SUMMER– 17 EXAMINATION

Model Answer

Subject Code: 17208

Important Instructions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills.
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

Q. No.	Sub Q. N.	Answer	Marking Scheme
1		**Attempt any nine:**	**18**
	(a)	**Name the two ores of iron. Write their chemical formulae.**	**(2)**
		i) Haematite – Fe_2O_3 ii) Magnetite - Fe_3O_4 iii) Limonite –2 $Fe_2O_3.3H_2O$ iv) Siderite – $FeCO_3$ **(any two ores)**	1 Mark each **(2)**
	(b)	**Give the function of coke & limestone in extraction of iron by blast furnace.** **Function of Coke (any one)** i) Coke (C) is used as a reducing agent for oxides of metals. ii) Coke (C) converts the ore into molten metal. **Function of Limestone (any one)** i) Limestone (CaO) is used as a flux in the blast furnace. ii) Flux (CaO) removes gangue in the form of fusible mass known as slag.	1 1

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1	(c)	**Explain the terms :** i) **Mineral ii) Flux** i) **Mineral**- A naturally occurring substance present in the earth's crust which contains metal in free State or combined state. E.g. Clay & Bauxite. **ii) Flux**:-The substance which is used to remove the gangue during the smelting process is known as flux. **OR** It is a substance added during smelting which reacts with gangue to form easily fusible material.	**2** 1 Mark each
	(d)	**Which oxide film is most protective against corrosion? Why?** **Non – Porous oxide film** is protective. **Reason:** In Non – Porous oxide film, volume of oxide is greater than the volume of metal. Due to absence of any pores in the oxide film, it forms a protective layer and hence the rate of corrosion of metal rapidly decreases. **Unstable oxide** film is protective. **Reason:** As soon as the film is formed it decomposes to give original metal again.Therefore corrosion is not possible here. **(Note: Any one of these film can be considered)**	**2** 1 1
	(e)	**Give any two examples of corrosion due to galvanic cell action.** i) Copper sheet joined by Iron nail undergoes corrosion due to galvanic cell action ii) Steel pipe connected to copper plumbing gets corroded due to galvanic cell action. Here steel is more reactive than copper forms anodic area and gets corroded while copper is less reactive form cathodic areas and gets protected from corrosion iii) Galvanized pipes buried underground gets corroded due to galvanic cell action iv) Fencing wire under joints gets corroded due to galvanic action **(any two examples)**	**2** 1 mark each
	(f)	**What is cementation? Name two methods of cementation.** **Cementation –** It is the process in which base metal is heated with the powder of coating metal and base metal gets diffused by using a coating metal. This method is also known as **diffusion** method or **Cementation.**	**2** 1

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Q. No.	Sub Q. N.	Answer	Marking Scheme
1		Methods of Cementation:- i) Sherardizing ii) Colourising iii) Chromizing **(any two methods)**	½ mark each
	(g)	**Name the different constituents of paints.** i) Pigments ii) Thinners iii) Drying Oil/ Medium iv) Plasticizers iv) Driers v) Extenders **(Any four constituents)**	**2** ½ Mark Each
	(h)	**Name the impurities present in natural water.** i) Suspended impurities ii) Dissolved impurities iii) Colloidal impurities iv) Biological impurities	**2** ½ mark each
	(i)	**Define sterilisation. Name different methods of sterilisation.** **Sterilisation**:- It is the process of killing disease producing bacteria present in water. Methods of sterilisation:- i) Boiling ii) Chlorination iii) Ozonisation iv) UV rays iv) Aeration. **(any two methods)**	**2** **1** ½ mark each

