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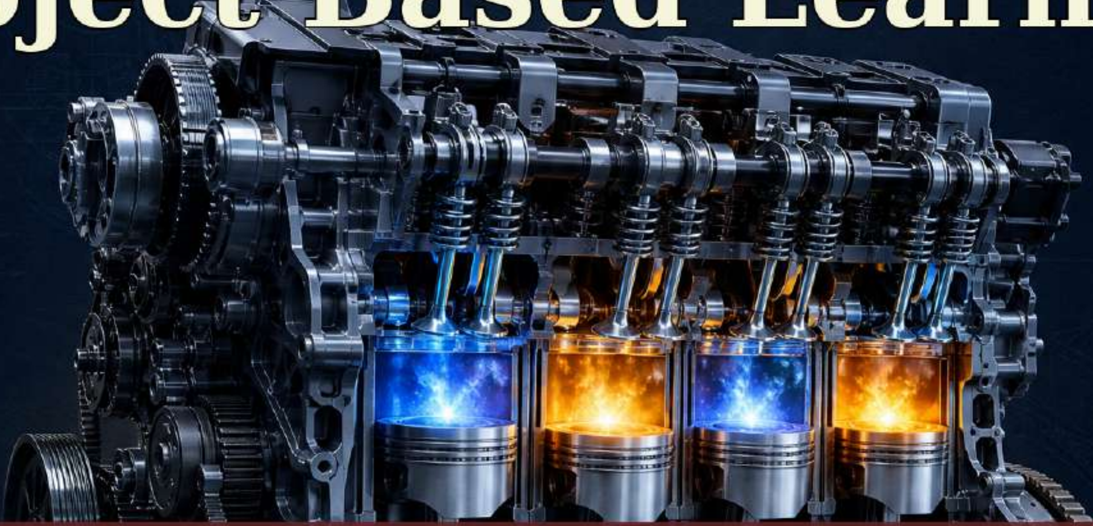
NARSIMHA REDDY ENGINEERING COLLEGE

(AUTONOMOUS)

INTERNAL COMBUSTION ENGINES

Project Based Learning



for III B.Tech I Semester - 2026-2027

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Department of Mechanical Engineering

Internal Combustion Engine (PBL)

Department of Mechanical Engineering

Project Based Learning on IC Engines

Title 1: Exergy Analysis of a Compressed Ignition Engine:

Description:

In conventional performance analysis of a Compressed Ignition (CI) engine (diesel engine), the evaluation is mainly based on energy (first-law) analysis, which accounts for energy input and output but does not consider the quality or usefulness of energy. As a result, it fails to identify the true sources of inefficiencies within the engine system. A significant portion of fuel energy supplied to a CI engine is lost through exhaust gases, cooling systems, and irreversibilities such as friction and combustion inefficiencies. These losses reduce the engine's overall efficiency and increase fuel consumption and emissions.

Need:

There is a need to perform an exergy (second-law) analysis, which evaluates both the quantity and quality of energy and identifies the location and magnitude of irreversibilities within the engine.

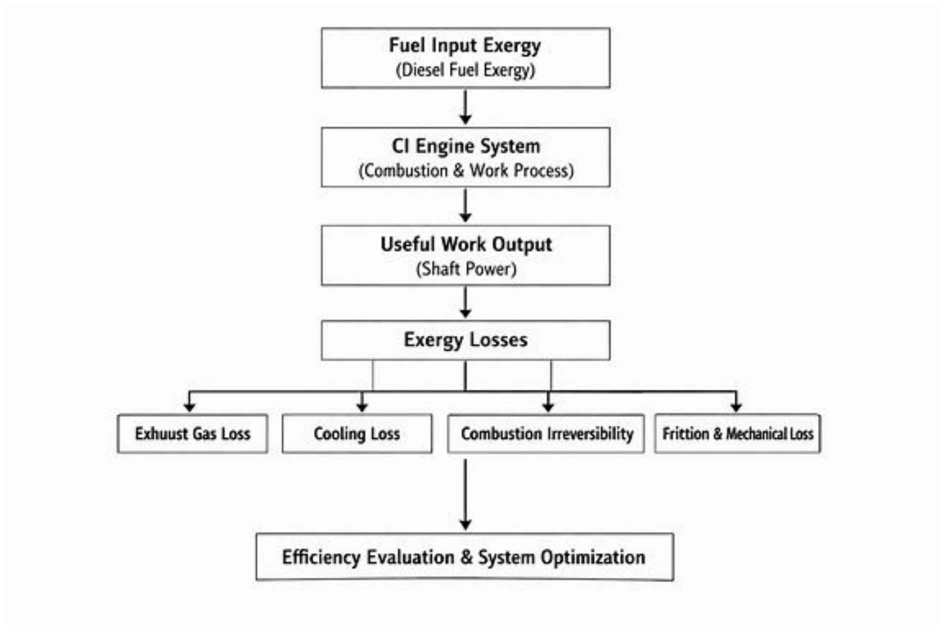
Key Features:

- Conventional CI engine performance analysis is based on first-law (energy) analysis, which only accounts for energy input and output.
- This approach does not consider the quality or usefulness of energy, limiting its ability to identify inefficiencies.
- A significant portion of the fuel energy is lost through:
    - Exhaust gases
    - Cooling systems
    - Irreversibilities such as friction and combustion inefficiencies
- These losses reduce the overall efficiency of the engine.
- Increased losses lead to higher fuel consumption and emissions.
- Therefore, there is a need for exergy (second-law) analysis, which evaluates both the quantity and quality of energy.
- Exergy analysis helps to identify the location and magnitude of irreversibilities within the engine system.

Expected Outcome:

Conducting an exergy analysis of a compressed ignition (CI) engine is a deeper understanding of the true sources of inefficiency within the system, beyond what conventional first-law energy analysis can reveal. By quantifying both the quantity and quality of energy flows, the analysis identifies the exact locations and magnitudes of irreversibilities such as combustion losses, friction, exhaust gas energy, and cooling system heat rejection. This leads to a more realistic evaluation of engine performance, enabling engineers to optimize design and operating parameters, reduce fuel consumption, and lower emissions. Additionally, it provides a framework for comparing different fuels, integrating waste-heat recovery technologies, and aligning engine improvements with sustainability goals, ultimately contributing to cleaner and more efficient energy utilization.

