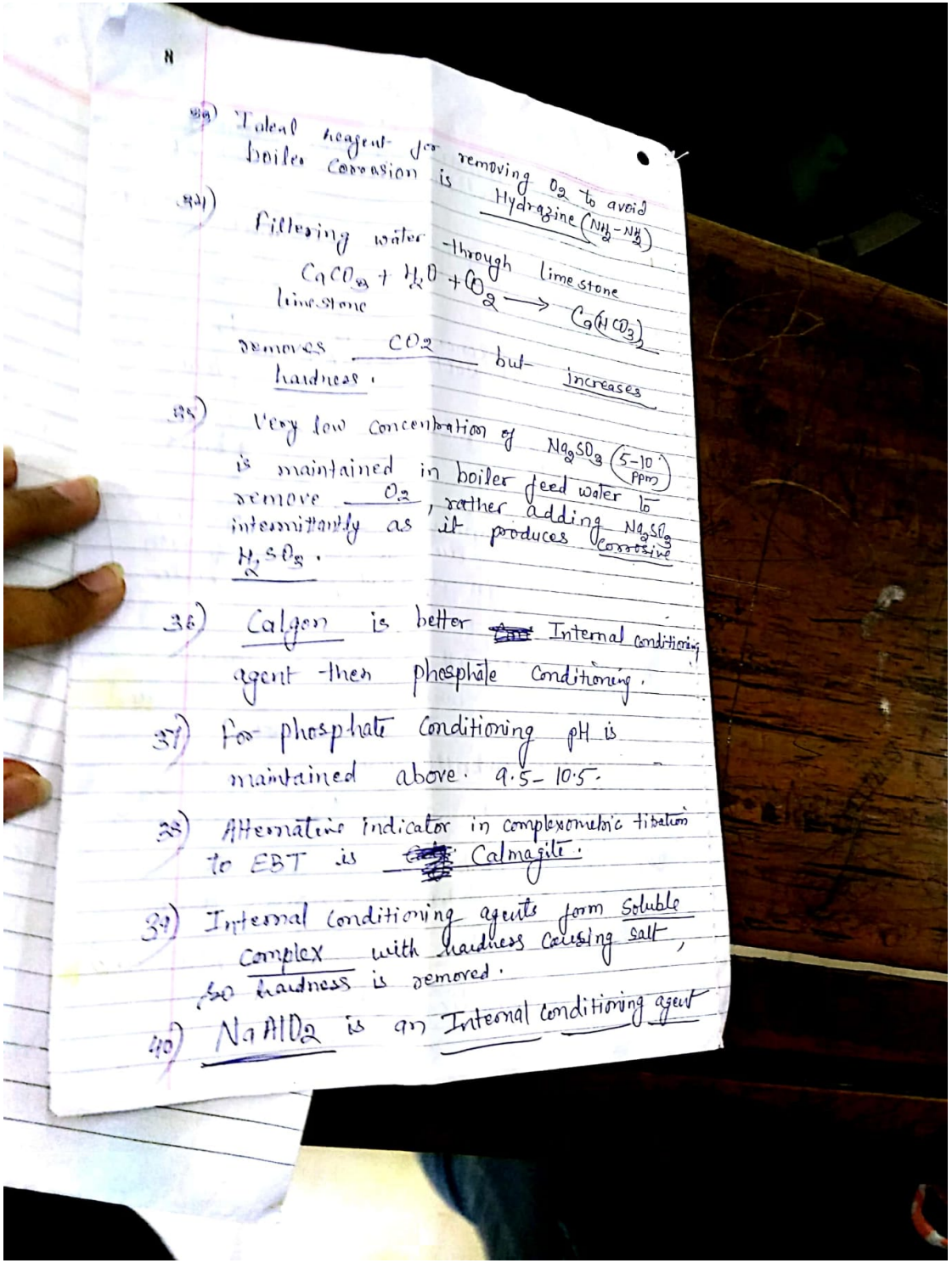

N

33) Ideal reagent for removing O_2 to avoid boiler corrosion is Hydrazine (NH_2-NH_2)

34) Filtering water through limestone

$CaCO_3 + H_2O + CO_2 \rightarrow Ca(HCO_3)_2$

limestone

removes CO_2 but increases hardness.

