A Practical Manual

for

DIPLOMA IN CHEMICAL ENGINEERING

Course Name

Plant Economics and Energy Management

(22312)

Semester – (III)

CH

BharatiVidyapeeth Institute of Technology

Navi Mumbai

BharatiVidyapeeth Institute of Technology

Navi Mumbai

Certificate

This is to certify that Mr. / Ms ……. Roll No…….of Third Semester of Diploma in Chemical Engineering (Code: CH3I) has completed the term work satisfactorily in course**Plant Economics and Energy Management (22312)** for the academic year 20…….to 20…..... as prescribed in the curriculum.

Place ……. Enrollment No……
Date:…..... Exam Seat No. …….....

Course Teacher **Head of the Department** **Principal**

Seal of the Institute

Practical- Course Outcome matrix

	Course Outcomes (COs) a. Identify forms of energy and its impact on plant environment b. Select energy source and method for energy conservation c. Perform energy conservation audit for chemical process industry d. Calculate cost, taxes and insurance liability for chemical process industry e. Estimate depreciation for chemical process industry					
S. No.	**Practical Outcome**	**CO a.**	**CO b.**	**CO c.**	**CO d.**	**CO e.**
1.	Determine the Calorific Value of given Solid Fuel	√				
2.	Determine the Calorific Value of given Liquid Fuel	√				
3.	Determine the Moisture Content in given coal sample.	√				
4.	Determine the Volatile Content in given coal sample.	√				
5.	Determine the Ash Content in given solid fuel sample.	√				
6.	Determine the Fuel Components from Kitchen Waste		√			
7.	Determine Thermal Characteristics of given Biomass		√			
8.	Prepare document for Energy Audit of given organization			√		
9.	Estimate Simple and Compound interest on given project cost				√	
10.	Prepare Cost sheet for given industrial data				√	
11.	Study balance sheet for given company account				√	
12.	Measure profitability of company using break even analysis					√

Guidelines to Teachers

1. ***Teacher need to ensure that a dated log book*** for the whole semester, apart from the laboratory manual is maintained by every student which s/he has to ***submit for assessment to the teacher*** in the next practical session.
2. There will be two sheets of blank pages after every practical for the student to report other matters(if any), which is not mentioned in the printed practicals.
3. For difficult practicals if required, teacher could provide the demonstration of the practical emphasizing of the skills which the student should achieve.
4. Teachers should give opportunity to students for hands-on after the demonstration.
5. Assess the skill achievement of the students and COs of each unit.
6. One or two questions ought to be added in each practical for different batches. For this teachers can maintain various practical related question bank for each course.
7. If some repetitive information like data sheet, use of software tools etc. has to be provided for effective attainment of practical outcomes, they can be incorporated in Appendix.
8. For effective implementation and attainment of practical outcomes, teacher ought to ensure that in the beginning itself of each practical, students must read through the complete write-up of that practical sheet.
9. During practical, ensure that each student gets chance and takes active part in taking observations/ readings and performing practical.
10. Teacher ought to assess the performance of students continuously according to the MSBTE guidelines

Instructions for Students

1. For incidental writing on the day of each practical session every student should maintain a ***dated log book*** for the whole semester, apart from this laboratory manual which s/he has to ***submit for assessment to the teacher*** in the next practical session.
2. For effective implementation and attainment of practical outcomes, in the beginning itself of each practical, students need to read through the complete write-up including the practical related questions and assessment scheme of that practical sheet.
3. Student ought to refer the data books, IS codes, Safety norms, Electricity act/rules, technical manuals, etc.
4. Student should not hesitate to ask any difficulties they face during the conduct of practicals.

Content

List of Practicals and Progressive Assessment Sheet

Practical No.1

Calorific Value of Solid Fuel

I PracticalSignificance

Importance of fuel in industry is depends upon its calorific value. Calorific value determines amount of heat available from that fuel. Calorific value play important role in industry while purchasing fuel. It is also important while determining efficiency of various equipments like boiler, heater etc.

II Relevant Program Outcomes (POs)

*PO 1.**Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic engineering to solve the Chemical engineering problems.*
*PO 3.**Experiments and practice:** Plan to perform experiments and practices to use the results to solve technical problems related to Chemical engineering.*

III Competency and Skills

This practical is expected to develop the following skills for the industry identified competency ***'Use the principles of energy management and economics in chemical process industry'***

1. Determination of different properties of fuels
2. Selection of fuel for various equipments in industry

IV Relevant Course Outcome(s)

- Identify forms of energy and its impact on plant environment.

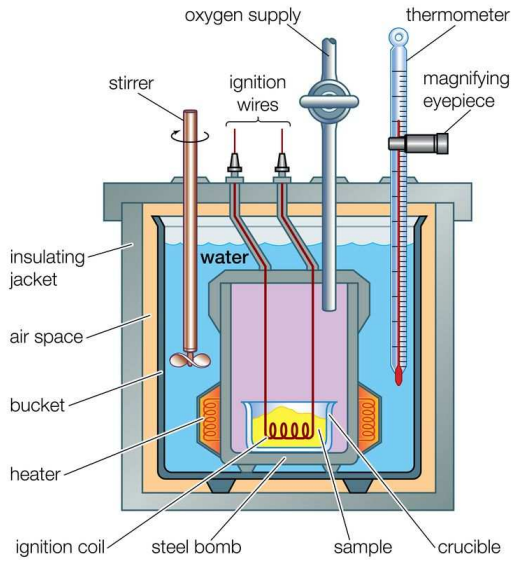
V Practical Outcome

- Determine the calorific value of given solid fuel.

VI Minimum Theoretical Background

A bomb calorimeter is a type of constant-volume calorimeter used in measuring the heat of combustion of a particular reaction. Bomb calorimeters have to withstand the large pressure within the calorimeter as the reaction is being measured.

VII Practical Setup



VIII Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Bomb Calorimeter	isoperibol, adiabatic or dynamic that allows measurements from equipment to conform to ASTM D240-02, D4809-00, E144-94, D5865 and other equivalent methods	1 No.
2	O_2 gas pressure regulator with filter cartridge		1 No.
3	O_2 gas cylinder		1 No.
4	Solid fuel	Coal	1 gm
5	Benzoic acid		1 gm

IX Precautions to be Followed

1. Use a properly grounded electrical outlet of correct voltage and current handling capacity.
2. Disconnect from power supply while organizing setup.
3. Sample should not exceed 1 gm.
4. Don't charge with more oxygen than is necessary.
5. Don't fire the bomb if gas bubbles are leaking from the bomb when it is submerged
6. in water
7. Does not use calorimeter in the presence of flammable or combustible materials; fire or explosion may result.This device contains components which may ignite such materials.
8. Keep safe distance during firing.

X Procedure

1. Weigh about 1 gm of coal pellet and introduce it into the bomb.
2. Add 2 ml of distilled water and connect the fuse to the lid wires.
3. Pressurize the bomb with oxygen (25 atm) and place it inside the jacket.
4. Fill the jacket with 2000ml of water.
5. Assemble the calorimeter and run the motor for 5 minutes.
6. Record the temperature of the water bath accurately using a precision thermometer at an interval of ½ minute for 5 minutes and ignite the charge at the start of 6^{th} minute.
7. Keep recording the temperature every minute till constant temperature is attained.
8. Open the bomb carefully.
9. Wash all the interior surfaces of the bomb with the jet of distilled water and collect the washings in a beaker.
10. Remove all unburned pieces of the fuse wire and measure the length of the pieces.
11. Collect and weigh the residual ash.
12. Repeat the above procedure using 1 gm of benzoic acid in place of coal.