Flow Chart:



Title 2: Energy Analysis of a Compressed Ignition Engine:

Description:

In a Compressed Ignition (CI) engine, a large amount of energy supplied by the fuel is not fully converted into useful mechanical work. Instead, a significant portion is lost through exhaust gases, cooling systems, friction, and other thermal losses**.** Traditional performance evaluation based on brake power and efficiency provides limited insight into how the input fuel energy is distributed within the engine. Without a detailed energy (first-law) analysis**,** it is difficult to identify the exact pathways of energy losses and quantify their impact on overall engine performance.

Need:

Need to perform a comprehensive energy balance analysis of a CI engine to account for all energy inputs and outputs and to determine the distribution of energy across useful work and various loss mechanisms.

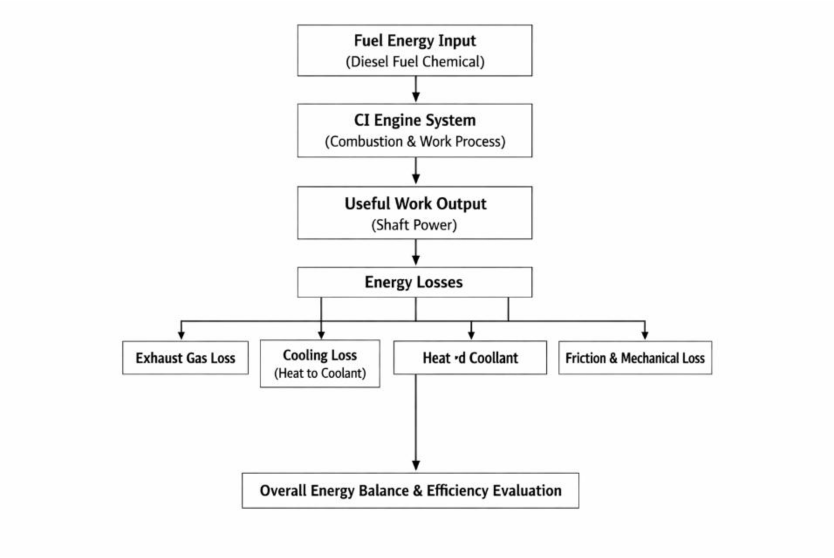
Key Features:

- Complete accounting of all energy inputs and outputs.
- Based on the principle of energy conservation (First Law of Thermodynamics).
- Tracks distribution of fuel energy into useful work and various losses.
- Identifies losses through exhaust gases, cooling systems, friction, and other thermal pathways.
- Provides performance evaluation in terms of brake power, indicated power, and mechanical efficiency.
- Highlights inefficiencies and supports strategies for reducing waste heat.
- Enables comparison of energy distribution under different operating conditions, fuels, or designs.
- Serves as the foundation for advanced exergy (Second-Law) analysis.

Expected Outcome:

The expected outcome of conducting an energy (first-law) analysis of a compressed ignition (CI) engine is a clear quantification of how the chemical energy supplied by the fuel is distributed across useful mechanical work and various loss mechanisms. This analysis enables precise identification of the major pathways of energy losses, such as exhaust gases, cooling systems, friction, and other thermal inefficiencies, while also providing a realistic evaluation of brake power, indicated power, and mechanical efficiency. By establishing a complete energy balance, the study highlights inefficiencies in the system, supports strategies for reducing waste heat, and offers insights for improving overall thermal efficiency. Furthermore, it allows comparative assessment under different operating conditions and fuels, and serves as a foundational step toward advanced exergy (second-law) analysis for deeper evaluation of energy quality and irreversibility.

Flow Chart:



Fuel Energy Input
(Diesel Fuel Chemical)
CI Engine System
(Combustion & Work Process)
Useful Work Output
(Shaft Power)
Energy Losses
Exhaust Gas Loss
Cooling Loss
(Heat to Coolant)
Heat •d Coollant
Friction & Mechanical Loss
Overall Energy Balance & Efficiency Evaluation

Title 3: Economic Analysis of a Compressed Ignition Engine:

Description:

Compressed Ignition (CI) engines are widely used in transportation, power generation, and industrial applications due to their high efficiency and durability. However, the overall performance of a CI engine cannot be evaluated solely on technical parameters such as power output and thermal efficiency. The economic aspects, including fuel consumption, operating cost, maintenance cost, and lifecycle cost, play a crucial role in determining its practical feasibility and sustainability. In real-world applications, a CI engine may exhibit good performance but may not be economically viable due to high fuel consumption, frequent maintenance, or inefficient operation under varying load conditions. There is often a lack of systematic analysis that correlates engine performance with operating cost, making it difficult to optimize the engine for both performance and economy.

Need:

It is necessary to perform a comprehensive economic analysis of a CI engine to evaluate the cost-effectiveness of its operation and identify opportunities for cost reduction and improved efficiency.

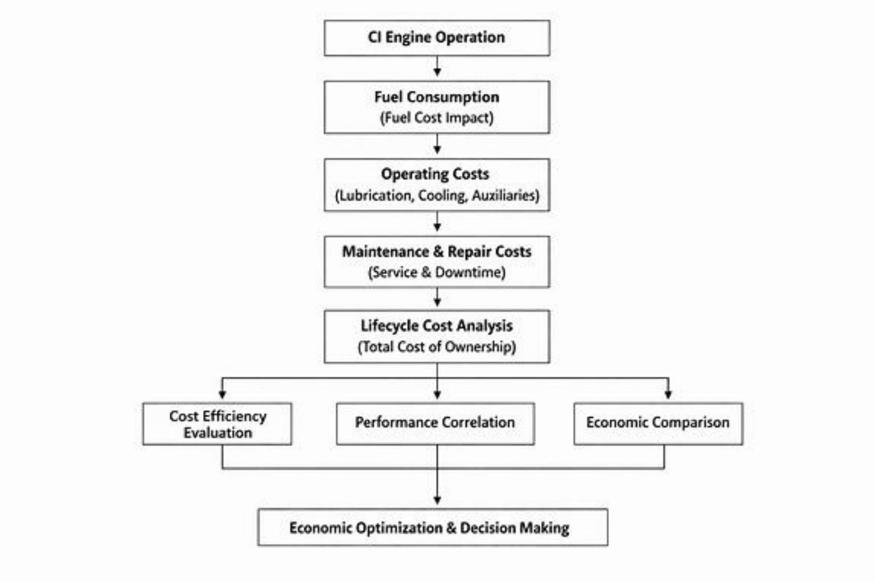
Key Features:

- Comprehensive evaluation of all cost components (fuel, maintenance, operation, lifecycle).
- Assessment of fuel consumption under varying load and speed conditions.
- Analysis of operating costs including lubrication, cooling, and auxiliary systems.
- Study of maintenance and repair costs, including downtime and spare parts.
- Estimation of lifecycle cost covering installation, operation, and decommissioning.
- Correlation of technical performance parameters with economic indicators.
- Identification of opportunities for cost reduction and efficiency improvement.
- Determination of economic feasibility and long-term sustainability.
- Comparative benchmarking of CI engines against alternative technologies or fuels.
- Support for decision-making in engine design, selection, and operational strategies.

