STUDY MATERIAL

SUBJECT : BASIC MANUFACTURING PROCESSES (BMP)

MODULE-II

SEMESTER : 5TH

BRANCH : MECHANICAL ENGG.

CONTENTS :

- OBJECTIVE TYPE QUESTIONS AND ANSWERS
- SHORT TYPE QUESTIONS AND ANSWERS
- LONG TYPE QUESTIONS AND ANSWERS

DEPARTMENT OF MECHANICAL ENGINEERING

CHAPTER : 03
FABRICATION PROCESSES : WELDING PROCESSES AND POWDER METALLURGY

OBJECTIVE TYPE QUESTIONS AND ANSWERS

IES – 2016

1. If H is the heat input, l is the weld length, V is the voltage applied, I is the current, v is the welding speed and e is the efficiency of the process, then the process-governing equation in arc welding is given by

(a) $\frac{H}{l} = e\frac{VI}{v}$ (b) $\frac{H}{v} = e\frac{VI}{l}$

(c) $H = e\frac{VI}{vl}$ (d) $H = eVI \cdot vl$

2. **Statement (I)** : In resistance welding of sheet metal filler rod is not used.

Statement (II) : It is the filler rod which gets oxidized and deposits the oxide in the weldment.

3. **Statement (I)** : In gas welding process, neutral flame is the most common flame used for welding and cutting stainless steel.

Statement (II) : Neutral flame has tendency to react with stainless steel being welded.

IES – 2015

4. **Statement (I)** : Low-carbon steel has high weldability and is more easily welded.

Statement (II) : Higher carbon contents tend to soften the welded joints resulting in development of cracks.

5. Consider the following statements in respect of the oxidizing flame due to excess of oxygen in welding:

1. At high temperature, it combines with many metals to form hard and brittle oxides.
2. It causes the weld bead and the surrounding area to have a scummy appearance.
3. It has good welding effect in welding of copper-base metal.

Which of the above statements are correct?

(a) 1, 2 and 3 (b) 1 and 2 only

(c) 1 and 3 only (d) 2 and 3 only

IES – 2014

6. The proportion of acetylene and oxygen used in gas welding is

(a) 2 : 1 (b) 1 : 1

(c) 1 : 2 (d) 3 : 4

7. In liquid-state welding process, the zones formed are

(a) gas-shielded zone, fusion zone and unaffected original base metal zone

(b) liquid zone, fusion zone and heat-affected unmelted zone

(c) liquid-shielded zone, gas-shielded zone and flux-metal reactive zone

(d) fusion zone, heat-affected unmelted zone and unaffected original base metal zone

8. **Statement (I):** Melting point of alloy containing 62% tin and 38% lead is 327°C.

Statement (II): Low melting point of this alloy enables delicate parts of metal to be soldered.

9. **Statement (I):** The length of the oxidizing flame is smallest compared to neutral or reducing flame.

Statement (II): Due to extra oxygen available, the combustion is faster producing smaller length of flame.

IES – 2013

10. Weldability depend on :

1. Thermal conductivity
2. Surface condition
3. Change in microstructure

(a) 1 and 2 only (b) 1 and 3 only

(c) 2 and 3 only (d) 1, 2 and 3

11. Consider the following statements:

In metal arc welding

1. Utilizes a consumable electrode
2. A welding torch used is connected to acetylene gas supply
3. The electrode and work-piece are connected to the welding power supply

Which of these statements are correct?

(a) 1, 2 and 3 (b) 1 and 2 only

(c) 1 and 3 only (d) 2 and 3 only

12. **Statement (I):** The deflection of Arc from its intended path is called 'Arc blow'.

Statement (II): The changes of Arc blow is common in A.C. arc welding.

13. **Statement (I):** Non consumable electrodes, used in arc welding are made of high melting point temperature materials, even then the length of electrode goes on decreasing with passage of time.

Statement (II): The electrode material gets oxidized and melts on the weld material to form a strong flux.

IES – 2012

14. Which of the following factors improve weldability of steel?

1. Low carbon content
2. High carbon content
3. Good affinity to oxygen
4. Poor affinity to oxygen

(a) 1 and 3 (b) 2 and 3

(c) 1 and 4 (d) 2 and 4

15. Brittle welds are mainly obtained due to

(a) Wrong electrode, faulty preheating and metal hardened by air

(b) Faulty welds, faulty sequence and rigid joints

(c) Wrong speed, current improperly adjusted and faulty preparation

(d) Uneven heat, improper sequence and deposited metal shrinks

16. The advantage of the welding process is

(a) It relieves the joint from residual stresses

(b) It helps in checking of distorion of work piece

(c) Large number of metals and alloys, both similar and/or dissimilar can be joined

(d) Heat produced during the welding does not produce metallurgical changes

17. Which of the following are associated with Heat Affected Zone?

1. Cold cracking
2. Notch toughness
3. Hydrogen embrittlement
4. Stress corrosion cracking

(a) 1, 2 and 3 only (b) 1, 3 and 4 only

(c) 2, 3 and 4 only (d) 1, 2, 3 and 4

18. **Assertion (A):** In gas welding the metal to be joined gets oxidized or carburized.

Reason (R): The neutral flame affects no chemical change on the molten metal.

19. **Assertion (A):** DC with reverse polarity is used in MIG welding.

Reason (R): Use of DC with reverse polarity enables deeper penetration and a clean surface.

20. **Assertion (A):** Hydrogen induced cracking occurs in the heat affected zone adjacent to fusion zone and classified as solid-state cracking.

Reason (R): Hydrogen from burning of flux coating penetrates martensitic micro cracks preventing healing as well as enlarging them.

IES – 2011

21. During plasma arc welding of aluminium, improved removal of the surface oxide from the base metal is obtained with typical polarity of

(a) DC straight

(b) DC reverse

(c) AC potential

(d) reverse polarity of phase of AC potential

22. The welding process in which bare wire is used as electrode, granular flux is used and the process is characterized by its high speed welding, is known as

(a) Shielded are welding

(b) Plasma arc welding

(c) Submerged arc welding

(d) Gas metal arc welding

23. Consider the following statements

Cast iron is difficult to weld, because of

1. Low ductility
2. Poor fusion
3. Tendency to crack on cooling

Which of these statements are correct?

(a) 1, 2 and 3 (b) 1 and 2 only

(c) 2 and 3 only (d) 1 and 3 only

24. Match List-I with List-II and select the correct answer using the code given below the lists:

List-I

A. Laser beam welding

B. Electron beam welding

C. Ultrasonic welding

D. Friction welding

List-II

1. Can be applied welding of refractory metals like niobium, tantalum, molybdenum & tungsten.
2. A sound and clean joint is created due to rubbing of two parts against each other with adequate speed and pressure producing intense heat raising temperature above melting point created much away from job, a narrow spot is heated, work chamber operates in a high vacuum.
3. Clean heat source.
4. Clean heat source, very quick heating, very small focal spot, no vacuum chamber is required.

Codes:

	A	B	C	D
(a)	4	3	1	2
(b)	2	3	1	4
(c)	4	1	3	2
(d)	2	1	3	4

25. Cold-cracking in steel weldments depends on

1. Carbon equivalent
2. Heat input
3. Effective thickness
4. Hydrogen content in weld pool

(a) 1, 2 and 3 (b) 1, 2 and 4 only

(c) 2, 3 and 4 only (d) 1, 2, 3 and 4

IES – 2010

26. In an inert gas welding process, the commonly used gas is

(a) Hydrogen (b) Oxygen

(c) Helium or Argon (d) Krypton

27. In arc welding, the arc length should be equal to

(a) 4.5 times the rod diameter

(b) 3 times the rod diameter

(c) 1.5 times the rod diameter

(d) Rod diameter

28. Weldability of ferritic stainless steel used in automotive exhaust system is improved by selecting stainless steel electrode having low content of

(a) Carbon (b) Nitrogen

(c) Chromium (d) Carbon and Nitrogen

29. The ratio between Oxygen and Acetylene gases for neutral flame in gas welding is

(a) 2 : 1 (b) 1 : 2

(c) 1 : 1 (d) 4 : 1

30. **Assertion (A):** Oxidizing flame is used in gas welding to joint medium carbon steels having high melting point.