Note: Above is standard procedure. Please follow the instructions given by manufacturer of the equipment.

XI Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					
4.					
5.					

XII Actual Procedure Followed

1. ……
2. ……
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XIII Actual Precautions Followed

1. ……
2. ……
3. ……
4. ……
5. ……
6. ……
7. ……

XIV Observations and Calculations

1. Heating value of benzoic acid HV_{acid}= J/g
2. Heating value of fuse wire $HV_{wire)}$= J/g
3. Specific heat of water$C_{v_{water}}$= J/g^{o}C
4. Temperature reading after every ½ minute:

Table 1. For benzoic acid

Time (min)	Temperature (^{o}C)	Time (min)	Temperature (^{o}C)

Temperature change ΔT_{water1} =

Table 2. For Solid fuel

Time (min)	Temperature (^{o}C)	Time (min)	Temperature (^{o}C)

Temperature change ΔT_{water2} =

Table 3. Weight of various materials

Parameter	Unit	Benzoic Acid-1	Solid Fuel-2
Material / fuel weight	gm		
Fuse wire weight before burning	gm		
Fuse wire weight after burning	gm		
Water in calorimeter	gm		

Difference of mass of wire before and after experiment Δm_{wire1} = gm
Difference of mass of wire before and after experiment Δm_{wire2} = gm

Water equivalent of calorimeter, stirrer, thermometer, bomb

$$m^*_{water} = \frac{\left[(HV_{acid} * m_{acid}) + (\Delta m_{wire} * HV_{wire1})\right]}{C_{v_{water}} * \Delta T_{water1}}$$

XV Results

Gross Calorific Value of Fuel =

$$HV_{fuel} = \frac{[(m^*_{water} * C_v * \Delta T_{water2}) - (\Delta m_{wire} * HV_{wire2})]}{m_{fuel}}$$

XVI Interpretation of Results

(Giving meaning to the results)

XVII Conclusions

(Actions to be taken based on the interpretations.)

XVIII Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questionsso as to ensure the achievement of identified CO.

1. Give the specification of pressure gauge used for oxygen cylinder.
2. Write safety precautions for handling oxygen cylinder.

XIX References / Suggestions for Further Reading

1. http://www.iitk.ac.in/mme/test/MME331.pdf
2. http://www.rofa-praha.cz/files/files/Kalorimetrie/Parr%201341/Parr_1341_EN.pdf
3. http://chemistry.bd.psu.edu/jircitano/Bomb.pdf
4. https://en.wikipedia.org/wiki/Calorimeter
5. http://www.scimed.co.uk/wp-content/uploads/2013/03/Introduction-to-bomb-calorimetry.pdf
6. https://www.youtube.com/watch?v=utrvS84CeCk
7. https://www.youtube.com/watch?v=RzAPQPWOlNI

XX Assessment Scheme

Performance Indicators		Weightage	Marks obtained
Process Related (60%)			
1	Handling of bomb calorimeter	20%	
2	Recording change in temperature	20%	
3	Safety measures followed	20%	
Product Related (40%)			
4	Interpretation of result& Conclusion	20%	
5	Practical related questions	20%	
	Total	100 %	

Names of Student Team Members

1. …….
2. ……
3. ……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No.2

Calorific Value of Liquid Fuel

I PracticalSignificance

Importance of fuel in industry is depends upon its calorific value. Calorific value determines amount of heat available from that fuel. Calorific value play important role in industry while purchasing fuel. It is also important while determining efficiency of various equipments like boiler, heater etc.

II Relevant Program Outcomes (POs)

*PO 1.**Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic engineering to solve the Chemical engineering problems.*
*PO 3.**Experiments and practice:** Plan to perform experiments and practices to use the results to solve technical problems related to Chemical engineering.*

III Competency and Skills

This practical is expected to develop the following skills for the industry identified competency ***'Use the principles of energy management and economics in chemical process industry'***

1. Determination of different properties of fuels
2. Selection of fuel for various equipments in industry

IV Relevant Course Outcome(s)

- Identify forms of energy and its impact on plant environment.

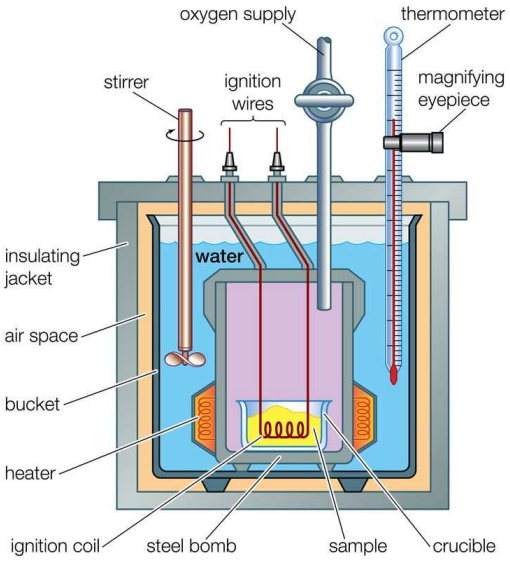
V Practical Outcome

- Determine the calorific value of given liquid fuel.

VI Minimum Theoretical Background

A bomb calorimeter is a type of constant-volume calorimeter used in measuring the heat of combustion of a particular reaction. Bomb calorimeters have to withstand the large pressure within the calorimeter as the reaction is being measured.

VII Practical Setup



VIII Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Bomb Calorimeter	isoperibol, adiabatic or dynamic that allows measurements from equipment to conform to ASTM D240-02, D4809-00, E144-94, D5865 and other equivalent methods	1 No.
2	O_2 gas pressure regulator with filter cartridge		1 No.
3	O_2 gas cylinder		1 No.
4	Liquid fuel	Kerosene, Diesel, FO, LDO	1 gm
5	Benzoic acid		1 gm

IX Precautions to be Followed

1. Use a properly grounded electrical outlet of correct voltage and current handling capacity.
2. Disconnect from power supply while organizing setup.
3. Sample should not exceed 1 gm.
4. Don't charge with more oxygen than is necessary.
5. Don't fire the bomb if gas bubbles are leaking from the bomb when it is submerged
6. in water
7. Does not use calorimeter in the presence of flammable or combustible materials; fire or explosion may result.This device contains components which may ignite such materials.
8. Keep safe distance during firing.

X Procedure

1. Weigh about 1 gm of liquid fuel and introduce it into the bomb.
2. Add 2 ml of distilled water and connect the fuse to the lid wires.
3. Pressurize the bomb with oxygen (25 atm) and place it inside the jacket.
4. Fill the jacket with 2000ml of water.
5. Assemble the calorimeter and run the motor for 5 minutes.
6. Record the temperature of the water bath accurately using a precision thermometer at an interval of ½ minute for 5 minutes and ignite the charge at the start of 6^{th} minute.
7. Keep recording the temperature every minute till constant temperature is attained.
8. Open the bomb carefully.
9. Wash all the interior surfaces of the bomb with the jet of distilled water and collect the washings in a beaker.
10. Remove all unburned pieces of the fuse wire and measure the length of the pieces.
11. Collect and weigh the residual ash.
12. Repeat the above procedure using 1 gmof benzoic acid in place of fuel.