Expected Outcome:

By conducting an economic analysis of a compressed ignition (CI) engine is a comprehensive understanding of the cost-effectiveness of its operation across the entire lifecycle. This analysis provides clear quantification of fuel consumption costs under varying load conditions, operating expenses related to lubrication and cooling, and maintenance costs including downtime and spare parts. It enables correlation between technical performance parameters and economic indicators, thereby identifying inefficiencies that increase operating costs. By evaluating lifecycle costs, the study highlights opportunities for cost reduction, improved resource utilization, and enhanced sustainability. Furthermore, it supports comparative benchmarking against alternative technologies or fuels, offering valuable insights for decision-making in engine design, selection, and operational strategies aimed at achieving both performance and economic viability.

Flow Chart:


CI Engine Operation
Fuel Consumption
(Fuel Cost Impact)
Operating Costs
(Lubrication, Cooling, Auxiliaries)
Maintenance & Repair Costs
(Service & Downtime)
Lifecycle Cost Analysis
(Total Cost of Ownership)
Cost Efficiency Evaluation
Performance Correlation
Economic Comparison
Economic Optimization & Decision Making

Title 4: Exergy Analysis of a Spark Ignition Engine:

Description:

Spark Ignition (SI) engines, commonly used in automobiles and small power applications, are typically evaluated using energy (first-law) analysis, which accounts for energy input and output. However, this method does not consider the quality or usability of energy, and therefore fails to accurately identify the true causes of inefficiencies within the engine. A significant portion of the fuel's available energy in an SI engine is lost due to irreversibilities in combustion, heat transfer, friction, and exhaust losses**.** These losses reduce engine efficiency and contribute to higher fuel consumption and emissions.

Need:

To overcome these limitations, it is essential to apply exergy (second-law) analysis, which evaluates both the quantity and quality of energy and identifies where and how energy degradation occurs within the system.

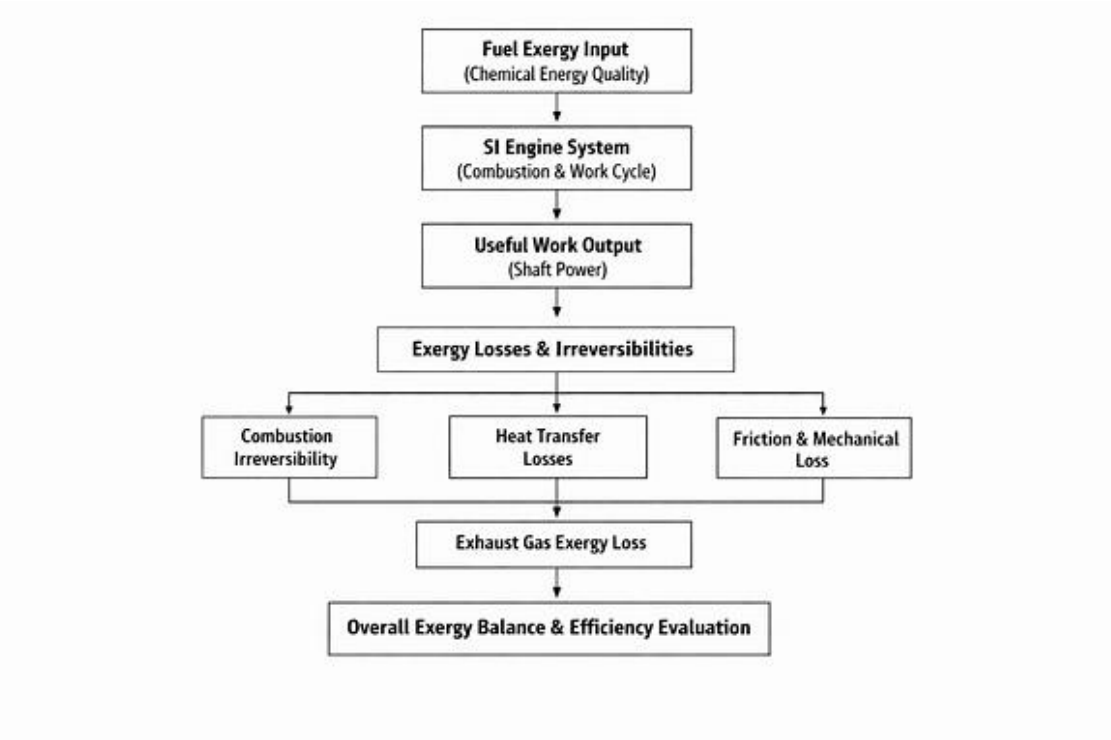
Key Features:

- Evaluation based on the Second Law of Thermodynamics, considering both energy quantity and quality.
- Identification of irreversibilities in combustion, heat transfer, friction, and exhaust processes.
- Quantification of exergy destruction to locate sources of energy degradation.
- Component-wise exergy balance for cylinder, exhaust, cooling, and mechanical systems.
- Assessment of fuel exergy utilization efficiency and conversion into useful work.
- Determination of exergy losses contributing to reduced performance and higher emissions.
- Integration with energy (first-law) analysis for a complete thermodynamic evaluation.
- Comparative analysis of different fuels, combustion modes, or engine designs.
- Identification of optimization opportunities to minimize exergy destruction.
- Support for sustainable and efficient engine operation through improved thermodynamic insight.

Expected Outcome:

The expected outcome of applying exergy analysis to a spark ignition engine is a deeper understanding of the true causes of inefficiencies by evaluating both the quantity and quality of energy transformations. Unlike first-law analysis, this approach identifies where exergy destruction occurs due to irreversibilities in combustion, heat transfer, friction, and exhaust processes. It provides a clear quantification of energy degradation, enabling accurate assessment of fuel utilization efficiency and highlighting the pathways that contribute to higher emissions and wasted energy. By correlating exergy losses with engine components, the analysis offers valuable insights for design improvements, operational optimization, and comparative evaluation of fuels or combustion strategies. Ultimately, the outcome is a holistic framework that supports enhanced efficiency, reduced fuel consumption, and more sustainable operation of spark ignition engines.