35) Very low concentration of Na_2SO_3 (5-10 ppm) is maintained in boiler feed water to remove O_2, rather adding Na_2SO_3 intermittently as it produces corrosive H_2SO_3.

36) Calgon is better ~~Cost~~ Internal conditioning agent then phosphate Conditioning.

37) For phosphate conditioning pH is maintained above 9.5 - 10.5.

38) Alternative indicator in complexometric titration to EBT is ~~Calcite~~ Calmagite.

39) Internal conditioning agents form soluble complex with hardness causing salt, so hardness is removed.

40) $NaAlO_2$ is an Internal conditioning agent

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29) Aluminium compounds ~~formers~~ are used to avoid ~~foaming~~.

30) The Iron in cracks forms Anodic part and corrodes.

+ −

Fe | conc. NaOH || Dil NaOH | Fe

Cracks, rivets, Bends, joints.. in Boilers.

Plane part of the Boilers

Concentration cell corrosion due to diff. conc. of NaOH in different parts of boiler.

31) The above cell is concentration cell formed in boiler due to cracks and conc. NaOH. Thus this "Caustic embrittlement" is the example of concentration cell corrosion.

32) Caustic embrittlement is the case of stress-corrosion also, because craks are stressed part and form Anodic part.

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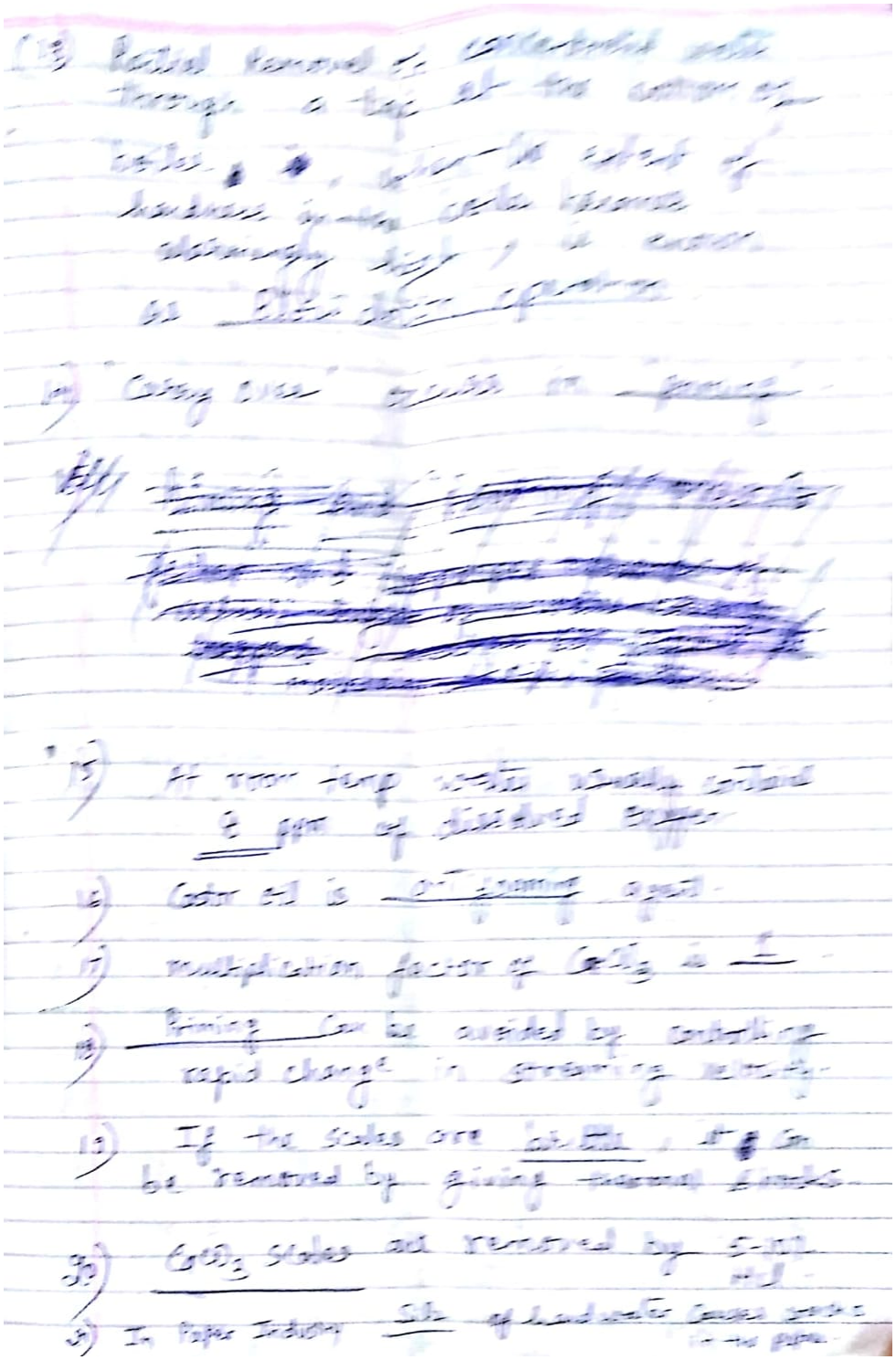