Reason (R): In gas welding oxidizing flame produces the maximum temperature compared to neutral and reducing flame.

31. **Assertion (A):** Straight polarity is always recommended for Carbon electrode welding.

Reason (R): Carbon arc is stable in straight polarity.

32. **Assertion (A):** It is generally difficult to weld Aluminium parts by normal arc welding process.

Reason (R): Hard and brittle, Aluminium-oxide film is formed at the welded joints.

33. **Assertion (A):** Inert gas and bare electrode instead of flux coated electrode is used in the case of automatic TIG and MIG welding processes.

Reason (R): Better protection is provided by a cloud of inert gas than the cover created by the flux.

IES – 2009

34. By which one of the following methods gray iron is usually welded?

(a) TIG welding (b) MIG welding

(c) Gas welding (d) Arc welding

35. Match List-I (Welding Process) with List-II (Application) and select the correct answer using the code given below the lists:

List-I

A. Laser welding B. Friction welding

C. Ultrasonic D. Explosive welding

List-II

1. Uniting large-area sheets
2. Reparing large parts
3. Welding a rod to a flat surface
4. Fabrication of nuclear reactor components
5. Welding very thin materials

Codes:

	A	B	C	D
(a)	5	4	3	2
(b)	1	4	2	5
(c)	1	3	4	2
(d)	5	3	4	1

IES – 2008

36. **Assertion (A):** Submerged arc welding is not recommended for high carbon steels, tool steels, aluminium, magnesium etc.

Reason (R): This is because of unavailability of suitable fluxes, reactivity at high temperature and low sublimation temperatures.

IES – 2007

37. Which of the following effects are possible due to residual stresses in welding?

1. Reduce dimensional stability
2. Weld cracking
3. Effect on fatigue strength
4. Reduction in the creep strength

Select the correct answer using the code given below:

(a) 1 and 2 only (b) 2 and 3 only

(d) 1 and 3 only (d) 1, 2, 3 and 4

38. Consider the following statements in respect of the laser beam welding:

1. It can be used for welding any metal or their combinations because of very high temperature of the focal points.
2. Heat effect zone is very large because of quick heating.
3. High vacuum is required to carry the process.

Which of these statements is/are correct?

(a) 1 and 2 only (b) 2 and 3 only
(c) 1 only (d) 1, 2 and 3

39. In MIG welding, the metal is transfered into the form of which one of the following?

(a) A fine spray of metal
(b) Molten drops
(c) Weld pool
(d) Molecules

40. The coating material of an arc welding electrode contains which of the follwing?

1. Deoxidizing agent
2. Arc stabilizing agent
3. Slag forming agent

Select the correct answer using the code given below:

(a) 1, 2 and 3 (b) 1 and 2 only
(c) 2 and 3 only (d) 1 and 3 only

41. Consider the following statements in respect of oxyacetylene welding:

1. The joint is not heated to state of fusion
2. No pressure is ued
3. Oxygen is stored in steel cylinder at a pressure of 14 MPa.
4. When there is an excess of acetylene used, there is a decided change in appearance of flame.

Which of these statements are correct?

(a) 1, 2 and 3 (b) 2, 3 and 4
(c) 1, 3 and 4 (d) 1, 2 and 4

IES – 2006

42. Which one of the following welding processes consists of minimum heat affected zone (HAZ)?

(a) Shielded Metal Arc Welding (SMAW)
(b) Laser Beam Welding (LBW)
(c) Ultrasonic Welding (USW)
(d) Metal Inert Gas welding (MIG)

43. Fabrication weldability test is used to determine

(a) mechanical properties required for satisfactory performance of welded joint
(b) susceptibility of welded joint for cracking
(c) suitability for joint design
(d) appropriate machining process

44. Which one of the following is not a fusion welding process

(a) Gas welding
(b) Arc welding
(c) Brazing
(d) Resistance welding

45. In which of the following welding process flux is used in the form of granules?

(a) AC arc welding
(b) Submerged arc welding
(c) Argon arc welding
(b) DC arc welding

46. **Assertion (A):** Aluminium has poor weldability.

Reason (R): Aluminium has high thermal conductivity and high affinity to oxygen.

IES – 2005

47. Consider the folloiwng statements:

1. In gas welding, the torch should be held at an angle of 30° to 45° from the horizontal plane
2. In gas welding, the size of the torch depends upon the thickness of metal to be formed.
3. Drag in gas cutting is the time difference between heating of the plate and starting the oxygen gas for cutting.

Which of these statements are correct?

(a) 1, 2 and 3 (b) 1 and 2

(c) 2 and 3 (d) 1 and 3

48. Which of the following are the major characteristics of submerged arc welding?

1. High welding speeds
2. High deposition rates
3. Low penetration
4. Low cleanliness

Select the correct answer using the code given below:

(a) 2 and 3 (b) 1, 2 and 3

(c) 3 and 4 (d) 1 and 2

49. In atomic hydrogen welding, hydrogen acts as

(a) A heating agent

(b) One of the gases to generate the flame

(c) An effective shielding gas protecting the weld

(d) A lubricant to increase the flow characteristics of weld metal

50. Hot cracks occur in the weld and fusion zone as the metal solidifies. Which of the following are the causes for hot cracks?

1. Presence of sulphur and phosphorus in the base metal
2. High carbon or alloy content of the base metal
3. Moisture in the joint or electrode
4. Joint restraint

Select the correct answer using the code given below:

(a) 1, 2 and 4 (b) 1, 2 and 3

(c) 3 and 4 (d) 1, 2, 3 and 4

51. Consider the following statements:

1. In arc welding, 65% to 75% heat is generated at the anode.
2. Duty cycle in case of arc welding is the cycle of complete welding of work piece from the beginning.
3. Arc blow is more common with DC welding.

Which of these statements are correct?

(a) 1, 2 and 3 (b) 1 and 2

(c) 2 and 3 (d) 1 and 3

IES – 2004

52. Match the List-I (Welding problems) with List-II (Causes) and select the correct answer using the codes given below the lists:

List-I

A. Cracking of weld metal

B. Cracking of base metal

C. Porosity

D. Inclusion

List-II

1. Excessive stress

2. High joint rigidity

3. Failure to remove slag from previous deposit

4. Oxidation

5. Excessive H_2, O_2, N_2 in the welding atmosphere

Codes:

	A	B	C	D
(a)	2	1	5	3
(b)	3	4	2	1
(c)	2	4	5	3
(d)	3	1	4	2

53. Consider the following statements:

The size of heat affected zone will increase with:

1. Increase starting temperature
2. Increase welding speed
3. Increased thermal conductivity of base metal
4. Increase in base metal thickness

Which of these statements are correct?

(a) 1, 2 and 4 (b) 1, 2 and 3

(c) 1 and 3 (d) 2 and 3

IES – 2003

54. Match List-I (Welding Defects) with List-II (Causes) and select the correct answer using the codes given below the lists:

List-I

A. Spatter
B. Distortion
C. Slag inclusion
D. Porosity

List-II

1. Damp electrodes
2. Arc blow
3. Improper cleaning in multipass welding
4. Poor joint selection

Codes:

	A	B	C	D
(a)	4	2	3	1
(b)	4	2	1	3
(c)	2	4	1	3
(d)	2	4	3	1

55. High speed electron beam of electron beam welding is focused on the weld spot using

(a) Vacuum lens
(b) Inert gas lens
(c) Optical
(d) Magnetic lens

56. In resistance welding, heat is generated due to the resistance between

(a) Electrod and workpiece
(b) Asperities between touching plates
(c) Two dissimilar metals being in contact
(d) Interface forces

IES – 2002

57. Match List-I (Ingredients) with List-II (Welding functions) and select the correct answer using the codes given below the lists:

List-I

A. Silica
B. Potassium silicate
C. Ferro silicon
D. Cellulose

List-II

1. Arc stabilizer
2. Deoxidizer
3. Fluxing agent
4. Gas forming material

Codes:

	A	B	C	D
(a)	3	4	2	1
(b)	2	1	3	4
(c)	3	1	2	4
(d)	2	4	3	1

58. In which one of the following welding techniques is vacuum environment required?

(a) Ultrasonic welding
(b) Laser beam welding
(c) Plasma arc welding
(d) Electron beam welding

IES – 2001

59. The maximum heat in resistance welding is at the

(a) tip of the positive electrode
(b) tip of the negative electrode
(c) top surface of the plate at the time of electric contact with the electrode
(d) Interface between the two plates being

60. Arc blow is more common in

(a) a.c. welding
(b) d.c. welding with straight polarity
(c) d.c. welding with bare electrodes
(d) a.c. welding with bare electrodes

61. Pinch effect in welding is the result of

(a) expansion of gases in the arc
(b) electromagnetic forces
(c) electric force
(d) surface tension of the molten metal

62. In manual arc welding, the equipment should have dropping characteristics in order to maintain the

(a) voltage constant when arc length changes

(b) current constant when arc length changes

(c) temperature in the arc constant

(d) weld pool red-hot

63. In arc welding d.c. reverse polarity is used to bear greater advantage in

(a) overhead welding

(b) flat welding of lap joints

(c) edge welding

(d) flat welding of butt joints

64. Oxyacetylene reducing flame is used while carrying out the welding on

(a) mild steel (b) high carbon steel

(c) grey cast iron (d) alloy steels

IES – 2000

65. Which of the following statements is correct?

(a) No flux is used in gas welding of mild steel

(b) Boarx is the commonly used flux coating on welding electrodes

(c) Laser beam welding employs a vacuum chamber and thus avoids use of a shielding method.

(d) AC can be used for GTAW process

66. Consider the following processes:

1. Gas welding
2. Thermit welding
3. Arc welding
4. Resistance welding

The correct sequence of these processes in increasing order of their welding temperature is

(a) 1, 3, 4, 2 (b) 1, 2, 3, 4

(c) 4, 3, 1, 2 (d) 4, 1, 3, 2

IES – 1999

67. The correct sequence of the given materials in ascending order of their weldability is

(a) MS, copper cast iron, aluminium

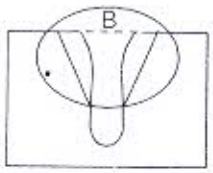
(b) Cast iron, MS, aluminium copper

(c) Copper, cast iron, MS, aluminium

(d) Aluminium, copper, cast iron, MS

IES – 1998

68. An arc welded joint is shown in the above figure. is known as



(a) Weld preparation (b) Penetration

(c) Reinforcement (d) Slag

69. The voltage-current characteristics of a dc generator for arc welding is a straight line between an open-circuit voltage of 80 V and short-circuit current of 300 A. The generator setting for maximum arc power will be

(a) 80V & 150A (b) 40V & 300A

(c) 40V & 150A (d) 80V & 300A

70. Which of the following joining processes ae best suited for manufacturing pipes to carry gas products?

1. Riveting
2. Welding
3. Bolts and nuts

Select the correct answer using the codes given below:

(a) 1 and 2 (b) 1 and 3

(c) 2 alone (d) 1, 2 and 3

71. In oxy-acetylene gas welding, for complete combustion, the volume of oxygen required per unit of acetylene is

(a) 1 (b) 1.5

(c) 2 (d) 2.5

IES – 1997

72. Consider the following statements:

MIG welding process uses

1. consumable electrode
2. non-consumable electrode
3. D.C. power supply
4. A.C. power supply

Which of these statements are correct?

(a) 2 and 4 (b) 2 and 3

(c) 1 and 4 (d) 1 and 3

73. **Assertion (A):** The electrodes of AC arc welding are coated with sodium silicate, whereas electrodes used for dc are welding are coated with potassium silicate binders.

Reason (R): Potassium has a lower ionisation potential than sodium.

❑❑❑

ANSWER KEY

1.	(a)	20.	(a)	39.	(b)	58.	(d)
2.	(c)	21.	(b)	40.	(a)	59.	(d)
3.	(c)	22.	(c)	41.	(b)	60.	(b)
4.	(c)	23.	(a)	42.	(b)	61.	(b)
5.	(a)	24.	(a)	43.	(b)	62.	(b)
6.	(b)	25.	(d)	44.	(c)	63.	(a)
7.	(d)	26.	(c)	45.	(b)	64.	(b)
8.	(a)	27.	(d)	46.	(a)	65.	(d)
9.	(a)	28.	(a)	47.	(b)	66.	(*)
10.	(d)	29.	(c)	48.	(d)	67.	(d)
11.	(c)	30.	(d)	49.	(a)	68.	(c)
12.	(c)	31.	(c)	50.	(d)	69.	(c)
13.	(c)	32.	(a)	51.	(d)	70.	(c)
14.	(c)	33.	(a)	52.	(a)	71.	(d)
15.	(a)	34.	(c)	53.	(c)	72.	(d)
16.	(c)	35.	(d)	54.	(d)	73.	(d)
17.	(d)	36.	(c)	55.	(d)		
18.	(d)	37.	(d)	56.	(b)		
19.	(a)	38.	(c)	57.	(c)		

SOLUTION...

Sol–1: (a)

Governing equation in are welding is

$$\frac{H}{f}(\text{Heat input/mm}) = \frac{e \times V \times I}{\text{velocity}}$$

Sol–2: (c)

Resistance welding is an autogenous welding procedure which does not require filler rod and the metal is melted by resistive heating. In other process, use of filler materials other than base metal may lead to formation of galvanic couples leading to weld corrosion.

Sol–3: (c)

A neutral flame is used to weld stainless steel as it does not react with steel.

Sol–4: (c)

High carbon content tends to make the weld more brittle and thus more prone to cracking. Low carbon steels have excellent weldeability due to low carbon content.

Sol–5: (a)

Oxidising flame

- Forms hard oxides which protect the weld metal

- Gives dirty & scummy appearance to weld bead
- Has good welding effect on copper base alloys, manganese steels and cast iron.

Sol–6: (b)

In gas welding, three types of flames can be obtained based on mixing of acetylene and oxygen

(1) **Neutral flame:** Here oxygen and acetylene are in equal volumes, i.e. proportion of acetylene and oxygen is 1 : 1.

(2) **Carburising flame:** Here there is excess of acetylene.

(3) **Oxidising flame:** Here there is excess of oxygen.

If nothing is stated, we assume neutral flame in gas welding, so the proportion of acetylene and oxygen is 1:1.

Sol–7: (d)

In liquid state welding process, there are three distinct zones in a welded part:

(i) Fusion zone,

(ii) Heat affected unmelted zone (HAZ),

(iii) Unaffected original base metal zone.

In the weld, the metal solidifies from the liquid state and hence fusion welds can be considered as castings. Therefore within the fusion zone there is columnar growth of grains. A random grain growth takes place at the melt boundary. Within HAZ, the grains become coarse due to the heat input and partial recrystallization takes place at the melt boundary. With the increase in distance from the melt boundary, the grains become finer until the heat unaffected zone with original grains is reached.

Sol–8: (a)

Soft solder- Lead 38% + Tin 62 %

It is used for soldering of delicate parts of metals, only because of its low melting point of 327°C.

Sol–9: (a)

The length of the oxidising flame is smallest compared to neutral or reducing flame. The reduction of length of the inner cone is a measure of excess oxygen because extra oxygen leads to faster combustion thus producing smaller length of flame and also hottest flame.

Sol–10: (d)

Weldability depends on physical, chemical, metallurgical and environmental conditions.

Sol–11: (c)

There is no role of acetylene gas in metal arc welding. Electrode and work piece are connected to positive and negative terminals of power source depending on polarity used.

Sol–12: (c)

Arc blow is deflection of arc due to setting of magnetic field when current passes through the circuit. Arc blow is a common phenomenon with DC and minimizes with AC as current charges polarity every half cycle.

Sol–13: (c)

Non consumable electrode does not become part of final weld. It may severely affect the properties of weld. Therefore, it does not melt on weld material to form a strong flux.

Sol–14: (c)

Higher is carbon content, lower is weldability. Poor affinity to oxygen ensures protection of weld pool from oxidation. These are improving the weldability.

Sol–15: (a)

Brittle welds are due to wrong electrode, faulty preheat and metal hardened by air.