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Q. No.	Sub Q. N.	Answer	Marking Scheme
1	(j)	**Give any four characteristics of potable water.** i) It should be clear, colorless, odourless with pleasant in taste. ii) It should be free from diseases producing micro-organisms. iii) Its hardness should be 150-250 ppm $CaCO_3$ equivalent. iv) It should not contain any poisonous or objectionable matter. iv) The total dissolved solids should not exceed 500 mg/lit. v) Turbidity & colloidal impurities should not be more than 10 ppm. **(any four characteristics)**	**2** 1/2 Mark each
	(k)	**What is slaking of lime?** When lime is mixed with water (3:1), it absorbs water begins to burst & swell with evolution of heat. This heat brings entire mass to boil with hissing sound & solid lime crumbles into fine dry white powder resulting in a suspension of finely divided calcium hydroxide in water called slaked lime. The process is called slaking of lime. $CaO + H_2O \Longrightarrow Ca(OH)_2 + 1.5$ Kcal Quick lime slaked lime (Heat)	**2** 1 1
	(l)	**Name the constituents of Portland cement.** i) Lime(CaO) ii) Silica(SiO_2) iii) Alumina(Al_2O_3) iv) Iron Oxide(Fe_2O_3) iv) Magnesia(MgO) v) Sulphur trioxide vi) Soda & Potash vii) Gypsum($CaSO_4.2H_2O$) **(any four constituents)**	**2** ½ mark each

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2		**Attempt any four:**	**16**
	a)	**Write chemical reactions involved in the zone of reduction of blast furnace.**	**4**
		The reduction is done in stages as given below:- $Fe_2O_3 \rightarrow Fe_3O_4 \rightarrow FeO \rightarrow Fe$ i) In between 300 – 500°C, when charge is heated, Fe_2O_3 (Ferric oxide) is reduced to Fe_3O_4 (Ferroso ferric oxide) $3Fe_2O_3 + CO \rightarrow 2Fe_3O_4 + CO_2$ This Fe_3O_4 is stable upto 650°C in presence of CO, CO_2 & free coke. ii) In between 650 – 700°C, Fe_3O_4 is reduced to FeO $Fe_3O_4 + CO \rightarrow 3FeO + CO_2$ iii)At temperature between 700 – 800°C, FeO is reduced to metallic iron. $FeO + CO \rightarrow Fe + CO_2$ iv) Simultaneously, the limestone present in the charge is also decomposed to produce lime. $CaCO_3 \rightarrow CaO + CO_2$ v) The metal produced is spongy; simultaneously a part of metallic iron reacts with CO to form Fe_2O_3 or Fe_3O_4. $2Fe + 3CO \rightarrow Fe_2O_3 + 3C$ $3Fe + 4CO \rightarrow Fe_3O_4 + 4C$ **(Note: Write any four reactions)**	1 mark each
	b)	**Explain the reactions taking place during hardening & setting of cement.**	**4**
		Setting and Hardening of cement: - The setting and hardening of cement is due to hydration and hydrolysis reaction taking place between the different constituents of cement and water. Anhydrous compounds undergo hydration forming insoluble gels and crystalline products. **Setting:** is defined as stiffening of the original plastic mass due to initial gel formation. **Hardening:** is the development of strength due to crystallization.	2
		Following chemical reaction taking place during setting and hardening. **1] Hydrolysis:** $C_3S + (x+1)\ H_2O \rightarrow C_2S.\ xH_2O + C.H_2O$ $C_4AF + 7\ H_2O \rightarrow C_3A.\ 6H_2O + CF.H_2O$	1
		2] Hydration: $C_3S + xH_2O \rightarrow C_2S\ .x\ H_2O + CaO$ $C_3A + 6\ H_2O \rightarrow C_3A.6\ H_2O + Heat$	1