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(13) Partial Removal of concentrated water through a tap at the bottom of boiler, when the extent of hardness in the boiler becomes alarmingly high, is known as 'blow down operation'.

14) 'Carry over' occurs in 'priming'.

15) ~~Priming and Foaming ... Neither ... improper ... height of water ... maintain boiler ...~~

15) At room temp water usually contains 8 ppm of dissolved oxygen.

16) Castor oil is antifoaming agent.

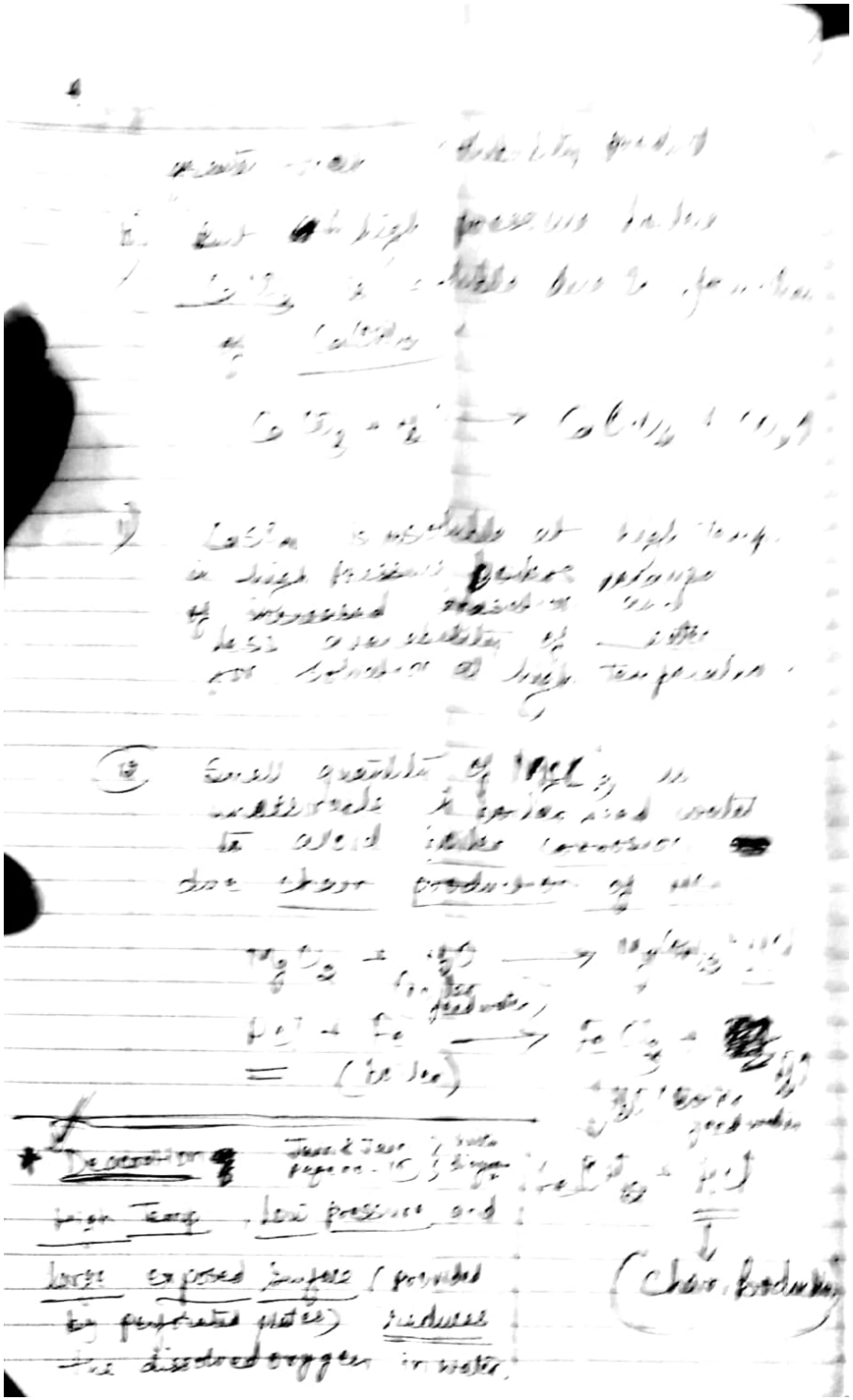
17) multiplication factor of $CaCl_2$ is 1.