Sol–16: (c)

Large number of metals and alloys, similar or dissimilar can be easily joined by variety of welding process available.

Sol–17: (d)

All defects are associated with HAZ.

Sol–18: (d)

In gas welding metal is joined by neutral, oxidizing or carburizing flame.

Sol–19: (a)

DC reverse polarity is commonly used with MIG welding. DC reverse polarity leads to deeper presentation lesser penetration and clean surface.

Sol–20: (a)

Hydrogen induced cracking mainly occurs in HAZ where most of H^+ ions are trapped putting pressure on microstructure.

Sol–21: (b)

DC reverse polarity helps in removing surface oxide layer over aluminium by high speed electrons blast. This is called "cathode cleaning".

Sol–22: (c)

Submerged arc welding uses a bare electrode, uses granular flux and performed high speed welding.

Sol–23: (a)

Cast iron is brittle due to high carbon content. It has poor fusion characteristic and cracks on cooling.

Sol–24: (a)

Laser welding- quick heating, small focal point, no vacuum

Electron beam - clean heat source

Ultrasonic welding - welding of niobium, tantalum and tungsten

Friction welding- Welding by rubbing of two parts in a vacuum.

Sol–25: (d)

Cold cracking is nothing but formation of martensite on cooling of weld. Martensite is very brittle and highly susceptible to cracking. Cold cracking depends on carbon equivalent, heat input, effective thickness and hydrogen content in weld pool.

Sol–26: (c)

Most common inert gases used in welding process are helium or argon.

Sol–27: (d)

For a stable arc, the arc length should be approximately equal to electrode diameter.

Sol–28: (a)

In welding stainless steel carbides migrates towards grain boundaries of HAZ resulting in inter granular corrosion. To minimize carbide precipitation following things can be used.

(1) Use below carbon

(2) Use cobalt stabilizer filler rod

(3) Heat the metal above 982°C and quench it immediately after welding.

Sol–29: (c)

In neutral flame, oxygen and acetylene are used in same proportions.

Sol–30: (d)

Oxidizing flame has the highest temperatures among all flames due to excess oxygen. Therefore, it is mainly used for cutting rather than welding. It is suitable for welding of brass. Neutral flame is highly suitable for MS and CI.

Sol–31: (c)

Straight polarity is used when less heat is to be generated at electrode (1/3rd of total heat), thus controlling rate of melting of electrode.

Polarity does not affect stability of arc.

Sol–32: (a)

Aluminium is hard to weld normal arc welding as it has high affinity to oxygen forming Al_2O_3 layer over metal surface. Al_2O_3 is a ceramic having melting point of over 2000°C and is very difficult to remove.

Sol–33: (a)

Both assertion and reason are correct.

Sol–34: (c)

Gray iron is usually welded by gas welding having neutral flame.

Sol–35: (d)

Laster welding - welding very thin materials

Friction welding - welding rod to flat surface

Ultrasonic welding - Nuclear reactor components

Explosive welding - uniting large area sheets

Sol–36: (c)

Submerged arc welding is not recommended for high carbon steels, tool steels, aluminium, magnesium etc. because high heat input in SAW reduces notch two separate words toughness of materials. Also, high heat input leads to high thermal stresses being developed in high carbon steels and cast iron

Sol–37: (d)

Once stresses develope in a welding, it impacts fatigue strength, creep strength, promotes cracking of weld and reduce dimensional stability.

Sol–38: (c)

It is true that Laser Beam Welding (LBW) gives highly focussed heat input. It leads to least HAZ. Also, no vacuum is required to do the welding in LBW.

Sol–39: (b)

In MIG welding, metal is transferred in the form of molten drops leading to a short-circuit. This is also called short circuit transfer at the rate of 200 to 300 drops/ second.

Sol–40: (a)

The electrode coating in welding (arc) contains deoxidizing agent, arc stabilizers and slag forming agents.

Sol–41: (b)

Oxyacetylene welding is a fusion welding process i.e., work piece arc melted, but no pressure is applied during welding. Also, in carburizing flame a distinct blue feather appears in the flame. Joint is heated to a state of fusion.

Sol–42: (b)

The more the energy (heat input) is focussed, the lower is HAZ. Out of the processes mentioned, laser beam welding gives heat input in the form of a laser beam, which is highly focussed at a spot. Thus, it gives minimum HAZ.

Sol–43: (b)

Fabrication weldability test is for determining susceptibility of welded joints to cracking. On the other hand, service weldability test is for determining mechanical properties required for satisfactory performance of welded joints.

Sol–44: (c)

Brazing is not a fusion welding process, as the temperatures attained (above 450°C) are not sufficient to melt the metal.

Sol–45: (b)

Submerged arc welding (SAW) uses a grannular flux to protect weld pool from atmospheric action. It provides a coating above the weld pool.

Sol–46: (a)

Aluminium has poor weldability mainly due to facts that its forms a layer Al_2O_3 by reacting with oxygen. Al_2O_3 has very high melting point, making aluminium very difficult to weld. It also has high thermal conductivity and heat loss is very significant in welding.

Sol–47: (b)

In gas welding torch is held at an angle of 30° to 45° from horizontal plane and the size of torch depends on thickness of metal to be cut.

But drag is not the time difference rather these are the marking on the side of kerf. These markings indicate cutting action of oxygen and arc expressed as percentage of the thickness of metal to be cut.

Sol–48: (d)

Characteristics of SAW are high speed, high deposition rates, high penetration and good quality welds.

Sol–49: (a)

In atomic hydrogen welding, hydrogen acts as a heating agent which releases heat by initially dissociating into H^+ ions in an electric arc and later fusion of H^+ ions takes place at weld to from H_2 gas.

Sol–50: (d)

All factors contribute to hot cracks in weld and fusion zone as metal solidifies.

- Presence of impurities such as sulphur and phosphorus.
- High carbon content means more brittleness and high chances of cracking.
- Moisture causes hydrogen embrittlement which causes hot cracking.

Sol–51: (d)

In arc welding, approx. $3/4^{th}$ of heat is generated at anode. Also, arc blow is more common in DC compared to AC welding. the duty cycle is the percentage of the time out of total 10 minutes for which the power source is operation for example, 50% duty cycle indicates that power source works for 5 minutes and than is switched off for next 5 minutes.

Sol–52: (a)

- Cracking of weld metal - High joint rigidity.
- Cracking of base metal - excessive stresses mainly due to uneven cooling.
- Porosity - excessive H_2, O_2, N_2 in welding atmosphere.
- Inclusion - failure to remove slag from previous deposit.

Sol–53: (c)

The size of HAZ depends on :

(i) HAZ increases with increasing starting temperature, as it increase heat input to metal

(ii) HAZ reduces with increasing welding speed as heat input is inversely proportional to welding speed

(iii) HAZ increases with increasing thermal conductivity. High thermal conductivity means that heat from the weld will penetrate the base metal to a greater distance and hence larger HAZ

(iv) High base metal thickness means low heat penetration in thickness and hence lower HAZ.

Sol–54: (d)

- Spatter is due to arc blow.
- Distortion is due to poor joint selection.
- Slag inclusion is due to trapping of impurity between successive welding pass.
- Porosity is due to damp electrodes.

Sol–55: (d)

In electron beam welding a magnetic lens is used to focus the electron beam and an electrical field is used to accelerate the electrons.

Sol–56: (b)

Maximum resistance in resistance welding is due to presence of asperities (air trapped) between touching plates.

Sol–57: (c)

Silica - Fluxing agent.

Potassium silicate - Arc stabilizer.

Ferro silicon - Deoxidizer.

Cellulose - Gas forming material.

Sol–58: (d)

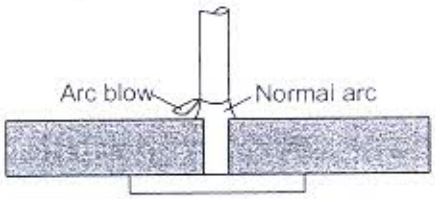
Vacuum environment is required in electron beam welding to prevent oxidation of filament and to prevent slowing down of electrons due to collisions with air molecular.