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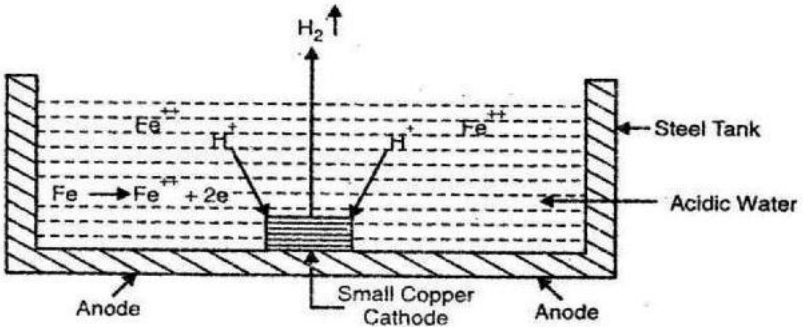
	c)	**Describe the mechanism of immersed corrosion with evolution of hydrogen gas.**	**4**
			1
		Steel tank: - Anode **Cu – strip:- Cathode** These types of corrosion occur usually in acidic environments like industrial waste, solutions of non – oxidizing acids. Consider a steel tank containing acidic industrial waste and small piece of copper scrap in contact with steel. The portion of the steel tank in contact with copper acts as anode & is corroded most with the evolution of hydrogen gas.	1
		Reactions: **At Anode:** **$Fe \rightarrow Fe^{++} + 2\,e^{-}$ (Oxidation)** These electrons flow through the metal from anode to the cathode that is piece of copper metal where they are accepted by H^+ ions to form H_2 gas	1
		At cathode : H^+ ions are eliminated as H_2 gas **$2H^+ + 2\,e^{-} \rightarrow H_2\uparrow$ (Reduction)** Thus, over all reaction is **$Fe + 2H^+ \rightarrow Fe^{++} + H_2\uparrow$**	1

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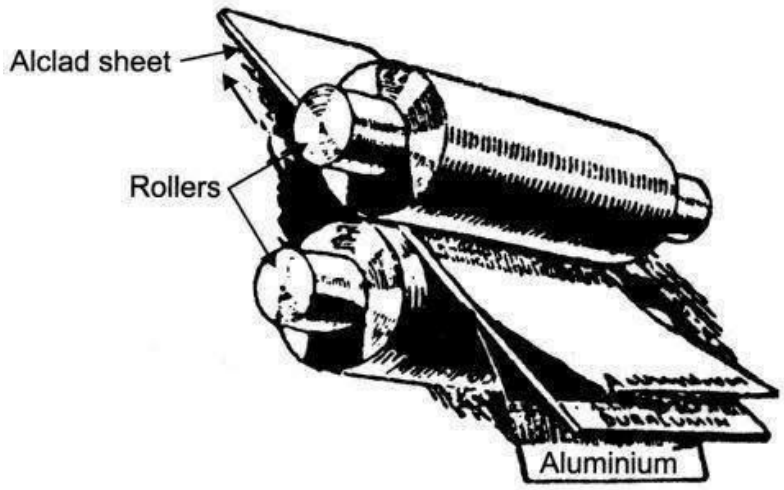
2.	**d)**	**State and explain metal cladding process with diagram.**	**4**
		Metal cladding involves bonding firmly and permanently a dense , homogenous layer of a coating metal to the base metal on one or both sides	1
		Process: i) The base metal is sandwiched or cladded between the two sheets of coating metal. ii) This sandwich is then passed through two heavy rollers maintained at high temperature & pressure. iii) Cladded metal is cathodic with respect to base metal so that electrolytic protection is provided	2
			1
	e)	**Discuss the bad effect of using hard water in following industries:** **i) Paper ii) sugar**	**4**
		Paper industry(Any two) 1) If hard water used in textile industry then large quantity of soap is wasted. 2) If hard water is used in paper manufacturing, then Ca^{2+} and Mg^{2+} ions react with the paper material to form unwanted precipitates. Hence, paper will not have desired smoothness and glossiness. 3) Iron & manganese impurities in hard water affect whiteness of colors.	2
		Sugar industry (Any two) 1) If hard water used in sugar industry then sugar may not crystallize well. 2) Sugar may be deliquescent. 3) Sugar may gets decomposed during storage	2