18) Priming can be avoided by controlling rapid change in steaming velocity.

19) If the scales are brittle, it can be removed by giving thermal shocks.

20) $CaCO_3$ scales are removed by 5-10% HCl.

21) In Paper Industry SiO_2 of hardwater causes cracks in the paper.



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FIB : Fill in the [illegible]

([illegible])

1) Tannin or Lignin is added to [illegible] feed water to avoid [illegible]

2) Na_2SO_4 is added to [illegible] water in [illegible] so that the ratio [illegible] is kept as 1:1 [illegible] boilers working [illegible] boiler.

3) Drinking water has [illegible] ppm range of hardness.

4) Hard water is good for health

5) Soft water is good for [illegible] but not good for [illegible]

6) Trade name of Sodium [illegible] phosphate is Calgon

7) Hardness of boiler feed water should be below 0.2 ppm.

8) Sand filter water has impurity of SiO_2 which form hard scale of $CaSiO_3$ (Calcium silicate)

9) $CaSO_4$ is insoluble at high temperature, because of increased [illegible] at high temp. and it's [illegible]

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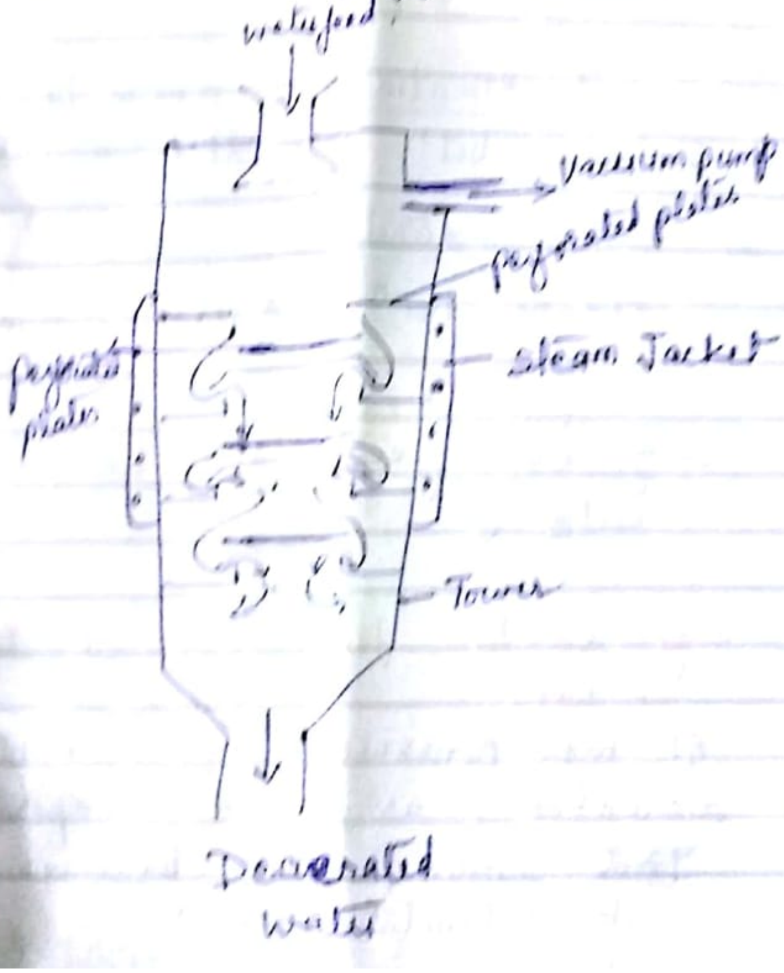
Q. What is Mechanical Deaeration ? (Diagram)