Note: Above is standard procedure. Please follow the instructions given by manufacturer of the equipment.

XI Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					
4.					
5.					

XII Actual Procedure Followed

1. ……
2. ……
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XIII Actual Precautions Followed

1. ……
2. ……
3. ……
4. ……
5. ……
6. ……
7. ……

XIV Observations and Calculations

1. Heating value of benzoic acid HV_{acid}= J/g
2. Heating value of fuse wire $HV_{wire)}$= J/g
3. Specific heat of water$C_{v_{water}}$= J/g^{o}C
4. Temperature reading after every ½ minute:

Table 1. For benzoic acid

Time (min)	Temperature (^{o}C)	Time (min)	Temperature (^{o}C)

Temperature change ΔT_{water1} =

Table 2. For Solid fuel

Time (min)	Temperature (^{o}C)	Time (min)	Temperature (^{o}C)

Temperature change ΔT_{water2} =

Table 3. Weight of various materials

Parameter	Unit	Benzoic Acid-1	Solid Fuel-2
Material / fuel weight	gm		
Fuse wire weight before burning	gm		
Fuse wire weight after burning	gm		
Water in calorimeter	gm		

Difference of mass of wire before and after experiment Δm_{wire1} = gm
Difference of mass of wire before and after experiment Δm_{wire2} = gm

Water equivalent of calorimeter, stirrer, thermometer, bomb

$$m^*_{water} = \frac{\left[(HV_{acid} * m_{acid}) + (\Delta m_{wire} * HV_{wire1)}\right]}{C_{v_{water}} * \Delta T_{water1}}$$

XV Results

Gross Calorific Value of Fuel =

$$HV_{fuel} = \frac{[(m^*_{water} * C_v * \Delta T_{water2}) - (\Delta m_{wire} * HV_{wire2})]}{m_{fuel}}$$

XVI Interpretation of Results

(Giving meaning to the results)

XVII Conclusions

(Actions to be taken based on the interpretations.)

XVIII Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questionsso as to ensure the achievement of identified CO.

1. Write material of construction of cup in calorimeter.
2. Write safety precautions for handling liquid fuels.

XIX References / Suggestions for Further Reading

1. http://www.iitk.ac.in/mme/test/MME331.pdf
2. http://www.rofa-praha.cz/files/files/Kalorimetrie/Parr%201341/Parr_1341_EN.pdf
3. http://chemistry.bd.psu.edu/jircitano/Bomb.pdf
4. https://en.wikipedia.org/wiki/Calorimeter
5. http://www.scimed.co.uk/wp-content/uploads/2013/03/Introduction-to-bomb-calorimetry.pdf
6. https://www.youtube.com/watch?v=utrvS84CeCk
7. https://www.youtube.com/watch?v=RzAPQPWOlNI

XX Assessment Scheme

Performance Indicators		Weightage	Marks obtained
Process Related (60%)			
1	Handling of bomb calorimeter	20%	
2	Recording change in temperature	20%	
3	Safety measures followed	20%	
Product Related (40%)			
4	Interpretation of result& Conclusion	20%	
5	Practical related questions	20%	
	Total	100 %	

Names of Student Team Members

1. …….
2. ……
3. ……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No.3

Moisture Content in coal

I PracticalSignificance

The amount of moisture in coal can affect its performance in, for example, its use in pulverized form as a fuel to generate electricity. It brings down the GCV of coal (thermal content of coal) which reduces the output it delivers, reduced boiler efficiency and unit overall efficiency. Also, wet coal is difficult to handle & its movement in conveyors, chutes, hoppers, bunkers and pipes is considerably hindered making its grinding, milling and flow into the boiler very difficult.

II Relevant Program Outcomes (POs)

*PO 1.**Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic engineering to solve the Chemical engineering problems.*
*PO 3.**Experiments and practice:** Plan to perform experiments and practices to use the results to solve technical problems related to Chemical engineering.*

III Competency and Skills

This practical is expected to develop the following skills for the industry identified competency ***'Use the principles of energy management and economics in chemical process industry'***

1. Determination of different properties of fuels
2. Selection of fuel for various equipments in industry

IV Relevant Course Outcome(s)

- Identify forms of energy and its impact on plant environment.

V Practical Outcome

- Determine the moisture content in given coal sample.

VI Minimum Theoretical Background

Moisture in coal consists of inherent moisture (IM) and surface moisture (SM). Then total moisture (TM) is a sum of IM and SM. Inherent moisture is moisture which is an integral part of the coal seam in its natural state, including water in pores but excluding that in macroscopically visible fractures. Equilibrated moisture (in chemically equilibrated condition) or chemical moisture is taken as inherent moisture though it can be different for low grade coals.

VII Practical Setup

VIII Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Air Oven	5°C above ambient to 250°C maximum	1 No.
2	Desiccator	300 ml	1 No.
3	Digital Weighing Balance	Capacity -0.1 mg to 230 gm Pan size-90 mm ACC -0.1 mg Calibration - Internal	1 No.
4	Crucible	20- 100 ml	1 No
5	Pulverized coal	Hard coal	1 gm

IX Precautions to be Followed

1. Use a properly grounded electrical outlet of correct voltage and current handling capacity.
2. Disconnect from power supply while organizing setup.
3. Handle coal dust safely.

X Procedure

1. Heat the empty crucible and cover in oven maintained at a temperature of 104-110 deg. C.
2. After one hour, remove the crucible from the oven and cool in a desiccator for 15-20 minutes.
3. Using tongs, record the empty crucible weight W1.
4. Using a spatula, transfer approximately 1 g of the coal sample to the crucible and mass to the nearest 0.0001 g and record grams as W2.
5. Secure the crucible in a desiccator and transfer into a pre-heated oven at 104-110 deg. C.
6. Heat for one hour without the lid on the crucible.
7. Place the cover on the crucible and transfer into the desiccator for 15-20 minutes to cool.
8. Weigh the crucible to the nearest 0.0001 g and record the weight in grams as W3.

XI Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					
4.					
5.					

XII Actual Procedure Followed

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14. ……

XIII Actual Precautions Followed

1. ……
2. ……
3. ……
4. ……
5. ……
6. ……
7. ……

XIV Observations and Calculations

W1 = mass of crucible = gm

W2 = mass of crucible with sample before heating= gm

W3 = mass of crucible with sample after heating = gm

T = Temperature of oven = ^{o}C

XV Results

% moisture content in fuel

= (Initial mass of fuel -Final mass of fuel/Initial mass of fuel) x 100

= [(W2-W1) – (W3-W1)/(W2-W1)] x 100

= [(W2-W3) /(W2-W1)] x100

XVI Interpretation of Results

(Giving meaning to the results)

XVII Conclusions

(Actions to be taken based on the interpretations.)

XVIII Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questionsso as to ensure the achievement of identified CO.