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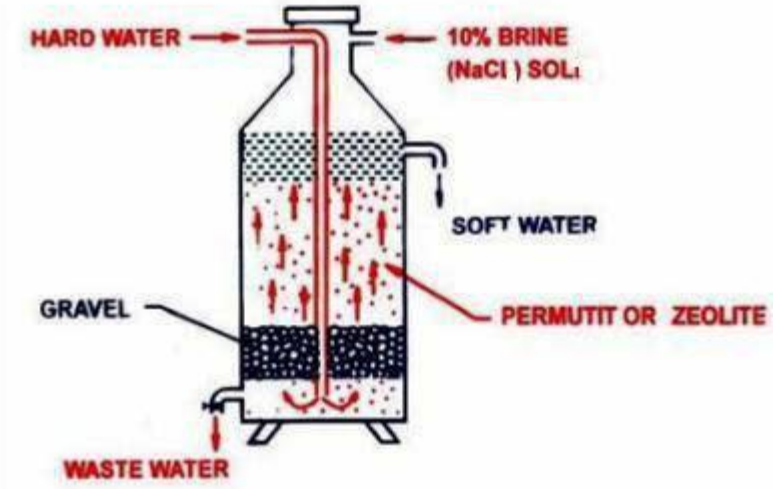
Q. No.	Sub Q. N.	Answer	Marking Scheme
2.	f)	**Describe in brief the zeolite process for softening of hard water.**	4
			1
		PERMUTIT'S PROCESS OF SOFTENING OF HARD WATER	
		Explanation:-In this process sodium permutit is placed in a suitable container and hard water is allowed to pass through it. The calcium & magnesium salts present in the hard water react with the sodium permutit to form water insoluble calcium & magnesium permutit which are retained by filter bed. Thus water obtained is free from calcium & magnesium salts.	1
		Reaction with temporary hardness causing salts:- $Ca(HCO_3)_2 + Na_2P \rightarrow Na_2(HCO_3)_2 + CaP$ $Mg(HCO_3)_2 + Na_2P \rightarrow Na_2(HCO_3)_2 + MgP$ **Reaction with permanent hardness causing salts:-** $CaCl_2 + Na_2P \rightarrow 2NaCl + CaP$ $MgCl_2 + Na_2P \rightarrow 2NaCl + MgP$ $CaSO_4 + Na_2P \rightarrow Na_2SO_4 + CaP$ $MgSO_4 + Na_2P \rightarrow Na_2SO_4 + MgP$ **(consider any Two reactions)**	2

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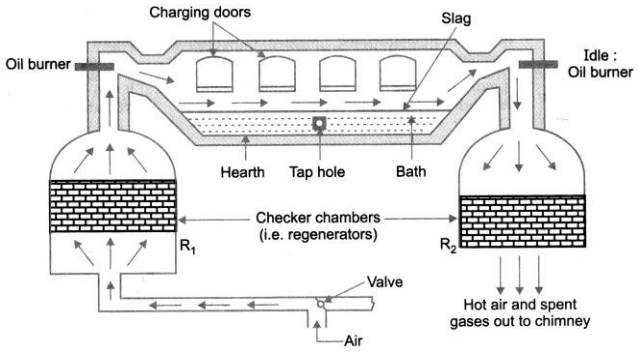
Q. No.	Sub Q. N.	Answer	Marking Scheme
3		**Attempt any four:**	**4 x 4=16**
	a)	**Explain open hearth process for manufacturing of steel.**	**4**
		Procedure:-1) The charge consists of pig / cast iron (Cold or molten), scrap iron / steel &haematite (Ore). 2) Heating the charge on the hearth of furnace by the heat produced by burning fuel in air or by producer gas. 3) **First Phase of Cycle: -**Producer gas / air is passed through previously heated regenerator (R) while the products of combustion flow through the regenerator. 4) The charge is fed through a charging door & heated to 1600^0C to 1650^0C by means of producer gas. Fuel is fired through nozzles. 5) The hot gases formed in (R_1) pass over the hearth to its opposite end & metal charge supported on the hearth is openly exposed to the flames & is converted into molten metal. Metal charge is also heated by the radiations from the walls. 6) After passing over the hearth, the products of combustion pass through R_2 (Checker chamber) & heat it after about 25 to 30 min. **7) Second Phase Cycle:-**Idle burner fires the fuel. 8) Regenerators R_1, R_2store & release large quantities of heat which would have escaped to the atmosphere & thus wasted. 9) Tap hole in the lowest part of the hearth always closed with refractory plug until metal is ready to be poured.	2