Sol–59: (d)

At the interface between two plates, there is no entire metal to metal contact. The plates touch each other at certain points of irregularity, these points create contact resistance. In the left out space between the plates air is trapped, that has very high resistance when compared to metals.

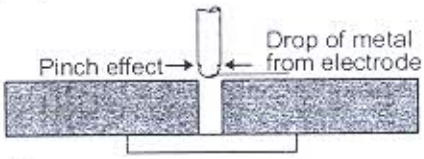
Sol–60: (b)

Arc blow is more common in DC straight polarity. It is caused by deflection of arc due to magnetic field generated by flow of welding current. Arc blow can be minimized by using AC as polarity changes after every half cycle



Sol–61: (b)

Pinch effect in welding is the result of electromagnetic forces. It helps in metal transfer in welding from electrode. It acts perpendicular to the axis of electrode



Sol–62: (b)

In dropping characteristic, current is constant when arc length changes. This is because in manual arc welding arc length may vary greatly due to human factor.

Sol–63: (a)

In D.C. reverse polarity, work piece is connected to negative terminal of power source. Therefore, less heat is generated on work piece and thus less amount of metal is melted. This conditions are suitable for overhead welding, as there are less chances of metal dropping due to gravity force.

Sol–64: (b)

As a thumb rule, reducing (or carburizing) flame is used for high carbon content materials because excess oxygen in oxidizing flame may react with carbon in the material.

Mild steel - Neutral flame.

High carbon steel - Reducing flame.

Grey cast iron - Neutral flame.

Alloy steels - Neutral flame.

Sol–65: (d)

- Alternating current along with DC reverse polarity are most commonly used in gastungstun arc welding (GTAW).
- In welding mild steel both rutile as well as basic fluxes can be used along with cellulose and iron power.
- Laser beam does not use vacuum, rather elector-beam welding uses vacuum.
- Boarx is used as a flux in brazing and not other welding electrodes.

Sol–66: (*)

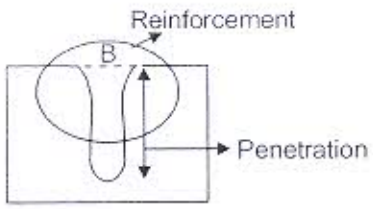
Welding processes	Average temperature
Gas welding	2300 – 3300°C
Thermit welding	2500 – 3000°C
Arc welding	3600 – 15000°C
Resistance welding	750 – 1850°C

The correct sequence is 4 < 2 < 1 < 3.

Sol–67: (d)

In case of iron and steel, general rule is that lower the carbon content, higher is ease of welding and thushigher is the weldability. Thus, mild steel (MS) having very low carbon content has high weldability. Cast iron has minimum 2% carbon. Aluminium, copper have other problem such as formation of oxides, high thermal conductivity of metal etc.

Sol–68: (c)



Sol–69: (c)

The straight line voltage - current (V – I) characterisitcs is given as

$$V = OCV - \left(\frac{OCV}{SCC}\right)I = 80 - \left(\frac{80}{300}\right)I$$

where V is arc voltage

OCV = Open circuit voltage

SCC = Short circuit current

I = Arc current

Power arc current

Power of arc = voltage × current

$$= \left[80 - \left(\frac{800}{300}\right)I\right] \times I = 80I - \frac{80}{300}I^2$$

Diff. of maximum arc power

$$\frac{dP}{dI} = 0$$

$$\frac{dP}{DI} = 80 - \frac{160}{300}I = 0$$

$$I = \frac{80 \times 300}{160} = 150\,A$$

$$V = 80 - \frac{80}{300} \times 150 = 40$$

Sol–70: (c)

Main criteria for selection of joining process for pipes carrying gas products are

(i) Joint should be able to withstand tensile stress due to high gas pressure and

(ii) There should be no leakage of gas. It is difficult to achieve leak proof by rivets and nuts with bolts. Thus, welding remains the only option.

Sol–71: (d)

The chemical equation for combustion of acetylene is

$$C_2H_2 + \frac{5}{2}O_2 \rightarrow 2CO_2 + H_2O$$

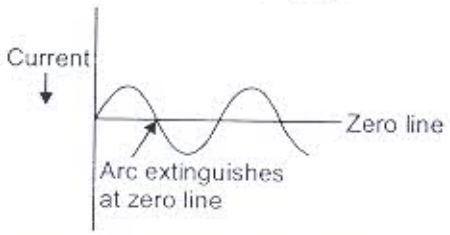
Thus, one mole of acetylene requires, 2.5 moles of oxygen for complete combustion.

Sol–72: (d)

- MIG (Metal inert gas) welding uses a consumable electrode and uses D.C. power supply with reverse polarity (i.e., electrode positive) as it gives better cleaning by removing oxides of metal from surface called cathode cleaning.
- TIG on the other hand uses a non consumable tungsten electrode with dc reverse polarity.

Sol–73: (d)

Potassium has lower ionisation potential than sodium. Therefore it requires lower voltage to reignite the arc while using AC power source. The main problem with using AC power source is that as soon as the current cycle crosses zero line, the arc extinguishes. Thus, electrode of AC arc welding are coated with potassium silicate rather than sodium silicate.



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CHAPTER 6

Powder Metallurgy

IES – 2016

1. **Statement (I)** : Metal powders can be produced by atomization process.

   Statement (II) : In case of metals with low melting point, the size of particles cannot be controlled and the shape of the particles remains regular in atomization.

2. Spark sintering is a kind of hot pressure shaping technique in which
   (a) the arc is produced inside the mould
   (b) the electrical heating of metallic powders by the production of spark in a graphite die is for a short time under pressure
   (c) before passing through the extrusion dies, a constant spark is produced
   (d) None of the above is applicable

IES – 2015

3. Consider the following statements regarding powder metallurgy:
   1. Refractory materials made of tungsten can be manufactured easily.
   2. In metal-powder, control of grain size results in relatively much uniform structure.
   3. The powder heated in die or mould at high temperature is then pressed and compacted to get desired shape and strength.
   4. In sintering, the metal powder is gradually heated resulting in coherent bond.

   Which of the above statements are correct?
   (a) 1, 2 and 3 only (b) 1, 2 and 4 only
   (c) 2, 3 and 4 only (d) 1, 2, 3 and 4

IES – 2014

4. The process of impregnation in powder metallurgy technique is best described by which of the following?
   (a) After sintering operation of powder metallurgy, rapid cooling is performed to avoid thermal stresses
   (b) Low melting point metal is filled in the pores of a sintered powder metallurgy product
   (c) Liquid oil or grease is filled in the pores of a sintered powder metallurgy product
   (d) During sintering operation of powder metallurgy, rapid heating is performed to avoid sudden produce of high internal pressure due to volatilization of lubricant

5. **Statement (I):** In powder cutting process, iron powder is injected into the oxygen jet while the cutting is proceeding.

   Statement (II): In this process of powder cutting, iron gets oxidized by the oxygen jet and produces additional heat for preheating of metal.

IES – 2012

6. **Statement (I):** Parts made by powder metallurgy do not have as good physical properties as parts casted.

Statement (II): Particle shape in powder metallurgy influences the flow characteristic of the powder

IES – 2010

7. Consider the following parts:

1. Grinding wheel
2. Brake lining
3. Self-lubricating bearings

Which of these parts are made by powder metallurgy technique?

(a) 1, 2 and 3 (b) 2 only

(c) 2 and 3 only (d) 1 and 2 only

IES – 2007

8. What are the advantages of powder metallurgy?

1. Extreme purity product
2. Low labour cost
3. Low equipment cost

Select the correct answer using the code given below:

(a) 1, 2 and 3 (b) 1 and 2 only

(c) 2 and 3 only (d) 1 and 3 only

IES – 2004

9. Consider the following factors:

1. Size and shape that can be produced economically
2. Porosity of parts produced
3. Available press capacity
4. High density

Which of above are limitations of powder metallurgy.