1. State the importance of dedicator in drying.
2. Write specifications of oven and digital balance.

XIX References / Suggestions for Further Reading

1. https://pubs.usgs.gov/bul/1823/report.pdf
2. http://www.insa.nic.in/writereaddata/UpLoadedFiles/PINSA/Vol06_1940_3_Art34.pdf
3. http://www.coaleducation.org/lessons/sec/properties/coalmoi.htm
4. http://www.tovatech.com/blog/2540/moisture-analyzers-2/how-to-test-coal-with-a-moisture-balance

XX Assessment Scheme

Performance Indicators		Weightage	Marks obtained
Process Related (60%)			
1	Handling of coal sample	20%	
2	Recording change in weight	20%	
3	Safety measures followed	20%	
Product Related (40%)			
4	Interpretation of result& Conclusion	20%	
5	Practical related questions	20%	
	Total	100 %	

Names of Student Team Members

1. ……..
2. ……
3. ……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No.4

Volatile Content in coal

I PracticalSignificance

Volatile matters are the methane, hydrocarbons, hydrogen and carbon monoxide, and incombustible gases like carbon dioxide and nitrogen found in coal. Thus the volatile matter is an index of the gaseous fuels present. Typical range of volatile matter is 20 to 35%. It proportionately increases flame length, and helps in easier ignition of coal. It sets minimum limit on the furnace height and volume. It also influences secondary air requirement and distribution aspects.

II Relevant Program Outcomes (POs)

*PO 1.**Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic engineering to solve the Chemical engineering problems.*
*PO 3.**Experiments and practice:** Plan to perform experiments and practices to use the results to solve technical problems related to Chemical engineering.*

III Competency and Skills

This practical is expected to develop the following skills for the industry identified competency ***'Use the principles of energy management and economics in chemical process industry'***

1. Determination of different properties of fuels
2. Selection of fuel for various equipments in industry

IV Relevant Course Outcome(s)

- Identify forms of energy and its impact on plant environment.

V Practical Outcome

- Determine the volatile content in given coal sample.

VI Minimum Theoretical Background

Volatile matter is material that is driven off when coal is heated to 950 °C (1,742 °F) in the absence of air under specified conditions. It is measured practically by determining the loss of weight. Consisting of a mixture of gases, low-boiling-point organic compounds that condense into oils upon cooling, and tars, volatile matter increases with decreasing rank. In general, coals with high volatile-matter content ignite easily and are highly reactive in combustion applications.

VII Practical Setup

VIII Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Fieldner furnace	According to ASTM standards	1 No.
2	Desiccator	300 ml	1 No.
3	Digital Weighing Balance	Capacity -0.1 mg to 230 gm Pan size-90 mm ACC -0.1 mg Calibration - Internal	1 No.
4	Silica Crucible	15 ml	1 No
5	Pulverized coal	Hard coal	1 gm

IX Precautions to be Followed

1. Use a properly grounded electrical outlet of correct voltage and current handling capacity.
2. Disconnect from power supply while organizing setup.
3. Handle coal dust safely.

X Procedure

1. Heat the empty crucible and cover in oven maintained at a temperature of 104-110 deg. C.
2. After one hour, remove the crucible from the oven and cool in a desiccator for 15-20 minutes.
3. Using tongs, record the empty crucible weight W1.
4. Using a spatula, transfer approximately 1 g of the coal sample to the crucible and mass to the nearest 0.0001 g and record grams as W2.
5. Secure the crucible in a desiccator and transfer into a pre-heated oven at 925 deg. C.
6. Heat for 7 minutes without the lid on the crucible.
7. Place the cover on the crucible and transfer into the desiccator for 15-20 minutes to cool.
8. Weigh the crucible to the nearest 0.0001 g and record the weight in grams as W3.

XI Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					
4.					
5.					

XII Actual Procedure Followed

1. ……
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14. ……

XIII Actual Precautions Followed

1. ……
2. ……
3. ……
4. ……
5. ……
6. ……
7. ……

XIV Observations and Calculations

W1 = mass of crucible = gm

W2 = mass of crucible with sample before heating= gm

W3 = mass of crucible with sample after heating = gm

T = Temperature of oven = ^{o}C

% moisture content in fuel = (From practical no.4)

XV Results

% weight loss in fuel

= (Final mass of sample/Initial mass of sample) x 100

= [(W2-W1) – (W3-W1)/(W2-W1)] x 100 = [(W2-W3) /(W2-W1)] x100

% volatile content in fuel

= 100 - % weight loss in fuel - % moisture content in fuel

XVI Interpretation of Results

(Giving meaning to the results)

XVII Conclusions

(Actions to be taken based on the interpretations.)

XVIII Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questionsso as to ensure the achievement of identified CO.

1. State the importance of material of construction of crucible.
2. Write specifications of oven and digital balance.

XIX References / Suggestions for Further Reading

1. http://shodhganga.inflibnet.ac.in/bitstream/10603/68365/14/14_chapter%205.pdf
2. http://www.razi-foundation.com/Portals/0/Files/standards/ASTM%20D%203175%202011.pdf?ver=1395-08-22-190150-283
3. https://www.ideals.illinois.edu/bitstream/handle/2142/35126/comparisonofmeth240rees.pdf?sequence=2
4. http://eguruchela.com/chemistry/learning/Analysis_of_Coal.php

XX Assessment Scheme

	Performance Indicators	Weightage	Marks obtained
	Process Related (60%)		
1	Handling of coal sample	20%	
2	Recording change in weight	20%	
3	Safety measures followed	20%	
	Product Related (40%)		
4	Interpretation of result & Conclusion	20%	
5	Practical related questions	20%	
	Total	100 %	

Names of Student Team Members

1. ……..
2. ……
3. ……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No.5

Ash content in Solid Fuel

I PracticalSignificance

Ash content is to be determined for estimating the quality of solid fuel materials such as coke materials. Ash is an impurity that will not burn. Typical range is 5 to 40%. It reduces handling and burning capacity. Increases handling costs, affects combustion efficiency and boiler efficiency, and Causes clinkering and slagging.

II Relevant Program Outcomes (POs)

*PO 1.**Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic engineering to solve the Chemical engineering problems.*

*PO 3.**Experiments and practice:** Plan to perform experiments and practices to use the results to solve technical problems related to Chemical engineering.*

III Competency and Skills

This practical is expected to develop the following skills for the industry identified competency ***'Use the principles of energy management and economics in chemical process industry'***

1. Determination of different properties of fuels
2. Selection of fuel for various equipments in industry

IV Relevant Course Outcome(s)

- Identify forms of energy and its impact on plant environment.

V Practical Outcome

- Determine the volatile content in given coal sample.

VI Minimum Theoretical Background

The ash in coal has much of its origin in mineral matter that remains behind after coal is burned. The mineral matter is introduced during deposition of the peat that makes up the coal. Coals that have a lot of mineral matter, and hence, ash, also have a fair amount of partings in the coal. Partings in coal are thin layers of mudstone introduced during deposition. Interestingly, and not well understood, ash content of coal decreases with coal rank. In general, higher ash content is found in lignites and lower ash content occurs in anthracites. How the mineral matter is removed from the coal with change in rank requires more study.

VII Practical Setup

VIII Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Muffle furnace	Max temp 1350 ^{o}C Accuracy + or – 1 ^{o}C	1 No.
2	Desiccator	300 ml	1 No.
3	Digital Weighing Balance	Capacity -0.1 mg to 230 gm Pan size-90 mm ACC -0.1 mg Calibration - Internal	1 No.
4	Silica Crucible	15 ml	1 No
5	Pulverized coal	Hard coal	1 gm

IX Precautions to be Followed

1. Use a properly grounded electrical outlet of correct voltage and current handling capacity.
2. Disconnect from power supply while organizing setup.
3. Handle coal dust safely.