Flow Chart:



Fuel Exergy Input
(Chemical Energy Quality)
SI Engine System
(Combustion & Work Cycle)
Useful Work Output
(Shaft Power)
Exergy Losses & Irreversibilities
Combustion Irreversibility
Heat Transfer Losses
Friction & Mechanical Loss
Exhaust Gas Exergy Loss
Overall Exergy Balance & Efficiency Evaluation

Title 5: Energy Analysis of a Spark Ignition Engine

Description:

Spark Ignition (SI) engines are widely used in passenger vehicles, two-wheelers, and small-scale power applications**.** Although these engines are designed for efficient performance, a considerable portion of the fuel energy supplied is not converted into useful mechanical work**.** Instead, energy is lost through exhaust gases, cooling systems, friction, and other heat losses**.**

Conventional performance parameters such as brake power and efficiency provide only limited information about engine behavior and do not clearly indicate how the input energy is distributed within the system. Without a detailed energy (first-law) analysis, it is difficult to identify the major sources of energy loss and evaluate the engine's actual performance. Therefore, a systematic energy analysis of a Spark Ignition engine is necessary to establish a complete energy balance, quantify useful output, and identify various loss components for improving overall efficiency.

Need:

A systematic energy analysis of a Spark Ignition engine is necessary to establish a complete energy balance, quantify useful output, and identify various loss components for improving overall efficiency.

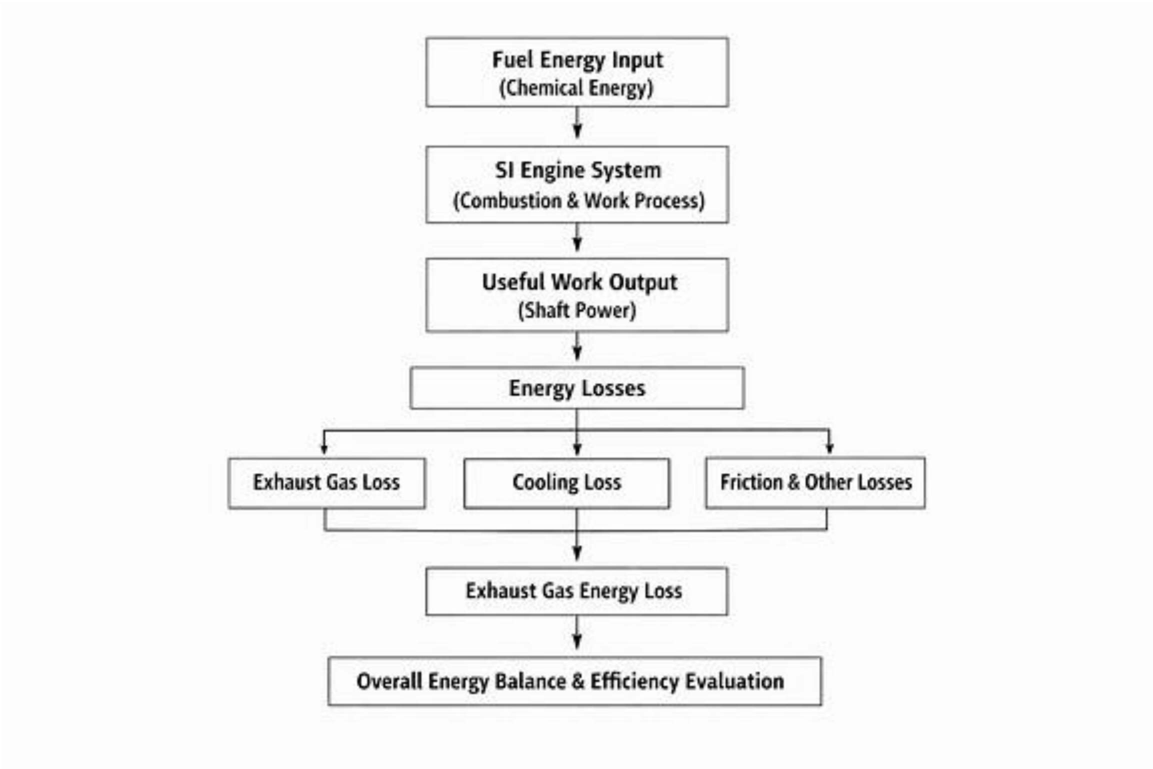
Key Features:

- Establishes a complete energy balance between fuel input, useful output, and losses.
- Quantifies fuel energy conversion into mechanical work and heat.
- Identifies major energy loss components such as exhaust, cooling, friction, and radiation.
- Evaluates thermal efficiency and overall energy utilization of the engine.
- Provides component-wise energy distribution for cylinder, exhaust, and cooling systems.
- Helps determine energy flow paths and pinpoint inefficiencies in the system.
- Supports comparison of performance under different operating conditions and loads.
- Aids in optimization of design and operation to minimize energy losses.
- Integrates with performance parameters like brake power and indicated power for deeper insight.
- Contributes to improved fuel economy and sustainable operation through efficient energy management**.**

Expected Outcome:

The expected outcome of performing an energy analysis on a spark ignition engine is a detailed understanding of how the supplied fuel energy is distributed among useful work and various loss components. This analysis establishes a complete energy balance, enabling precise quantification of energy conversion efficiency and identification of major losses through exhaust gases, cooling systems, friction, and radiation. It provides insights into the proportion of energy utilized for mechanical output versus that dissipated as heat, helping to pinpoint inefficiencies in the combustion and heat transfer processes. By correlating energy flow with performance parameters, the study supports optimization of engine design and operating conditions to minimize losses, improve thermal efficiency, and enhance overall fuel economy. Ultimately, the analysis contributes to developing more energy-efficient and sustainable spark ignition engines.

Flow Chart:



Fuel Energy Input
(Chemical Energy)
SI Engine System
(Combustion & Work Process)
Useful Work Output
(Shaft Power)
Energy Losses
Exhaust Gas Loss
Cooling Loss
Friction & Other Losses
Exhaust Gas Energy Loss
Overall Energy Balance & Efficiency Evaluation

Title 6: Energy Analysis of a Spark Ignition Engine

Description:

Spark Ignition (SI) engines are extensively used in cars, motorcycles, and small utility systems due to their simplicity and smooth operation. However, their widespread usage leads to significant fuel consumption and operational costs, especially under varying driving and load conditions. While performance analysis focuses on parameters such as power and efficiency, it does not provide a clear understanding of the economic feasibility of engine operation**.** Factors such as fuel cost, brake specific fuel consumption (BSFC), maintenance expenses**,** and depreciation play a crucial role in determining the overall cost-effectiveness of SI engines. With increasing fuel prices and operating expenses, it becomes essential to evaluate how efficiently an SI engine converts fuel into useful work from an economic perspective. A detailed economic analysis is therefore required to assess the cost per unit power outpu**t** and identify the most economical operating conditions.

