Chemical Engineering and Process Safety Fundamentals

Difference between distillation and fractionation

- Distillation: Process to separate components based on boiling points.
- Fractionation: Separation of a mixture into multiple fractions, usually in a column, based on different boiling points.

Function of waste heat boiler and steam drum

- Waste Heat Boiler: Recovers heat from exhaust gases of a system to generate steam.
- Steam Drum: Collects and separates steam from water in the boiler.

Immediate action when compressor trips

- Start the standby compressor as soon as possible to maintain system operation.

Difference between endothermic and exothermic reactions

- Endothermic: Absorbs heat to proceed.
- Exothermic: Releases heat during the reaction.

Describe density

- Mass per unit volume of a substance.

Describe dew point

- Temperature at which gas starts to condense into liquid.

Why purge flare system with N2

- To make the system oxygen-free and prevent combustion hazards.

Appearance of superheated and saturated steam leak

- Superheated steam: Appears like smoke.
- Saturated steam: Visible as showers or mist.

Level control valve action when installed upstream if level goes down

- The valve opens to maintain the liquid level in the vessel.

Purpose of mechanical lockout system

- Protects mechanical equipment from accidental operation or damage.

Difference between thermal and catalytic cracking

- Thermal cracking: Uses heat to break chemical bonds.
- Catalytic cracking: Uses a catalyst to accelerate breaking of chemical bonds at lower temperatures.

Function of catalyst

- Increases the rate of a chemical reaction without being consumed.

13. **Why chemical dosing in the BFW (Boiler Feed Water)?**

- To make the boiler feed water soft and prevent scaling.

14. **Describe the feed composition and effect if it changes**

- Any change in feed composition can disturb the unit process and affect performance.

15. **What is de-aeration in a critical boiler?**

- Removal of oxygen from boiler water to prevent corrosion.

16. **Experience when pump loses flow**

- Low suction pressure and cavitation occur.

17. **Steps when N2 concentration increases while a person is in a confined vessel**

- Stop the job and evacuate the area immediately.

18. **How to train personnel as supervisor or subcontractor**

- Share knowledge according to area requirements.

19. **Your concentration during training for a person**

- Deliver precise knowledge as required for the role.

20. **Reasons for pump losing suction**

- Low suction, insufficient liquid level, cavitation, or air lock.

21. **What is a ratio controller?**

- Controls the ratio of two or more products or process streams.

22. **Negative consequences of interpreting analysis wrongly**

- Leads to incorrect decisions, process disturbances, safety hazards, and financial loss.

23. **Why vacuum distillation is preferred over normal distillation**

- Requires less energy for distillation and allows separation at lower temperatures.

24. **Function of a preheater**

- Prepares the feed for distillation by raising its temperature.

25. **VGO (Vacuum Gas Oil) temperature**

- High.

26. **Action when flow controllers fail-safe at panel**

- Call the field operator to adjust the system via bypass for safe shutdown.

27. **Difference between paraffin and olefin compounds**

- Paraffin: Saturated hydrocarbons with single bonds (C_nH_{2n+2}).
- Olefin: Unsaturated hydrocarbons with at least one double bond (C_nH_{2n}).

28. **How will you prepare a vessel for vessel entry?**

- Isolate the vessel, purge with inert gas, ventilate, check oxygen and toxic gas levels, and obtain confined space permit.

29. **If a person is lying on the ground as a field operator, first action**

- Identify the reason, assist the person while keeping yourself safe.

30. **Remedial actions if fire occurs due to gas or liquid leakage**

- Inform supervisor, isolate the source, and start fire extinguishing.

31. **Different types of fire extinguishing equipment**

- CO_2 extinguishers, dry chemical powder, foam, water, fire hoses, fire blankets.

32. **If leakage occurs on the unit, first action**

- Inform supervisor, isolate the system, and stay safe.

33. **Implementation of SCBA (Self-Contained Breathing Apparatus)**

- Use in areas where toxic gases are released for emergency handling only.

34. **If lifeline fails during work at height, how to communicate to ground personnel**

- Pull the communication rope.

35. **Height for confined space entry permit and wooden planks requirement**

- Confined space permit required for work in any enclosed space; wooden planks used to prevent mud/falling material depending on area risk assessment.

36. **Difference between cold work permit and hot work permit**

- Cold work: Work without fire, heat, or spark risk.
- Hot work: Involves welding, cutting, grinding, or activities producing heat or sparks.

37. **From where is a confined space permit issued?**

- Safety department.

38. **Communication devices used in industry**

- VHF radios, PA systems, field telephones.

39. **Actions in case of fire alarm or toxic gas alarm**

- Stop work and evacuate the area.

40. **Basic first aid procedure**

- Provide care as per patient's condition and monitor vital signs.

41. **Firefighting equipment types, materials, and types of fire**

- Equipment: Extinguishers, hoses, hydrants.
- Materials: Water, CO_2, foam, dry chemical.
- Fire types: Class A (solid), B (liquid), C (electrical), D (metal).

42. **Sensitive tray temperature**

- Top tray in a distillation column where temperature is closely monitored to control product quality.

43. **What is flooding and weeping in distillation?**

- Flooding: Excess liquid accumulates on trays, reducing separation efficiency.
- Weeping: Liquid leaks through tray perforations due to low vapor flow.

44. **What is polymerization reaction?**

- Chemical reaction in which monomers combine to form a polymer.

45. **Scaffolding in plant, need authorization?**

- Yes, approval required from safety engineer.

46. **Centrifugal compressor, explain surge**

- Surge occurs due to negative pressure on suction side causing flow reversal, vibration, and noise.

47. **Why measure pH in reboiler blowdown?**

- To avoid scaling and corrosion in the boiler system.

48. **Meaning of saturated steam, its use, and importance**

- Steam at boiling temperature for a given pressure; used in heating, turbines, and process operations; important for energy transfer without changing phase.

49. **Complete and balance equations**

- $S + O_2 \rightarrow SO_2$
- $2C_2H_6 + 7O_2 \rightarrow 4CO_2 + 6H_2O$
- $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$

Meaning, use, and importance of saturated steam

- Steam at boiling temperature corresponding to system pressure.
- Used in heating, turbines, and process operations.
- Important for energy transfer without changing phase.

Complete and balanced equations

- $S + O_2 \rightarrow SO_2$
- $2C_2H_6 + 7O_2 \rightarrow 4CO_2 + 6H_2O$
- $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$

- $H_2 + Cl_2 \rightarrow 2HCl$
- $C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$
- $2Na + Cl_2 \rightarrow 2NaCl$
- $C_2H_4 + H_2 \rightarrow C_2H_6$ (hydrogenation)

Boiling point

- Temperature at which a liquid's vapor pressure equals the surrounding pressure.

Partial pressure

- Pressure contributed by an individual gas in a mixture of gases.

Vapor pressure

- Pressure exerted by a vapor in equilibrium with its liquid at a given temperature.

Latent heat

- Heat absorbed or released during a phase change without changing temperature.

Sensible heat

- Heat absorbed or released causing a temperature change without phase change.

Viscosity of a polymer measurement

- Measured using viscometers or rheometers to determine resistance to flow.

Volumetric pump

- Positive displacement pump that delivers a fixed volume per cycle.

Advantages of volumetric pump vs centrifugal pump

- Volumetric pump: Precise flow, handles high viscosity, constant delivery.
- Centrifugal pump: Simpler, higher capacity, good for low-viscosity fluids.

Steam turbine principle

- Converts thermal energy of steam into mechanical energy via rotating blades.

Governor valve working principle

- Controls turbine speed by adjusting steam flow to maintain set speed.

How to detect nitrogen leak

- Using gas detectors, oxygen depletion alarms, or observing sudden pressure drops.

How to detect H2S leak and immediate action

- Detect with H_2S gas detectors or smell (rotten egg).
- Evacuate area, alert supervisor, use PPE, and isolate source if safe.

Why nitrogen is used for purging process

- Inert, non-reactive, prevents combustion.
- Other gases may react or be unsafe.

Effect if compressor suction pressure increases

- May overload compressor, reduce efficiency, or trigger safety trips.

Effect if compressor suction temperature increases

- Reduces gas density, efficiency drops, may cause overheating.

Difference between paraffin, olefin, and acetylene with examples

- Paraffin: Saturated hydrocarbons (e.g., C2H6 ethane).
- Olefin: Unsaturated hydrocarbons with double bonds (e.g., C2H4 ethylene).
- Acetylene: Unsaturated hydrocarbons with triple bonds (e.g., C2H2).

Meaning of safety-related terms

- SHE: Safety, Health, Environment.
- HAZOP: Hazard and Operability study.
- HSE: Health, Safety, and Environment.

Hydrogenation reaction and its use in olefin industry

- Addition of hydrogen to unsaturated compounds (olefins) using a catalyst.
- Used to convert olefins to paraffins or reduce unsaturation.

Solids handling in polyolefin plant

- Managing polymer powders or granules; involves feeding, conveying, storage, and minimizing dust hazards.

Types of heat exchangers and functions

- Shell and tube: Common, transfers heat between two fluids.
- Plate: Compact, high heat transfer efficiency.
- Air-cooled: Uses air as cooling medium.
- Function: Heat recovery, cooling, heating, condensation.

Meaning of MSDS (Material Safety Data Sheet)

- Document providing information on chemical properties, hazards, handling, storage, and emergency measures.

- 44. if O2 is 21% in a container under atm.pressure then what will O2 concentration if same container is more pressurized with 6 Kg/Cm2 nitrogen 3%,3.5%,6% or 21%? Ans: I don't know exactly what is right answer.
- 45. some chemical equations to be wtitten right hand side on answer sheet.
- · CH4+2O2---------- CO2+2H2O
- · S+O2----------SO2
- · 7O2+2C2H6----------4CO2+6H2O
- · 2NaOH+CO2----------Na2CO3+H2O
- · 2NaOH+H2S----------Na2S+2H2O

Qapco Test/Interview Pattern :

First Technical Test:
(Operation, Safety, QA/QC, Engineering) for almost 40 Questions.
These are Basic definitions, some Technical terms for example

What is Exothermic/Endothermic Reactions, Define what is Catalyst ..examples, What is distillation, reflux, Boiling point, adiabatic process.....,
Define Pumps (types of pumps specially Centrifugal pumps....), Compressors (specially Centrifugal both Turbine and Motor driven with all Detail from Mechanical, Process, Operation, Startup Shut Down as well)
Important to prepare Chemical Equation Balance egg;

Unbalanced Equation: - $C_3H_8 + O_2 \rightarrow H_2O + CO_2$

Balanced Equation: - $C_3H_8 + 5O_2 \rightarrow 4H_2O + 3CO_2$

NOTE: If Technical Test pass then, Can be enter for English and IQ Test.
Second, there will Be English and IQ Test Same day.
Regarding that, it is very easy Test just go through Basic English...40 Question,
In addition, go through basic IQ test Book ...40 Question.

NOTE; If all three test Pass Successfully then their will Interview on Same day.

Interview Detail

Please prepare all your industrial Experience as mention in your Resume.
Some Hints here below

- Name of company, position title and description, dates of employment -
- What were your expectations for the job and to what extent were they met? -
- What were your responsibilities? -
- What major challenges and problems did you face? How did you handle them? -
- What have you learned from your mistakes? -
- What did you like or dislike about your previous job? -
- Which was most / least rewarding? -
- What do you expect from a supervisor? -
- What problems have you encountered at work? -
- Why are you leaving your job? -
- Why did you resign? -

Job Interview Questions about You

- What is your greatest weakness? -
- What is your greatest strength? -
- How would you describe yourself? -
- How do you handle stress and pressure? -
- What motivates you? -
- What are your salary expectations? -
- What do you find are the most difficult decisions to make? -
- Tell me about yourself. -
- What has been the greatest disappointment in your life? -
- Give some examples of teamwork. -
- More job interview questions about your abilities. -
- More job interview questions about you. -
-
- Job Interview Questions About the New Job and the Company

Why do you want this job? -

- What applicable attributes / experience do you have? -
- Are you overqualified for this job? -
- What can you do for this company? -
- Why should we hire you? -
- Why are you the best person for the job? -
- What do you know about this company? -
- Why do you want to work here? -
- What challenges are you looking for in a position? -
- Are you willing to travel? -
- How long do you expect to remain employed with this company? -

Interview Questions: The Future

- What are you looking for in your next job? What is important to you? -
- What are your goals for the next five years / ten years? -
- How do you plan to achieve those goals? -
- What are your salary requirements -
- Questions about your career goals

TEST PAPER FOR (PROCESS OPERATOR) YEAR - 2009

IQ

1- Two ducks and two dogs have a total of ----------legs
   a. 8
   b. 10
   c. 12
   d. 14
2- Tick the words that least likely belong in the group.
   a. Father
   b. Mother
   c. Uncle
   d. Nephew
3- 27 minutes before seven o clock is ----------minutes past six o clocks.
   a. 27
   b. 23
   c. 33
   d. 3
4- Tick the word that likely belongs in the group.
   a. Butter
   b. Cheese
   c. Milk
   d. Eggs
5- Which one are these is at-least like three:
   a. Horse
   b. Kangaroo
   c. Goat
   d. Deer
6- Tick the word that least likely belongs in the group:
   a. Soccer
   b. Boxing
   c. Basket ball
   d. Bowling
7- What no should replace the blank mark? 1, 3, 4, 7, 11, 18----------?
   a. 39
   b. 29
   c. 19
   d. 20
8- Tick the word that least likely belongs in the group:
   a. Height
   b. Width
   c. Tall
   d. Short
9- A car traveling at a speed of 10 km/hr. how much distance it will travel in 300 minutes
   A. 40 km
   B. 30 km
   C. 50 km
   d. 60lm
10- A, C, F, J, O? What letter comes next?
   a. R
   b. T
   c. U
   d. Z
11- Tick the word that least replaces the question mark? 1,4,9,16,25?
   a. 30
   b. 26
   c. 36
   d. 40
12- The number X in the series 1, 2, 3, X, 12, 24, 48------is
   a. 4
   b. 9
   c. 6
   d. 8
13- What is the next logical number in the following sequence 2, 6, 14, 30------?
   a. 60

b. 62
c. 64
d. 66

14- Which number should come next? 144, 121, 100, 81, 64?
a. 25
b. 36
c. 19
d. 49

15- What no is one-half of one quarter of one tenth of 800?
a. 2
b. 10
c. 40
d. 80

16- The sum of all the odd numbers from zero to 10 is = ----------
a. 20
b. 30
c. 26
d. 25

17- Which number should come next 64, 16, 4, 1, and ¼?
a. 1/8
b. 1/64
c. 1/16
d. ½

18- What is 5/9 divided by 15/18.
a. 3/2
b. ¾
c. 2/3
d. ¼

PHYSICS

1- At constant temperature, if the volume of the given mass of gas is double then the density of the gas becomes.
a. Double
b. ¼ of the original
c. ½ of the original of value
D. Remains constant

2- Light year is the unit of
a. Light
b. Time
c. Velocity
d. Distance

3- The process in which volume of the system remains constant is called
a. Isothermal process
b. Isobaric process
c. Isochoric process
d. Adiabatic process

4- ½ p * v^2 is called
a. Kinetic energy
b. Potential energy
c. Kinetic energy per unit volume
d. None

5- The amount of heat required to raise the temperature of 01 kg of substance through 01 k is called
a. Heat capacity
b. Specific heat
c. Heat of fusion
d. Heat of vaporization

6- The pressure will be low where the speed of the liquid is
a. Zero
B. High
c. Low
d. Constant

7- One calorie is equal to
a. 4.18 erg
B. 4.18 joule
C. 41.8 joule
d. 4.35 j

8- In going from a denser to rarer medium a ray of light is
a. Un deviated
b. Bent away from the normal
c. Bent towards the normal
d. Diffracted

9- Mercury is used as thermometric substance because
a. It is opaque
b. It does no stick glass
c. Its specific heat is low

d. All of above

10- An instrument which is used to measure current, voltage and resistance is

a. Galvanometer
b. Potentiometer
c. Volt meter
d. AVO meter

CHEMISTRY

1- Relative atomic mass is the mass of an atom of an element compared to the mass of an atom----------

a. Hydrogen taken as 1.
b. Carbon taken as 12.
c. Sodium taken as 23
d. Chlorine taken as 35.

2- A limiting reactant is the one which

a. Is taken in lesser quantity as compared to other reactants.
b. Is taken in lesser quantity in volume as compared to others
c. Carries the maximum amount of the product which is required
d. Gives the maximum amount of the product under consideration

3- 01 molar volume of gas at S.T.P (standard conditions of temperature & pressure) is equal to

a. 1 g of gas
b. $6x10^{23}$ g of gas
c. 22.4 dm^3 of gas
d. 1 gram molecular mass of gas

4- Mathematically boyle's is shown as

a. PT=k
b. VT=k
c. PT=k
d. PV=k

5- The gases exerts pressure on the walls of container due to

a. Collision on the walls of the container
b. Collisions of molecules among themselves
c. Change of direction of molecules
d. Reason that same of the collision are inelastic.

6- To cook food at a height mountain is difficult as compared to sea level.

a. The temperature at the top of the mountains law
b. The density of the water decrease at the mountain
c. The boiling point of the water decrease of mountain
d. The hydrogen bonding in water changes with the change of height

7- In the ground state of an atom the electron is present

a. In its nucleus
b. In the second shell
c. Nearest to the nucleus
d. Farthest from the nucleus

8- The molecular weight of urea (NH2 CO NH2) is

a. 66
b. 46
c. 60
d. 54

9- In endothermic reaction, the heat constant of the

a. Product is more than that of reactants
b. Reactants is more than that of the products
c. Both a & b
d. Reactants & products are equal

10- A catalyst increases the rate of reaction by

a. Reacting with reactants
b. Increasing the activation energy
c. Reacting with products
d. Decreasing the activation energy

11- Hydrated copper sulphate is of ---------color

a. White
b. Blue
c. Pink
d. Colorless

12- ---------- is the driving force by which heat transferred from one body to other

a. Pressure
b. Concentration
c. Temperature
d. None of the above

Process operator

1- The rate absolute discharge pressure to absolute suction pressure in a compressor is called.

a. Compression ratio

b. Suction ratio
c. Both A & B
d. None

2- If gauge pressure is 10 psi the absolute pressure will be
a. 10 psia
b. 24.7 psia
c. 20 psia
d. 14.7 psia

3- Most abundant element in meta crust is
a. Silicon
b. Oxygen
c. Aluminum
d. Iron

4- The difference between suction pressure and discharge pressure is the ---------added to liquid by the pump.
a. Pressure
b. Energy
c. Both a & b
d. Heat

5- At 01 psi gas acting on a 3 inch^2 surface exerts a total force of -------pounds.
a. 1/3
b. 3
c. 5
d. None

6- The amount of liquid moving through the pipe may be increased by installing a ---------- in the line.
a. Compressor
b. Pump
c. Orifice
d. Fan

13- Distillation is the separation technique, the working principle of the technique is.