(a) 1, 3 and 4 (b) 2 and 3

(c) 1, 2 and 3 (d) 1 and 2

IES – 1999

10. Consider the following processes for the manufacture of gears

1. Casting
2. Powder metallurgy
3. Machining from bar stock
4. Closed die forging

The correct sequence in increasing order of bending strength of gear teeth is

(a) 1, 2, 3, 4 (b) 1, 2, 4, 3

(c) 2, 1, 4, 3 (d) 2, 1, 3, 4

11. **Assertion (A):** In atomization process of manufacture of metal powder, the molten metal is forced through a small orifice and broken up by a stream of compressed air.

Reason (R): The metallic powder obtained by atomization process is quite resistant to oxidation.

IES – 1998

12. In powder metallurgy, the operation carried out to improve the bearing property of a bush is called

(a) Infiltration (b) Impregnation

(c) Plating (d) Heat treatment

IES – 1997

13. Whic of the following components can be manufactured by powder metallurgy methods?

1. Carbide tool tips 2. Bearings
3. Filters 4. brake linings

Select the correct answer using the codes given below:

(a) 1, 3 and 4 (b) 2 and 3

(c) 1, 2 and 4 (d) 1, 2, 3 and 4

ANSWER KEY

1. (c)	5. (a)	9. (a)	13. (d)
2. (b)	6. (d)	10. (a)	
3. (c)	7. (a)	11. (c)	
4. (c)	8. (b)	12. (a)	

SOLUTION...

Sol–1: (c)

In case of low melting point metals used for producing powder through atomization, the size of the particles can be controlled but the shape remains irregular.

Sol–2: (b)

Spark sintering or spark plasma sintering is a sintering technique where a dc current passes through the powder compact through a graphite die. The heat is generated through Joule heating. This is a very fast process used to sinter nano material.

Sol–3: (c)

Tungsten powder is not easy to compact due to its relative high hardness.

Sol–4: (c)

The impregnation is the process in which the sintered product is dipped into the liquid oil or grease so that oil moves to the pores of the product by capillary action.

Sol–5: (a)

In powder cutting process, similar to oxygen cutting, iron powder is injected into the oxygen jet, while cutting is proceeding. Iron gets oxidised by the oxygen jet, thus producing additional heat for preheating of metal. The temperature at which rapid oxidation of material takes place is called KINDLING TEMPERATURE.

Sol–6: (d)

Parts made by powder metallurgy have physical properties comapred to their casting counterparts and in some case have better properties comapred to casted parts (like in HSS, magnets, superalloys etc.). Irregular shaped grains give better compactness as compared to regular shaped grains.

Sol–7: (a)

All products viz grinding wheel, self lubricated bearings and brake linings can be made by powder metallurgy.

Sol–8: (b)

Equipment of powder metallurgy (powder production, compaction, sintering) is costly. It involves low labour cost as the process can be automated. Also, final products are extremely pure.

Sol–9: (a)

A major limitation of powder metallurgy is low density of products due to presence of high volumes of pores present after compaction of powders.

Sol–10: (a)

The correct sequence in increasing order of bending strength of gear teeth is casting → Powder metallurgy → Machining from bar stock → Closed dieforging.

Sol–11: (c)

The metallic powders produced by atomization process where a stream of metal is forced through an orifice are not resistant to oxidation. Therefore an inert gas is prefered in atomization process.

Sol–12: (a)

Infiltration is a process in which a softer metal is melted and fills the pores of bearing. This increase strength and density of bearing and thus its bearing capacity increases.

Sol–13: (d)

Powder metallurgy can produce a variety of components such as gears, filters, brake linings, pores bearings, eams, piston rings, valve gwdes permanent magnets etc.

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CHAPTER : 03
FABRICATION PROCESSES : WELDING PROCESSES AND POWDER METALLURGY

SHORT TYPE QUESTIONS AND ANSWERS

Solved Problems

2.1. *Spot welding of two 1 mm thickness sheet of steel is carried successfully by passing a certain amount of current from 0.1 second through the electrodes. The resultant weld nugget formed is 5 mm india 1.5 mm thick calculate the amount of current passing through electrode*

If $\rho_{steel} = 8000\ kg/m^3$

content heat of fusion $= h_f = 1400\ kJ/kg$

Resistance of welding operation $= 200$ *micro ohm* $= 200 \times 10^{-6}$ ohm

Soln. As per the data given in the question

$$\text{Volume of nugget is} = \left(\frac{\pi}{4} \times d^2 \times t\right) = \left(\frac{\pi}{4} \times 5^2 \times 1.5\right) mm^3$$

$$= 29.4375 \times 10^{-9}\ m^3$$

Amount of heat required to melting

$$= h_f \times \rho \times v$$

$$= 1400 kJ/k \times 8000\ kg/m^3 \times 29.4375 \times 10^{-9} = 329.7 \text{ Joule.}$$

But in spot welding

$$H = I^2 Rt = 329.7 \text{ Joule}$$

$$R = 200 \times 10^{-6} \text{ ohm}$$

$$t = 0.1 \text{ sec}$$

$$I^2 = \frac{329.7}{200 \times 10^{-6} \times 0.1}$$

$$I = \sqrt{16.485 \times 10^6} \cong 4.06 \times 10^3 \text{ Amp.} \qquad \cong 4060 \text{ Amp.} \qquad \text{(Ans.)}$$

2.2. *Two 1mm thick steel sheets are to be spot welding at a current of 5000 Amp. Assuming effective resistance to be 200 micro ohms and current flow time of 0.2 sec. heat generated during the process will be how much.*

Soln. According to question

Thickness of sheet = 1 mm

Resistance = 200 micro ohm

Current = 5000 Amp

Time = 0.2 second

So heat generated as

$$H = I^2Rt$$

$$= (5000)^2 \times (200 \times 10^{-6}) \times (0.2) = 1000 \text{ joule}. \quad \text{(Ans.)}$$

2.3. *Calculate the welds per minute work speed and RPM of circular electrode of 220 mm dia for carring out seam welding at 4 welds per cm on 1.6 mm thick mild steel tube welding cycle consists of 3 cycle 'on' and 2 cycles 'off' power supply is at 50 Hz. Also calculate energy requirement effective resistance between electrodes as 100 micro ohm.*

Soln. As per given data

Frequency = 50 Hz

cycles for weld = 3

Interval cycle = 2

welds requried per cm = 4

Electrode diameter = 220 mm

$$\text{welds per minute} = \frac{\text{Frequency} \times 60}{\text{cycles for weld} + \text{interval cycles}}$$

$$= \frac{50 + 60}{3 + 2} = 600 \text{ welds/minute}$$

$$\text{Works speed (mm/min)} = \frac{\text{welds / min}}{\text{welds required / min}}$$

$$= \frac{600}{4/10} = 500 \text{ mm/min.}$$

$$\text{RPM of electrode} = \frac{\text{workspeed(mm / min.)}}{\pi \times \text{electrode dia}}$$

$$= \frac{1500}{3.14 \times 220} = 2.17 \text{ (rpm)}$$

For 1.6 mm thick M.S. palte current requirement is 10,000 Amp. (considering practical parameter)

$\therefore$ Energy requirement $= I^2Rt = (10000)^2 \times 100 \times 10^{-6} \times \left(\frac{3}{50}\right)$

$= 100 \times 100 \times \frac{3}{5} = 600$ joules. (Ans.)

2.4. *Calculate the kinetic energy of electrons, beam current, powr density of beam (0.5 mm diameter) of electron beam welding unit operating at 100 kV and rated at 1 kW.*

Soln. Kinetic energy of an electron accelerated by 1 volt is called 1 electron volt (1 eV)

and $1\ eV = 1.602 \times 10^{-19}$ Joules.

The kinetic energy of each electron accelerated by 100 kV

$$K.E. = 100 \times 1000 \times 1.602 \times 10^{-19} = 1.602 \times 10^{-14} \text{ Joules}$$

If V is the velocity of electrons, then

$$K.E. = \frac{1}{2}mv^2$$

$$V = \frac{2 \times K.E.}{m} = \sqrt{\frac{2 \times 1.602 \times 10^{-14}}{91 \times 10^{-31}}} = 0.187 \times 10^9 \text{ metre/second}$$

(The mass of an electron at rest $= 9.1 \times 10^{-31}$ kg)

An ampere of current is equivalent to a flow rate of 6.28×10^{18} electrons/second. Let beam current be C .