X Procedure

1. Heat the empty crucible and cover in oven maintained at a temperature of 800 deg. C.
2.
3. After one hour, remove the crucible from the oven and cool in a desiccator for 15-20 minutes.
4.
5. Using tongs, record the empty crucible weight W1.
6. Using a spatula, transfer approximately 1 g of the coal sample to the crucible and mass to the nearest 0.0001 g and record grams as W2.
7.
8. Secure the crucible and transfer into a pre-heated oven at 850deg. C.
9. Heat for 1 hour without the lid on the crucible.
10.
11. Place the cover on the crucible and transfer into the desiccator for 15-20 minutes to cool.
12.
13. Weigh the crucible to the nearest 0.0001 g and record the weight in grams as W3.

XI Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					
4.					
5.					

XII Actual Procedure Followed

1. ……
2. ……
3. ……
4. ……
5. ……
6. ……
7. ……
8. ……
9. ……
10. ……
11. ……
12. ……
13. ……
14. ……

XIII Actual Precautions Followed

1. ……
2. ……
3. ……
4. ……
5. ……
6. ……
7. ……

XIV Observations and Calculations

W1 = mass of crucible = gm

W2 = mass of crucible with sample before heating= gm

W3 = mass of crucible with sample after heating = gm

T = Temperature of oven = ^{o}C

XV Results

% ash content in fuel

= (Final mass of sample/Initial mass of sample) x 100

= [(W3-W1)/(W2-W1)] x 100

XVI Interpretation of Results

(Giving meaning to the results)

XVII Conclusions

(Actions to be taken based on the interpretations.)

XVIII Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questionsso as to ensure the achievement of identified CO.

1. State the importance of material of construction of crucible.
2. Write specifications of furnace.

XIX References / Suggestions for Further Reading

1. http://ethesis.nitrkl.ac.in/1127/1/ASSESSMENT_OF_COAL_QUALITY_OF_SOME_INDIAN_COALS.pdf
2. http://shodhganga.inflibnet.ac.in/bitstream/10603/68365/14/14_chapter%205.pdf
3. https://www.astm.org/Standards/D3174.htm

XX Assessment Scheme

Performance Indicators		Weightage	Marks obtained
Process Related (60%)			
1	Handling of coal sample	20%	
2	Recording change in weight	20%	
3	Safety measures followed	20%	
Product Related (40%)			
4	Interpretation of result & Conclusion	20%	
5	Practical related questions	20%	
	Total	100 %	

Names of Student Team Members

1. …….
2. ……
3. ……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No.6

Fuel Components from Kitchen Waste

I PracticalSignificance

Kitchen waste is defined as left-over organic matter from restaurants, hotels and households. Tons of kitchen wastes are produced daily in highly populated areas. Kitchen wastes entering the mixed-municipal waste system are difficult to process by standard means, such as incineration, due to the high moisture content. Furthermore, organic matter can be transformed into useful fertilizer and biofuel. New disposal methods that are both environmentally and economically efficient are being developed which rely on various forms of microbial decomposition.

II Relevant Program Outcomes (POs)

*PO 1.**Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic engineering to solve the Chemical engineering problems.*
*PO 3.**Experiments and practice:** Plan to perform experiments and practices to use the results to solve technical problems related to Chemical engineering.*

III Competency and Skills

This practical is expected to develop the following skills for the industry identified competency ***'Use the principles of energy management and economics in chemical process industry'***

1. Determination of different properties of fuels
2. Selection of fuel for various equipments in industry

IV Relevant Course Outcome(s)

- Identify forms of energy and its impact on plant environment.
- Select the energy source and method for energy conservation
- Perform energy conservation audit for chemical process industry

V Practical Outcome

- Determine the fuel components from kitchen waste

VI Minimum Theoretical Background

Kitchen waste is a nutrient rich, or eutrophic, environment containing high levels of carbohydrates, lipids, proteins, and other organic molecules which can support abundant populations of microorganisms]. The anaerobic nature of kitchen wastes is typical for a eutrophic environment, because aerobic bacteria deplete oxygen through respiration at a faster rate than oxygen can be replenished by diffusion. Although the presence of water is essential for bacteria growth, the high moisture content in kitchen waste exacerbates the anaerobic condition as oxygen is insoluble in water and it is hard for oxygen to diffuse through water. Kitchen waste is usually acidic due to the action of acid fermentation bacteria such as lactic acid bacteria. As lactic acid can act as an uncoupler in acidic environment, it is toxic to other bacteria, thus a buffer is usually added into kitchen wastes to make the environment less acidic. Overall, the high moisture and nutrient level make kitchen waste an ideal environment for anaerobic biodegradation.

VII Practical Setup

VIII Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Kitchen Waste	From various household, canteen , hostel	5 kg
2	Weighing balance	10 gm to 5 kg	1 no
3	Container	2 lit	10 no

IX Precautions to be Followed

1. Do not collect waste from only one place. It will give misleading results.
2. Use surgical hand gloves while handling waste

X Procedure

1. Collect kitchen waste from various places like home, restaurant, hostel etc.
2. Take weight of empty containers.
3. Make 5 batches of 1 kg each and place in five containers.
4. Segregate waste as degradable and non-degradable and place in 5 different containers.
5. Take a weight of container containing degradable mass.
6. Segregate dry combustible waste and non-combustible waste.
7. Weigh dry combustible mass of waste.

XI Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					
4.					
5.					

XII Actual Procedure Followed

1. ……
2. ……
3. ……
4. ……
5. ……
6. ……
7. ……
8. ……
9. ……
10. ……
11. ……
12. ……
13. ……
14. ……

XIII Actual Precautions Followed

1. ……
2. ……
3. ……
4. ……
5. ……
6. ……
7. ……

XIV Observations and Calculations

Container	Place	Weight (empty) kg	Weight (with waste) kg	Weight (Waste) Kg W_1	Weight (bio degradable Waste) Kg W_2	Weight (dry combustible Waste) Kg W_3
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						

XV Results

% fuel component in kitchen waste in wet form (for biogas production)

$= 100 \times W_2/W_1$

% fuel component in kitchen waste in dry form (for incineration)
$= 100 \times W2/W_1$

Sr. No	Place	% fuel component in kitchen waste in wet form	% fuel component in kitchen waste in dry form	Total % fuel component
1				
2				
3				
4				
5				

XVI Interpretation of Results

(Giving meaning to the results)

XVII Conclusions

(Actions to be taken based on the interpretations.)

XVIII Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questionsso as to ensure the achievement of identified CO.

1. List the food items found in kitchen waste
2. Draw diagram of aerobic digester for production of bio gas.

XIX References / Suggestions for Further Reading

1. https://en.wikipedia.org/wiki/Waste-to-energy
2. https://en.wikipedia.org/wiki/Food_waste
3. http://www.instructables.com/id/Bio-gas-plant-using-kitchen-waste/

XX Assessment Scheme

	Performance Indicators	Weightage	Marks obtained
	Process Related (60%)		
1	Handling of coal sample	20%	
2	Recording change in weight	20%	
3	Safety measures followed	20%	
	Product Related (40%)		
4	Interpretation of result & Conclusion	20%	
5	Practical related questions	20%	
	T**otal**	100 %	

Names of Student Team Members

1. ……..
2. ……
3. ……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No.7

Thermal Characteristics of Biomass

I PracticalSignificance

Biomass is renewable source of energy. It is CO_2 neutral. Various agricultural bio products can be used as fuel by replacing conventional fuel. Biomass produces less energy compared to fossil fuel. Its physical and chemical characteristics are important when used as fuel in industry. It will be helpful to analyze if we replace FO in boiler with biomass.