ENGLISH

1- Fill in the blanks with appropriate words

○ She--------her bag to school everyday.

a. Will take
b. Would take
c. Is taking
d. Takes

2- Yesterday I saw a garden where----------
a. I wanted to sit amongst the flower
b. I want to sit amongst the flower
c. I will be waiting to sit amongst the flower
d. I have been wanting to sit amongst the flower
e. I will want t sit amongst the flower

Each question below consist of related pair of words or phrases , followed by four or five lettered pair of words or phrases select the lettered pair that best expresses a relationship similar to that expressed in the original pair

○ Circle : square

a. Ball : bat
b. Oval : rectangle
c. Angular : straight
d. Volume : area

○ Cat : Mouse

a. Bird : worm
b. Dog : tall
c. Trap : cheese
d. Hide : hide seek

Each question below consists of words, followed by four or five lettered words or a set of words. Select any one that is opposite in meaning to main words

3- Concise
a. Pacific
b. Mundane
c. Ignorant
d. Wrong

4- Awkward
a. Relevant

b. Graceful
c. Chimney
d. Pious

5- He is beyond all doubt that best students of his class
a. Certainly
b. Perhaps
c. Possibly
d. Probably

6- Let us make a move
a. Let us go
b. Let us reach there
c. Let us leave this place
d. Let us leave

Correct the sentence by replacing the under lined word with the options given

7- I passed the intermediate examination this year
a. Have passed
b. Passing

MATHEMETICS

1- If the diameter of circle is 4 cm then its circumference is
a. 2 ^
b. ^
c. 4^
d. 8^

2- The average of 4, 5, 6, and x is 15. Then x is?
a. 7
b. 15
c. 80
d. 45

3- 9 is what %age of 81 (to the nearest decimal)?
a. 10
b. 11
c. 12
d. 13

4- If $a + b = 8$ and $a - b = 6$ then $a^2 + b^2 =$
a. 36
b. 100
c. 25
d. 50

5- Cos (A+B) =
a. CosA cosB + sinA sin B
b. sinA cosB – cosA sinB
c. sinA cosB + cosA sin B
d. cosA cosB – sinA sinB

1

1. Fill in the blanks

i. 2, 4, 7, 11, 16, -----, ------.

2. In the following give the number of pair which is different from the other.

i. Mathemetics and Algebra
ii. Petals and flower
iii. Pages and book
iv. Water and wind

3. In the following which choice gives answer

i. 5+3 = 28
ii. 9+1 = 810
iii. 2+1 = 13
iv. 5=4 19
v.Then 7+2 =---------

4. A man was cycling south wards at a speed of 10 miles / hr when he met another man who was cycling west wards at the speed of 11 miles / hr. How far apart they would be after a period of 01 hour.

i. 12 miles
ii. 21 miles
iii. 22 miles
iv. 16 miles

5. Which choices mention the two letters which will occur next in the following series in the correct manner?

o F,E,D,I,H,G,L,J,K

i. ON
ii. NM
iii. MN
iv. NO

6. Supply the missing figures.
i. if 3 + 5 = 5
ii. 4+24 = 6
iii. 5+40 = 8
2
iv. Then 2 + 8 = ---
1. 12
2. 6
3. 4
7. Complete the following series.
o ------, ------ 6, 10,9,15,12,20,15.
8. Which choice supplies the answer in the following?
i. 5 + 10 = 25
ii. 7 + 8 = 28
iii. 9 + 6 = 27
iv. 12 + 10 = 60
o Then 26 + 4 = ----------
i. 20
ii. 52
iii. 24
iv. 25
9. PKCDQRTJKRS stands for RESULT, what ABJKMNSTBC stands for----------.
10. B's son is cousin of A's son .if A has no sister what is B to A----------
11. Give the numbers of the pair which is dissimilar from the other in the following
i. River and Ship
ii. Bulb and light
iii. Watch and time
iv. Thermometer and temperature
12. Which choice supplies the answer in the following?
i. If BME = DOG
ii. MLC =
1. one
2. eye
3. two
13. three
14. Continue the following series.
3
i. 3/27, 5/24, 7/21, 9/18, 11/15, ------.
15. 7 meters is to 28 meters as 2 yards is to ----------.
16. If 7th of month falls two after Wednesday, what day of the week will precede the 18th of the month?
i. Monday
ii. Tuesday
iii. Wednesday
17. A man can build a wall 8 ft high in 8 hrs. How many feet high wall can one built in one hour.
i. 4 ft
ii. ¼ ft
iii. ½ ft
18. If a boy stands upside down with his face towards north, where will his right hand point? ----------.
19. Re- arrange the following group of jumbled words to form sensible sentence and state the choice which mentions the letter of the correct sentence.
o All cats are cats but all animals are not animals.
i. Animals
ii. Cats
iii. All
20. I purchased a thing at Rs. 80. What will it give if I sell it at a profit of 25 %.
21. Fill in the blanks in the followings
i. Wxyz, xyzw, yzwx, zwxy, ----------.
22. Trace out the stranger from the following
i. Square
ii. Circle
iii. Rectangle
iv. Quadrilateral
23. Complete the series.
i. 3, 6, 12, 24, 48, 96, ----------.
4

GENERAL QUESTION

1. Why water wets glass while mercury does not.
2. You are standing at the top of building. How will you measure the height of building by dropping stone from it?
3. Why it is easier to roll a barrel, on road than to pull it.
4. Why does an object weight less at equator than at poles?

5. Why white roof keeps a house cooler as against black roof.
6. Why cloudy night are hotter than clear night.
7. Why does metal bench in feels in cooler in winter compared with a wooden bench and feels hotter in summer as compared with a wooden bench.
8. Why a thick glass or jug cracks when very hot water is poured into it.
9. Why we bring our hands closer to mouth while shouting to some body at distance.
10. Why grass looks black in blue lights.
11. What is meant by persistence of vision?
12. It's a pitch dark night. You are standing near tall building .a rope is hanging from a top of building to the bottom, How will measure the height of the building.
13. Name the Pakistani scientist who won the noble prize.
14. Name at least three subject in which noble prize is given.
15. Russian equivalent of American Astronaut is ----------.
16. Independence of Pakistan according to Islamic calendar in ----------.
17. Name of UN secretary general is ----------.
18. Name the most populous country of the world----------.
19. Who wrote the national anthem of Pakistan? ----------.
20. If a velocity of body increasing the acceleration is
i. Positive
ii. Negative
iii. Zero
5
21. A ball throwing competition is going among children what angle of throwing you will suggest for them so that the ball can cover the maximum distance.
22. As we go below the surface of earth the value of 'g'.
i. Increase
ii. Decrease
iii. Same
23. Work done is maximum when force is ---------- to displacement.
i. Equal
ii. Perpendicular
iii. Parallel.
24. The average kinetic energy of the molecules of the object is called its----
i. Heat
ii. Temperature
iii. Specific heat
25. Number of molecules in one kilo mole are.
i. 6.025x 1026
ii. 2.73x 1026
iii. None
26. The kinetic energy of molecules of an ideal gas at absolute zero will be
i. Very low
ii. Very high
iii. Zero
27. First law thermodynamics is restatement of the
i. Law of conservation of energy
ii. Law of conservation of momentum
iii. Law of conservation of mass
28. In an adiabatic expansion of gas
i. Heat is gained or lost
6
ii. Heat is neither gained nor lost
iii. Volume is kept constant
29. The electric field lines always start from a
i. Positive charge
ii. Negative charge
iii. Point charge
30. The phenomenon that the resistance of metal falls exactly to zero at a few degrees above absolute zero is called
i. Conductivity
ii. Super conductor
iii. Super resistivity
31. Which one following bulb has a least resistance
i. 100 watts
ii. 1000 watts
iii. 500 watts
32. On a hot day or in a hot climates white cloth are worn because they are
i. Absorber
ii. Reflector

iii. Emitter
33. Strength of an electro magnetic field can be increased
i. Increasing current supply
ii. Adding more coiled wire
iii. All
34. A bus and car is moving the same velocity if a same retarding force is applied on both of them which will first come to rest.
i. The car
ii. The bus
iii. Both
35. The number of protons or electrons present in an atom of an element is called.
i. Atomic weight
7
ii. Molecular weight
iii. Atomic number
iv. Mole
36. In a collection of 2.48 x 1026 molecules of C2H5OH, what is the number of moles of carbon atoms?----------.
37. 1 a.m.u = ----------.
38. Low temperature can be produced by the ----------of gases.
i. Compression
ii. Expansion
iii. Contraction
39. What we mean by standard temperature and pressure.
i. 0 C
ii. 0 K
iii. 25 C
iv. 700 mm
v.76 cm
vi. 10 cm
40. During respiration we inhale air: in lungs oxygen is taken from air CO_2 is given to air, why in lungs oxygen passes from fresh air to lungs.----------
41. The temperature at which volume of gas theoretically become zero is called ----------temperature
42. 22.4 liters of CO_2 is ----------than 22.4 liters of SO_4.
i. Heavier
ii. Lighter
iii. Equal
43. The viscosity of liquid decreases with the ----------temperature.
44. Mercury does not stick to glass because of high ----------.
i. Density
ii. Viscosity
iii. Surface tension
8
45. The Le- Chatelier's principle in case of exothermic reaction the formation of products is favored at ---------- temperature.
i. Lower
ii. Higher
iii. None
46. Calculate the molarity of solution containing : 3g of H_2SO_4 in 200 ml
i. $Fe^{3+} + e^- \text{ ---------- } Fe^{2+}$
1. Above is the oxidation reaction or reduction reaction.
47. Why steam causes more sever burns than does the boiling water.
48. Calculate the pH & poH of a solution whose hydrogen ion concentration is 2.0 x 102 moles per liter
49. Slope of x-axis or of any line parallel to x-axis is --------
i. 0
ii. Base / 2
iii. Undefined
50. d / dx (lnx) =
i. X
ii. 1/x
iii. Lnx
51. Sum of the square on the two sides of a right angle triangle is equal to the square on the
i. Base
ii. Perpendicular
iii. Hypotenuse
iv. None
52. What are the roots of the quadratic equation $2y2 - 6y + 3 = 0$
i. $2 + \sqrt{3} / 2, 2 - \sqrt{3}/2$
ii. $3 + \sqrt{3} / 2, 3 + \sqrt{3}/2$

iii. 2 ,-15
53. What is solution of equation?
11x + 15y + 23 = 0
9
7x – 2y – 20 = 0
i. 7,1 ii -2.3 iii 2,-3 2,3
54. (2a3 / b4) 4
i. 16a12 / b16
ii. 16a11 / b16
iii. 16a82 / b16
1) Corrosion resistance property of metal?
i. Chromium
ii. Nickel
iii. Carbon
iv. All above
2) (18 - 4 – 1) This is H.S.S Percentage?
i. Chromium , Nickle , Carbon
ii. Chromium , Vanadium , Nickle
iii. Nickel , Tungiston , Vanadium
iv. Cr , V , W
3) Which part is not used in Diesel engine?
i. Carbourator
ii. Spark plug
iii. Piston
iv. Piston rod
4) 100m3 of air contain?
i. 87 % m3 of Oxygen.
ii. 78 % m3 of Oxygen
iii. 29 % m3 of Oxygen
iv. 21 % m3 of Oxygen.
5) Composition of Brass?
i. Copper + tine.
ii. Copper + Zink
iii. Nickel + Copper
iv. Brass + Copper
6) The process in I.C engine?
i. **Adiabatic**
ii. Isothermal
iii. Isometric
iv. Non above
7) Slip of belt is occurred?
i. Load
ii. Tension b/w belts.
iii. Creep
iv. Tension of load.
10
8) If increase the acetylene gas in the flame is called?
i. **Carborizing flame**.
ii. Neutral flame.
iii. Oxidizing flame.
iv. Non above
9) Casting is used?
i. For change of volume.
ii. For change shape.
iii. For change temperature
iv. Non above
10) If the percentage of Carbon in iron is increase till 2.11 % there is called?
i. Pig iron.
ii. Cast iron.
iii. Wrought iron.
iv. Non above
11) Which one of the following devices generates current through chemical action?
i. Generator
ii. Dynamo
iii. Dryeell
iv. Motor
12) Repeated time which load is applied on a body in elastic limit causes?
i. Endurane
ii. Elasticity
iii. Plasticity
iv. Fatigue
13) Resistance of metal for permanent indentation is called?
i. Hardness

ii. Toughness
iii. Elasticity
iv. Plasticity
14) In Electric arc welding is
i. Constant voltage.
ii. Constant current.
iii. High voltage.
iv. High current.
15) Which process is performed when tool is perpendicular?
i. Turning
ii. Milling
iii. Facing
iv. Non above
11
16) Which process is used when a hole is do much larger?
i. Reaming
ii. Turning
iii. Boring
iv. Broching
17) Density
i. Increase with increase in temp.
ii. **Decrease with increase in temp**.
iii. Constant
iv. Non above
18) Steam trape is used :
i. For trape the steam.
ii. To trape water.
iii. To drain costenate water.
iv. Non above
19) Heat transfer resources:-
i. Conduction
ii. Conduction , Convection
iii. Conduction , Radiation
iv. Conduction, Convection. Radiation
20) In throttling process constant thug is?
i. Volume
ii. Temperature
iii. Pressure
iv. Non above
1) Which Gear Transfer Power at 90□?
i. Spur Gear
ii. Bevel Gear
iii. Helical Gear
iv. Non above
2) Which Metal Has Best Corrsion Resistance Property?
i. Carbon Steel
ii. Aluminum Steel
iii. Stain Less Steel
iv. Non above
3) Gases Used For Gas Welding?
i. (**Oxygen + Acetylene)**
ii. (Acetylene + Carbon)
iii. (Oxygen + Hydrogen)
iv. (None above)
4) In Spur Gear The Shaft Is _____ To The Gear?
i. **Parallel**
12
ii. Horizontal
iii. Perpendicular
iv. None above
5) Gear Terminology? (The Diameter of the Pitch Circle to the O.D?)
i. **Addendum**
ii. Dedendum
iii. Pitch dia
iv. (None above)
6) Ball Baring Is Used To?
i. **Radial load**
ii. Axial load
iii. Both ends
iv. None above
7) If Area Reduce Velocity, Pressure Effect Is?
i. Increase , Decrease
ii. Decrease , Increase
iii. Constant

iv. (None above)
8) The Process In Which Material Soft.
i. **Anne ling**
ii. Quenching
iii. Hardning
iv. (None above)
9) Friction Is Directly Propositional To The?
i. **Weight of body.**
ii. Temperature of body.
iii. Height of body.
iv. (None above)
10) OIL IS,
i. Compressible
ii. In Compressible
iii. (None above)
11) Which Is Driver?
i. Motor
ii. Turbine
iii. Gas Compressor
iv. (None above)
12) Which Gear Exerts No Load On Shaft?
i. Spur Gear
ii. Helical Gear
iii. Helical both gear
13
iv. (None above)
what is sensative tray temperature
2 what is catalyst
3. what is foolding and weeping
4. what is polymerization reaction
5. scaffolding in plant need authorization....?
6. Centrifugal compressor explain Surge
7. Why PH measure in reboiler Blowdown ...?
8.what is the meaning of saturated steam..?
where use in plant and what its importance
14
9.complete and balance eqautions
S+O2=
2C2H6+7O2=
CH4+O2=
Just go through FSC chemistry book and make
more equations.....etc
10. what is boiling point
11. what is partial pressure
12. what is vapour pressure
13. what is latent heat
14. what is sensible heat
15
15 . How is the viscosity of a polymer
measured.....?
16. what is volumetric pump
17. what is advantages to use volumetric pump
or Centrifugal Pump in Industry
18. what is steam turbine principal
19. how Governor valve working prncipal
20. how u can observe there is Nitrogen Leak
in area.....?
21 how u can observe there H2S leak in area
and what u will do or what will be ur quick
16
action.....?
22. why nitrogen use for purging process.....?
why not other gas....?
23. what happen if Compressor Suction
Pressure increase....?
24. what happen if compressor suction
temperature increase...?
25. what is difference between
Paraffin,Olefin and acetylene give example...?
26. WHAT IS MEANING OD SAFTEY
RELATED TERMS
SHE,HAZOP,HSE.....
17
27.WHAT EXOTHERMIC REACTION GIVE

EXAMPLE...
28. WHAT IS ENDOTHERMIC REACTION
GIVE EXAMPLE...
29. Explain HYDROGENATION REACTION
and what its use in Olefin industry
30. what is In solids handling in Polyolefin
plant explain term
31. explain distillation
32. explain difference between fractionation
and distillation term..?
18
33. explain Ur main activity while shift
started...?
34. how much salary (they will ask in question)
35. why u want to move there..? interview
question
36. types heat exchanger... function
37. use of reboiler
38. what is meaining of MSDS doc detail.....?
1- How many moles contains 6 gram of carbon?
6 moles
12 moles
1/2 moles
3 moles
Mole= Weight in gm/Mol. wt
2- Complete and balance the equations?
C2H6 + O2 =
CH4 + O2 =
NaOH + CO2 =
H2 + S =
C2H6 +O2 =
3- Why flooding occurs in a fractionation column?
Sudden low Pressure
19
Sudden high Pressure
High liquid load
Velocity increase of vapors
Velocity decrease of vapors
4- What is the Latent heat?
Change the phase
Change the temperature
Melt the solids
Freeze the liquids
5- How you define boiling point?
When liquid pressure equals to atmospheric pressure
When Vapor pressure equals to atmospheric pressure
When any liquid boils
When any liquid change his phase
6- What is the color of mandatory sign of site?
Red
Green
Yellow
Blue
7- Write the name of green house gas?
Keton
Portals
CO2
H2
8- What is the partial pressure?
Pressure of the all gases
Individual gas pressure
9- Which one is the quality policy sentence?
Process is the main aim
Quality of products is the target
Specifications are not important
Consumer's satisfaction is our goal
10- Why the cavitation occurs?
Low NPSH
High suction pressure
Low discharge pressure
High discharge pressure
11- Why surging occurs in a centrifugal compressor?
High suction pressure
Low discharge pressure

