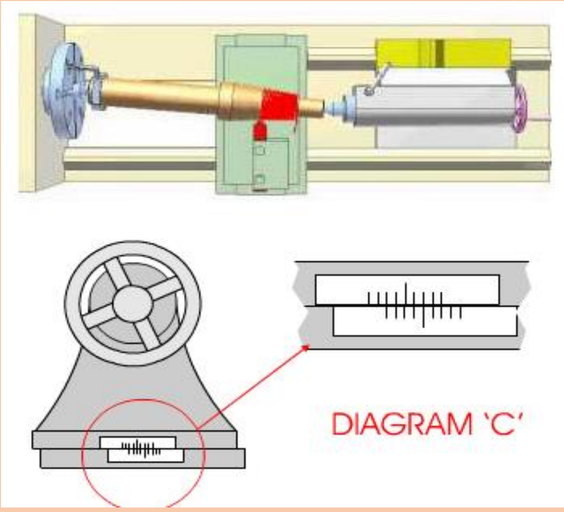
- Only hand feed can be given
- Threads on taper portion cannot be produced
- Taper length is limited to the movement of the top slide.

Tailstock method Videos

In this method the job is held at an angle and the tool moves parallel to the axis. The body of the tailstock is shifted on its base to an amount corresponding to the angle of taper. This method. The taper can be turned between centres only and this method is not suitable for producing steep tapers.

ADVANTAGES

- Power feed can be given
- Good surface finish can be obtained
- Maximum length of the taper can be produced
- External threads on taper portion can be produced
- Duplicate tapers can be produced

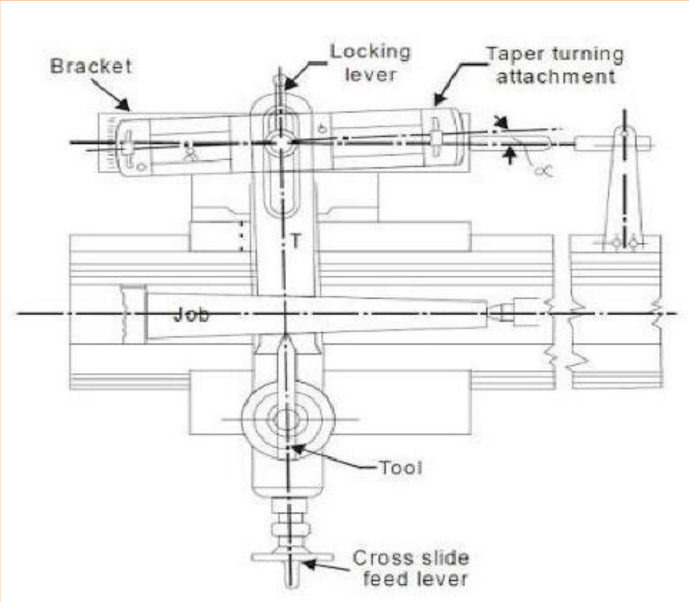


DISADVANTAGES

- Only external taper can be turned
- Accurate setting of the offset is difficult
- Taper turning is possible when work is held between centres only
- Damages to the centre drilled holes of the work
- The alignment of the lathe centres will be disturbed
- Steep tapers cannot be turned

Taper turning attachment method

Taper Turning Attachment is very much popular and fits on all lathe machines. In ordinary straight turning, the cutting tool moves along a line parallel to the axis of the work, causing the finished job to be the same diameter throughout.



When the diameter of a piece changes uniformly, from one end to the other, the piece is said to be tapered. Taper turning as a machining operation is the gradual reduction in diameter from one part of a cylindrical workpiece to another part. Tapers can be either external or internal. If a workpiece is tapered on the outside, it has an external taper; if it is tapered on the inside, it has an internal taper.

Advantages of Using Taper Attachment for Tapers:

- Both internal and external tapers can be produced.
- Threads on both internal and external taper portions can be cut.
- Power feed can be used.
- Lengthy taper can be produced.
- Good surface finish is obtained.
- The alignment of the lathe centres is not disturbed.
- It is most suitable for producing duplicate tapers because. the change in length of the job does not affect the taper.
- The job can be held either in chuck or in between centres.

Disadvantages of Taper Turning Attachment:

- Only limited taper angles can be turned.
- Cross feed must be disengaged for operation, time consuming.
- Only viable for large production

"If you don't like the road you're walking, start paving another one."

—Dolly Parton