II Relevant Program Outcomes (POs)

*PO 1.**Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic engineering to solve the Chemical engineering problems.*
*PO 3.**Experiments and practice:** Plan to perform experiments and practices to use the results to solve technical problems related to Chemical engineering.*

III Competency and Skills

This practical is expected to develop the following skills for the industry identified competency ***'Use the principles of energy management and economics in chemical process industry'***

1. Determination of different properties of fuels
2. Selection of fuel for various equipments in industry

IV Relevant Course Outcome(s)

- Identify forms of energy and its impact on plant environment.
- Select the energy source and method for energy conservation
- Perform energy conservation audit for chemical process industry

V Practical Outcome

- Determine the thermal characteristics of biomass.

VI Minimum Theoretical Background

The term "biomass" refers to raw organic material used to generate a number of energy resources, including heat, liquid or gaseous fuels, and electricity. Chemical energy stored in biomass can be converted to heat through combustion (burning). Biomass can be converted to liquid or gaseous fuels or can be used to generate electricity in the same way that coal is used. The electricity generated can be sent to energy consumers via electric transmission systems. These applications can be at a small scale (e.g., to cook or make hot water in individual buildings) or at a large scale (e.g., to generate ethanol, biodiesel, biogas, or electricity for general distribution).
Biomass includes all of the earth's living matter, plants and animals, and the remains of this living matter. Plant biomass is a renewable energy source that is produced through photosynthesis when plants capture carbon dioxide from the air and combine it with water to form carbohydrates and oxygen under the influence of sunlight. The chemical energy in plants gets passed on to animals and people that eat the plants. Biomass does not include plant or animal matter that has been converted by geologic processes to create fossil fuels such as oil or coal.

VII Practical Setup

Same as experiment no. 1 , 4, 7

VIII Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Bomb Calorimeter	isoperibol, adiabatic or dynamic that allows measurements from equipment to conform to ASTM D240-02, D4809-00, E144-94, D5865 and other equivalent methods	1 No.
2	O_2 gas pressure regulator with filter cartridge		1 No.
3	O_2 gas cylinder		1 No.
4	Fieldner furnace	According to ASTM standards	1 No.
5	Desiccator	300 ml	1 No.
6	Digital Weighing Balance	Capacity -0.1 mg to 230 gm Pan size-90 mm ACC -0.1 mg Calibration - Internal	1 No.
7	Silica Crucible	15 ml	1 No

IX Precautions to be Followed

Same as experiment no. 1, 4, 7

X Procedure

Thermal Characteristics of biomass are
1. Calorific value (Heating Value) : Same as experiment no.1
2. Volatile matter: Same as experiment no.4
3. Ash Content : Same as experiment no.7

XI Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					
4.					
5.					

XII Actual Procedure Followed

1. ……
2. ……
3. ……
4. ……
5. ……
6. ……
7. ……
8. ……
9. ……
10. ……
11. ……
12. ……
13. ……
14. ……

XIII Actual Precautions Followed

1. ……
2. ……
3. ……
4. ……
5. ……
6. ……
7. ……

XIV Observations and Calculations

1. Calorific value (Heating Value) : Same as experiment no.1

2. Volatile matter: Same as experiment no.4

3. Ash Content : Same as experiment no.7

XV Results

XVI Interpretation of Results

(Giving meaning to the results)

XVII Conclusions

(Actions to be taken based on the interpretations.)

XVIII Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questionsso as to ensure the achievement of identified CO.

1. List the types of various biomass fuels
2. List the methods for determination of physical properties of biomass

XIX References / Suggestions for Further Reading

1. https://link.springer.com/article/10.1007/s10973-012-2933-y
2. https://extension.psu.edu/characteristics-of-biomass-as-a-heating-fuel
3. http://www.indjsrt.com/administrator/modules/category/upload/12-16.pdf
4. http://www.researchjournal.co.in/upload/assignments/3_223-227.pdf
5. https://teeic.indianaffairs.gov/er/biomass/restech/uses/index.htm

XX Assessment Scheme

Performance Indicators		Weightage	Marks obtained
Process Related (60%)			
1	Handling of coal sample	20%	
2	Recording change in weight	20%	
3	Safety measures followed	20%	
Product Related (40%)			
4	Interpretation of result & Conclusion	20%	
5	Practical related questions	20%	
	Total	100 %	

Names of Student Team Members

1. ……..
2. ……
3. ……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No.8

Document for Energy Audit

I PracticalSignificance

An energy audit is an inspection, survey and analysis of energy flows, for energy conservation in a building, process or system to reduce the amount of energy input into the system without negatively affecting the output(s). In commercial and industrial real estate, an energy audit is the first step in identifying opportunities to reduce energy expense and carbon footprints. Documentation of energy audit is in the form of Energy Audit Report. This report is valuable for industry to implement energy conservation measures.

II Relevant Program Outcomes (POs)

*PO 1.**Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic engineering to solve the Chemical engineering problems.*
*PO 3.**Experiments and practice:** Plan to perform experiments and practices to use the results to solve technical problems related to Chemical engineering.*

III Competency and Skills

This practical is expected to develop the following skills for the industry identified competency ***'Use the principles of energy management and economics in chemical process industry'***

1. Determination of different properties of fuels
2. Selection of fuel for various equipments in industry

IV Relevant Course Outcome(s)

- Identify forms of energy and its impact on plant environment.
- Select the energy source and method for energy conservation
- Perform energy conservation audit for chemical process industry

V Practical Outcome

- Prepare the energy audit document for the given organization

VI Minimum Theoretical Background

The term energy audit is commonly used to describe a broad spectrum of energy studies ranging from a quick walk-through of a facility to identify major problem areas to a comprehensive analysis of the implications of alternative energy efficiency measures sufficient to satisfy the financial criteria of sophisticated investors. Numerous audit procedures have been developed for non-residential (tertiary) buildings .Audit is required to identify the most efficient and cost-effective Energy Conservation Opportunities (ECOs) or Measures (ECMs). Energy conservation opportunities (or measures) can consist in more efficient use or of partial or global replacement of the existing installation.
All Energy Audits conducted for facility must result in a final Energy Audit Report which broadly consists of scope, methodology, procedure used, recommendations and finally data collected.

VII Practical Setup

Energy audit requir following instruments

Digital tachometer, Lux meter, Power analyzer, IR thermometer, Dry and Wet bulb thermometer

VIII Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Digital tachometer	0.5 to 100,000 RPM	1 No.
2	Lux meter	1 to 50000 Lux	1 No.
3	Power analyzer	200 kS/s on each channel simultaneously	1 No.
4	IR thermometer	-30°C to 500°C (-22°F to 932°F)	1 No.
5	Dry and Wet bulb thermometer	20-50 ^{o}C	1 No.