Need:

The need for this project arises from the growing importance of evaluating fuel utilization and cost-effectiveness in Spark Ignition (SI) engines. With increasing fuel prices and maintenance expenses, it is essential to analyze how efficiently the engine converts fuel energy into useful work. A systematic energy analysis helps identify major loss components, establish a complete energy balance, and correlate performance with economic viability. This ensures optimized operation, improved fuel economy, and sustainable engine performance under real-world conditions.

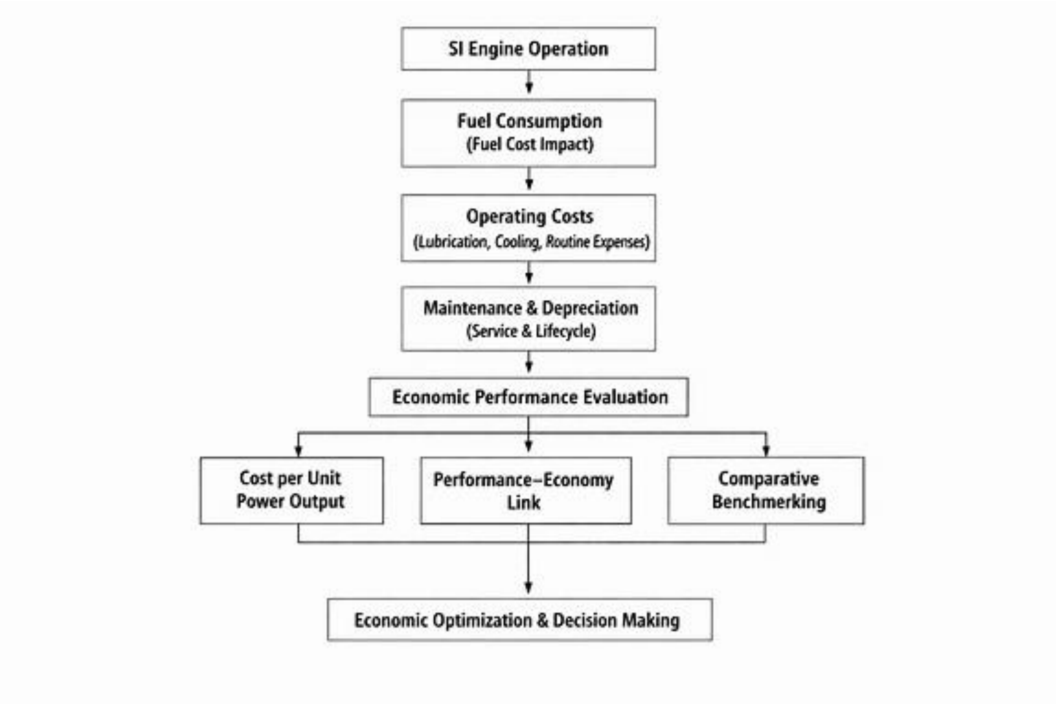
Key Features:

- Evaluation of fuel cost and its impact on overall operating expenses.
- Analysis of Brake Specific Fuel Consumption (BSFC) to determine cost per unit power output.
- Consideration of maintenance and servicing costs, including spare parts and downtime.
- Inclusion of depreciation and lifecycle costs to assess long-term economic feasibility.
- Correlation of performance parameters (power, efficiency) with economic indicators.
- Identification of economical operating conditions under varying load and speed ranges.
- Comparative benchmarking with alternative technologies or fuels for cost-effectiveness.
- Support for optimization strategies to minimize fuel consumption and reduce expenses.
- Contribution to sustainable and efficient engine operation from an economic perspective.

Expected Outcome:

The expected outcome of conducting an economic analysis of a spark ignition engine is a comprehensive evaluation of its cost-effectiveness under varying operating conditions. This analysis provides quantification of fuel costs through brake specific fuel consumption (BSFC), along with assessment of maintenance, servicing, and depreciation expenses. It establishes the cost per unit of power output, enabling identification of the most economical speed and load ranges for operation. By correlating technical performance parameters with economic indicators, the study highlights inefficiencies that increase operating costs and supports strategies for optimization. Ultimately, the outcome is a clear framework for improving fuel economy, reducing overall expenses, and ensuring sustainable and economically viable engine performance.

Flow Chart:



Title 7: Thermo Economic Analysis of a Compressed Ignition Engine

Description:

Compressed Ignition (CI) engines are widely used in transport, agriculture, and power generation due to their high efficiency and reliability. Traditionally, engine performance is evaluated using energy (first-law) and exergy (second-law) analyses, which provide insights into energy distribution and irreversibilities. However, these approaches do not directly account for the economic implications of energy losses and inefficiencies. At the same time, purely economic analysis considers fuel cost, maintenance, and operating expenses, but does not link these costs to the thermodynamic inefficiencie**s** occurring within the engine. This disconnect makes it difficult to identify how thermodynamic losses translate into monetary losses**.**

Need:

A need for a thermo-economic analysis**,** which integrates thermodynamic (energy/exergy) analysis with economic evaluation. This approach helps in quantifying the cost of energy losses, inefficiencies, and irreversibilities in a CI engine and enables better decision-making for performance improvement and cost optimization.