OR

How dissolved O_2 (or any other gas) is removed from boiler feed water.

Ans. [Jain & Jain page no. 11] Mechanical Deaeration.

Ans. (Key line) — " High temperature, low pressure and large exposed surface (provided by perforated plates) reduces the dissolved oxygen in water.



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Que - Because of improper judgement of actual height of water column, the maintenance of boiler pressure becomes difficult.

Que - A boiler feed water should have what permitted values of hardness and alkalinity ?

1) Hardness should be below 0.2 ppm
ideally = 0 ppm

2) Caustic Alkalinity (due to $\bar{O}H$)
shd be betn 0.15 and 0.45 ppm.

3) Soda Alkalinity - (Due to Na_2CO_3)
shd be betn 0.45 - 1 ppm.

Que Why boiler feed water should not have SiO_2 ?

Que why $CaSO_4$ forms scale in high pressure boilers

Ans: At high Pressure / Temp. Solubility of $CaSO_4$ decreases, as water evaporates its Ionic product becomes greater than its Solubility Product $K_{sp} < K_{Ionic\ Product}$

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reduction in surface tension.

(II) For avoiding foaming or reduction in surface tension, Aluminium compds are added. e.g.

(i) Sodium Aluminate $NaAlO_2$

(ii) Aluminium Sulphate $Al_2(SO_4)_3$

which hydrolyse to $Al(OH)_2$ flocks and entrap the oil drops. The flocks of $Al(OH)_3$ containing oil droplets are removed by filtration through Anthrafilt filter bed.

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Why even a small amount of $MgCl_2$ cause corrosion of iron to large extent?

Mineral acids are very important causes of boiler corrosion. If $MgCl_2$ is present in boiler feed water, it can hydrolyse to produce HCl.

$$MgCl_2 + H_2O \rightarrow Mg(OH)_2 \downarrow + 2HCl$$

Liberated acid reacts with boiler material (Fe) to form $Fe(OH)_2$ which in turn converted to rust.

$$Fe + 2HCl \rightarrow FeCl_2 + H_2$$
$$FeCl_2 + 2H_2O \rightarrow Fe(OH)_2 + 2HCl$$
$$2Fe(OH)_2 + O_2 \rightarrow Fe_2O_3 \cdot H_2O$$

Thus a small amount of acid may cause extensive corrosion since HCl is produced in a chain like manner. Consequently presence of even a small amount of $MgCl_2$ cause corrosion to large extent.

But as the boiler water is generally alkaline hence acid is usually neutralized.

Ques - Why Sodium phosphate is preferred to Na_2CO_3 as softening agent in water treatment.