IX Precautions to be Followed

- Handle single and three phase connections safely.
- Do not touch moving parts

X Procedure

1. Intensity of light

1. Side the “Power ON/OFF” to the “ON” position.

   ‘1’-ON, ‘0’- OFF
2. Select the proper range 2,000 Lux, 20,000 Lux or 50,000 Lux on the “Range Switch”.

3. Hold the “light sensor” by hand & face the sensor to light source. Then Display will show value directly.
4. Zero adjustment:-

   Due to drift environment temperature value, Battery power change or meter used for a long time or other reasons. The display value may not exist zero value (few digits) after blanketing the “light sensor”. Generally speaking those not zero value will not affect the precision measurement the following zero adjustment procedures should be executed.

   Select the “range switch” to the “2,000 Lux” range. Blank the “light sensor”. Use a convenient screw driver to adjust “zero adjusts” until the display reaches the “zero value”.

Measuring Consideration:

1. The “Range B” is designed to measure 2,000 to 29,990 Lux only.
2. The “Range C” is designed to measure 20,000 to 50,000 Lux only.
3. If the measured value < 2,000 Lux it should select to “Range A”.
4. If the measured value within 2,000 to 19,990 Lux, it should select to “Range B”.
5. If the measured value is less or equal to 20,000 Lux, it should select the “Range C”.

2. Measurement of speed

1. Apply a reflective mark to the object to the object being measured slide the function switch to RPM postion.
2. Depress the measure button and align the visible light beam with the applied target. Verify that the moniter indication lights when the target aligns with the beam.
3. For high speed measurement apply only one reflector on rotating object.
4. For low speed measurement apply 3-4 reflectorsand divide reading by number of reflectors.

3. Measurement of electrical parameters

1. Connect to load to the electricity test rig fitted with various meters.
2. Note down current, Voltage, Power factor and Wattmeter readings.
3. Note down rated or nameplate ratings of power.
4. Calculate power consumed by various equipments using formulas given above.
5. Compare both readings taken by watt meter, nameplate ratings and calculate values.

XI Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					
4.					
5.					

XII Actual Procedure Followed

1. ……
2. ……
3. ……
4. ……
5. ……
6. ……
7. ……
8. ……
9. ……
10. ……
11. ……
12. ……
13. ……
14. ……

XIII Actual Precautions Followed

1. ……
2. ……
3. ……
4. ……
5. ……
6. ……
7. ……

XIV Observations and Calculations

Intensity of Light

Sr. no	Place	Lux Level	Observation
1			
2			
3			
4			
5			
6			

Speed Measurement

Sr.no	Equipment	Speed (RPM)
1.		
2.		
3.		
4.		

5		
6		

Electrical parameters

Sr No	Load	Voltage (V)	Current (I)	Power Factor	Calculated Power (W)	Rated Power (W)
1						
2						
3						
4						
5						

XV Results

Included in audit report

XVI Interpretation of Results
(Giving meaning to the results)

Included in audit report

XVII Conclusions
(Actions to be taken based on the interpretations.)Included in audit report
XVIII Practical Related Questions
Note: Below given are few sample questions for reference. Teachers must design more such questionsso as to ensure the achievement of identified CO.

1. List the types of energy audit.
2. State the structure of Energy Management cell in industry

Note : Students should prepare energy audit report as per structure given below. Use data collected above.

Structure of Report(Students can design their own report in following lines according to available equipments, load in department)

Abstract

Acknowledgments

Chapter 1 Executive Summary

1.1 Introduction

1.2 Background

1.3 Project Statement

1.4 Methods

1.5 Recommendations

Chapter 2 Background

2.1 About department

2.2 Laboratories and equipments used

2.3 Instruments for audit

2.4 Lighting

2.5 Motors

2.6 Computers

2.7 Cooling tower

2.8 Energy Audit

2.14 Summary

Chapter 3 Methodology

3.1 Introduction

3.2 Step One: Collection of data

Chapter-4 Result and analysis

3.1 Lighting in department

3.2 Cooling tower

3.3Electrical load

3.4 Computers

Chapter-5 Conclusion and suggestions

Appendix

(Group of student should prepare this report on separate pages by tying and submit to the department)

XIX References / Suggestions for Further Reading

1. http://students.iitk.ac.in/ge3/Energy%20audit.pdf
2. http://ahec.org.in/internship/ENERGY_AUDIT_report_of_IITR_jan2010.pdf
3. https://en.wikipedia.org/wiki/Energy_audit
4. http://ahec.org.in/internship/ENERGY_AUDIT_report_of_IITR_jan2010.pdf
5. http://smallbusiness.chron.com/write-energy-audit-report-12313.html
6. http://www.pcra.org/pages/display/65-Energy-Audit-Instrument/22
7.

XX Assessment Scheme

Performance Indicators		Weightage	Marks obtained
Process Related (60%)			
1	Handling of coal sample	20%	
2	Recording change in weight	20%	
3	Safety measures followed	20%	
Product Related (40%)			
4	Interpretation of result & Conclusion	20%	
5	Practical related questions	20%	
	Total	100 %	

Names of Student Team Members

1. …….
2. ……
3. ……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No.9

Estimate Simple and Compound interest on given project cost

I Significance

Interest rates are one of the most important aspects of the economic system. They influence the cost of borrowing, the return on savings, and are an important component of the total return of many investments. Moreover, certain interest rates provide insight into future economic and financial market activity.

II Relevant Program Outcomes (POs)

*PO 1.**Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic engineering to solve the Chemical engineering problems.*
*PO 3.**Experiments and practice:** Plan to perform experiments and practices to use the results to solve technical problems related to Chemical engineering.*

III Competency and Skills

This practical is expected to develop the following skills for the industry identified competency ***'Use the principles of energy management and economics in chemical process industry'***

1. Determination of interest rate
2. Selection of suitable finance borrowing

IV Relevant Course Outcome(s)

- Calculate tax, cost and insurance liability for Chemical Process Industry

V Practical Outcome

Estimate Simple and Compound interest on given project cost

VI Minimum Theoretical Background

Interest is the charge for the privilege of borrowing money, typically expressed as annual percentage rate (APR). Interest can also refer to the amount of ownership a stockholder has in a company, usually expressed as a percentage.Two main types of interest can be applied to loans: simple and compound. Simple interest is a set rate on the principle originally lent to the borrower that the borrower has to pay for the ability to use the money. Compound interest is interest on both the principle and the compounding interest paid on that loan. The latter of the two types of interest is the most common.

Simple interest is calculated on the principal, or original, amount of a loan. Compound interest is calculated on the principal amount and also on the accumulated interest of previous periods, and can thus be regarded as "interest on interest." There can be a big difference in the amount of interest payable on a loan if interest is calculated on a compound rather than simple basis. On the positive side, the magic of compounding can work to your advantage when it comes to your investments and can be a potent factor in wealth creation. While simple interest and compound interest are basic financial concepts, becoming thoroughly familiar with them may help you make more informed decisions when taking out a loan or investing.

SIMPLE INTEREST

The formula for calculating simple interest is:

Simple Interest = Principal x Interest Rate x Term of the loan

= P x i x n

Thus, if simple interest is charged at 5% on a Rs. 10,000 loan that is taken out for a three-year period, the total amount of interest payable by the borrower is calculated as Rs.10,000 x 0.05 x 3 = Rs. 1,500.
Interest on this loan is payable at Rs. 500 annually, or Rs. 1,500 over the three-year loan term.