Low suction flow
High suction flow
High discharge pressure
12- How we remove conductivity to make demin water?
Remove ions
20
Remove Ca, Mg
Remove dust
Remove salt
13- What is the effect of H2S gas on human body?
Irritant and Toxic
Very pleasant
Bleeding start
Cough start
14- Why IBD performed in a steam drum?
To remove the TDS
To control the level
Because boss says
To remove the slug
15- Where is the sensitive tray in the column?
Where hydrocarbon enters
Where temp is measure
Where higher/ heavy hydrocarbon boils
Where stripping steam given
16- How you start the screw compressor?
Open suction valve
Open discharge valve
Open suction and discharge valve
Close suction and discharge valve
17- Why weeping occurs in a distillation column?
Sudden low Pressure
Sudden high Pressure
High liquid load
Velocity increase of vapors
Velocity decrease of vapors
18- What does catalyst in reaction?
Increase rate of reaction
Decrease the rate of reaction
Does not act any part in reaction
Consume during reaction
19- Why maintain high PH in a boiler?
Because acid prepares in boiler
To steam flow easily
To control TDS
Because boss says
20- Which steam is called saturated steam?
HP
LP
MP
None of above
21
21- If you want to work on erected scaffolding what will you do?
Check Safety tag
See Height
Nothing
Check PTW
22- Where sieve trays use normally in column?
In stripping section
In top section
In middle section
23- Why excess air confirmed in a fired heater?
To ensure complete combustion
To control draft
To control firing
No reason
24- At what temperature C2H4 liquefy?
25- Which department checks Scaffolding?
Safety department
Process department
Maintenance department
None of above
26- Which give chemical information?
MSDS
PTW

DMDS
MEA
27- Which type of reaction is polymer reaction?
Exothermic reaction
No heat release
Both endothermic exothermic
Endothermic
28- How we control centrifugal pump flow?
With discharge control valve
With suction valve
With both discharge and suction
None of them
29- How we control PD pump flow?
With stroke length
With variable rpm
Both of above
None of above
30- Why we do fast purging in boiler?
To remove water
To remove slug
To remove level
To remove dust
31- Why CBD is opened in continuous operation of boiler?
22
To steam purity
To control level
To remove slug
To remove precipitates
32- How you purge out any vessel in industry?
With N2
With O2
With air
With fuel gas
33- If you find a fire what will you do first?
Inform to control room
Inform to unit head
Leave the plant
Try to extinguish the fire
34- Why boilers PH control more than 7?
To control corrosion
To control steam easy flow
Because boss says
None of above
35- Liquid emission from plant?
COD
SO2
CO
CO2
36- How we increase or decrease PD compressor Capacity?
Recycle Valve
Suction valve
Discharge valve
RPM control
37- Why polymer became solids?
Long chain molecule
High molecular wt
Fast reaction out of control
All of above
38- Why reflux is used in a column?
To increase purity
To control product flow
Because more liquid is prepared
None of above
39- To enter a fork lifter in operation area?
Its speed should be 40Km/hr
Having a fire extinguisher
PTW required
Having no load
40- Partial pressure of a gas is equal?
23
Individual pressure of gas
Total pressure of gases
None of above
All of above

41 - Loading and unloading arm of ethylene before use required?
Maintenance
Pressure testing
Cooling
Heating
42- If a toxic gas released what will you do first?
Leave the Plant
Inform to control room
Use BA to stop leakage
Take no action
43- A vessel contains 1kg/cm2g air, increase pressure with N2 up to 6 kg/cm2g what will be the O2 percentage in it?
5.5%
3.5%
3%
2.5%

In desorption column which tray is sensitive tray? Ans: top tray on which temp is controlled.
2. Why CBD is carried out in boilers? Ans: for better steam quality.
3. In surging what is main cause? Ans: suction low flow.
4. What parameter is checked in waste water effulent? Ans: chemical oxygen demand (COD).
5. Why demin water Ph is kept slightly basic? Ans: to avoid corrosion.
6. Polymerization process is? Ans: exothermic.
7. 6 gms of carbon is equal to? Ans: 0.5 or half mole.
8. In case of fire firstly? Ans: inform CCR.
9. In case of sulphur smell firstly? Ans: use escape mask & inform CCR.
10. Fork lifter entry in operating area required? Ans: valid work permit.
11. Why saturated steam is used in reboilers? Ans: to reduce heat duty.
12. Boiling point is? Ans: temp at which vapor press. = atm. Press.
13. What is flooding? Ans: high accumulated level in column.
14. Who authorized scaffolding? Ans: safety section.
15. What is cavitation? Ans: When NPSH available < NPSH required.
16. How flow is controlled in centrifugal pump? Ans: by throttling discharge valve.
17. Which action is wrong to control flow in PD compressor? Ans: by throttling discharge valve.
18. What is volumetric pump? Ans: vol.pump is PD pump.
19. Why polymers are solids at ambient temp? ans: due to higher molecular weights.
20. Which statement is not quality policy? Ans: maximum production.
21. Which is not quality policy? Ans: tracibility of product is optional.
22. What shows chemical properties? Ans: MSDS material safety data sheet.
23. Which is saturated steam? Ans: steam at saturated pressure.
24. Why saturated steam used? Ans: due to latent heat.
25. How demin water conductivity checked? ANS: because it is good conductor after ion exchanging process.
24
26. How viscosity is checked? Ans: by allowing liquid through a calibrated dia orifice.
27. Why fast purging is done boilers? Ans:to remove sludge and dirt.
28. Which is green house gas? Ans: CO2.
29. Why hose pipes couplings are kept flexible? Ans: to facilitate operator.
30. What is mandatory signs color? Ans: blue.
31. What are disadvantages of sulphur dusr? Ans: irritation & toxication.
32. What latent heat does? Ans: phase change and temp is constant.
33. Ethylene process is fast or slow? Ans: fast.
34. What is meaning of "correction"? ans: rework.
35. Demine water Ph? Ans" 08 basic.
36. Why steam turbine heating is carried out? Ans: to avoid thermal shock.
37. Why O2 is kept excess in furnace? Ans: for complete combustion.
38. in refrigeration compressor if suction pressure goes high? Ans: cooling will reduce and process temp will go high.
39. in solid handling what is for dilute phase conveying? Ans: air at 3 bar pressure.
40. why double block & bleed valves used? Ans: to isolate system.
41. how N2 leakages detected, by odour,color,smell or none of these? Ans: none of these.
42. why any additive is used in polymers? Ans: for customer's satisfaction.
43. what affects better upon polyolefin, (oxygen, water or acetylene)? Ans: acetylene.
44. if O2 is 21% in a container under atm.pressure then what will O2 concentration if same container is more pressurized with 6 Kg/Cm2 nitrogen 3%,3.5%,6% or 21%? Ans: I don't know exactly what is right answer.
45. some chemical equations to be wtitten right hand side on answer sheet.
CH_4+2O_2---------- CO_2+2H_2O
S+O_2----------SO_2
$7O_2+2C_2H_6$----------$4CO_2+6H_2O$
2NaOH+CO_2----------$Na_2CO_3+H_2O$

2NaOH+H2S----------Na2S+2H2O
What is Exothermic/Endothermic Reactions,Define what is Catalyst ..examples,What is distillation,reflux,Boiling point,adiabatic process.....,
Denfine Pumps (types of pums specially Certifugal pumps....),Compressors (specially Centrifugal both Turbine and Motor driven with all
Detail from Mechanical ,Process, Operation, Start up Shut Down as well)
Important to prerpare Chemcial Equation Balance e,g;
Unbalanced Equation:- C3H8 + O2 ---> H2O + CO2
Balanced Equation:- C3H8 + 5O2 ---> 4H2O + 3CO2
Regarding that it is very easy Test just go through Basic English.....40 Question,
and also go through basic IQ test Book .....40 Question.
Name of company, position title and description, dates of employment. -
25
What were your expectations for the job and to what extent were they met? -
What were your responsibilities? -
What major challenges and problems did you face? How did you handle them? -
What have you learned from your mistakes? -
What did you like or dislike about your previous job? -
Which was most / least rewarding? -
What do you expect from a supervisor? -
What problems have you encountered at work? -
Why are you leaving your job? -
Why did you resign? -
What is your greatest weakness? -
What is your greatest strength? -
How would you describe yourself? -
How do you handle stress and pressure? -
What motivates you? -
What are your salary expectations? -
What do you find are the most difficult decisions to make? -
Tell me about yourself. -
What has been the greatest disappointment in your life? -
26
Give some examples of teamwork. -
More job interview questions about your abilities. -
More job interview questions about you.
Why do you want this job? -
What applicable attributes / experience do you have? -
Are you overqualified for this job? -
What can you do for this company? -
Why should we hire you? -
Why are you the best person for the job? -
What do you know about this company? -
Why do you want to work here? -
What challenges are you looking for in a position? -
Are you willing to travel? -
How long do you expect to remain employed with this company? -
Interview Questions: The Future
What are you looking for in your next job? What is important to you? -
What are your goals for the next five years / ten years? -
How do you plan to achieve those goals? -
What are your salary requirements -
Questions about your career goals. –
27
Draw the organization chart where you are working.
2. What is NPSH
3. Cavitation
4. Define Exothemic & Endothermic reactions & give some example.
5. Reactions at different reactors.
6. O2 at Furnace
7. Steam / NG ratio.
8. Causes of Boiler trip.
9. Electrical & oil Fire Extinguishers.Fire extinguishers used in NH3 Plant
10. Nical Carbonyl at Methantor.
11. Changeover of a standby DSV filter.
12. Flow establish of Benfield circulation
13. Surging
14. Inerts in the Synthesis loop.
15. Draw a simple & cascade loop.

16. Demin unit outlet Ph.
17. 1st. & 2nd. Reformer outlet CH4 content.
18. H2/N2 ratio of Matanator out let gas.
19. 1st. Reformer tube leak effect on furnace.
20.Baring device of Turbines.
21. Steps to handover Centrifugal pump for maintenance.
22. Compressor checklist before start up.
23. CO2 removal system diaghram.
24. Causes of increase of conductivity of steam cond.
25. Blowdown & its necessaty.
26. Why air charged ti 2RF.
27. Necessaty of de-aeration

28

Q1 What is Gas Turbine?
_____
_____
_____
_____
_____
_____2 The Compression ratio of IP and HP compressors
are respectively.
_____
Q3 The low and low low levels of 71QGGRT are.
_____
_____
Q4 At which logic the stand By GG
Lube oil pump will cut in. Write
set
point also.
_____
_____
_____
_____
_____
Q5 What is maximum allowable deviation b/w lube oil
flow control valve
Out put and its feed back?
_____
_____
Q6 What will be GG lube oil flow to bearings at operating
speed?
. Q7 Permissive for startup of gas turbine regarding GG Lube oil
System
29
a) _____
b) _____

Q8 Write Auxiliary mineral lube oil pump cut in / cutout
logic.
_____
_____
_____
Q9 The low and low low level settings of 71QLT are.
_____
Q10 How we can calculate the main Lube oil supply (calculated)
pressure.
(63QS). Write formula
_____
_____
_
Q11 Write the name of oil which we are using in Mineral lube
oil system.

Q12 At which temperature the oil cooler fan # 2 and cooler fan #
3 will
Start regarding mineral lube oil system.
_____
3 Permissive for startup of gas turbine regarding mineral lube
oil
System
30
a)

_____
_____
b)
_____
_____

Q14 Permissive for startup of gas turbine regarding Fuel Gas System
a)
_____
___
b) _____
c) _____
d) _____
e) _____
Q15 Contactor / Breaker of heat tracing on fuel gas line is present in.
_____
____
Q16 Gas turbine is running on Diesel. Now we want to run it on condensate. How can we change it?
_____
_____
_____
_____
_____
Q17 Maximum allowable Exhaust Temperature during turbine ignition Time.
31
_____
Q18 63GG05T (GG cooling air Press. To 05 module) have Alarm value = 36 PSI and Trip value = 7.2 PSI. Explain it.
_____
_____
_____
_____
_____
_____
The ratio of reduction gear is.
_____
Q20 Write down the No. of UPS batteries and Capacity in UCP.
_____
Q21 Write down the shut down and control logic of Gas detectors in side
GT compartment.
_____
_____
_____
_____
Q22 Write down anti surge valve opening / closing set point formula.
_____
_____
Q23 Suppose more than 01 hour has passed after shut down of a gas
32
turbine. What will be the position of 20TSA?
_____
Q25 Permissive for Start up of gas turbine regarding Hydraulic oil System.
_____
b)
_____
_____
Q26 What isolations required for change over the Hydraulic starter PLC
From GT- A to GT- B.
_____
_____
_____
_____
_____

Q27 Hydraulic Starter Crash disengagement set point is.

□□_____
_____
□□Q28 Hydraulic motor engages with.
□□_____
The over speed trip setting is linked with which speed?
□□_____
_
□□Q30 The drain of V-2210 is linked with.
33
□□Q31 At E-3210-A WHRU Heating medium discharge temperature high
□□High alarm (032-TAHH-002) actuates. What will be the effect?
□□_____
□□_____
□□Q32 If any of these FALL-07/09/11 actuates. What will be the effect?
□□_____
□□_____
□□Q33 What is the capacity of alarm history.
□□_____
□□Q34 At a time how many trend pen can be selected?
□□_____
□□Q35 Write Rated Output and rated amperes of Peebals Generator used with
□□Gas turbine in Bhit Gas Field.
□□_____
□□_____
□□Q36 Write 03 necessary parameters which are most important during
□□Synchronization?
□
□□a) _____
□□b) _____
□□c) _____
34
□□Q37 What is Droop?
□□_____
□□_____
_____
□□_____
_____
□□Q38 Write procedure for synchronization of Gas turbine with Dead Bus.
□□_____
_____
_____
_____
_____
_____
□□Q39 If gas turbine has trip due to any security actuation from generator
□□Side. To make it ready for startup, how can we reset all alarms?
□□_____
_____
_____
_____
_____
_____
□
□□Q40 If all 03 Gas turbines are in service. How many NER'S breakers
□□Should be close?
□
35
□□_____
_____
_____
_____
□
□□Q41 How many fans are there in Air cooler of EDG?
□□_____

_____
Q42 No. of cylinders of EDG.
_____
Q43 No. of U.V dectors in EDG compartment.
_____
Q44 Logic for Startup of EDG in Total power failure.
_____
_____
__ Compression ratio of EDG engine is.
_____
Q46 The Power supply for project camp is coming from.
_____
Q47 Write Start Permissive for water wash.
_____
_
b)
_____
_____
c)
_____
_____
36
d)
_____
_____
e)
_____
_____
f)
_____
_____
g)
_____
_____
Q48 In Gas turbine startup sequence, PT short warm up period duration is.

Q50 If Device net power supply fails due to any reason on MCC Pannel
What will be the effect?
_____
Q51 “Control Panel Healthy” is one of the turbine startup permissive.
We will get this permissive OK when following five sub permissive
will be OK.
a) _____
37
b) _____
c) _____
d) _____
e) _____
Q52 During start up sequence when GG N2 speed crosses 3500 rpm then
What happens?
_____
_____

Q53 What is the difference b/w hot start and cold start? Is it make any
Difference in startup sequence or not.

_____
_____
_____
_____

Q54 During Stop sequence at which speed of PT (N3), the excitation will
Turn off.

Q55 The alarm and Trip setting of 26GTE2A (GT enclosure temp.) is

Q56 Draw the sketch of PT lube oil system.

Q57 Draw the sketch of gas system.

a-

4. Define Exothermic & Endothermic reactions & give some example.
5. Reactions at different reactors.
6. 02 at Furnace
7. Steam / NG ratio
8. Gauses of Boiler trip.
9. Electrical & oil Fire Extinguishers. Fire extinguishers used in NH3 Plant (Due , cor,)
10. Nical Garbonyl at Methantor.
11. Changeover of a standby DSV filter.
12. Flow establish of Benfield circulation
13. Surging
14. lnerts in the Synthesis loop.
15. Draw a simple & cascade loop.
16. Demin unit outlet Ph.
17. 1st. & 2nd. Reformer outlet GH4 content.
18. H2lN2 ratio of Matanator out let gas.
19. 1st. Reformer tube leak effect on furnace.
20. Baring device of Turbines. Stry ttso-l-!- 20". to,,ro-f'^^ \
21. Steps to handover Gentrifugal pump for maintenante!7 o!.;" Su-"lr^ , &,4:n'^,/!'
22. Compressor checklist befoie s-tart up. lr Slyc'0f,3 r""r'' v h* /4 -z
23. CO2 removal system diagram.
24. Causes of increase of conductivity of steam cond.
25. Blow down & its necessity.
26. Why air charged ti 2RF.
27. Necessity of de-aeration

1- Why GBD is carried out?
-An". Salt & stug removal.
y,.2-What is checked in waste effluent?
Ans. COD (chemical Oxygdne demande.)
.r.,3-why DM water PH kept high?
Ans. To avoid corrosion.
vz 4- Polymerization is exothermic reaction.
,'S{6 gm of G is 0.5 mole of G.)
„.6- lncase of fire 1"t inform GCR.
u,7-incase of sulpher smell 1st mask & inform CCR.
r.- 8-for fork lifter entry in area ,work permit, required.
-,29-why in reboiler saturated steam is used.
Ans.to reduces duty on reboiler.
l0-what is flooding? n Ans. y"*-! /ncrJ- * cuU**n'
,-.11- Requirement to climb up scaffolding
Ans. Safety authorization required.
1 2-what is cavitations?
13-how centrifugal pump flow is controlled?
,r-"'Ans.by discharge valve throttl i ng.
„/ 14- how PD pump flow is controlled?
Ans. Adjusting pump stroke length
14-what is difference between centrifugal pump & VOL. pump?
"z Ans. vol pump is pressure pump whereas centrifugal pump is head pump.
15-why polymers are solids at ambient temperature?
..„Ans.Due to high molecular wt.
16-which statement isis not quality policy?
v/fun". "maximum production"
17-which is not quality policy?
-r'Ans. "trackivi I ity of prod uction is opticonal"
;218-chemical properties from where to check?
AnS.MSDS
19-which is saturated steam?
,.-Efeam at saturation pressure.
20-why saturated steam is used?
Ans.to use latent heat.
21-why conductivity of DMW is checked?