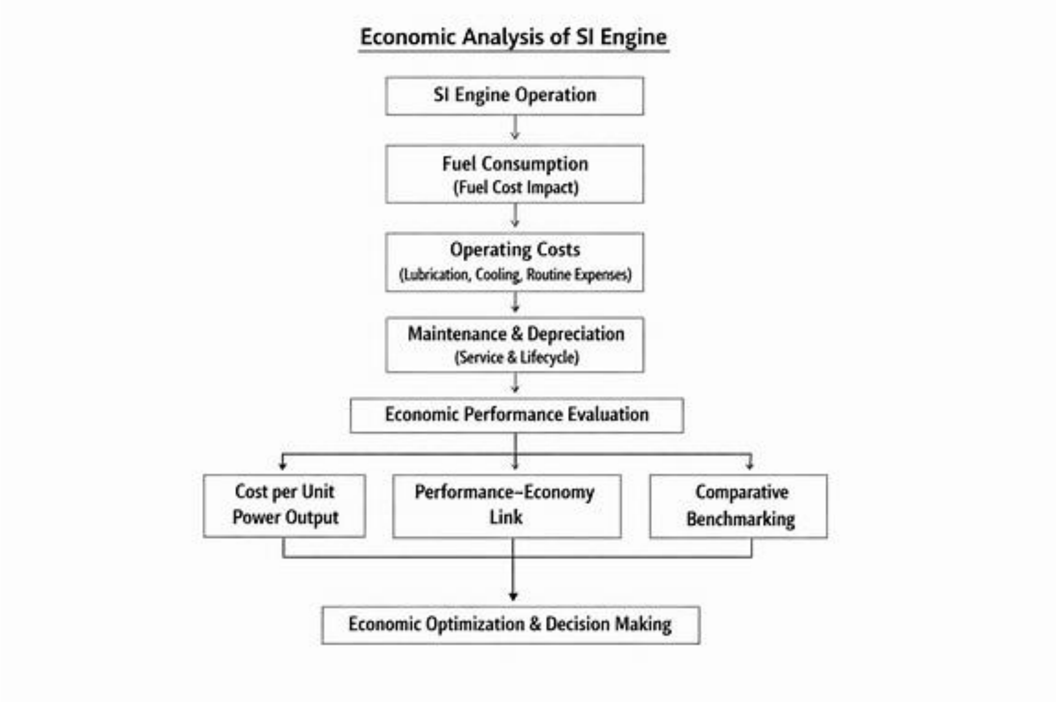
Key Features:

- Evaluation of fuel cost and consumption to determine cost per unit power output.
- Assessment of Brake Specific Fuel Consumption (BSFC) for economic performance measurement.
- Inclusion of maintenance, servicing, and depreciation costs for total cost estimation.
- Analysis of operating expenses such as lubrication, cooling, and routine running costs.
- Correlation between technical efficiency and economic feasibility under different load conditions.
- Identification of most economical operating speed and load ranges.
- Comparison of cost-effectiveness among different fuels or engine configurations.
- Support for optimization strategies to reduce fuel and maintenance expenses.
- Contribution to sustainable and cost-efficient engine operation through economic evaluation.

Expected Outcome:

The expected outcome of this project is a comprehensive understanding of the cost-effectiveness of Spark Ignition (SI) engine operation under different load and speed conditions. The analysis will quantify fuel consumption, maintenance, and depreciation costs to determine the cost per unit power output. It will identify the most economical operating range by correlating technical performance parameters with economic indicators such as Brake Specific Fuel Consumption (BSFC) and overall running cost. This outcome will help optimize engine operation for reduced fuel expenditure, improved cost efficiency, and sustainable performance, supporting informed decisions in design and usage for better economic viability.

Flow Chart:


Economic Analysis of SI Engine
SI Engine Operation
Fuel Consumption
(Fuel Cost Impact)
Operating Costs
(Lubrication, Cooling, Routine Expenses)
Maintenance & Depreciation
(Service & Lifecycle)
Economic Performance Evaluation
Cost per Unit
Power Output
Performance–Economy
Link
Comparative
Benchmarking
Economic Optimization & Decision Making

Title 8: Thermo Economic Analysis of a Spark Ignition Engine

Description:

Spark Ignition (SI) engines are widely used in automobiles due to their smooth operation and relatively lower emissions compared to compression ignition engines. However, their performance is often limited by lower thermal efficiency and higher fuel consumption. Traditional performance evaluation methods focus primarily on energy analysis, which does not account for the quality of energy losses or their economic implications. Thermo-economic analysis combines thermodynamic (energy and exergy) evaluation with economic assessment to provide a more comprehensive understanding of engine performance. Despite its importance, there is limited integration of thermo-economic principles in the design and optimization of SI engines. The problem is to analyze and quantify the thermodynamic inefficiencies and associated economic costs in a spark ignition engine under various operating conditions. This includes identifying major sources of irreversibility, evaluating exergy destruction, and correlating these losses with fuel cost, operating expenses, and overall engine efficiency.

Need:

A thermo-economic analysis is essential to bridge the gap between thermodynamic performance and economic feasibility of Spark Ignition (SI) engines. Traditional energy or exergy analyses alone cannot reveal the cost implications of inefficiencies and irreversibilities. By integrating thermodynamic and economic perspectives, this study helps quantify exergy destruction, fuel cost, and operational expenses to identify the most cost-effective and efficient operating conditions. Such an approach supports optimization of engine design and operation, ensuring improved thermal efficiency, reduced fuel consumption, and sustainable economic performance.

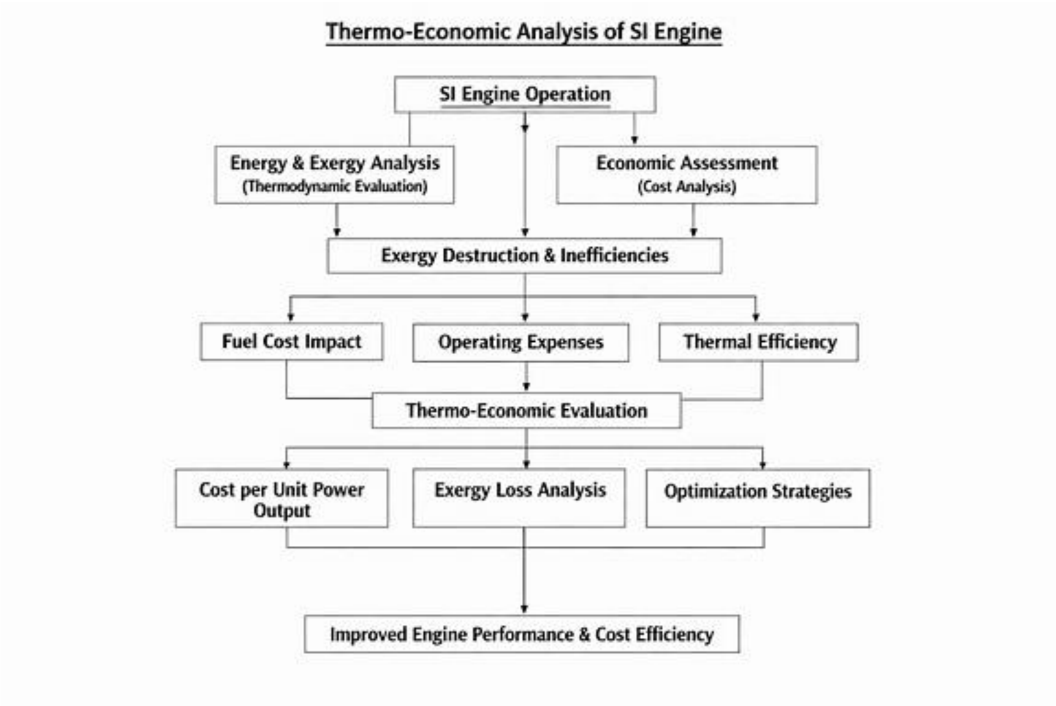
Key Features:

- Integration of thermodynamic and economic evaluation.
- Analysis of energy and exergy flows.
- Quantification of exergy destruction and irreversibilities.
- Correlation of losses with fuel cost and operating expenses.
- Evaluation of thermal efficiency and cost per unit output.
- Identification of major sources of inefficiency.
- Linking technical performance with economic feasibility.
- Optimization of design and operation for cost-effectiveness.
- Comparative assessment of fuels or configurations.
- Promotion of sustainable and efficient engine performance.

Expected Outcome:

The expected outcome of this project is a holistic evaluation of Spark Ignition (SI) engine performance by integrating thermodynamic and economic perspectives. The analysis will quantify energy and exergy losses, identify major sources of irreversibility, and correlate exergy destruction with fuel costs and operating expenses. It will establish the cost per unit of useful power output while highlighting inefficiencies that impact both thermal efficiency and economic viability. Ultimately, the study will provide a framework for optimizing engine design and operation, ensuring improved fuel economy, reduced operating costs, and sustainable performance under diverse operating conditions.

Flow Chart:



Thermo-Economic Analysis of SI Engine
SI Engine Operation
Energy & Exergy Analysis
(Thermodynamic Evaluation)
Economic Assessment
(Cost Analysis)
Exergy Destruction & Inefficiencies
Fuel Cost Impact
Operating Expenses
Thermal Efficiency
Thermo-Economic Evaluation
Cost per Unit Power Output
Exergy Loss Analysis
Optimization Strategies
Improved Engine Performance & Cost Efficiency

Title 9: Comparative study of performance of SI and CI Engines of 2 Stroke

Description:

Two-stroke engines are widely used in small-scale applications due to their simplicity, lightweight design, and high power-to-weight ratio. Both Spark Ignition (SI) **and** Compression Ignition (CI) engines operate on different combustion principles, resulting in variations in performance, efficiency, fuel consumption, and emissions. While SI engines rely on spark plugs for ignition and are generally smoother in operation, CI engines use high compression to ignite fuel and are known for higher efficiency and fuel economy. However, in two-stroke configurations, factors such as scavenging efficiency, fuel-air mixing, combustion characteristics, and heat losses significantly affect performance.

Need:

There is a need to conduct a comparative performance analysis of 2-stroke SI and CI engines under similar operating conditions to understand their relative advantages and limitations.

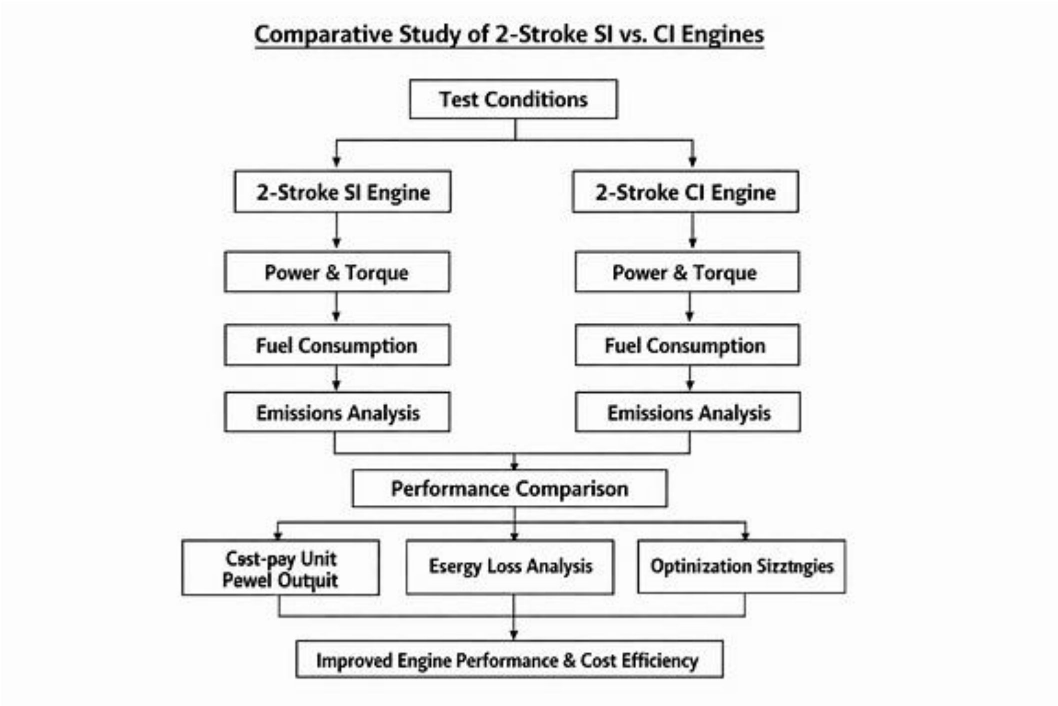
Key Features:

- Comparative evaluation of combustion principles in SI and CI engines.
- Analysis of power output, torque, and efficiency under identical conditions.
- Study of fuel consumption and specific fuel efficiency for both engine types.
- Examination of scavenging efficiency and air–fuel mixing characteristics.
- Assessment of heat losses and thermal behavior during operation.
- Comparison of emission levels and environmental impact.
- Identification of advantages and limitations of each engine type.
- Evaluation of performance variation with load and speed.
- Determination of overall suitability for small-scale applications.
- Support for design optimization and selection of efficient engine configuration**.**

Expected Outcome:

The expected outcome of this study is a detailed comparative evaluation of the performance characteristics of two-stroke Spark Ignition (SI) and Compression Ignition (CI) engines under identical operating conditions. The analysis will quantify variations in power output, torque, fuel consumption, thermal efficiency, and emission levels. It will identify the influence of scavenging efficiency, combustion behavior, and heat losses on overall engine performance. The results will highlight the relative advantages and limitations of each engine type, providing insights into their suitability for specific small-scale applications. Ultimately, the study will support informed decisions in engine selection, design optimization, and performance improvement strategies.