COMPOUND INTEREST
The formula for calculating compound interest in a year is:
Compound Interest = Total amount of Principal and Interest in future (or Future Value) less the Principal amount at present called Present Value (PV). PV is the current worth of a future sum of money or stream of cash flows given a specified rate of return.

$= [P (1 + i)^n] – P$

$= P [(1 + i)^n – 1]$

where P = Principal, i = annual interest rate in percentage terms, and n = number of compounding periods for a year.
Continuing with the above example, what would be the amount of interest if it is charged on a compound basis? In this case, it would be: Rs. 10,000 $[(1 + 0.05)^3 – 1]$ = Rs. 10,000 [1.157625 – 1] = Rs. 1,576.25.
While the total interest payable over the three-year period of this loan is Rs. 1,576.25, unlike simple interest, the interest amount is not the same for all three years because compound interest also takes into consideration accumulated interest of previous periods.

VII Data

VIII Calculations

_____

_____

_____

_____

_____

Names of Student Team Members

1. …….
2. ……
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Marks Obtained			Dated signature of Teacher
Theory Related(15)	**Application Related(10)**	**Total (25)**	

Practical No.10

Prepare Cost sheet for given industrial data

I Significance

A cost sheet is a report on which is accumulated all of the costs associated with a product or production job. A cost sheet is used to compile the margin earned on a product or job, and can form the basis for the setting of prices on similar products in the future. It can also be used as the basis for a variety of cost control measures. Despite the name, a cost sheet can be compiled and viewed on a computer screen, as well as being manually developed on paper.

II Relevant Program Outcomes (POs)

*PO 1.**Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic engineering to solve the Chemical engineering problems.*
*PO 3.**Experiments and practice:** Plan to perform experiments and practices to use the results to solve technical problems related to Chemical engineering.*

III Competency and Skills

This practical is expected to develop the following skills for the industry identified competency ***'Use the principles of energy management and economics in chemical process industry'***

1. Preparation of cost sheet
2. Identify cost control measures.

IV Relevant Course Outcome(s)

- Calculate tax, cost and insurance liability for Chemical Process Industry

V Practical Outcome

Prepare Cost sheet for given industrial data

VI Minimum Theoretical Background

Cost sheet is a document that provides for the assembly of an estimated detailed cost in respect of cost centers and cost units. It analyzes and classifies in a tabular form the expenses on different items for a particular period. Additional columns may also be provided to show the cost of a particular unit pertaining to each item of expenditure and the total per unit cost. Cost sheet may be prepared on the basis of actual data (historical cost sheet) or on the basis of estimated data (estimated cost sheet), depending on the technique employed and the purpose to be achieved.

The main advantages of a cost sheet are:

(i) It indicates the break-up of the total cost by elements, i.e. material, labor, overheads, etc.

(ii) It discloses the total cost and cost per unit of the units produced.

(iii) It facilitates comparison.

(iv) It helps the management in fixing selling prices.

VII Data

VIII Cost sheet

Names of Student Team Members

1. …….
2. ……
3. ……
4. …….

Marks Obtained			Dated signature of Teacher
Theory Related(15)	**Application Related(10)**	**Total (25)**	

Practical No.11

Study balance sheet for given company account

I Significance

In financial accounting, a balance sheet or statement of financial position is a summary of the financial balances of an individual or organization, whether it be a sole proprietorship, a business partnership, a corporation, private limited company or other organization such as Government or not-for-profit entity. Assets, liabilities and ownership equity are listed as of a specific date, such as the end of its financial year. A balance sheet is often described as a "snapshot of a company's financial condition". Of the four basic financial statements, the balance sheet is the only statement which applies to a single point in time of a business' calendar year.

II Relevant Program Outcomes (POs)

PO 1. ***Basic knowledge:*** *Apply knowledge of basic mathematics, sciences and basic engineering to solve the Chemical engineering problems.*
PO 3. ***Experiments and practice:*** *Plan to perform experiments and practices to use the results to solve technical problems related to Chemical engineering.*

III Competency and Skills

This practical is expected to develop the following skills for the industry identified competency ***'Use the principles of energy management and economics in chemical process industry'***

1. Study balance sheet of company
2. Identify interest, taxes and net profit of company.

IV Relevant Course Outcome(s)

Find depreciation of the chemical process industry.

V Practical Outcome

Study balance sheet for given company account.

VI Minimum Theoretical Background

A standard company balance sheet has two sides: assets, on the left and financing, which itself have two parts, liabilities and ownership equity, on the right. The main categories of assets are usually listed first, and typically in order of liquidity.] Assets are followed by the liabilities. The difference between the assets and the liabilities is known as equity or the net assets or the net worth or capital of the company and according to the accounting equation, net worth must equal assets minus liabilities.

There are two formats of presenting assets, liabilities and owners' equity in the balance sheet – account format and report format. In account format, the balance sheet is divided into left and right sides like a T account. The assets are listed on the left hand side whereas both liabilities and owners' equity are listed on the right hand side of the balance sheet. If all the elements of the balance sheet are correctly listed, the total of asset side (i.e., left side) must be equal to the total of liabilities and owners' equity side (i.e., right side).

In report format, the balance sheet elements are presented vertically i.e., assets section is presented at the top and liabilities and owners equity sections are presented below the assets section.

VII Company background

VIII Balance sheet

Names of Student Team Members

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2. ……
3. ……
4. …….

Marks Obtained			Dated signature of Teacher
Theory Related(15)	**Application Related(10)**	**Total (25)**	

Practical No.12

Measure profitability of company using break even analysis

I Significance

Financial information is the key to understanding the business's profitability, and knowing the numbers is essential for learning about your company and planning for the future. Conducting a breakeven analysis is a critical step for every business to determine what sales volume is necessary to cover costs..

II Relevant Program Outcomes (POs)

*PO 1.**Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic engineering to solve the Chemical engineering problems.*
*PO 3.**Experiments and practice:** Plan to perform experiments and practices to use the results to solve technical problems related to Chemical engineering.*

III Competency and Skills

This practical is expected to develop the following skills for the industry identified competency ***'Use the principles of energy management and economics in chemical process industry'***

1. Find break even point for the business

IV Relevant Course Outcome(s)

- Calculate tax, cost and insurance liability for Chemical Process Industry

V Practical Outcome

Measure profitability of company using break even analysis

VI Minimum Theoretical Background

Break-even analysis is useful in the determination of the level of production or in a targeted desired sales mix. The analysis is for management's use only as the metric and calculations are often not required to be disclosed to external sources such as investors, regulators or financial institutions. Break-even analysis looks at the level of fixed costs relative to the profit earned by each additional unit produced and sold. In general, a company with lower fixed costs will have a lower break-even point of sale. For example, a company with 0 of fixed costs will automatically have broken even upon the sale of the first product assuming variable costs do not exceed sales revenue. However, the accumulation of variable costs will limit the leverage of the company as these expenses are incurred for each item sold.

VII Company background use for study

VIII Formula used for break-even analysis

IX Case Study

Names of Student Team Members

1. …….
2. ……
3. ……
4. …….

Marks Obtained			Dated signature of Teacher
Theory Related(15)	**Application Related(10)**	**Total (25)**	