Ans. To avoid 'Caustic embrittlement' by Caustic alkali produced in boiling water in boilers due to following reaction -

$$Na_2CO_3 + H_2O \rightarrow 2NaOH + CO_2$$

be used in exc... used because which causes co... used in conde... $+ N_2$ ... used in free... a very low ... a rule. and ... for removal of Na_2SO_4 ... SO_4 ... SO_4 ... ses to give ... and ... hurous acid, ... ule a ... of

$$Na_2S + 2O_2 \longrightarrow Na_2SO_4$$

Under high pressure Na_2SO_4 decomposes to give SO_2, which enters the steam pipes and appears as corrosive H_2SO_3 Sulphurous acid in steam condensate. So, as a rule a very low concentration of 5-10 ppm of Na_2SO_3 in the boiler is maintained, rather than adding intermettently.

Qu 5 why CO_2 when removed by ~~passing~~ filtering water through lime-stone ($CaCO_3$), hardness increases.

$$CaCO_3 + H_2O + CO_2 \longrightarrow Ca(HCO_3)_2$$

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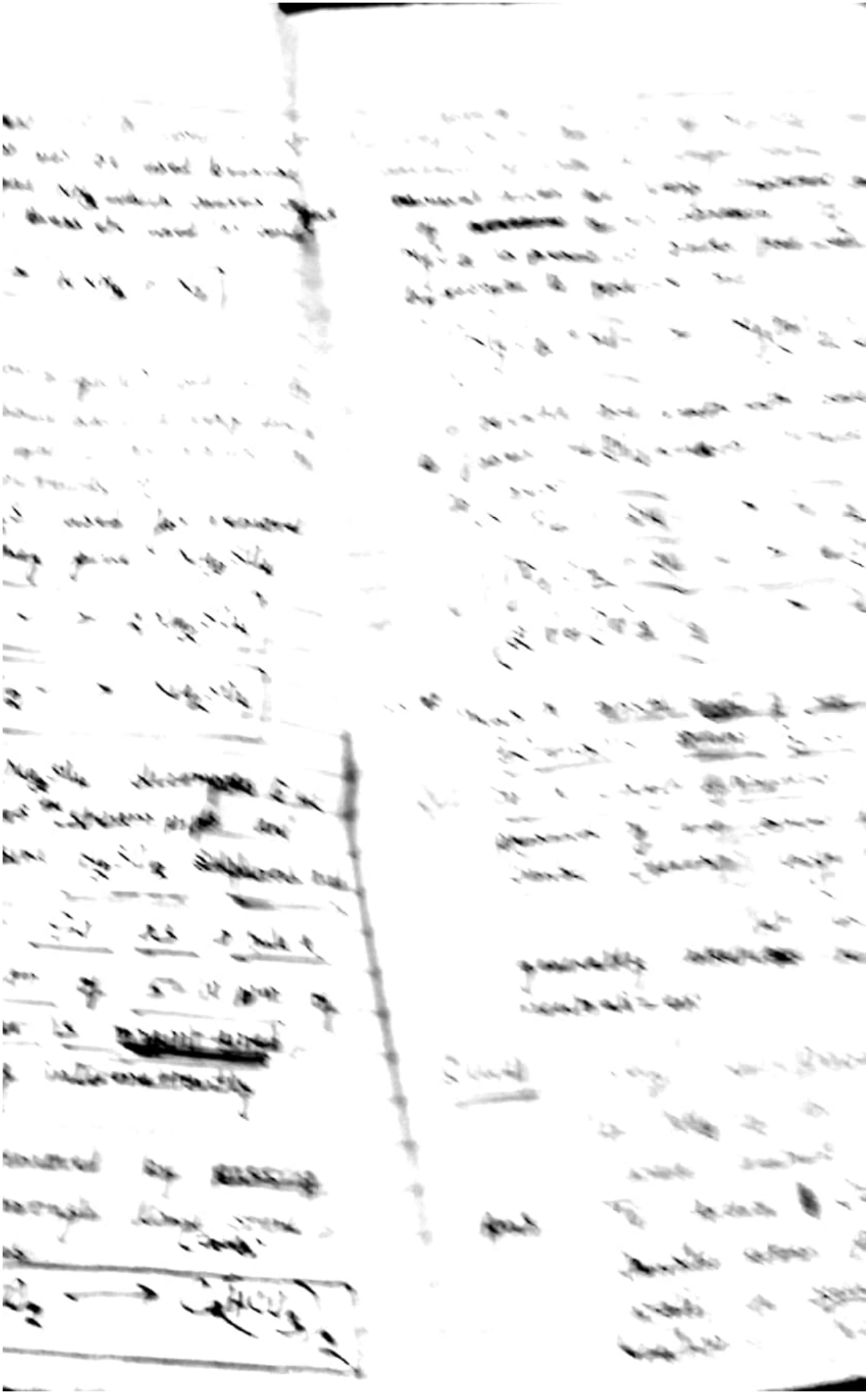