Flow Chart:


Comparative Study of 2-Stroke SI vs. CI Engines
Test Conditions
2-Stroke SI Engine
2-Stroke CI Engine
Power & Torque
Power & Torque
Fuel Consumption
Fuel Consumption
Emissions Analysis
Emissions Analysis
Performance Comparison
Cost-pay Unit Pewel Output
Esergy Loss Analysis
Optinization Sizztngies
Improved Engine Performance & Cost Efficiency

Title 10: Comparative Study of Performance of SI and CI Engines of 4 Stroke

Description:

Four-stroke internal combustion engines are widely used in automobiles, power generation, and industrial applications due to their better fuel efficiency and controlled combustion process. Among them, Spark Ignition (SI) and Compression Ignition (CI) engines differ significantly in terms of fuel type, ignition method, efficiency, and operational characteristics.SI engines, which use petrol and a spark plug for ignition, are known for smoother operation and higher speed capability. In contrast, CI engines, which use diesel fuel and compression-based ignition, generally offer higher thermal efficiency and better fuel economy. However, these differences lead to variations in performance parameters such as power output, fuel consumption, efficiency, and emissions.

Need:

A comparative study of 4-stroke Spark Ignition (SI) and Compression Ignition (CI) engines is essential to understand their relative performance, efficiency, and operational characteristics under similar conditions. While SI engines offer smoother operation and higher speed capability, CI engines provide better fuel economy and thermal efficiency. Evaluating these differences through systematic experimentation helps identify the influence of combustion method, fuel type, and heat losses on overall engine behavior. This study is needed to determine the most suitable engine type for specific applications, optimize design parameters, and enhance performance, fuel efficiency, and emission control in modern automotive and industrial systems.

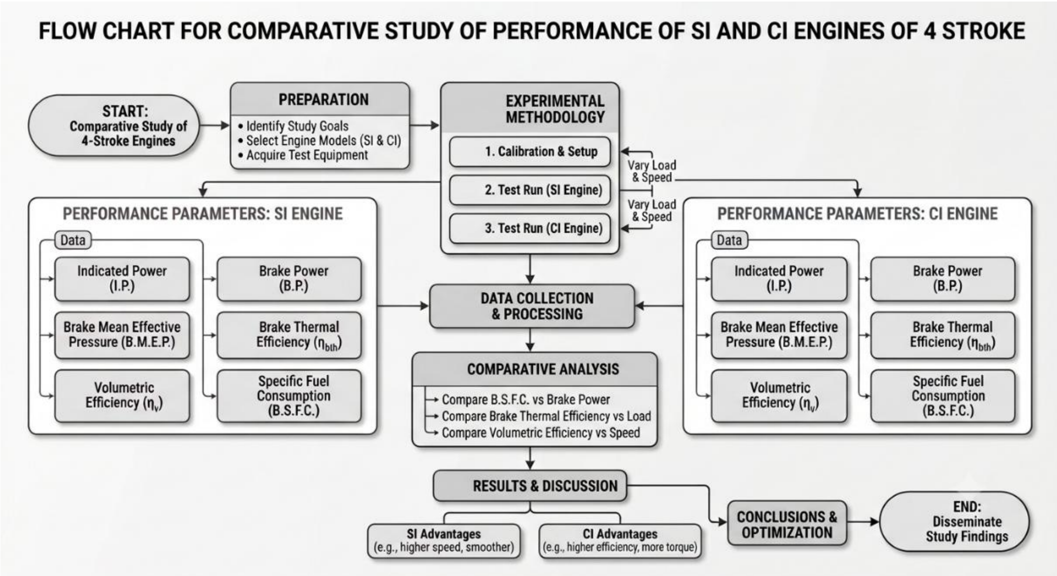
Key Features:

- Comparative evaluation of combustion principles in 4-stroke SI and CI engines.
- Analysis of power output, torque, and efficiency under identical conditions.
- Study of fuel consumption and specific fuel efficiency.
- Examination of ignition methods and combustion characteristics.
- Assessment of thermal efficiency and heat losses.
- Comparison of emission levels and environmental impact.
- Identification of performance variations with load and speed.
- Evaluation of mechanical and volumetric efficiency.
- Determination of relative advantages and limitations of each engine type.
- Support for design optimization and selection of efficient engine configuration.

Expected Outcome:

The expected outcome of this study is a systematic comparison of the performance characteristics of four-stroke Spark Ignition (SI) and Compression Ignition (CI) engines under similar operating conditions. The analysis will quantify differences in power output, torque, fuel consumption, thermal efficiency, and emission levels. It will highlight the influence of ignition method, combustion process, and fuel type on overall engine behavior. The results are expected to identify the relative advantages and limitations of each engine type, providing insights into their suitability for automotive, industrial, and power generation applications. Ultimately, the study will support design optimization, improved fuel economy, and effective emission control strategies for sustainable engine performance.

Flow Chart:


FLOW CHART FOR COMPARATIVE STUDY OF PERFORMANCE OF SI AND CI ENGINES OF 4 STROKE
START: Comparative Study of 4-Stroke Engines
PREPARATION
• Identify Study Goals
• Select Engine Models (SI & CI)
• Acquire Test Equipment
EXPERIMENTAL METHODOLOGY
1. Calibration & Setup
2. Test Run (SI Engine)
3. Test Run (CI Engine)
Vary Load & Speed
Vary Load & Speed
PERFORMANCE PARAMETERS: SI ENGINE
Data
Indicated Power (I.P.)
Brake Power (B.P.)
Brake Mean Effective Pressure (B.M.E.P.)
Brake Thermal Efficiency (η_{bth})
Volumetric Efficiency (η_v)
Specific Fuel Consumption (B.S.F.C.)
PERFORMANCE PARAMETERS: CI ENGINE
Data
Indicated Power (I.P.)
Brake Power (B.P.)
Brake Mean Effective Pressure (B.M.E.P.)
Brake Thermal Efficiency (η_{bth})
Volumetric Efficiency (η_v)
Specific Fuel Consumption (B.S.F.C.)
DATA COLLECTION & PROCESSING
COMPARATIVE ANALYSIS
Compare B.S.F.C. vs Brake Power
Compare Brake Thermal Efficiency vs Load
Compare Volumetric Efficiency vs Speed
RESULTS & DISCUSSION
SI Advantages (e.g., higher speed, smoother)
CI Advantages (e.g., higher efficiency, more torque)
CONCLUSIONS & OPTIMIZATION
END: Disseminate Study Findings