r,"Ans.since it is conductor.
22-how viscosity is checked?
„.rAllowing drop flow throw orifice. Of calibrated dia. (viscometer)
23- why fast purging (blowing) is done?
n-Ans.to remove slug and dirt.
24-which is green house gas?
v/Ans.COz
2S-what is for CHa loading -?
An$verhauling.\
26- frhy flexible 6oupling is at UTY points?
Ans.to facilitate area opt.
27-what are mandatory sign?
„-/Ans. BLUE.
28-what are disadvantage of sulpher dust.
u.-Ans.(a) irritation & toxication.
29-what is latent heat?
n-- Ans.phase change temp.
3O-wether ethylene process is fast or slow?
-,.-Ans. Fast
31-what is correction.
--Ans. Rework.
s2- (a) 2ftadmd[NazGos+Hro (b) 2NaOH + HzS--- Na2S+2H2O (c) CH4+26r- ----- CO2+211, (d) S+Oz--" (e) ----SOz 7Oz+2CzH6---------- 4CO2+6H2O+heat
33-why heating of steam turbine is done?
Ans.to avoid thermal shock.
34- why 02 is excess in furnance?
Ans.for complete combustion.
35-why GBP is checked?
Ans.For corrosion prevetion.
These are the max. question that i can collect that had been asked during test & interview.Thanks & wish you good luck.
Regarding Qafco, No doubt it is one of the best company (job atmosphere) & salary package u have to compare yourself.
Gost of living is more in Qatar as compare to Saudia.
But keep in the mind, Free accommodation, medical & children education will give a good relief to overcome this issue.
As per my opinion if u or anybody gets a chance, please don't miss it.(after comparing the salary package).
*.'tr Whet is NF$F and **vltati*ru?
A. NPSH
The liquid pressure that exists at the suction end of a pump. lf the NPSH is insufficient, the pump can cavitate
Gavitation:
Formation of vapour bubbles within a liquid at low-pressure regions that occur in places where the liquid has been accelerated to high velocities, as in the operation of centrifugal pumps.
#$.: Whmt is se*sih{s haat? A. The heat which when added to a substance will cause a rise in temperature.
*.S Whet is Lats*t h*mt? A. The heat energy which cause the conversion of a liquid to vapour (change of state) when it is near the boiling point.
G'd whmt ix purxtp *:and #w*r $*rs#sd*xne fq*n mmEr:t*mxerwe? A. Pump hand over procedure for maintenance:
- Stop the pump
- lsolate process and electrically.
'Drain the liquid and depressurize it and make sure valves are not passing.
- lnert the pump.
- Gheck the permit and hand over to the maintenance.
&.S What is c*nd*nslng turb$r":e stsrt-a,tg* pnaxec#axr*? A. Start-up procedure:
6)
-Check l.A, PSV, Gontrol valves are in service and blinds are removed.
.Check all indication bulbs on local panel are OK.
- Open N2 to the seal.
- Start lube oil pump.
-Put cooling water in service
- Make-up level in the condenser.
- Put start-up ejector in service.
- Put condensate pump in service.
- Start baring gear.
- Keep the turbine remote control disable.
-Reset the turbine and put under heating.
- When turbine heating completed i.e. temp >320C and compressor side is ready, put the turbine on ldle speed and check the vibration & leakage., keep it for one hour.
- Put turbine on Rated speed and check the vibration.

- lnform panel operator and put turbine remote control enable, panel operator will increase the speed as per his requirement.
ffi.6 Wfiat is t*'*e q*Efference hetwesra ffiauge pfr-ss$r$$"ffi m*nd &fuw**x*€* preswure?
A. Gauge pressure is that pressure indicated by a pressure gauge and is the above or below that of the atmospheric pressure at the point of measurement and it shown by PSIG.
To obtain absolute pressure, the pressure of the atmosphere (14.7psi) must be added to the gauge pressure and it is shown by PSIA.
ffi"y Xtrfuy stre*s'!*r used *t the swctisn *f ths pmt"sxp? A. lt is for safety of the pump to avoid solid materiar to go the pump suction.
Q.8 why strainer used at the suction of the centrifugar compressor?
It is for safety of the compressor to avoid solid material to go the compressor.
Q.g" Equati*nm.
NaOH+GO2----------Na2GO3+H2O
S+O2--- --SO2
C2H4+H2 ------C2H6 C2H2+CIZ ---2HC1+2C
*.1fi #ef*ne h*ilir*g p*int.
A. The temperature at which a liquid boils and changes rapidly into gas (vapour) at atmospheric pressure, is called boiling point of the liquid.
Q.'!t What is tfie effect of reflux an dlsttllation colun:n? A. Distillation column top temperature is controlled by reflux flow and in result product purity is achieved. lf reflux flow is low, column top temperature increases and heavy components go to the top with product, hence product go to off spec, lf reflux flow increases, column top temp decreases and product starts to condense, go to the bottom of the column, so we loose product and also column bottom specification changes.
Q.1t What ia vapour pressure?
A. The pressure exerted by vapours of a liquid at equilibrium at particular temperature is called vapour pressure of that liquid.
Q.13 Draw PF* {Process Ftow Diagram} cf your vuorking &res.
Q.14 Why we use sirainer at centrifug*l frorfipressar su*ti$n? A. To avoid sending any solid material to the compressor.
Q.15 What is F.D {Positive Displacernenti **mpress*r wta*-*p pr****ur*?
A. Start-up procedure:
-Put l.A, PSVs and control valves in service.
-Gheck indication bulbs on the local panel.
-Put lube oil in service.
-Put cooling water in service.
-Gompressor suction and discharge isolating valves keep open.
-Line-up compressor upstream and downstream circuit.
-start compressor at oFF LOAD to avoid over load trip and put on load after some time.
Q.16 What is draft furnace mair:tenance hand over procedure? A. Hand over procedure:
-Cut process gas and keep under steam to quench tower.
-Furnace change over to decoke drum.
-Open sealing steam and connect decoke air spool piece.
-Put process gas blind close position.
-Open decoke air step by step according to the procedure.
-When decoking finish, close decoke air.
-Start to cool down furnace by 50C/H.
-when quench boiler outlet temperature less than 110c, replace steam with air.
-When all burners cut off, keep air open to coot down more.
- Put fuel gas blind close position.
- When temperature is less than 50C, close BFW, close air, remove air spool piece, keep damper full open, put blinds in dilution steam, sealing steam, anti-coking steam, HS (high pressure steam) lines.
- Drain steam drum and furnace hand over to maintenance.
Q.17 What parameters of distillation column ar* controlled?
A. Distillation column parameters:
-Sensitive tray temperature.
-Golumn pressure.
-Reflux flow.
-Bottom level.
*.$# trdtfumt $s pax*r':p ntmr-t-a.lp pr***#r*re m€ -$*S#? A. Pump start-up procedure after maintenance:
-lnert the pump.
-Make-up lube oil level and seal pot level.
-Put pump under slow cooling to flare, with gas at normal suction pressure.
-When start to appear on casing, open crack suction valve to start cooling with liquid, close to flare and open normal degassing valve.
-Open suction valve step by step and rotate the shaft time to time.

-When casing is completely covered with ice, open suction and
discharge valves full.
-Gancel the electric isolation and now the pump is stand-by.
&"f S What is distll$w€E*s: *md'fraettmro*ti**?
Distillation is the process for the extraction of the voratire
components of a mixture by the condensation and collection of the vapors
that are produced when the mixture is heated. oR a process in which a
liquid or vapour mixture of two or more substances is separated into its
component fractions of desired purity, by the application and removal of
heat. Fractionation is the process to separate (a chemical compound) into
components, as by distillation or crystallization.
.H# kYhst i mpecEfs* gravitSr? A. Specific gravity is the ratio of the density of a material to the density
of water.
&.#"{ W$rst is xp**ifi* h**€ mf * saab*tmrcee? A. The number of units of heat required to raise the temperature of a
unit mass of the substance at that temperature one degree
&"ftZ Wh*t is buhh$e *eps tray fu*c€$*nT A. Bubble cap travs
A bubble cap tray has riser or chimney fitted over each hole, and a
cap that covers the riser. The cap is mounted so that there is a space
between riser and cap to allow the passage of vapour. Vapour rises
through the chimney and is directed downward by the cap, finally
discharging through slots in the cap, and finally bubbling through
the liquid on the tray.
fr.*3 ltVhat im cra*klv:g?
Gracking is the name given to breaking up large hydrocarbon molecules
into smaller and more useful bits. This is achieved by using high pressures
and temperatures_without a catalyst, or lower temperatures and pressures
in the presence of a catalyst
Thermal cracking
ln thermal cracking, high temperatures (typically in the range of 4s0.c to
J50'C) and pressures (up to about 7O atmospheres) are used to break the
largg hydrocarbons into smaller ones. Thermal cracking gives mixtures of
products containing high proportions of hydrocarbons with double bonds -
alkenes.
1) What all we check while issuing a confined space permit

2) How much is the Minimum requirement of Oxygen

3)What is the TLV,STEL and IDLH of Hydrogen sulphide

4) How to prepare equipment for hot work

5) While issuing an excavation permit what all precaution's we have to take

6)Start up of centrifugal compressor

7) What is surging in a centrifugal compressor ? How it occur's ? How is antisurging done ?

8) What is hamerring? Steam and defferent pressures and temperatures, superheating.

Following defnitions:

1) flow - units 2) pressure- units 3) temperature-units, conversions of units.

Absorption & adsorption

Pumps & types

what is NPSH?

compressors & types

Generators

turbines (types) Steam, gas, combined cycle-- condensing, ... etc

Exchangers -- types Shell, tube, baffels, finfan

Thermocouple & RTD (resistance thermometerdevice)

Basic knowledge on DCS systems.(distributed control system)

Controlers - types

Shut down systems

Permit to work systems. (hot work, cold work, open flame mainly 3 types) others all certificates attached to the permits. like excavation,

Flow rate

Calorific value

what is the purpose of lubrication oil

Density - units

Viscocity -- Units

PH

Anode protection & cathodic protection

Flash point, ignition Temperature, Auto ignition temperature (values for H2S, Methane)

Filtration - types of filtration

absolute temperature

Dewpoint & Atmospheric dew point

Current -- Units -- types (AC/DC) step up transformers/ step down transformers.

Ampere

Heters , types of heat transfers (covection, conduction, Radiation)

Joul thomson effect

Specific heat & latent heat

Storage tanks and types (for Cruid oils , LPG, LNG)

Cavitation -- effects of cavitation & how to control

What is corrosion? types of corrosion? preventive methods.

Simple mathmatics with limited time.

Write an essy on your plant systems, start-up or shut down in simple with good wording (criteria easy to understand to all, gramer, hand writing, clear masage with 10 to 15 centenses)

Reading of P & ID's (need to understand all sybols of valves, equipmets, directions, links to next pages, signals, line specifications, data given on P &ID like design & operating, importance of notes, revisions, P & ID numbering.

Prepare any of your unit to draw a flow chart.

For example absorption or regeneration or compressor loop or distilation or boiler.

Criteria is drawing to be neat, good look, all main equipments and controlers with control points(signals) other monitoring parametres (like PT, TT, LT,FT, DT...) numbers are not too important.

INTERVIEW QUESTIONS FOR SULFUR RECOVERY UNIT
FOR ADNOC/RASGAS/ QATAR GAS

1- Draw flow diagram of SR section of sulfury recovery unit.
2- Draw flow diagram of TGT section.
3- Draw flow diagram of DEA circulation system.
4- Start up procedure of Scot line Heater specially emphasis on safety aspect.

5- Why air to fuel ratio adjusted lower than 100% required for complete combustion during start up of Scot Heater.
6- Procedure for Passivation and Sulfiding Scot reactor catalyst.
7- How will you control increasing temperature of three reactor of sulfur recovery unit?
8- What are the reasons of plugging of sulfur condensers?
9- If SR section tripped due to any reason, what will be effect on Incinerator?
10- If Incinerator tripped due to any reason, what will be the effect on SR section and what will be your first action.
11- Why LS is provided at super heater at Incinerator.
12- How much pressure will you adjust at super heater in case of SR section tripping and why.
13- If molten sulfur line is plugged, what will you do?
14- How will you calculate air to CAG ratio?
15- If steam drum level becomes zero, what will be the effect on Incinerator and Waste heat boiler?
16- What is foaming and what are the indications on DCS panel and its remedial actions.
17- If system pressure increased more than normal, what are the causes and its remedial actions?
18- What is function of snuffing steam?
19- What are the indications, If fire occurred in sulfur pit.
20- What is function of De-gassing air in sulfur pit?
21- Why the temperature is maintained 20 ^{0}C more in first reactor than second reactor.
22- How much ratio is controlled at tail gas analyzer?
23- What are different temperatures and pressure at unit?
24- What are the line diameters at the unit?
25- What is length of seal legs?
26- What are start up procedures of Reaction Furnace and Incinerator.
27- What is the TLV value for H2S gas?
28- What are the different types of work permits implemented in MCR?
29- What is function of ERT member?
30- Implementation of SCBA.
31- If leakage occurred on unit, what will you do first?
32- What are different types of fire extinguishing equipments?
33- What are the remedial actions, If fire occurred due to gas or liquid leakage.
34- If person lying down on ground, being field operator what will be your first action.
35- How will you prepare vessel for vessel entry.
36- What is procedure for catalyst loading and unloading?
37- How to hand over toxic gas service equipment to maintenance department.
38- What are the reasons for increasing and decreasing PH of water of Quencher (Water wash column).
39- What are different design parameters at the unit?
40- you are doing work in deep and using life line, If life line failed to work how will you tell to the person on ground (consider that stand by person is far away from you).
41- What are PPE's used during start up of Furnaces at sulfur recovery unit.
42- If temperature indicators on Reaction Furnace failed to work, what will be the next observing parameters for you as panel operator?
43- Briefly explain the different compartments of sulfur pit, their uses and effectiveness.
44- If leakage occurred in MDEA reboiler or at any other place, what will be your first action and what is remedial action.
45- Why DEA & MDEA solution temperature maintained 130 ^{0}C at bottom of Regenerator.
46- Why De-super heater is necessary for LS at MDEA & DEA Regenerator.
47- How will you commissioned Re-boiler.
48- What are equipments safety precautions for steam drum, waste heat boiler, sulfur condensers or LS producer equipment and Scot waste heat boiler?
49- Why we start recycle blower first before igniting Scot line Heater.
50- What is importance of Amine filtration system in operation of Absorber and Regenerator?
51- What are different types of chemical reactions at unit?
52- What is function of flame arrestor and why it is installed at different locations?
53- What will happen in case of LS failure?
54- Draw drying out curve for 820-H1/H2, H3/H4, H51/H52 refractory.
55- What is draw back of operating reaction furnace at lower temp? than design value.
56- What is effect of ammonium hydrosulphide salt on condensers and how we can avoid this?
57- What is difference between blower and compressor?
58- Why sulfur recovery section designed at 0.63kg/cm2, can this be operated at higher pressure?
59- What are the draw backs of operating SR-section at higher pressure more than 0.85kg/cm2?
60- Why H2 mole ratio is not allowed more than 3% during sulfiding, if it is more than 3 % then what is draw back.
61- What is the height at which confined space entry permit to be valid and wooden planks are necessary on sides at which height to save person working inside from falling of mud lumps?
62- Why pressure set point for CAG is 0.85 kg/cm2, can it be increased and for combustion air is 0.75 kg/cm2.
63- What is foaming and how it can be differentiated with flooding.
64- Explain the effect of FeS, LVGO, HVGO, Ammonium bi-sulphite, carbon particle, ammonium hydro sulphide salt and antifoam solution solution on amine solution in regenerator.
65- Explain in detail function of DSP and TSP in steam drum (810-V6) w.r.t chemical reaction and action in control of PO_4, PH, conductivity and TDS.

1. If hydrocarbons increases in acid feed gas what will happen?

A. If hydrocarbons increases in feed gas, tail gas H2S/SO2 ratio will increase, SRU unit recovery will come down and TGT unit will be over loaded due to hydrocarbons will consume more Oxygen than H2S,

$H_2S + 1.5O_2 \rightarrow SO_2 + H_2O$ (1 mole of H_2S required 1.5 mole of oxygen)

$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$ (1 mole of CH_4 required 2.0 mole of oxygen)

$C_2H_6+3.5O_2 \rightarrow 2CO_2+3H_2O$ (1 mole of C_2H_6 required 3.5 mole of oxygen)

Reaction furnace Air to Acid gas ratio has to be increased to bring back tail gas H_2S/SO_2 ratio to 2:1. Due to the hydrocarbons more carbonyl Sulphide and carbon disulphide are formed.

2. If CO/CO_2 increases in acid feed gas what will happen?

A. If CO/CO_2 increases in acid feed gas feed, tail gas H_2S/SO_2 ratio will decrease because of CO_2 will not burn and CO will consume less oxygen than H_2S. Reaction furnace Air to Acid gas ratio has to be decreased for bringing back tail gas H_2S/SO_2 ratio to 2:1. Due to the CO & CO_2 carbonyl Sulphide (COS) and carbon disulphide (CS_2) are formed. These are reversible reactions. Carbonyl Sulphide and carbon disulphide will be recovered in reactor-1 and SCOT reactor. If the amount of carbon-sulfur compounds (COS&CS_2) increases, than the recovery will come down.

$CO_2 + H_2S \rightarrow COS + H_2O$

$CO_2 + 2H_2S \rightarrow CS_2 + 2H_2O$

Reactor-1 bottom contains hydrolysis catalyst. In presence of this catalyst and at a temperature of 290ºC, COS and CS_2 will be converted to CO_2 and H_2S.

$COS + H_2O \rightarrow CO_2 + H_2S$

$CS_2 + 2H_2O \rightarrow CO_2 + 2H_2S$

3. When unit trip and again when we go for start up (Hot Start up) why excess air operation is not allowed?

A. Total plant contains sulfur compounds. Mainly reactors contain more sulfur. If any oxygen enters into the system, sulfur will start burning and there will be a run away temperature, which will damage the catalyst and equipment. Rapid combustion of sulfur inside the reactors may form some crystal aluminum sulfates, which are not able to regenerate. This kind of sulfates will de-activates catalyst permanently. Excess air operation is allowed only after removing all sulfur compounds by sweeping using hot inert gases (flue gases).

4. During acid gas cut in what are the changes will be observed and when we will cut-in the tail gas to TGT unit?

A. Flame color will be changed from orange to slight bluish and Scanner intensity will be increased. Incinerator temperature will shoot up. Reactors ΔT will start increasing, If the catalyst is new than most of the reaction will take place at the top layer and the temperature rise will be maximum at top layer, as the catalyst become aged temperature rise will be shifted to the middle layer and to bottom layer. After acid gas cut-in with in 10-15 min we will get sulfur from the first condenser seal leg, with in 20-40 min we will get sulfur from all seal legs (before acid gas cut-in ensure that all seal legs are filled with sulfur, also ensure that all sulfur lines jacketing steam is lined up and working effectively). After adjust tail gas H_2S/SO_2 ratio to 2:1, If TGT unit is ready with normal operating parameters (under hot inert gas circulation) than cut in tail gas to TGT unit. There will be more upsets in the Incinerator temperature.