The number of electrons in the beam $= 6.28 \times 10^{18} \times C$

Total power of the beam

or $P = K.E. \times$ No. of electrons in beam/sec

1 kW = 1000 J/sec.

$$= 1.602 \times 10^{-14} \times 6.28 \times 10^{18} \times C$$

and $$C = \frac{1000}{1.602 \times 10^{-14} \times 6.28 \times 10^{18}} = 0.01 \text{ A}$$

$$\text{Power density} = \frac{\text{Power}}{\text{Beam area}} = \frac{1000}{\frac{\pi}{4}\left(0.5 \times 10^{-3}\right)^2} = 5 \times 10^9 \text{ watts/m}^2 = 5 \times 10^6 \text{ kW/m}^2 \text{ .(Ans.)}$$

2.5. *Calculate the melting efficiency in the case of arc welding with a potential difference of 30v and current of 180 A. The heat transfer efficiency may be taken as 0.85. The travel speed is 5 mm/sec and cross section of joint is 18 mm^2. heat required to melt steel may be considered as 10 J/mm^3.*

Soln: Net heat supplied to the joint = voltage × current × heat transfer efficiency

$= 30 \times 180 \times 0.85$

$= 4590$ Joule.

Considering above heat supplied in one second the heat supply rate = 4590 J/sec.

Volume of metal melted per second

= cross section area × velocity

$= 18 \times 5$

$= 90$ mm^3/sec.

Amount of heat utilised for melting the joint per second

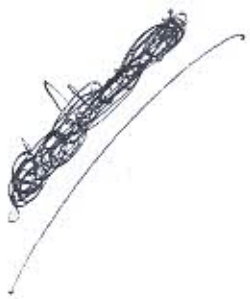
$= 90 \times 10$

$= 900$ Joule/second

$$\text{Melting efficiency} = \frac{\text{Heat utilised per second}}{\text{Heat supplied per second}}$$

$$= \frac{900}{4590} \cong 0.196$$

$= 19.6\%$



Melting efficiency of this above process is 19.6%. (Ans.)

QUESTIONS WITH ANSWERS

1. What are the qualities of flame used for welding ? How can you distinguish three types of welding flames and for what applications these are used ?

Ans. Qualities of welding flame

- High temperature to melt the metals.
- Very intense concentrated flame so that a spot under the flame becomes molten and forms a liquid puddle.
- Must not burn the metal (oxidise it).
- Must not add dirt or foreign material to the metal.
- Products of combination should not be toxic.

Types of Flames

Neutral flame. It is the result of a perfect proportion and mixture of acetylene and oxygen. It releases only heat and harmless gases. Inner cone of a neutral flame is smooth and rounded. It is used for fusion welding of steel and cast iron.

Carburising Flame. It is produced by use of excess acetylene. It has three distinct flame sections

It is used for hard-facing and welding white metal and aluminium, and in brazing where oxidising of metal would interfere with welding.

Oxidising Flame. It results due to use of too much oxygen. The inner cone of oxidising flame is sharp and pointed.

It is used for braze welding with bronze rod.

2. (a) What are the advantages of AC arc welding ?

(b) Why is it difficult to start AC arc ? How it is simplified in practice.

Ans. (a) The biggest advantage of AC arc welding is complete absence of magnetic arc blow and thus quality welds are produced. The arc is forceful and produces good penetration. Once the arc is started, it is easy to control and maintain it. It is usually faster because larger electrodes and more current can be used due to minimum magnetic blow conditions. It is very well suited to weld aluminium and is very popular for welding on heavy gauge steel.

(b) Because of alternating current flow, starting the arc is more difficult. This difficulty is overcome by having hot start circuit which provides an extra flow of very high frequency current at the time of striking the arc. In some machines, capacitors are employed in arc (secondary) circuit to give high current surges for the arc striking.

3. (a) What are the qualities of flame used for welding ?

(b) Name the commercially used gas welding and cutting flames.

Ans. (a) The flame used for welding must have high enough temperature to melt the metals to be welded but it must not burn or oxidise the metal. A sufficient quantity of heal must be supplied to overcome heat losses. The flame must not add carbon, dirt or foreign material to the metal. The products of combustion should not be toxic.

(b) The commercially used gas welding and cutting flames are :

Oxygen — acetylene

Oxygen — hydrogen

Oxygen — natural gas or artificial gas

Oxygen — liquefied petroleum gas

4. Why a copper piping is never used with acetylene?

Ans. Copper piping in the presence of acetylene forms copper acetylide, which is unstable compound and which disassociate violently at the slightest shock. Hence only brass tubing is used with acetylene in which no such reaction takes place.

5. What are the ad vantages of using liquefied petroleum gas (LPG) over acetylene for cutting?

Ans. LPG has a narrower explosive range (3.4 to 10.8%) in air compared to acetylene (2.5 to 80%). Further LPG can be used at pressure above (atmospheric gauge pressure) whereas acetylene is used above this pressure and thus LPG can be used for underwater cutting.

6. (a) Is the work piece connected to positive terminal or negative terminal of the welding machine in case of direct-current straight polarity.

(b) Does arc voltage increase or decrease with increase in arc length ? What will be the voltage drop across the arc if the electrode is shorted to the workpiece ?

(c) Does deposition rate of filer metal increase or decrease with increase in current ?

(d) How does penetration vary for DCSP, AC and DCRP arc welding ?

(c) How much of the useful arc heat appears at the anode and how much at cathode ?

Ans. (a) positive (b) increases, zero (c) increases (d) penetration is deepest for DCSP, less for A.C, and least for DCRP arc welding, (e) 1/3 at cathode.

7. What do you understand by arc blow ?

Ans. Arc blow is the phenomenon of wandering of arc and it occurs in d.c. welding. What hapens i , that when a current flows in any conductor, a magnetic field is formed around the conductor at right angles to the current. Since in the case of d.c. arc welding, there is current through the electrode, arc, workpiece, and ground clamp, magnetic fields exist around each of these components. The arc thus lack control as though it were being blown to and by the influence of these complex magnetic fields. This is more common in welding with very high or very low currents, and especially in welding in corners or other confined spaces. Usually arc blow results from the interaction of the magnetic fields of the electrode workpiece with that of the arc. The movement of arc blow causes atmospheric gases to be pulled into the arc, resulting in porosity or other defects.

8. Why electrodes for a.c. welding are coated with potassium silicate binder and those for d.c.arc welding with sodium silicate ?

Ans. In case of a.c. arc welding with 50 Hz frequency, every half cycle repeats every 0.01 sec. Arc takes around 0.001 sec. to reach equilibrium state. Thus behaviour of arc for d.c. supply holds good for a.c. arc also but arc has to reignite itself every 0.01 sec. In order to facilitate the reignition of arc, help of ions having low ionisation potential is taken and tfiese are provided by potassium silicate binders coated on electrodes. It may be noted that potassium has a tower ionisation potential than sodium. For this reason sodium silicate is coated over d.c. electrodes.

9. What are the advantages of low temperature joining methods over fusion welding ?

Ans. Following are the advantages :

(a) Low-temperature joining methods overcome the metallurgical problems in joint as well as in heat affected joint created by fusion method. Preheating and post-heating are not required. Brazing rods need not be matched to the composition of the base metal.

(b) Because of the lower temperature, distortion is much less.

(c) Brazing can be done at any desired temperature due to availability of a wide range of brazing metals, with different melting points.

(d) Low-temperature joining is best suited for joining thin-gauge materials, metal foils, and small parts.

(e) Locked-in stresses of welded joints are negligible.

(f) By methods like furnace brazing, induction brazing, etc., whole assemblies can be brazed, soldered, or bonded at the same time, without the necessity of running a bead.

(g) Easily adopted to mass production techniques.

(h) Unlike materials can be easily joined.

(i) Joints are usually not visible and thin.

10. What are the advantages of brazing ?

Ans. Advantages of brazing include:

(1) Dissimilar metals can be joined.

(2) Assemblies can be brazed in a stress free condition.

(3) Complex assemblies can be brazed in several steps by using filler metals with progressively lower melting temperatures.

(4) Materials of different thicknesses can be joined easily.