Q. No.	Sub Q. N.	Answer	Marking Scheme
		Reaction:- a) Oxidation of impurities of Mn, P and Si by hematite. $2Fe_2O_3 + 6Mn \rightarrow 4Fe + 6MnO$ $5\ Fe_2O_3 + 6P \rightarrow 10Fe + 3P_2O_5$ $2Fe_2O_3 + 3Si \rightarrow 4Fe + 3SiO_2$ b) Formation of slag for the removal of Mn, P & Si. $MnO + SiO_2 \rightarrow MnSiO_3$ $P_2O_3 + 3CaO \rightarrow Ca_3(PO_4)_2$ } Slag $SiO_2 + CaO \rightarrow CaSiO_3$ c) Finally C & S from gaseous oxides which leave the furnace as five gases $2\ Fe_2O_3 + 3C \rightarrow 4Fe + 3CO_2\uparrow$ $2Fe_2O_3 + 3S \rightarrow 4Fe + 3SO_2\uparrow$	1
		 	1
	b)	**Define heat treatment. Write the purposes of heat treatment**.	**4**
		Heat Treatment: It is the process of heating steel to a certain high temperature and then cooling it at a controlled rate, in order to develop certain desirable physical properties in it without changing its chemical composition.	1
		Purpose of heat treatment:- 1) To change the structure of steel. 2) To increase surface hardness. 3) To increase resistance to heat & corrosion. 4) To change the magnetic properties of steel. 5) To increase tensile strength. **(State any three relevant purposes)**	3

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3	c)	**Distinguish between Galvanizing and Tinning.**	**4**

Sr.No.	Galvanizing	Tinning
i)	A process of covering iron or steel with a thin coat of **Zinc** to prevent it from rusting.	A process of covering iron or steel with a thin coat of **Tin** to prevent it from corrosion.
ii)	In galvanising, zinc protects the iron as it is more electropositive than iron.It does not allow iron to pass into solution.	Tin protects base metal iron from corrosion, as it is less electropositive than iron and higher corrosion resistance.
iii)	In galvanizing Zn continues to protect the metal by galvanic cell action, even if coating of Zn is broken.	In tinning, tin protects the iron, till the coating is perfect.Any break in coating causes rapid corrosion.
iv)	Galvanized containers can not be used for storing acidic food stuff, since Zn reacts with food acids forming Zn compounds which are highly toxic i.e. poisonous.	Tin coated containers and utensils can be used for storing any food stuff since Tin is non toxic and protects the metal from corrosion and does not causes food poisoning.

1 mark each

d) **Explain the ill effects of using hard water in boilers.** **4**

The ill effects of using hard water in boilers are:-

i) Boiler Corrosion: It takes place due to dissolved gases like O_2, CO_2, dissolved salts like $MgCl_2$ or acidic or alkaline water.

ii) Caustic embrittlement: It means corrosion due to highly alkaline water. Water becomes alkaline due to sodium carbonate added for water softening. It reacts with water to form NaOH. This NaOH deposits in minute cracks present on the inner side of boiler where it attacks the boiler parts and causes its corrosion.

iii) Scale and Sludge formation in boilers: If hard water is used in boilers then it causes scale & sludge formation.

Scale: H**ard, adherent coating** formed on the inner surface of the boiler is known as scale.

Sludge: Soft, loose, slimy deposit formed inside the boiler are known as sludge.