5. Air to Acid gas ratio goes high or low what will happen?

A. Tail gas H_2S/SO_2 ratio (2:1) will change, SRU sulfur recovery will come down and TGT unit will be over loaded.

6. If the reactor inlet temperature decreases than the normal operating temperature what will happen?

A. Reactor-1 normal operating inlet temperature is 230ºC and Reactor-2 normal operating inlet temperature is 210ºC. If the reactor inlet temperature goes lower than the sulfur dew point (About 195ºC this due point will change based on the pressure), Sulfur will start condensing on the catalyst, Reaction rate & ΔT will come down, reactor ΔP will go high and recovery will come down. Even if the reactors are operated at normal operating temperatures it is possible that some sulfur will get condensed on the catalyst. To overcome this problem, reactors inlet temperatures shall be increased of additional 10ºC to 20ºC for about 24hrs every month or based on the reactors ΔP. This operation will remove the condensed sulfur on the catalyst and the catalyst activity will be restored.

7. If reactor inlet temperature increases than normal operating temperature what will happen?

A. This reaction is a reversible reaction. Equilibrium is favorable at Low temperature. But at low temperature sulfur will get condense, so we have to maintain a favorable temperature (210ºC & 230ºC). If the temperature goes higher than normal operating temperature reversible reaction will take place (Equilibrium will be shifted to backward) and recovery will come down. If the reactor temperature goes above 500ºC catalyst will get damaged.

8. In reactor-1&2 what type of catalyst is used and what are the reactions?

A. Reactor-1 Contains two types of catalyst, top layer Alumina catalyst and bottom layer Hydrolysis catalyst.

Reactor-2 contains only Alumina catalyst.

<u>Reaction furnace reactions (Reaction rate 60% - 65%)</u>

<u>Main Reactions</u>

$H_2S \rightarrow H_2 + 1/nSn$ (Dissociation reaction concerns about 6% of H2S contained in the feed gas.)

$H_2S + 1.5O_2 \rightarrow SO_2 + H_2O$

$2H_2S + SO_2 \rightarrow 3/nSn + H_2O$ ("n" lies between 1 to 8)

$H_2S + 0.5O_2 \rightarrow 1/nSn + H_2O$ (This Thermal conversion reaction essentially depends on the flame temperature, H2S concentration in the feed gas and the residence time (Min. 2sec) of combusted gas in the thermal reactor)

<u>Side reactions (Impurities coming along with the feed)</u>

$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$

$C_2H_6+3.5O_2 \rightarrow 2CO_2+3H_2O$

$CO_2 + H_2S \rightarrow COS + H_2O$

$CO_2 + 2H_2S \rightarrow CS_2 + 2H_2O$

$2NH_3 + 1.5O_2 \rightarrow N_2 + 3H_2O$

<u>Reactor-1 reactions (Reaction rate 15% - 20%)</u>

$2H_2S + SO_2 \rightarrow 3/nSn + 2H_2O$ (This Claus reaction will take place in presence of alumina catalyst)

$COS + H_2O \rightarrow CO_2 + H_2S$ (This Hydrolysis reaction will take place in presence of Titania catalyst)

$CS_2 + 2H_2O \rightarrow CO_2 + 2H_2S$ (This Hydrolysis reaction will take place in presence of Titania catalyst)

Reactor-2 reaction (Reaction rate 10% - 15%)

$2H_2S + SO_2 \rightarrow 3/nSn + 2H_2O$ (Claus reaction)

Sulfur condensers (Process gas cooling phase)

S_8 (gas) → 8 S1 (Liquid)

S_6 (gas) → 6 S1 (Liquid)

S_2 (gas) → 2 S1 (Liquid)

9. Why reactor-1 inlet temperature is more than reactor-2 inlet temperature?

A. In reactor-1 along with Claus reaction Hydrolysis reaction also will take place. This reaction takes place at Reactor-1 bottom in presence of hydrolysis catalyst at a minimum temperature 300ºC. Reactor-1 inlet temperature is maintained at 230ºC to achieve 300ºC temperatures at reactor-1 bottom. In reactor-2 there is no hydrolysis reaction, only Claus reaction will take place. For Claus reaction favorable temperature is 210ºC (About 20ºC - 25ºC above the sulfur dew point).

$2H_2S + SO_2 \rightarrow 3/nSn + 2H_2O$ (Claus reaction in reactor-1 &2)

$COS + H_2O \rightarrow CO_2 + H_2S$ (Hydrolysis reaction only in reactor-1)

$CS_2 + 2H_2O \rightarrow CO_2 + 2H_2S$ (Hydrolysis reaction only in reactor-1)

10. Tail gas H_2S/SO_2 ratio goes high/low what will happen and what is the reason for high /low?

A. If H_2S/SO_2 ratio goes high or low than the normal range (2:1) SRU recovery will come down and TGT unit will be over loaded. This will happen due to acid feed gas composition change. The trim air controller will control small changes. If it is a big change main Air to be adjusted to bring back the H_2S/SO_2 ratio to normal.

11. What is the use of sulfur seal legs (seal locks), how much is the seal leg height and if the height is reduced what will happen?

A. Sulfur seal legs will prevent the process gas escaping along with the liquid sulfur. Seal leg height will be about 6 meters. Seal leg will withstand up to 1.0 bar pressure. (Solid sulfur density is about 2.07, Liquid Sulfur density is about 1.8, 6×1.8=10.8 meters of H_2O; it is equal to about 1.0bar). Based on the seal leg height seal leg withstanding pressure will vary. If the seal leg height is reduced, than the seal leg withstanding pressure will also reduce, seal may break at low pressure and process gas may come out along with the sulfur. Seal legs height is designed based on the blower discharge pressure. Seal legs will withstand 10% above the blower discharge design pressure. If the thermal reactor pressure goes more than 1.0bar than the seals will break and process gas will come out along with the sulfur. To prevent this Main burner high pressure trip (0.66bar) is given.

12. Liquid Sulfur temperature increases or decreases what will happen?

A. If the sulfur temperature goes below 120ºC sulfur will gets solidify and if it goes above 160ºC Sulfur Viscosity will increase and sulfur pumps may trip on overload. If the viscosity increases the sulfur from the degassing pit will become difficult to strip out. Liquid Sulfur optimum temperature is 130ºC - 150ºC. Before Degassing Liquid sulfur contains about 300PPM of dissolved H_2S, after degassing H_2S will be reduced to less than 10PPM.

13. What are the reasons for Reactor-1&2 high differential pressures?

A. The main reason for reactors high DP is sulfur condensation on the catalyst. Condensed sulfur on the catalyst can be easily removed by increasing reactors inlet temperature to about 10°C to 30°C for about 24hrs. Carbon or Soot formation also will create high differential, but this can happen only during startup and shutdown time, when the thermal reactor is firing with fuel gas. Only unloading and screening the catalyst can remove soot. Theoretically the carbon can be eliminated from catalyst at a temperature of 400°C - 500°C by burning it inside the reactors, with controlled flow rate of combustion air in an inert gas (Flue gas) carrier. This regeneration procedure is never been used because; the risk of damage of the reactor is very high. The Carbon deposited catalyst (Mainly top layer) decreases the catalyst activity it has to be replaced with the new catalyst.

14. Explain about catalyst Heat Soaking, Rejuvenation, Sweeping and Regeneration steps.

A. The alumina catalyst used in reactors consists of small spheres. Each sphere contains number of small pores. The H_2S & SO_2 gases enter into these pores reacts with each other and forms sulfur and water vapors. Some of the sulfur may collect in the pores of the catalyst in liquid form and over a period of time will lower sulfur conversion efficiency and increases the reactors DP. In such case it becomes necessary for the catalyst beds initially to be given heat soaking.

Heat Soaking: - Most of the sulfur condensed in normal run can be removed by increasing the reactors inlet temperatures to about 10°C to 30°C for about 24 hours. After heat soaking if there is no significant improvement is seen than rejuvenation step to be followed.

Rejuvenation: - Normally a fraction of SO2 is chemisorbed (regardless of presence of oxygen) and fixed irreversible. The chemisorbed SO2 is not chemically stable; it reacts with activated alumina catalyst and forms aluminum sulfates (Al-SO4-Al). These sulfates can be removed by rejuvenation operation. In presence of oxygen these sulfates formation will be very high and there is a possibility of permanent damage to the catalyst (when sulfur compounds are present, oxygen is not allowed to enter into the reactors). This rejuvenation step is only necessary if a significant amount of sulfates has build up on the catalyst. Heat soaking procedure will remove condensed sulfur but it cannot remove sulfates. After heat soaking operation if there is no significant change in reactors ΔT, than rejuvenation step has to be followed. It is carried out with the plant in operation processing H_2S rich process gases. Re-heaters has to be operated at maximum load and plant load has to be reduced 30% to 40% of design feed to achieve maximum reactor inlet temperatures (250°C -340°C) and increase the tail gas H2S/SO2 ratio slowly to 3:1 – 4:1(Maximum allowed ratio 8:1) by reducing thermal reactor air to acid gas ratio. Hold these conditions for 24-36 hours. Normally heat soaking operation and rejuvenation operation are clubbed and performed same time. After rejuvenation there should be a noticeable temperature rise across each catalyst bed. If no significant improvement is seen after a number of rejuvenation exercises, then catalyst may be contaminated by carbon lay-down from excessive amount of hydrocarbons carried along with the acid feed gases or catalyst may be deactivated due to aging or surface lose or pores plugged with crystal aluminum sulfates. In this case the catalyst has most likely reached the end of its useful life and it as to be replaced. Always before shutting down the unit sulfur sweeping and regeneration has to be performed to remove all sulfur compounds.

Sulfur Sweeping (Part of catalyst regeneration): - This sweeping operation is required if the unit is going to shut down for a long period (more than 48 hours) or unit is to be opened for inspection or maintenance and there is possibility of air reaching the catalyst beds. Before Sweeping or regeneration, the catalyst beds and the total plant contain potentially hazardous materials such as H_2S, SO_2, sulfur and other sulfur compounds. The objective of the sweeping and regeneration exercise is to remove these contaminants under controlled conditions.

First slowly switch over Re-heaters (if it is direct fired re-heaters) and thermal reactor firing to fuel gas mode and cut off acid gas. Maintain stoichiometric ratio between fuel gas and air, excess air should not be allowed. Increase reactors inlet temperatures to about 10°C to 30°C more than normal operating temperature. Continue this hot inert gas (Flue gas) sweeping until seal pot flow ceases (It takes about 8-16 hours).

Regeneration for sulfur compounds (Sulfur stripping):- After sweeping operation, still some traces of sulfur compounds and pyrophoric FeS, (Fes is formed in the equipment during normal operation) will be left out, which are not able to remove through sweeping operation. These traces of sulfur compounds and FeS will be removed by regeneration (Control burning).

Revert back the reactor inlet temperatures to normal. Very slowly increase the thermal reactor fuel gas to air ratio by increasing combustion airflow. Increase combustion airflow every few minutes in very small increments until there is evidence of burning of sulfur compounds within the plant. Observe all temperature points across the plant. The first sign of the burning of sulfur compounds in the plant will be seen by a temperature increase in the top layer of catalyst in the first reactor. A temperature increase may also be seen in the waste heat boilers outlet or first condenser outlet as sulfur compounds in these sections starts burning. Hold the combustion air flow when a temperature rise is seen in the first reactor. Closely observe the reactors catalyst temperatures, if temperatures approach 400°C reduce the amount of combustion air and if required open nitrogen to reactors to control the rector's temperature. Under no circumstances should reactors catalyst temperatures exceed 400°C. Once the temperature front has passed through the first rector it will move into the second rector. Some time there may be some overlapping of temperature fronts between the first and second rector due to the possibility of channeling of gases through the rectors catalyst. When the temperature front has moved through the second rector's catalyst, over a period of time (about 8-16 hours) there will be no change in temperatures. Gradually reduce the flow of fuel gas to the reaction furnace leaving the combustion air and trim air flows unchanged to allow an excess of oxygen to appear in the process gas stream. After putting excess air, if there is no temperature rise is seen than it can be consider that regeneration is completed and now the unit is free of harmful gases. Regeneration of catalyst for carbon (by controlled burning at high temperature 400°C to 500°C) is not allowed. Now the unit can be cooled down at the rate of 75°C /hour.

15. What is the difference between cold and hot start up?

A. The normal start-up procedure of Claus section is classified into hot start-up and cold start-up. A hot start-up is followed when the unit is tripped or shut downed for a short duration. Usually this kind of shut-down shall be resumed within 48 hours and before the catalyst layers temperature drops less than 180°C. During hot startup excess air should not be allowed because the sulfur is still present in the system. During hot start up ratio between air to fuel gas should be maintained stoichiometric or slightly substoichiometric. A cold start-up is a re start-up after a shutdown of long duration. During long shutdown all the sulfur compounds are removed by sweeping and regeneration and the unit is free from sulfur. During cold start up excess air can be allowed.

16. Explain about SRU start up?

A. Clause section startup.

1. **Line up all utilities, Line LP steam to sulfur sump coils. Line up jacketing LP steam to all seal legs and sulfur lines.**
2. **Fill all seal legs with sulfur.**
3. **Fill E-01, E-02, E-03 and E-04 with BFW keeping vents open and maintain normal operating levels by keeping blow downs crack open.**
4. **Blow through operation is required when the unit is starting after a major maintenance. This is to remove the traces of dust. Mainly to remove the catalysts dust, if the catalyst is changed during the shut down.**
5. **Line up nitrogen purging to the flame detectors and sight glasses.**
6. **Start the Incinerator blower and light up the incinerator as per the light up sequences.**
7. **Start the main air blower, keeping vent open to prevent surging. Ensure that SCOT section is bypassed and tail gas is routed to the incinerator.**
8. **Before system preheating with fuel gas combustion, the temperature of the catalyst bed shall be increased above the dew point (approx. 80ºC) of the combustion gas to prevent condensation on the catalyst surface.**
9. **Open HP steam to the re-heaters and the combustion air pre-heater carefully.**
10. **Warm up the catalyst in the reactors to at least 80ºC by the main combustion air.**

    Air introduction (Blow through operation / catalyst warm up): - Open 36UV-006 (air to main burner Shut off valve) by 36HS-011O from DCS. When 36HS-011O has been actuated, 36FC006 (main air) and 36FC008 (trim air) gets opened to their predefined outputs. Within 30 seconds, the airflow must be established (Low-low air flow alarm 36FAL-010 has to be cancelled) if not, 36UV-006 is closed and the control valves 36FV-006 and 36FV-008 obtain their start-up position by a tracking signal. Within 30 seconds if the airflow is established above the low-low flow (1750 NM3/Hr) setting than the tracking signals to 36FC-006 (main air)

and 36FC-008 (trim air) are withdrawn. Thereby the controller modes, outputs and set points become accessible for the operator. Activating 36HS-011C from DCS can stop blow through operation. By this action, 36UV006 is closed and the control valves 36FV-006 and 36FV-008 are set at their start-up position by a tracking signal.

11. **Light up the thermal reactor burner as per the light up sequences and slowly increase the thermal reactor temperature. During fuel gas firing LP steam is used to protect acid gas burner nozzle and to control the temperature during stoichiometric firing.**
12. **As the temperature increases steam generations will starts, slowly increase the pressures equal to the header pressures and route to the headers.**
13. **Once the following parameters are achieved than acid gas can be cut-in to the thermal reactor.**
    Combustion chamber 1000 - 1200 °C

    Reactor beds 240 °C

    Waste heat boiler 28 barg

    Condensers 3.8 barg

    Incinerator 760°C

    Incinerator waste heat boiler 42.7 barg

14. **Line up HP steam to acid gas pre-heater, Open all sulfur outlets of the sulfur condensers, Ensure that the Sulfur seal legs are filled with liquid Sulfur and all sulfur lines jacketing steam heating is working effectively.**
15. **Adjust air to fuel gas ration to stoichiometric (8.5: 1). Ensure that the main airflow controller is in cascade and air to acid gas ratio is set at about 2:1 (This ratio will be adjusted based on feed gas composition) before acid gas intake.**
16. **Introduce acid gas to main burner by actuating 36HS-006O from DCS. By this action 36UV-003 and 36FV-001 are opened, thereby admitting acid gas to the main burner. Within 30 seconds the acid gas flow must be established and the low-low flow alarm 36FALL-002 (1000 NM3/Hr) has to be cancelled other wise again acid gas will be cut off. After this 30 seconds acid gas KOD high-high level override also will be cancelled and if any high level comes it will cut off the acid gas. Keep the main air controller in cascade, so that the main airflow will follow automatically the acid gas flow as per the set ratio. Slowly increase the acid gas flow and Shut-off fuel gas supply to main burner. Take all the acid gas and stop acid gas flaring. Put the acid gas flow controller 36FC001 in to cascade and the regenerator over head pressure controller in to auto. Adjust inlet temperature of reactors to 230°C (First Rx) & 210°C (Second Rx).**
17. **Line up tail gas analyzer, adjust H2S/SO2 ratio to 2:1(H2S-2SO2=0) Put the analyzer controller 36AC001 in Auto with set point "0" and put the trim air controller 36FC008 in Cascade. Set the Bias value (875 NM3/Hr), this value will be 50% of the trim air design flow (1750 NM3/Hr) and put the load-sharing controller 36FC012 in cascade. This load-sharing controller will maintain trim air controller flow at 50% (875 NM3/Hr) of its design flow. If the tail gas analyzer controller PV goes to positive value (above "0"), first the trim air controller will open and adjust the PV to "0" than the load sharing controller slowly will shift the flow (What ever the increased trim air flow) to the main air controller and it will reduce the trim air flow back to 50%(875 NM3/Hr). If the tail gas analyzer controller PV goes to negative value (less than "0"), first the trim air controller will close and adjust the PV to "0" than the load sharing controller will slowly reduce the main air flow (What ever the reduced trim air flow) and it will increase the trim air flow back to 50%(875 NM3/Hr).**
18. **Set Air to SWS gas ratio based on the gas composition (2.8:1) and introduce SWS gas to main burner. Ensure that the temperature in the combustion chamber remains above 1300 °C for proper ammonia destruction.**
19. **Start sulfur pump and degassing system.**

17. Explain about TGTU start up?

A.