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SUPERVISOR'S INITIAL

DATE

SUPPLE

VEERMATA JIJABAI TECHN

MATUNGA, MUMBA

Subject

Sectio

3

Boiler Tr

Boiler corrosion

1) Removal of oxyg

(1) Adding Hydr

Expected questions :-

Que (1) why Hydrazine is a
of dissolved oxygen

Ans. $N_2H_4 + O_2$ —
hydrazine

Since harmless N_2
removes oxygen witho
dissolved solids / se
Na_2SO_3 (sodium sul
sulphides on reaction
which under high po
SO_2 which enters
as corrosive H_2S
steam condensate.

Que (2) why pure Hydrazin

Ans. Hydrazine is explosi
40% aqueous solu
40% aqueous Soluti

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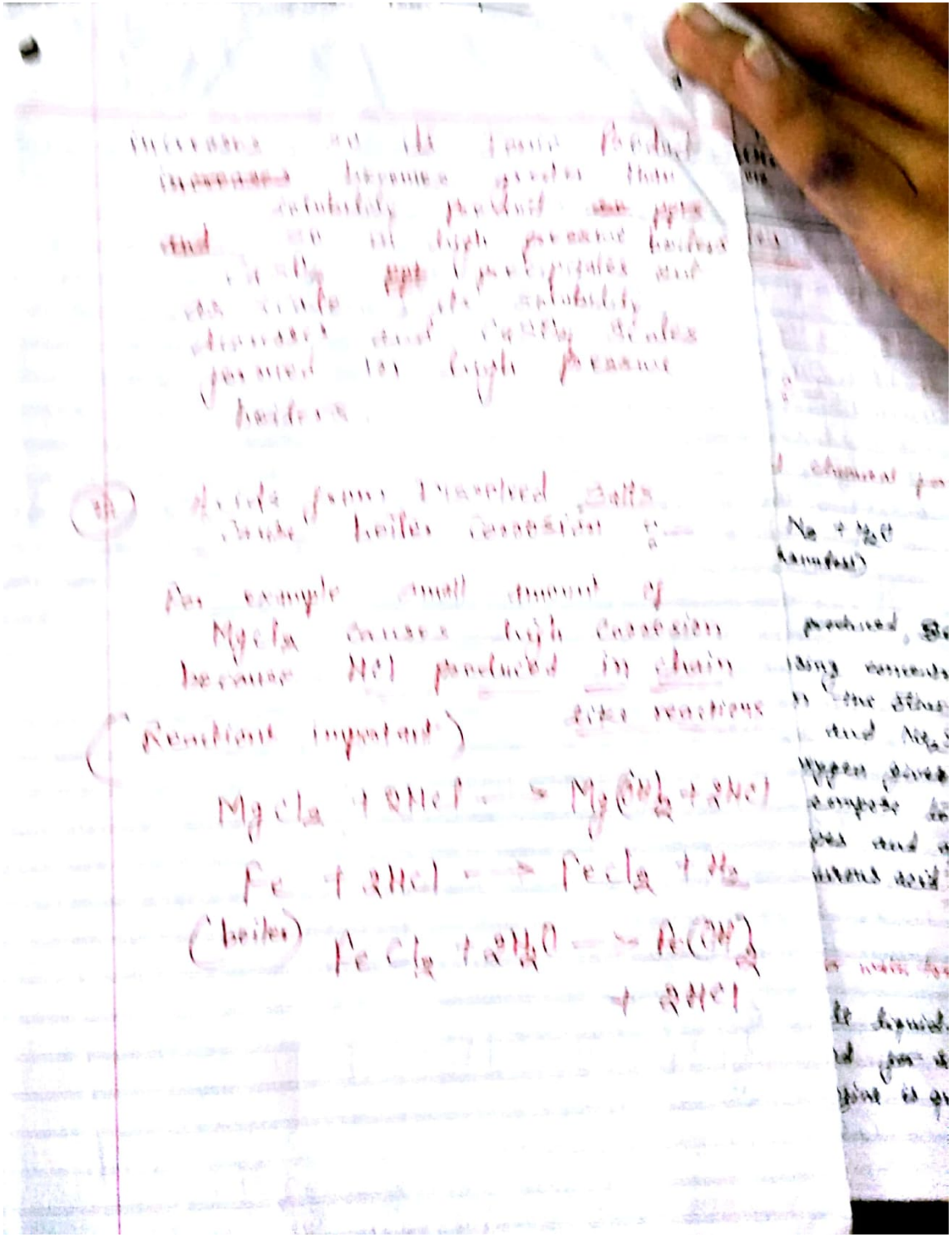