(Note:Any two ill effects 2 marks each)

2 mark each

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3	e)	**50ml of sample of water was titrated with 0.01M EDTA and following observations were reported.** i) Total hardness, burette reading = 25ml ii) Permanent hardness, burette reading = 10ml Find the temporary hardness of the same. [1ml of 0.01MEDTA=1mg of $CaCO_3$]	**4**
		Given: i) Total hardness, burette reading = 25ml ii) Permanent hardness, burette reading = 10ml iii) 1ml of 0.01MEDTA=1mg of $CaCO_3$	**1**
		To calculate Total Hardness: We know that, 1ml of 0.01MEDTA=1mg of $CaCO_3$ hence 25ml of 0.01MEDTA= $\frac{25 \times 0.01 \times 1}{1 \times 0.01}$ = 25mg 50 ml water sample contains = 25mg of total hardness hence 1000 mi water sample contains = $\frac{25 \times 1000}{50}$ = 500 mg of total hardness Total Hardness = 500 mg of $CaCO_3$	1
		To calculate Permanent Hardness: We know that 1ml of 0.01MEDTA=1mg of $CaCO_3$ hence 10 ml of 0.01MEDTA= $\frac{10 \times 0.01 \times 1}{1 \times 0.01}$ = 10 mg 50 ml water sample contains = 10 mg of permanent hardness hence 1000 mi water sample contains = $\frac{10 \times 1000}{50}$ = 200 mg of permanent hardness Permanent Hardness = 200 mg of $CaCO_3$	1
		To calculate Temporary Hardness: We know that, Total Hardness = Temporary Hardness + Permanent Hardness Hence Temporary Hardness = Total Hardness - Permanent Hardness = 500 - 200 = 300 Temporary Hardness = 300 mg of $CaCO_3$	1

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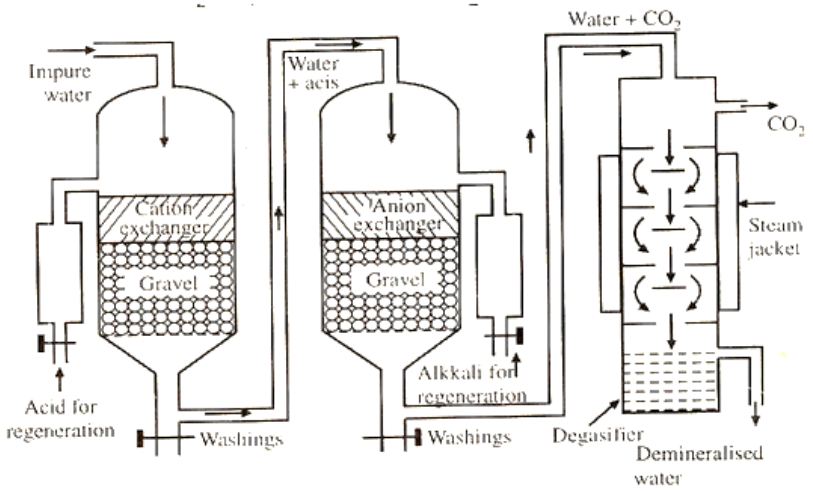
3	f	**Explain ion exchange process of water softening with a labeled diagram and write chemical reactions.** In ion exchange process, the softening agent used is synthetic organic polymers such as cation exchange resin and anion exchange resin. Cation exchange resins have exchangeable H^+ and anion exchange resins have exchangeable OH^- ions. Process :- It consist of three cylindrical towers, the first tower contains cation exchange resin ($R-H_2$) and the other contains anion exchange resin ($R' -OH_2$).Both towers are also connected to acid and alkali tanks for regeneration of exhausted cation exchange resin and anion exchange resin respectively. Third tower is degasifier. **Working :-** $RH_2+CaCl_2 \longrightarrow RCa+2HCl$ $RH_2+MgSO_4 \longrightarrow RMg+H_2SO_4$ **[Note: Any one reaction: 1 mark]** This acidified water is then passed through tank containing anion exchange resins. Here all the anions are replaced by OH- ions. $R'(OH)_2+2HCl \longrightarrow R'Cl_2+ 2H_2O$ $R'(OH)_2+H_2SO_4 \longrightarrow R'SO_4+ 2H_2O$ **[Note: Any one reaction: 1 mark]** Thus water becomes free from all ions. This water is then passed through a degasified to remove gases like CO_2.  	**4** 1 2 1

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