1. **Purge the system with nitrogen and bring down the oxygen content to less than 0.4%.**
2. **Fill the quench column with condensate up to 50% level and establish the circulation (put the filter and coolers in service). Close quench column outlet block valve to absorber and Commission quench column out let Start up vent line to incinerator and maintain the pressure at 0.1bar with nitrogen.**
3. **Commission the recycle circuit by opening the following valves:**
    a) **Open all valves in start up / recycle line**
    b) **Open ejector suction and discharge valves.**
    c) **Start the ejector by opening steam supply to ejector and Close the main process valve between ejector suction and discharge (Ejector Bypass valve). Open make up nitrogen as required.**
4. **Recycle gas is now routed from the outlet of the quench column back to the SCOT mixing chamber. As soon as the quench column out let low-low flow limit exceeded, logic will allow start-up procedure to proceed.**

5. **Line up the nitrogen purges to flame scanners and sight glasses and light up the SCOT burner as per the light up sequence.**
6. **Introduce the reduction hydrogen to the SCOT mixing chamber by activating 37HS012 from DCS. By this action import hydrogen line bleed shut off valve will close and both block shut off valves will open. Open flow control valve 37FC008 and bring up the hydrogen concentration up to 3% at quench column outlet. Put the hydrogen flow control 37FC008 valve in cascade. 37FC008 will get the remote set point from the hydrogen analyzer controller 37AC004. Put hydrogen analyzer controller in to Auto with set point 3%.**
7. **Raise the SCOT reactor catalyst temperature slowly to 200□C. Maintain air to fuel gas ratio Substoichiometrically (80-90%). This Substoichiometric firing will produce reducing gas (H2). As the hydrogen concentration increases, import hydrogen controller 37FC008 will get closed completely. If the catalyst is not presulfided, don't increase the temperature above 200□C. In presence of hydrogen and at above 200□C temp the catalyst will be over reduced and its activity will be decreased.**
8. **If the catalyst is new or if it is a regenerated (passivated) catalyst than only catalyst presulfiding is required. The SCOT reactor catalyst (cobalt and molybdenum oxide) is supplied by the manufacturer in the oxides form. These oxides have to be converted in to sulfides. When the catalyst bed temperature reaches 200°C, start acid gas (H2S) injection through acid gas presulfiding line to the SCOT reactor. Keep H2S content at 1% vol. and H2 content at 3% vol. Now slowly increase the reactor inlet temperature step by step up to 250°C and also increase the H2 concentration to 6% Vol. Once the reactor inlet and reactor outlet H2S remains same, that means presulfiding is completed. Increase the temp to 300°C and hold these conditions for 4 hours and than cut of the acid gas (H2S) injection to the reactor. Adjust the reactor inlet temperature to 280°C and H2 content to 3% Vol. Sulfiding is an exothermic reaction care must be taken.**
9. **Purge the absorber section and bring down the oxygen content less than 0.5% and introduce lean solvent in to the absorber (If the oxygen contacts with the amine solution, it will deactivate the solution by forming some organic acids). Increase the absorber bottom level up to 50% and start the Semi-lean solvent pump and send the semi lean solvent to the ARU (amine regeneration unit). The start-up of the absorption section should be in close co-operation with the Amine regeneration section. Adjust the solvent circulation as required.**
10. **Before tail gas feed intake ensure the following conditions.**
    a) **SCOT reactor inlet temperature should be 280□C and the H2 content in recycle gas should be 3% vol.**
    b) **Check the SO2 content in tail gas, which should not be higher than 0.5%vol.**
    c) **The manual valve in the gas inlet of the absorber is closed.**
    d) **The reduction section is on internal circulation and the pressure is controlled by venting off the generated combustion gases via the start-up vent line pressure control valve 37PC009 to the incinerator.**
    e) **The quench and absorption section are under circulation and ready for tail gas feed intake. .**
11. **Open SCOT tail gas feed valve by activating 37HS004 from DCS. By this action tail gas feed valve 37PDC002 solenoid will get energized and the control valve will go to auto mode with the set point of 0.03bar. Now the tracking signals of 36PDC-002 is withdrawn. Thereby the controller mode, output and set point become accessible for the operator. 37PDC002 differential pressure is measured between 37PDC002 control valve U/S (normal pressure 0.28 bar) and control valve D/S (normal press 0.25 bar).**
12. **Close the SCOT tail gas bypass valve by activating 37HS002 from DCS. By this action 37HC001 solenoid will get energize and it will remains in manual mode with 100% opening. Now the tracking signal is withdrawn and operator will get access to operate tail gas bypass valve 37HC001.**
13. **Now slowly introduce Claus tail gas by slowly closing the SCOT by-pass valve 37HC001. Keep 37PDC002 in auto mode with the set point of 0.03bar. As soon as the measured differential pressure of 37PDC002 (PV) exceeds the normal set point, than the 37PDV-002 will automatically open and tail gas will be introduced into the SCOT section. The process gas from the quench column is routed via the pressure control valve 37PC009 to the incinerator. Keep 37PC009 in auto with set point 0.1 bar.**
14. **Check the SO2 content of the SCOT reactor outlet it should be less than □10 PPM. Adjust the operating conditions and introduce process gas from the quench column to the absorber.**

15. **Open absorber inlet valve and absorber outlet long recycle loop valve back to the SCOT mixing chamber (Keep absorber main outlet valve to incinerator close). This long recycle is used to keep absorber in service during low through put (less than 40% loads, to avoid quench column low-low flow trip).**
16. **Close the quench outlet start up short recycle line valve.**
17. **Slowly increase the feed gas and close SCOT by-pass 37HV001 completely. As soon as 37PDV-002 opens completely, this 37PDC002 open indication will close 37HV001 completely by a tracking signal (after that it can not be operated).**
18. **As the feed gas increases (Load more than 40%), unit pressure increases will increase and 37PV-009 will get wide opened.**
19. **Now slowly open the absorber main outlet valve to the incinerator and close the absorber outlet start up long recycle valve.**
20. **Open the ejector process gas bypass line valve and stop the ejector.**
21. **Adjust the SCOT section to the required operating conditions.**
    a. **Weighted average reactor bed temperature 37TC026 to be at least 300 □C.**
    b. **Reactor inlet temperature 37TC004 to be at least 280 □C.**
    c. **H2 at outlet of quench column to be approx. 2% vol.**
    d. **Ratio H2S/SO2 content in Claus tail gas to be 2.0.**
    e. **Quench water circulation to be such that the gas outlet temperature is 41 □C**
    f. **PH of quench water should be maintained in between 6 to 7.**
    g. **Solvent solution circulation to be such that H2S content in absorber outlet gas is less than 250 ppm vol.**

18. Explain about thermal reactor light up sequence and what are the start permissives?

A. The following are the thermal reactor start permissives.

a. **Waste heat boiler level not low-low (36LALL-005).**
b. **Fuel gas supply pressure not high-high (36PAL-010) and the fuel gas KO drum level not high-high (7LAHH-004).**
c. **Ensure the emergency shutdown switches are in the correct position (36HS-020/021, 36HS-022/023 and 37HS-027/028).**
d. **Ensure that the acid gas valves (36UZSL-003, 36FZSL-001), SWS gas valves (36UZSL-004, 36FZSL-003), the fuel gas valves (36FZSL-022, 36UZSL-009) and the tail gas valve to the SCOT section (37PDZSL-002/004) are closed and that the fuel gas bleed (36UZSH-010) and the tail gas valve to incinerator section (37HZSH-001) are opened.**
e. **Main burner scanners not detecting any flame (36BY-001/002).**
f. **Unit pressure is not high-high (36PTHH-006).**
g. **Ensure that at least one of the main air blowers is in operation (36KM-3601A/B).**
h. **Igniter lance is fully retracted (36XZLH-001).**
i. **Ensure that the incinerator section is in operation.**

<u>Thermal reactor light up sequence:-</u>

a. **If above all permissives are OK than reset the logic system 36HS-017 from DCS for the Claus section.**
b. **To start the ignition sequence, activate the 36HS-018 from DCS. The following steps will take automatically.**
c. **Purge will start by Opening 36UV-008 thereby admitting N2 to the main burner. When the flow is established, the purge timer is started. The required flow shall be reached within 15 seconds if not, purge sequence is aborted and procedure is to be restarted (The purge nitrogen control valve will get open up to the predefined out put. If this out put is not enough to achieve the minimum purge flow than control valve can be opened little more from DCS. This out put adjustments no need to change every time. These adjustments will be done during commissioning time and the out puts are fixed). If the flow is notable to achieve check the line up and nitrogen header pressure for normal. If the required flow is established within 15 seconds than the purge timer will start**

and this timer elapses after 5 minutes, there by closing 36UV-008 (nitrogen) and allowing to proceed to next step.

d. **When the nitrogen purge has been completed, the ignition lance is automatically inserted. Simultaneously, 36UV-006 (air to burner) is automatically opened, thereby admitting air to the burner. 36FC-006 (main air) remains open in MANUAL at the predefined output. Within 30 seconds, the airflow must be established (Low-low air flow alarm as to be cancelled) and the ignition lance must be fully inserted, otherwise the ignition procedure is aborted. The output value shall be adjustable in the DCS, in case ignition is hard to obtain at the specified output.**

e. **As soon as the airflow exceeds the setting of 36FAL-010 and a fully inserted lance is detected, the fuel gas bleed is closed (36UZSL-010), this close indication will energize the solenoids of the fuel gas valves and the fuel gas valves 36UV-009 and 36FV-022 are opened thereby admitting fuel gas to the burner. Fuel gas valve 36FC-022 remains in MANUAL mode at the predefined output. The ignitor is energized for 5 seconds. After this 5 seconds ignition, flame scanners override will be cleared and the flame has to be detected with in 5 seconds. After purge complete, with in 40seconds flame has to be detected by the scanners (30seconds for opening the air valves and inserting the ignitor + 5 seconds for opening the fuel gas and for ignition + 5 seconds for scanner flame detecting) , if the flame is not detected with in 40 seconds, than the ignition sequences will be aborted. In case ignition is hard to obtain at the specified output, fuel gas and air control valves output shall be adjustable in the DCS (This out put adjustments no need to change every time. These adjustments will be done during commissioning time and the out puts are fixed).**

f. **In case of a successful ignition, the ignitor is automatically retracted with in 1minute (If not retracted with in 1 minute again the ignition sequences will be aborted). The air and fuel gas controllers will become accessible for the operator after the flame stabilization period of 1 min.**

g. **After establishing a stable flame pattern, adjust the size of the flame by adjusting fuel gas flow not lower than 65 Nm3/h (Low limit) and airflow not lower than 1750 Nm3/h (Low limit) through the main airline. This results in a "330 % of stoichiometric burn", i.e. with 230 % excess air. Adjust the air to fuel gas ratio as required based on the hot / cold start up. If it is hot start up excess air is not allowed so increase the fuel gas by keeping the air flow same and adjust the ratio to stoichiometric (8.4 : 1). Introduce the steam and adjust the steam flow as required. This steam is to cool the acid gas burner nozzle and to control the thermal reactor temperature. Set the air/fuel gas ratio in the ratio setter (36HC-014) based on the requirement and put 36FC-022 in to AUTO and then put 36FC-006 in to CASCADE.**

19. Explain about SCOT heater light up sequence and what are the start permissives?

A. The following are the SCOT heater start permissives.

a. **Quench column overhead gas temperature is not high (37TAHH-011).**
b. **Ensure the emergency shut-down switches are in the correct position (36HS-020/021, 37HS-013/014 and 37HS-027/028).**
c. **Fuel gas supply pressure not low (37PTLL-007) and the fuel gas KO drum level not high (37LTHH-004).**
d. **Ensure that the fuel gas valves (37UZSL-003/37FZSL-007), reducing gas valves (37UZSL-004/005) and the tail gas valves to the SCOT section (37PDZSL-002/004) are closed and that the fuel gas bleed (37UZSH-007), the reducing gas bleed (36UZSH-006) and the tail gas valves to incinerator section (37HZSH-001/ 003) are opened.**
e. **Ensure that at least one of the main air blowers is in operation (36KM-3601A/B).**
f. **Ensure that the incinerator is in operation (37BY-004/005).**
g. **Ensure that the SCOT burner scanners not detecting flame. (37BY-001/002).**
h. **The ignitor lance is fully retracted.**

<u>SCOT heater light up sequence:-</u>

a. **If above all permissives are OK than reset the logic system for the SCOT section by 37HS-015 from DCS.**
b. **Start the start up ejector by activating 37HS018 from DCS and recycle the gas from the outlet of the quench column back to the SCOT mixing chamber. As soon as the low limit of 37FALL-018 (Quench column outlet gas flow) has been exceeded ignition sequence can be started.**
c. **To start the ignition sequence, activate the 37HS-017 from DCS. The following steps will take automatically.**
d. **Purge will start by opening 37UV-001 (nitrogen to SCOT line burner), there by admitting nitrogen to the SCOT burner. The required flow shall be reached within 15 seconds. If not, the purge sequence is aborted and the procedure has to be restarted. (The purge nitrogen control valve will get open up to the predefined out put. If this out put is not enough to achieve the minimum purge flow than control valve can be opened little more from DCS. This out put adjustments no need to change every time. These adjustments will be done during commissioning time and the out puts are fixed). When the required purge flow is established with in 15 seconds than, the purge timer will start and this timer elapses after 5 minutes, thereby closing 37UV-001 (nitrogen) and allowing to proceed to next step.**
e. **When the nitrogen purge has been completed, the ignition lance is automatically inserted. Simultaneously, 37UV-002 (air to SCOT burner) is automatically opened, thereby admitting air to the burner. 37FC-005 (air) remains in MANUAL at the predefined output. Within 30 seconds, the airflow must be established (Low-low air flow alarm has to be cancelled) and the ignition lance must be fully inserted, otherwise the ignition procedure will be aborted.**
f. **As soon as the airflow exceeds the low setting of 37FALL-06 and a fully inserted lance is detected, the fuel gas bleed is closed, this close indication (37UZSL-007) will energize the solenoids of the fuel gas valves and the fuel gas valves 37UV-003 and 37FV-007 are opened thereby admitting fuel gas to the burner. Fuel gas valve 37FC-007 remains in MANUAL mode at the predefined output. The ignitor is energized for 5 seconds. After this 5 seconds ignition, flame scanners override will be cleared and the flame has to be detected with in 5 seconds. After purge complete with in 40seconds flame has to be detected by the scanners (30seconds for opening the air valves and inserting the ignitor + 5 seconds for opening the fuel gas and for ignition + 5 seconds for scanner flame detecting), if the flame is not detected with in 40 seconds, than the ignition sequences will be aborted. In case ignition is hard to obtain at the specified output, fuel gas and air control valves output shall be adjustable in the DCS (This out put adjustments no need to change every time. These adjustments will be done during commissioning time and the out puts are fixed).**
g. **In case of a successful ignition, the igniter is automatically retracted with in 1minute (If not retracted with in 1 minute again the ignition sequences will be aborted). The controllers of air and fuel gas to the burner become accessible for the operator after the flame stabilization period of 1 min.**
h. **Adjust air to fuel gas ratio to sub stoichiometrically (80-90%) and set ratio in the ratio setter. Due to sub stoichiometric firing Hydrogen is produced and import hydrogen can be slowly cut off. Put the air controller in cascade. This air controller will get the remote set point from ratio setter calculation block (Fuel gas flow × ratio (8.5) × stoichiometric % (1=100%Stoicho, 0.9=90%Stoicho, 1.1=110%Stoicho) will be the remote set value for airflow controller).**

   <u>Example</u>: - If the fuel gases flow is 150NM3/Hr,

   Air to fuel gas ratio is 8.5 (This value is set by the operator in the ratio setter).

   Stoichiometric is 85% (This value is set as 0.85 by the operator in the Stoichio setter)

   Than the air controller remote set point will be 150×8.5×0.85 = 1083NM3/Hr.

i. **Put fuel gas controller in to cascade. This fuel gas controller will receive remote set point from reactor inlet temperature controller. Put the reactor inlet temperature controller in to auto and slowly increase the reactor inlet temperature at the rate of 30□C/Hr up to 280□C, than cut-in the tail gas and stabilize the SCOT reactor**

temperatures. Put the reactor inlet temperature controller in cascade. This reactor inlet temperature controller will get the remote set point from reactor weighted average bed temperature controller 37TC026. Put reactor weighted average bed temperature controller 37TC026 in to auto with the set point 300 - 320□C. The fuel gas flow to the burner is controlled by the reactor inlet temperature controller 37TC004 and this reactor inlet temperature is again adjusted by the weighted average bed temperature controller 37TC026.

Aver bed temp controller →Reactor inlet temp controller →Cal→ Fuel gas controller

(Auto) (Cascade) (Cascade)

Reactor inlet temperature controller 37TC004 out put will go to a calculation block in that calculation block temp controller out put is multiplied with quench column outlet flow and this value is divided by design quench flow and than the final out put will go as remote set point to the fuel gas controller.

Example: - If the reactor inlet temperature controller output is 40%,

Quench column outlet flow is 11000 NM3/Hr,

Quench column outlet design flow is 15275NM3/Hr and

Fuel gas flow controller range is 0 - 500 NM3/Hr,

Than the fuel gas controller remote set point will be (40×11000)/15275 = 28.8%.

This output 44% will be rescaled in terms of flow 500×0.288 = 144 NM3/Hr and this 144NM3/Hr will go as a remote set point to the fuel gas controller.