(ii) Acidic fumes liberated during boiler corrosion :-

For example small amount of $MgCl_2$ causes high corrosion because HCl produced in chain like reactions

(Reactions involved)

$MgCl_2 + 2HCl \rightarrow Mg(OH)_2 + 2HCl$

$Fe + 2HCl \rightarrow FeCl_2 + H_2$

(boiler) $FeCl_2 + 2H_2O \rightarrow Fe(OH)_2 + 2HCl$

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Caustic embrittlement is case of

(I) Stress - Corrosion

(II) Concentration Cell Corrosion

+

Anode Fe | Conc. NaOH || Dil NaOH | Fe$^-$

(cracks, joints)

(II) $CaCO_3$ is scale formed in low ~~boiler~~ pressure boiler but in high pressure boiler, it is soluble as $Ca(OH)_2$.

React^n (Imp.) – $CaCO_3 + H_2O \longrightarrow Ca(OH)_2 + CO_2\uparrow$

soluble.

At high Temp pressure $CaCO_3$ forms $Ca(OH)_2$ which is soluble so $Ca(OH)_2$ does not cause hardness, it is soluble so does not cause scale.

(III) ~~At~~ high ~~pressure~~ boilers $CaSO_4$ scale is formed because at high Temp $CaSO_4$ Ionisation of $CaSO_4$

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Fe_3O_4 Magnetite — Protective layer

(II) Main Reaction

dissolves ↓ Conc. NaOH ($Fe_3O_4 + 4NaOH$)

$2NaFeO_2 + Na_2FeO_2 + 2H_2O$.

As soon as Fe_3O_4 magnetite dissolves water reacts directly with Iron as

(III) $3Fe + 4H_2O \longrightarrow Fe_3O_4 + H_2$

(IV) Caustic alkali may also react with Iron to form hydrogen.

$Fe + NaOH \longrightarrow NaFeO_2 + H_2$

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Four step reaction:-

Caustic Embrittlement :- (Reactions)

(I) $Fe \longrightarrow Fe^{2+} + 2e^-$

At Anode (Corrosion)

$\bar{O}H$ (Cathode)

$Fe(OH)_2$

$Fe_2O_3 \cdot H_2O$

(II) Main Reaction

Fe_3O_4 Magnetite — Protective layer

dissolves in Conc. NaOH ($Fe_3O_4 + 4NaOH$)

$2NaFeO_2 + Na_2FeO_2 + 2H_2O$

As soon as Fe_3O_4 magnetite dissolves water reacts directly with Iron as

(III) $3Fe + 4H_2O \longrightarrow Fe_3O_4 + 4H_2$

(IV) Caustic alkali may also react with Iron to form hydrogen-

$Fe + NaOH \longrightarrow NaFeO_2 + H_2$

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