(5) Cast and wrought metals can be joined.

(6) Non-metals can be joined to metals, when the non-metal is coaled.

(7) Metallurgical properties of the base materials are not seriously disturbed.

(8) Brazed joints require little or no finishing.

11. Describe the relative applications of A.C. and D.C. welding ?

Ans. White D.C. welding is best suited for thinner sheet metal (below 6 mm.) and also for welding non ferrous metal, A.C. welding is used for most manual welding of 6 mm. and thicker steel. As steel is the largest used structural material, A.C. welding finds maximum use, though D.C. welding has a greater variety of welding processes like GTAW and GMAW, straight polarity and reverse polarity, etc. Direct current straight polarity and reverse polarity welding can be used for overhead and vertical welds but A.C. welding is used for welding steel in the flat or horizontal position.

12. What are the advantage of Gas-Metal Arc Welding (GMAW) or Metal Inert Gas (MIG) welding ?

Ans. The advantages of GMAW or MIG are that it does not require any flux, high welding speeds are possible, process can be automated, difficult to weld metals like aluminium and stainless steel can be welded, and corrosion resistance is high.

13. Which gases are used for welding the following materials by GMAW or MIG process

(i) Steel

(ii) Copper or aluminium

(iii) Stainless steel

(iv) Titanium

(v) Copper-nickel and high-nickel alloys.

Ans. Following gases are used for welding various materials by GMAW or MIG process:

(i) steel—CO_2

(ii) copper or aluminium — argon or argon-helium mixtures

(iii) stainless steel—argon-oxygen or helium-argon mixtures

(iv) titanium—pure argon gas

(v) copper-nickel and high-nickel alloys—argon-helium mixtures.

14. In arc welding process, selection of proper current, voltage and speed are essential for smooth regular, well formed bead, no undercutting, overlapping or piling up. Discuss the effect of too low/ too high current, too high voltage and too fast/too slow speed.

Ans. Too low current results in excessive piling up of weld metal, poor penetration due to overlapping bead, wasted electrodes.

Too high current results in excessive spatter which has to be cleaned, weakening of joints due to under cutting along edges, irregular deposits, and wasted electrodes.

Too high welding voltage results into irregular bead with poor penetration, improper shielding of weld metal, inefficient weld and wasted electrodes.

Too high speed results in small bead with irregular contours, insufficient weld metal in the cross section, weak weld joint and wasted electrodes.

Too slow speed results in excessive piling up of weld metal, overlapping without penetration of edges, wastage of time and electrodes.

15. What are the advantages of laser welding over electron-beam welding ? Why laser welding is used only for micro-welding applications?

Ans. (i) In electron beam welding operation, a high vacuum is necessary around the filament to avoid its burning. Laser welding is done in air and thus non-operative time of creating vacuum, in the chamber including even workpiece, is eliminated.

(ii) Laser can be "aimed" with simple mirrors whereas in electron beam welding machine, the stream of electrons are electromagnetically aligned and focused to obtain a highly concentrated beam, (iii) It is possible to make welds inside transparent glass or plastic housings. Laser is used only for micro welding, i.e. welding very small wires to electronic devices as laser for generating high energy is very costly but microwelding applications can be precisely controlled by laser.

16. What are the essential steps in brazing operation ?

Ans. (1) It should be ensured that the mating parts have the proper fit or clearance. (Careful attention to tolerances is needed to be sure that capillary action will draw molten alloy through the joint area.

(2) The metal should be thoroughly cleaned as oil, grease, dirt and scale inhibit alloy flow. Oil films should be removed first with solvents or vapour degreasing. Scale may be removed by acid pickling.

(3) All mating surfaces must be coated with flux. Brushing, dipping, or squirting are the conventional methods. As a safely measure, flux should not be trapped in small enclosed areas of the workpiece.

(4) The workpiece is then assembled and supported. Ideally, the product should be self-supporting. If jigs and fixtures are necessary, they should have the smallest possible contact area e.g. pinpoint or knife edge). For prolonged use, stainless steel ceramic supports are recommended.

(5) The workpiece is heated and brought upto flow temperature which is determined by the type and thickness of the metals to be joined and the flux and brazing alloy selected. Then the alloy is applied heated to flow.

(6) The part is cleaned usually by hot water or steam which removes the residual flux. Quenching the pan immediately alter the alloy has set also facilitates cleaning. For some parts pickling may be used to return the part to its original colour.

17. What are the important design consideration in brazing parts ?

Ans. The various factors requiring due consideration in brazing joints are : (i) Base metals, (ii) Filler metals, (iii) Joint configuration, (iv) Service conditions, like oxidation and corrosion resistance.

Brazed joints may be either butt or lap or combination of two types. In designing joints, it should be remembered that the strength of the filler is often less than that of the base material. Joint clearance's important because it determines the maximum joint strength that can .be developed by the particular filler metal.

18. Describe in brief the process of brazing and soldering with paste and enumerate its advantages.

Ans. In this process, instead of applying flux and solder or brazing alloy separately, it is combined as a paste and applied in one operation. The paste is ejected from a pressurised gun. After the paste is applied on assembly, it is healed by torch, oven, infra-red source, inductance etc. Pastes are premixed to match particular requirement taking into account base metal properties, operating temperature, environment, and required joint strength. Advantages of technique are: the process can be automated, better control of flux and filler-metal use, joint consistency and reduced supply inventory.

19. What is soldering process ?

Ans. In soldering process, the low-melting point alloys are used 10 join metal components by filling the space between the surfaces to be joined by molten-solder: the solder thus adheres to the surface and solidifies. The usual steps in the soldering process are ; clean the metal, apply flux, apply solder, heat, and, if necessary, clean the joint.

20. What are the advantages and limitations of powdered metals ?

Ans. The advantages in manufacturing products with metal powders are:

(i) Elimination of machining operation, (ii) little wastage of material (iii) low labour cost, (iv) possibility of producing products of extreme purity, (v) possibility of obtaining wide range of physical properties with a given material, (vi) ease of controlling structure and porosity,(vii) ceramics or refractory materials which cannot be cast or are difficult to machine can be used to produce parts.

The principal limitations in the use of powder metallurgy are:

(i) large or irregularly shaped products are difficult to produce,

(ii) high cost of die and equipment,

(iii) high cost of metal powder,

(iv) impossibility of having completely dense product.

(v) some powders may present explosion hazards.

(vi) difficulty of sintering low-melting powder.

(viii) necessity of protective atmospheres.

21. What are the important design considerations in design of parts or dies required for powder metal techniques?

Ans. The various design requirements for successful operation of the parts and dies for use with metal powder are:

(i) Avoid holes in the parts that are at an angle to punch since they can't be produced directly,

(ii) Provide fillets on the inside corners of the part to permit better punch design.

(iii) Outside levels on the part should be made as flat as possible to avoid feather edges on the punch,

(iv) Undercuts such as on thread should be avoided since they can't be produced directly,

(v) Punch and die surfaces in contact with the powder must be very smooth since metal powders lack ability to flow readily.

(vi) The die material should be sufficiently hard so that scoring of the die surfaces by the powder is minimised.

(vii) Dies should be provided with a slight draft to facilitate ejection of the part.

ASSIGNMENT

1. What do you understand by gas welding?
2. Describe in brief the equipment required for gas welding.
3. How neutral, oxidising and reducing flame is obtained?
4. Describe the principle of gas cutting.
5. What is the principle of operation of electric Arc welding?
6. Describe and explain the following welding methods giving their advantage limitation and specific application

   (1) TIG (2) MIG (3) Plasma Arc (4) Laser beam
7. Describe with neat sketch about the following process

   (1) ultrasonic (2) electron beam
8. Write short note on following

   (1) Left ward welding technique

   (2) Edge preparation of butt welding.
9. Differentiate between soldering and brazing .
10. Describe in a brief about welding defects generally occurs in welding process (at least 5)
11. Describe in a brief about the destructive testing techniques of welds. (at least 4)
12. Describe one brief about Non-destructive testing techniques of welds (at least 5)
13. Describe about powder metallurgy process, advantages, limitation and specific applications.
14. What is the basic principle of operation of resistance welding?