20. Explain about Incinerator light up sequence and what are the start permissives?

A. The following are the Incinerator start permissives.

a. **Incinerator waste heat boiler level is not low (37LALL-006).**
b. **Ensure the emergency shut-down switches are in the correct position. (36HS-020/021 and 37HS-027/028).**
c. **Fuel gas supply pressure is not low (37PTL-019) and the fuel gas KO drum level is not high (37LAHH-004).**
d. **Ensure that the fuel gas valves (37UZSL-011/37FZSL-026) are closed and that the fuel gas bleed (37UZLH-010) is opened.**
e. **Incinerator temperature (37TTHH-024) is not high.**
f. **Ensure that at least one of the incinerator air blowers is in operation (37KM-3701A/B).**
g. **Incinerator flame scanners are not detecting flame (37BY-004/005).**
h. **The ignitor lance is fully retracted (37XZSH-004).**

<u>Incinerator light up sequence:-</u>

a. **Commission combustion air and nitrogen for purging of the flame detectors and sight glasses.**
b. **If above all permissives are OK than Rest the logic of the incinerator by 37HS-024 from DCS.**
c. **To start the ignition sequence, activate the 37HS-025 from DCS. The following steps will take automatically.**
d. **Purge will start by opening 37UV-009 (air to incinerator), thereby admitting primary air to the burner and secondary air to the incinerator. The required flow shall be reached within 30 seconds and low-low flow alarm 37FALL-024 has to be cancelled. If not, than the purge sequence is aborted and the procedure is to be restarted (The primary and secondary air control valves will get open up to the predefined out put. If this out put is not enough to achieve the minimum purge flow than primary control valve can be opened little more from DCS. This out put adjustments no need to change every time. These adjustments will be done during commissioning time and the out puts are fixed). When the required purge flow is established with in 30 seconds than, the purge timer is started and**

this timer elapses after 3 minutes. After purge, Primary and secondary air control vales still remain open at the predefined out.

e. **When the purge is completed, the ignition lance is inserted. When a fully inserted lance is detected, the fuel gas bleed is closed, this close indication (37UZSL-010) will energize the solenoids of the fuel gas valves and the fuel gas valves 37UV-010 and 37FV-026 are opened thereby admitting fuel gas to the burner. Fuel gas valve 37FC-026 remains in MANUAL mode at the predefined output. The ignitor is energized for 5 seconds. After this 5 seconds ignition, flame scanners override will be cleared and the flame has to be detected with in 5 seconds. After purge complete with in 40seconds flame has to be detected by the scanners (30seconds for opening the air valves and inserting the ignitor + 5 seconds for opening the fuel gas and for ignition + 5 seconds for scanner flame detecting), if the flame is not detected with in 40 seconds, than the ignition sequences will be aborted. In case ignition is hard to obtain at the specified output, fuel gas and air control valves output shall be adjustable in the DCS (This out put adjustments no need to change every time. These adjustments will be done during commissioning time and the out puts are fixed).**

f. **In case of a successful ignition, the ignitor is automatically retracted with in 1 minute (If not retracted with in 1 minute again the ignition sequences will be aborted). The controllers of air and fuel gas to the burner become accessible for the operators after the flame stabilization period of 1 min.**

g. **Incinerator air to fuel gas ratio will be always super stoichiometric (about 160%) Set the air to fuel gas ratio in the ratio setter (8.5). The primary air controller will supply 80% of the required airflow and the secondary air controller will supply another 80% of the flow.**

h. **Put the primary air controller in to cascade. This Primary air controller will get the remote set point from ratio setter calculation block (Fuel gas flow × ratio 8.5 × Stoichiometric 0.8). Primary airflow varies only based on the fuel gas flow.**

i. **Put the secondary air controller in to cascade. This secondary air controller will get remote set point from three places.**
    a. **From ratio setter calculation block (Fuel gas flow × ratio 8.5 × Stoichiometric 1.6 – primary airflow)**
    b. **From Stack oxygen analyzer controller.**
    c. **From Incinerator temperature controller**

Incinerator temp controller out put

(Ratio setter±O2 controller demand) output → High selector→ Secondary air controller

The oxygen analyzer controller value is added or subtracted (Based on the stack O2%) to the ratio setter value. If the Oxygen controller out put is at 50% than the oxygen demand is "0". When the Oxygen controller out put increases above 50% (PV is less than SP) that means oxygen demand is increased and this value is added to the ratio setter and when the out put decreases less than 50% (PV is more than SP) that means oxygen demand is reduced and this value is subtracted from the ratio setter. This ratio setter out put will goes to high selector. In this high selector incinerator temperature controller out put and ratio setter out put are compared and which ever out put is high that out put value will goes as a remote set point to the secondary air controller. Incinerator temperature controller is a split range controller. When the Temp controller out put is 100% - 30% fuel gas control valve will be operated and when the Temp controller out put is 30% - 0% secondary air control valve will be operated.

j. **Put the fuel gas controller in to Cascade. This fuel gas controller will get the remote set point from incinerator temperature controller. Put the incinerator temperature controller in to Auto with set point 760 C.**

k. **If the incinerator temperature goes high, than the incinerator temp controller out put will start reducing. When the output is coming down from 100-30% first fuel gas will be reduced to the minimum opening about 15% (Due to low limit block fuel gas valve will not close completely even though it receives remote set value "0"). If still the temperature is more, than the output will be reduced 30-0%. When the out put is reduced below 30% it will increase**

the secondary airflow to cool down the temperature. If TGT unit is running, than the fuel gas valve always will be opened more than 40% to maintain the incinerator temperature. If TGT unit not running and if there is upset in SRU and if more H2S comes in of gas than the fuel gas controller will goes to minimum opening and secondary air will get open more for cooling down the temperature.

l. Put the stack analyzer controller in to auto with set point 2 %.

21. Explain about SRU and TGTU shut down up procedure?

A. There are three shutdown procedures.

a. Normal shutdown for short period.

The unit remains under inert gas atmosphere and is immediately ready for start-up.

b. Normal shutdown for long period.

The unit has to be opened. In that case the catalyst has to be regenerated (passivated).

c. Emergency shutdown. The unit is shutdown automatically by the emergency shutdown system (process trips) or manually by the operator by actuating the shutdown switches in the control room or in the plant.

<u>TGTU Normal shutdown for short period:-</u>

a. Actuate 37HS-004C from DCS. By this action 37HC001 tracking signal will be with drawn. Open 37HC001 slowly. Keep 37PDC002 in auto with set point 0.03 bar. As soon as the measured differential pressure of 37PDC002 (PV) reduces than the normal set point, 37PDV-002 will start closing.

b. Commission the "long recycle" circuit (e.g. via absorber), including start-up vent line and steam tracing on the circuit.

c. Line up the Ejector and start the start-up ejector. Slowly close the main process valve (Ejector bypass valve) between the suction and discharge of the ejector.

d. Close the main valve at the absorber outlet and Keep start up vent line pressure control valve 37PC009 in auto with set point 0.1bar.

e. Slowly open 37HV-001 fully and close 37PDV-002. As soon as 37HZLH-001 (tail gas bypass to incinerator) detects a fully open position, the following sequence takes place:

1. Solenoid 37HY-001 is de-energised, thereby keeping 37HV-001 full open.

2. Solenoid 37PDY-002 is de-energised, thereby keeping 37PDV-002 closed.

f. Stop the reducing gas supply. Close the other valves in the reducing gas line. Adjust SCOT burner to stoichiometric (95% - 100%) combustion.

g. After the H2 content in the recycle gas has dropped to 1% vol. than stop the SCOT burner. Close the air and natural gas supply.

h. Stop the start-up ejector by closing the steam supply. Purge the recycle ejector with nitrogen.

i. Close the valve in the absorber feed line and the valve in the start-up/vent line.

j. Introduce a nitrogen purge flow into the SCOT off-gas lines to avoid overheating from hot gas from the incinerator.

k. Stop the quench water pump P-3701A/B and stop the quench water coolers. Stop the sea water supply.

l. Absorber solvent circulation can be kept ON for short shut down. If it required, stop the supply of lean solvent solution to the absorber and stop the absorber bottom pump P-3702A/B. Close block valves completely in the solvent lines and isolate the absorber.

m. The unit is now isolate under an inert gas atmosphere. The catalyst bed in the reactor is still hot, close to normal operating temperature (200 - 250 °C).

TGTU Normal shutdown for long period:-

a. **Follow the above procedure up to step "f".**
b. **After the H2 content in the circulating gas has dropped to below 1% vol, reduce the catalyst bed inlet temperature to 100 - 120 °C.**
c. **Keep the quench column in circulation and maintain the PH above 6.**
d. **Commission the "Short recycle" circuit (Quench column Outlet to mixing chamber) and isolate the absorber section and "Long recycle" circuit.**
e. **Close semi-lean solvent block valve gradually and then stop P-3702A/B. Close block valves completely in the solvent lines and isolate the absorber.**
f. **If the absorber is going to open for inspection or for any other maintenance than drain out all remaining solvent in the column to closed drain drum (keep purge nitrogen open to maintain positive pressure).**
g. **Flush the absorber with condensate and drain out all spent condensate to closed drain drum. Flush the absorber again and drain to sewer. Purge with nitrogen than install blinds at gas inlet, gas outlet, solvent supply and solvent discharge. Steamed out The absorber. After steaming leave the top vent open. This is to prevent vacuum creation during steam condensation.**
h. **If the reactor temperature is 60 - 70 °C and the H2 content in the circulating gas is still below 1% vol. than stop the SCOT burner. Close the air and natural gas supply and blind off the natural gas supply. Maintain positive pressure in the section, by supplying N2 to the system. If the reactor is not going to open than it has to be isolated positively, air should not enter in to the reactor.**
i. **If the reactor is going to open for inspection or for changing the catalyst than the reactor catalyst has to be passivated.**
j. **After some time of operation, SCOT reactor catalyst becomes pyrophoric due to the presence of iron sulfide (FeS). Exposure of the pyrophoric catalyst to air would result in uncontrolled burning and it may damage the catalyst and the reactor. Therefore controlled oxidation of the FeS in the reactor is carried out by introducing a controlled amount of plant air into the circulating gas. This procedure is called passivation of the catalyst and in most cases takes about two days. During this operation pyrophoric iron FeS is converted into non-pyrophoric iron compounds. During the catalyst passivation to control the catalyst bed temperatures, the reactor inlet temperature is reduced to 60°C-70°C by cooling the recycle gas in quench column.**
k. **Passivation procedure:- Remove the blind in the passivation plant air line that joins into the recycle line circuit. During passivation frequently analyze the O2 content at the reactor inlet and the O2, SO2 and CO2 at the reactor outlet. Slowly admit plant air into the start up recycle line along with the recycle flow. Open make up nitrogen as required to increase the circulation rate. Start with introduction of 140 kg/h air indicated by means of 37FI-013. Maintain the O2 content at the reactor inlet at 0.1% vol. by increasing the passivation air as necessary and maintain this concentration. The pyrophoric iron FeS is converted into non-pyrophoric iron compounds by controlled burning. Formation of SO2 (Due to sulfur compounds burning) in the reactor indicates the progress of oxidation (passivation).**

The CO2 content of the circulating gas should almost not increase, as this would indicate combustion of carbon. At a consistent increase of more than 0.5 vol.% CO2 over the reactor, the air supply must be reduced (carbon burning will take place at above 400°C. During sulfur compounds burning, at that location temperature may go up more than 400°C. If there is an excess air carbon will start burning and locally it will be over heated). The reactor outlet and reactor bed temperatures must be kept below 100°C. If the temperature rising more than 100°C than reduce the O2 content by reducing or stopping the plant air supply.

PH of the circulating quench water may reduce due to more SO2 coming from the reactor. It should remain above 6. For this purpose it is necessary to inject NH3.

Increase the oxygen content at the reactor inlet slowly in steps of 0.1% vol. keeping a close check on reactor outlet temperature and gas composition. When an O2 concentration of 1% vol. has been reached, gradually increase the O2 content to 2% vol. Maintain a close watch on the reactor temperatures and at any sign of an increase to above 100 □C, reduce the O2 content. If the maximum air quantity is introduced the O2 content in circulation gas can be controlled by reducing the make up (purge) N2.

When no further heat release in the reactor is observed and the analyses of the reactor effluent gas indicate that no more chemical reactions take place, slowly increase the O2 content of the circulating gas to about 20% vol. This means that pure air is circulated (make up N2 is closed). After the oxygen content of the circulating gas has been raised to 20% vol. maintain this condition at a reactor inlet temperature of 60 - 70 □C for one hour.

Maintain maximum recycle gas with air, the cooling of the process gas in the quench column should be maximized in order to cool all equipment in the system. . After cooling down Stop the passivation plant air supply.

l. **If the reactor is not going to open than the catalyst passivation is not required. Cool the system with maximum inert gas (N2) circulation.**
m. **After the reactor has been cooled down as far as possible, than stop the start-up ejector. Purge the start-up ejector with nitrogen. Stop the nitrogen purge. Close the valve in the start-up/vent line.**
n. **Stop the circulating quench water pump and stop the quench water coolers. Stop the sea water supply.**
o. **Open the vent on top of the quench column. Pump the cooling water to the sour water stripper. Flush the system with condensate and drain this to sewer.**
p. **Close all battery limit valves. Insert the necessary blinds to isolate the unit from other units.**

<u>SRU Normal shutdown for short period (Keeping hot Stand by):-</u>

a. **During normal operation some Sulfur is absorbed in the pores of the catalyst. Prior to a scheduled shut-down it is necessary to remove the Sulfur from the catalyst to prevent Sulfur solidification inside the catalyst and to prevent the Sulfur fire inside the catalyst when it is exposed to air at a temperature more than 180°C. For this purpose the inlet temperatures of the reactors are raised 15 °C to 20 °C above the normal operating temperature and operated at this temperature for 48 hours prior to shut-down. In this way the absorbed Sulfur will evaporate from the catalyst bed and gets condensed in the Sulfur condensers and drained to the Sulfur pit. This operation is called heat soaking operation. After 48 hours of heat soaking operation the acid gas supply is stopped and the Claus section is purged with hot inert gas (flue gas). The inert gas is obtained by slight substoichiometric (95%) combustion of fuel gas and air in the main burner. Before excess air is introduced, the unit should be purged by inert flue gas for at least 24 hours and the catalyst beds should be cooled to 200 °C. This operation is called sulfur stripping operation. LLP steam is used for controlling the temperature. Also this steam will increases the mass inert gas flow through the unit. The ratio steam/fuel gas is approximately 4 - 6 on weight basis. The total flow rate through the unit will be approximately 20 – 30 % of the design flow rate. During this operation, no excess air should be introduced via the main burner as the Sulfur will react (burn) with the air on the catalyst which may result in too high a catalyst temperature and sulfatation of the catalyst.**
b. **The acid gas supply is stopped, but the Claus section is kept on hot stand-by, so that the Claus section can be restarted immediately on acid gas. The whole Claus section is kept hot during this period. The main burner remains in operation on fuel gas and the steam supply to the re-heaters is maintained. In this way the Claus section can be shut down for a few days or even for a few weeks.**

<u>In Detailed:-</u>

a. **Increase reactor inlet temperatures. Operate the re-heaters at their maximum duties to increase the inlet temperatures of the reactors to 15 °C to 20 °C above the normal operating temperatures. Maintain this situation**

for 24-36 hours. Watch the temperatures in the incinerator. Prepare nitrogen lines to the reactors, so that nitrogen can be injected if required. Drain the main burner steam supply line and keep it ready.

b. Start co-firing of fuel gas by activating 36HS031O from DCS. By this action fuel gas bleed 36UV010 (detected by 36UZSL010) will get closed and this close indication will open the fuel gas valves 36UV009 and 36FV022, thereby admitting fuel gas to the main burner. After 30 seconds the mode and set point of 36FC022 (fuel gas) and 36FC023 (steam to burner) is accessible for the operator.

c. <u>Shut off the acid gases</u>: - Reduce the SWS gas flow by 36FC003 and close SWS gas valve 36UV-004 and 36FV-003 by activating 36HS-007C from DCS.

d. Reduce the acid gas flow by 36FC-001 (but stay above the set point of 36FALL-002) and close 36UV-003 and 36FV-001 (acid gas) by activating 36HS-006C from DCS.

e. Introduce the steam flow to the main burner. The ratio steam/fuel gas is approximately 4 - 6 on weight basis.

f. <u>Sulfur Stripping from the catalyst: -</u> Adjust air to fuel gas ratio slightly substoichiometric. Increase the inlet temperatures of the reactors to at least 240 °C and maintain these temperatures for at least 24 hours. If the temperature in a reactor runs away above 350 °C, shut down the corresponding re-heater. If the temperature increasing above 350 °C inject nitrogen to the inlet of the reactor. In case the temperature drops below 150 °C start the re-heater again. The catalyst temperature should not exceed more than 400°C.

g. Maintain the following temperatures and pressures.

Main combustion chamber: 1000 -1400 °C

Waste heat boiler: 28 bar

Sulfur condensers: 3.8 bar

Reactors: 240 °C

Incinerator: 760 °C.

Incin. Waste heat boiler: 42.7 bar.

<u>SRU Normal shutdown For a long period.</u>

a. Initially follow the short period shut down procedure up to the last step.

b. Ensure that the sulfur stripping with the inert gas flow produced by main burner has done at least 24 hours and there is no sulfur coming from the seal legs.

c. Cool down the catalyst beds of the Claus reactors to 200 °C by means of shutting off the steam supply to the re-heaters. As soon as the catalyst bed temperatures of the reactors are 200 °C, slowly introduce excess air via the main burner. The initial O2 content in the flue gas from the main burner shall be approximately 1 % to be checked at condenser-1 outlet by oxygen analysis.

d. Bed temperatures must be watched for any sign of temperature increase. In the event the temperature shows indications of running away above 230 °C, reduce immediately the excess air. If the temperature tends to increase towards 350 °C, nitrogen should be injected into the reactors. The temperature should never exceed 400 °C. Watch the reactor bed temperatures and the tail gas SO2 care fully. After putting excess air, if there is no temperature rise is seen than it can be consider sulfur burning (Regeneration) is completed.

e. Gradually cool down the unit by introducing more excess air. Continue watching the reactor bed temperatures. As the temperature decreasing WHB and all condensers steam generation will stop. Once the steam generation is stopped isolate the headers and open the vents to atmosphere. Bring down the thermal reactor temperature to 300°C than close the fuel gas supply and the LLP steam supply to the main burner. Close the Sulfur outlets of the

Sulfur condensers. Purge the unit with air so that no hazards and wet combustion gases are presents any more, which can cause corrosion. After purging, stop air supply.

f. Isolate the boiler feed water supply and close the blow down valves at the waste heat boilers and Sulfur condensers. Drain the waste heat boiler and Sulfur condensers if necessary.

g. If the sulfur pit is going to open than empty the Sulfur pit and close the valves in the Sulfur transfer line to the Sulfur storage tank.

h. If it is necessary to open the Sulfur lines and Sulfur seal legs, the seal legs can be emptied by blowing with steam. Otherwise Sulfur may be kept as liquid in the Sulfur locks by supplying heating steam.

i. Check if all shutdown valves are closed. Install blinds as required.

22. What are the reasons for foaming and how to control the foaming?

A. Foaming will take place due to liquid hydrocarbons and impurities coming along with the gas. Foaming can be controlled by skimming liquid hydrocarbons, by keeping the filters in continuous operation and by cleaning the filters as required. Absorber amine inlet temperature should be slightly more than the gas inlet temperature (Min 2 - 5°C); this is to avoid condensation of hydrocarbons. Adding antifoam will temporally control the foaming.

23. What are the reasons for absorber high differential pressure?

A. For high differential pressure main reason is foaming. Absorber inside trays damage and solution circulation rate or feed gas flow rate is more than design rate can also cause high differential pressure.

24. Absorber gas feed increases what are the other changes to be done?

A. If absorber feed gas increases according to that solution circulation rate and steam to re-boiler has to be increased. If the feed gas is completely cut off than reduce circulation rate and steam to re-boiler to minimum and keep the unit as a hot stand by. Even if the feed is delayed for 2-3 days also it is better to keep the unit under hot stand by.

25. If the H2S in the product gas (Absorber out let) is more than the Specification, than what are the actions to be taken to bring back to normal spec?

A. Increase the solution circulation rate, Adjust the steam flow to the regenerator re-boilers. Check the absorber for any foaming. Check the solution concentration and if required increase the concentration. Gas channeling due to absorber trays damage can also cause product off spec, in this case shut down the unit and rectify the problem or reduce the plant load (feed gas) to bring back the product spec.

26. What are the favorable conditions for absorption and regeneration?

A. For absorption favorable conditions are high pressure and low temperature. For regeneration favorable conditions are high temperature and low pressure.

27. What is the abbreviation of SCOT?

A. Shell Claus Off-gas Treating (SCOT). This Process will increase the sulfur recovery efficiency of Claus units from 95% to more than 99.8%.

28. Why pre-sulphiding is required for SCOT reactor (COMOX) new catalyst?

A. Pre-sulphiding is required for a controlled reaction. New COMOX catalyst is more active and this reduction reaction is an exothermic reaction. If the catalyst is not presulfided, than in presence of hydrogen and at above 200□C temp the catalyst will be over reduced and its activity will be decreased. It can also case a run away temperature due to a rapid reaction. The sulphided catalyst is pyrophoric so oxygen must not contact the catalyst either during operation or

shutdown. It can be exposed with oxygen only after proper regeneration (burn-off operation with controlled combustion air in an inert gas carrier).

29. SCOT reactor inlet temperature increases or decreases than normal operating temperature what will happen?

A. Reduction of SO2 and Sn ("n" lies between 1-8) can be achieved at the temperature of 230˚C but the hydrolysis of COS and CS2 required minimum 290˚C. There fore the optimum inlet temperature is 280˚C. Inlet temperature will be varying based on the weighted average reactor bed temperature. It means reactor inlet temperature plus 2/3 of the temperature rise over the reactor. It should be 300-340˚C (If the inlet temp 280˚C and outlet temp 310˚C than the weighted average temp will be 280 + 30×2/3 = 300˚C). Reactor outlet temperature will vary based on the SO2 content of the tail gas. 1% volume of SO2 in tail gas will rise 70˚C temperature. Normally tail gas contains about 0.44% volume of SO2. Oxygen is normally not present in the tail gas. 1% of oxygen will rise 15˚C temperature. To avoid Excess Oxygen entering through SCOT burner Air to Fuel gas ratio all the time has to be maintained substoichiometrically (80-90%). Due to this substoichiometric burning hydrogen is produced and this hydrogen is used in the COMOX reactor for the reduction reaction. Very low substoichiometric (70-80%) ratio will produce more carbon and it gets deposited on the catalyst and deactivates the catalyst. If the ratio is less than 70% it may put of the flame. If the reactor temperature goes above 450˚C catalyst will get damage.

30. If SCOT reactor outlet hydrogen concentration decreases what will happen and what are the reactions?

A. Normally reactor outlet hydrogen concentration will be about 2%. If SCOT reactor outlet hydrogen decreases less than 1% reduction of SO2 and Sn to H2S will not be completed. Reactor outlet effluent SO2 will increase and recovery will come down. Normally Reactor outlet SO2 will be about 10PPM.

$SO2 + 3H2 \rightarrow H2S + 2H2O$

$Sn + nH2 \rightarrow nH2S$ (n = 1 – 8)

$COS + H2O \rightarrow CO2 + H2S$ (Hydrolysis reaction)

$CS2 + 2H2O \rightarrow CO2 + 2H2S$ (Hydrolysis reaction)

31. What is the reason of incinerator temperature upsets?

A. If H2S concentration in OFF gas coming to incinerator varies than the incinerator temperature will also varies. This may happen due to some upset in SRU or TGTU. Normally the SCOT absorber outlet gas contains H2S less than 300PPM.

32. How much is the incinerator stack oxygen concentration and if it goes high or low what will happen?

A. Incinerator stack normal oxygen concentration is 2.0%. If it goes too low complete oxidation of H2S to SO2 will not take place. If it goes too high it consumes more fuel gas to maintain normal operating temperature, it is wastage of fuel.

33. What are the reasons of SCOT COMOX reactor high differential pressure?

A. Soot or Carbon formation is the main reason for high differential pressure. Too low substoichiometric (<80%) firing in SCOT burner is the main reason for Soot or Carbon formation.

34. Explain about sulfur degassing system?

A. The sulfur is degassed by Shell Sulfur Degassing Process, which is based on bubbling air into the liquid sulfur. For successful degassing, the sulfur has to be within 130 - 155 ºC temperature. As the temperatures increasing the dissolves H_2S also will increases (300-400PPM) in the liquid sulfur. If the temperature rises above 160ºC than the Liquid sulfur viscosity will increase and the contact between air and sulfur is therefore reduced and effective degassing is not possible.

Stripping air is supplied to the degasser and sweep air is supplied to the vapour space above the liquid sulfur to keep the H_2S concentration in the vapour space below explosive limits. There are two start-up sequences for the Sulfur degassing system (short and long start up). When the system has been out of operation for more than one hour than the long start-up sequence is automatically selected. During long start up a lot of H_2S is released immediately after start up of the degasser. The quantity of sweep air is therefore kept high by keeping both ejectors in service. This is to avoid formation of an explosive mixture. After one hour the H_2S release reduces significantly, than the sweep airflow is reduced by stopping one ejector. If the degasser is tripped and if it is started with in one hour than it is started on short start up mode (there is no need of starting second ejector).

The stripping air has to be maintained at a certain level to prevent a build up of H_2S in the sulfur. Low-low stripping air flow will trip the degasser. The off gases from the degassing pit are routed through ejector to the Incinerator. The degasser is therefore tripped in case the Incinerator trips.

Sulfur degasser pit and its internals can be damaged by overheating due to back flow of hot gases from the incinerator or by the ignition of pyrophoric material in the pit. A high-high temperature trip is given to protection the pit internals. The trip function will shut the ejectors and air supply to the degasser. Open snuffing steam to put off the sulfur fires. Fires in pits are rare, but sometimes may occur during shut down and emptying out of the pit.

35. How to prevent formation of explosive mixture in degasser off gas?

A. **The advantage of using air is that the H_2S removal is partially enhanced by oxidation reactions:**

$$H2S + 1.5O2 \rightarrow SO2 + H2O$$

$$2H2S + SO2 \rightarrow 3/nSn + H2O$$

The disadvantage of using air is the risk of forming an explosive mixture in the gas phase. Diluting the degasser gases with sweep air prevents this explosive mixture formation. During normal operation about 0.75 Ton sweep air is required per 1 ton of stripping air. In case if the degasser is not in operation for more than one hour, than more H_2S could have accumulated in the liquid sulfur. A large quantity of H_2S may be released immediately after starting the stripping air. Therefore, 1.5 ton of sweep air per 1 ton of stripping air is used during the first hour of operation (Long start up).

- **The degasser trips in case the stripping airflow drops below its design value. This is to prevent high dissolved H2S in the liquid sulfur (H_2S will not be stripped out effectively from the liquid sulfur). In this case sweep airflow will not be tripped.**
- **The degasser trips in case the sweep airflow drops below its design value. This to prevent formation of explosive mixture (H2S LEL is 4% at 130°C and 4.3 at ambient temperature) and to prevent back flow of hot gases from the incinerator. In this case both stripping air and sweep air will be tripped.**

<u>Sulfur Properties:-</u>

1. **Solid sulfur (Rhombic α-Sulfur) Bright yellow colour melting point 113°C**
2. **Solid sulfur (Monoclinic β-Sulfur) Bright yellow colour melting point 119°C**
3. **Liquid sulfur (Nacreous γ -Sulfur, temperature range 120-160°C) Low viscous, light yellow colour.**
4. **Liquid sulfur (Amorphous μ -sulfur, temperature range 160-187°C) High Viscous, Dark red colour.**
5. **Sulfur vapour ($S_8 \leftrightarrow S_6 \leftrightarrow S_4 \leftrightarrow S_2$ Boiling point 444°C) yellow colour.**
6. **Density of solid sulfur at 293K (20°C)**

	Kg/m³
Rhombic α	2070
Monoclinic β	1960
Nacreous γ	2050
Amorphous μ	1920

7. **Density of liquid sulphur decreases linearly with the temperature, except in the range 150-187 °C, where structural changes occur in the sulfur rings. In this temp range there will not be much change in density.**

7. **Liquid sulfur viscosity decreases as the temperature increases from 120-160°C. At 160°C the viscosity will be at minimum value. Again liquid sulfur viscosity increases as the temperature increases from 160-187°C. At 187°C the viscosity will be at maximum value. In this range 160-187°C sulfur is getting polymerization to μ-chains that's why viscosity is getting increased. If the temperature increases above 187°C than again viscosity will get decreased due to the long chains are cracked.**

Safety:-

1) **Handing over of Acid gas KOD or any vessel for maintenance.**
   a) **Close Inlet and Outlet valves and Depressurize to flare.**
   b) **If there is any condensate, drain to the closed drain drum.**
   c) **Purge with Nitrogen to flare by pressure bumping (Pressuring to 6 bar and de-pressuring) 7 to 8 times and check H2S concentration, If it is less than 10 PPM, stop purging with nitrogen.**
   d) **Fix blinds at all lines connected to the vessel (nearest to the vessel).**
   e) **Remove steam purge line blind or if there is no steam purge line, connect steam hose and purge to flare for 8 Hours, Open KOD top vent to atmosphere and close to flare, Continue purging to atmosphere for 8 Hours. During steam purging time-to-time drain the condensate to closed drain. Fix blind at flare line.**
   f) **Stop Steam purge. Keep KOD vent open to avoid vacuum formation during steam condensation.**
   g) **Open top and bottom man way and fix exhaust fan at top man way for air circulation.**
   h) **After 2 to 3 hours check for gas test. If the gas test is Ok than confined space Permit can be issued.**
   i) **For confined Space entry all the time stand by person should be standing out side and watching the inside people. Keep the exhaust fan running for ventilation.**
2) **Confined space entry.**
   a) **Positive isolation (Complete isolation and blinding all connected lines near to the vessel)**
   b) **Purging and ventilation.**
   c) **Check for the Gas test in side the vessel (Before Doing gas test stop the exhaust fan wait for 10 to 15 Min and do the gas test. If the exhausts fan running it will not give the correct reading, because fresh air will be circulating it will sweep out the hazardous gas.)**
   d) **If the gas test result is ok than confined space Permit can be issued.**
   e) **For confined Space entry all the time stand by person should be standing out side and watching the inside people and Exhaust fan should be running for ventilation.**
   f) **Stand by person will be maintaining the record of the people working in side the confined space (i.e. Name of the person, Emp.No, Time In, Time Out). All the time he has to watch in side working persons, If he see inside any abnormality he as to call for help to rescue the inside people. Stand by person should not inter inside the vessel to rescue people.**

3) **Types of work permit system.**

   a) **Cold work permit. Normally permit colour will be Blue. It can be renewed for 5 Shifts (This renewal period will vary company to company).**
   b) **Hot work permit. Normally permit colour will be Red. It is valid for only one shift(This renewal period will vary company to company), for hot work we have to do the gas test around the work area about 10 meters circumstances. If any welding or grinding job, work spot to be covered with flame proof tarpaulin so that no sparks are spread. For all hot works fire extinguisher and water hose to be kept as stand by. For welding or other big hot works one person should be assigned for fire and safety watch.**
   c) **Confined Space permit. Normally permit colour will be Yellow or Green. We have to follow all confined space procedure. Mainly stand by person and gas freeing.**
   d) **Excavation permit. Normally permit colour will be White and it will be valid up to 14 days(This renewal period will vary company to company), this permit will contain all department heads signatures i.e. Electrical, Instrument, Maintenance and operation. If they are doing excavation with hand tools they have to take Cold work permit along with Excavation permit. Hot work permit to be taken along with Excavation permit if they are doing excavation with Jack hammer or any other tools which may creates spark. Any Excavation above 1.2 meters they have to take confined space permit along with Excavation permit and also they have to take cold or hot permit based on the tools they are using.**
   e) **Electrical Permit. Hot work permit and electrical permit both are same. There is no separate permit for electrical. For all electrical jobs hot work permit is used and also for vehicle entries hot permit is used.**

4) **In side the plant if you see one person is fall down unconsciously, what are the actions you will take?**
   a) **Check the wind direction and come out from that location (Come out Up wind direction)**
   b) **Communicate the message to Control room / Panel operator. (Siren will be given from control room to evocate all the people to the muster point)**
   c) **Wear breathing apparatus, take help of other people (All should wear breathing apparatus, don't go alone) and rescue the Victim.**

d) Find the source of the leak and cut of the source of leak.
e) Clear the area and after making Area safe all clear siren will be given.

Questions of Amine circuit

What is the gas composition at inlet of Amine contactor?

1. What is the gas flow at inlet of Amine contactor?
2. What is the purpose of Amine system?
3. What is the reason for DEA selection as absorbent?
4. What is the gas temperature and pressure at inlet of Amine contactor?
5. What is the design temperature and pressure of Amine contactor?
6. What will happen if gas temperature of contactor goes high?
7. What will happen if gas temperature of contactor goes too low?
8. What is the effect of V-0510 low level?
9. What is the effect of V-0510 high level?
10. How you will drain V-0510 upper portion level?
11. How V-0510 "ON/OFF" level loop works?
12. How many trays are in the Amine contactor?
13. What is the type of trays of Amine contactor?
14. What is the height of Amine contactor?
15. At which tray lean solution enters in Amine contactor?
16. At which tray wash water enters in Amine contactor? What is the purpose of wash water?
17. What is the concentration of lean solution?
18. What will happen if solution concentration is too low?
19. What will happen if solution concentration is too high?
20. What is the purpose of W-3330?
21. What is the purpose of W-3340?
22. What is the purpose of W-3320?
23. What is cleaning procedure of W-3330?
24. What is recommended level of Iron concentration level of Iron?
25. What will happen if level of Iron concentration level of Iron becomes too high?
26. What is the reaction of CO2 with Amine solution?
27. What is the temperature of lean solution at inlet of Amine contactor?
28. Why we keep lean solution temperature high than gas?
29. What is foaming or foam?
30. What happens if the delta P across the contactor starts to increase?
31. What is the purpose of wash water?
32. What is the normal level and pressure in the contactor?
33. What is the importance of TI's at different trays?
34. Why low level and high level securities are installed at the contactor?
35. What is the location of CO2 analyzer point "sensing point"?
36. Why CO2 analyzer sensing point is installed at the contactor top instead of K.O drum?
37. What will happen if the contactor level will loss?
38. What is the function /purpose of contactor over head K.O drum?
39. What is happen if the solution is carry over from the contactor? How you will control carry over?
40. Why gas is entered from the bottom of the contactor and not from the mid?
41. Why we are not using the semi lean solution?
42. Why high level and low level securities are installed at V – 0530?
43. What will happen if the level in V – 0530 becomes high?
44. What will happen if the level in V – 0530 becomes too low?
45. Why thermal relief PSV's installed at V-0510, V-0520, V-0530?
46. Why NRV is not installed at contactor gas I/L line?
47. Why not vent valve installed "auto vent v/v" at contactor gas inlet?
48. What is the design pressure & temp: of V-0510, V-0520, & V-0530?
49. What is flooding, channeling etc?
50. Why not packing is installed in the contactor?
51. What is weir height? Briefly describe tray liquid and gas paths?
52. What is the purpose of test switch at 105-XSDV-001?
53. How you will reset 105-XSDV-001/009/007/011?
54. What is the purpose of TDIC-002?
55. What is the purpose of 105-FV-010?
56. When we can give gas forward side? From amine O/L?
57. What is design pressure and temp: of V-3320 and the set point of PSV's?
58. What is the importance of level in the flash drum?
59. What is the purpose of the flash drum?
60. How we are controlling the pressure in the flash drum?
61. Where is PV – 002 O/L line is going and why? Define PV – 002 loop?
62. What will happen if flash drum pressure increases or decreases? What will happen?
63. What will happen if the flash drum level increases or decreases?
64. What will happen if the flash drum pressure becomes too high or low?
65. Why 105-LV-010 d/s line is of S/S?
66. Is there any option to drain flash drum? And contactor? Why?
67. What is the function of plate exchanger "E-3310"?'

68. What is the temperature of lean solution at inlet and outlet of E-3310?
69. What is the temperature of rich solution at inlet and outlet of E-3310?
70. What is the effect of high DP across E-3310?
71. What is the purpose of Amine Regenerator?
72. How many trays are in the Amine Regenerator?
73. What is the function of amine Reboiler?
74. How level of regenerator is controlled?
75. Describe the temperature control loop of regenerator?
76. What will happen if rich solution flow becomes zero to regenerator?
77. What will happen if Reboiler level loss occurs?
78. What is the design temperature and pressure of Amine regenerator?
79. What will happen if reflux flow to V-3330 becomes zero?
80. What is Auto Cut in logic of P-3340?
81. What is Auto Cut in logic of P-3330?
82. What is sealing fluid of P-3340, 3330,3350,3310,3320?
83. What is normal operating pressure of P-3340, 3330,3350,3310,3320 sealing fluid?
84. What is the purpose of Inert gas in tanks?
85. What precautions you will take before starting P-3320?
86. What will happen if V-3330 bottom temp goes high?
87. What will happen if V-3330 bottom temp goes high low?
88. In which condition level will appear in E-3320 LG?
89. What is the purpose of vent at V-3310 top?
90. Why P-3310 is started with Discharge v/v pinched?
91. What will happen if P-3330 Trips?
92. Is there any provision to isolate E-3340 and how?
93. What will happen if sealing fluid cooling fans trip?
94. What is the purpose of yellow switch installed near W-3330?
95. What is the capacity of T-3310?
96. What is total volume of Amine solution circulating in each Amine unit?
97. What is the capacity of V-3310?
98. What is the purpose of concrete wall around T-3310?
99. What will happen if the regenerator level increases or decreases?
100. What is the set point of LALL-009 and effects of its actuation
101. Why low level security is provided on regenerator?
102. What will happen if carry over is started from amine regenerator? How we control carry over?
103. Draw the sketch of amine circulation?
104. Why Co2 is not flashed out in flash drum?
105. What is the composition of flash out gasses of flash drum?
106. What is the purpose of flash drums?

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