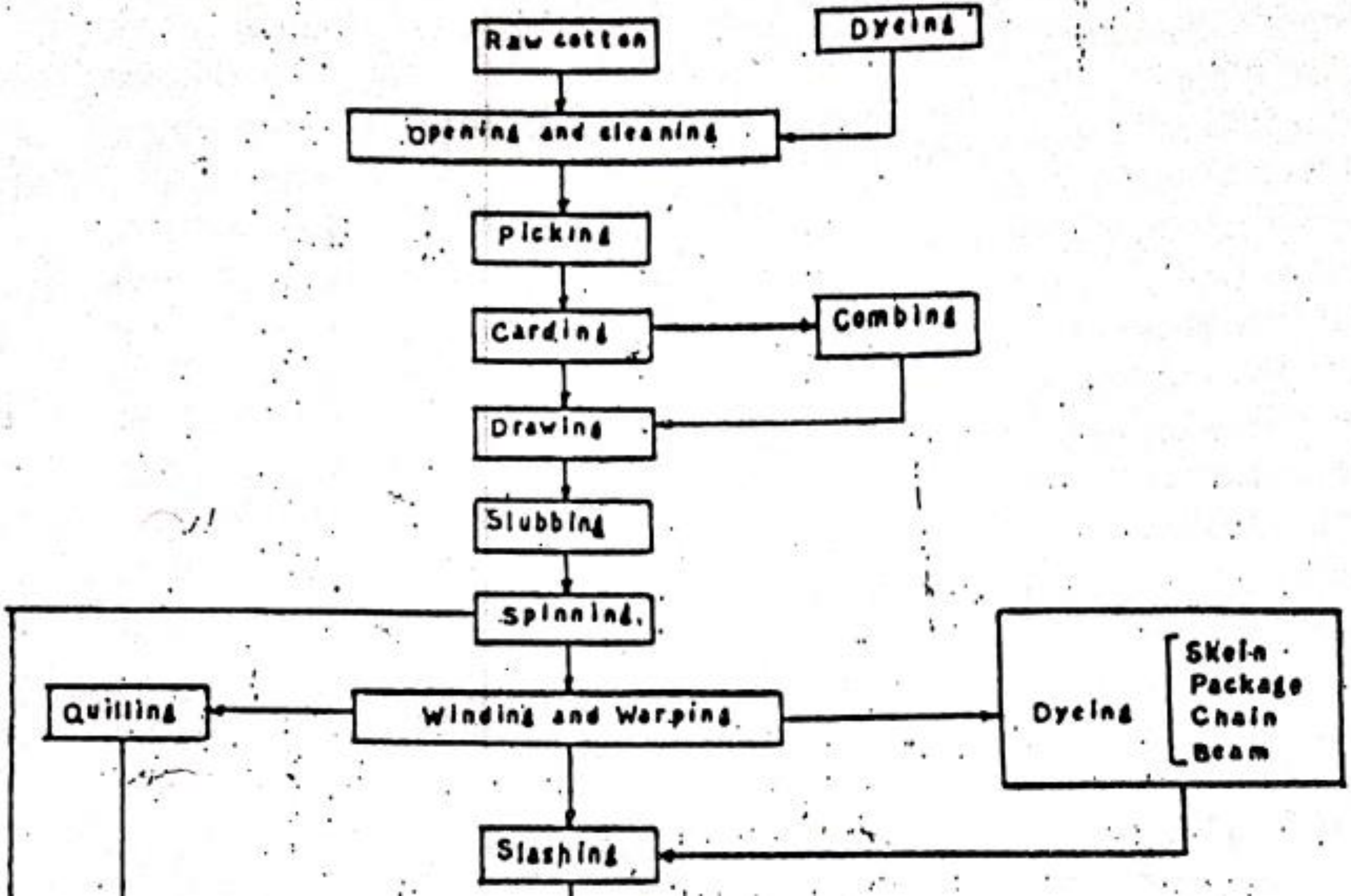
MIWWE 17CV71

MODULE 5

Cotton and textile industry


Raw cotton
Dyeing
Opening and cleaning
Picking
Carding
Combing
Drawing
Slubbing
Spinning.
Quilling
Winding and Warping
Dyeing
Skein
Package
Chain
Beam
Slashing

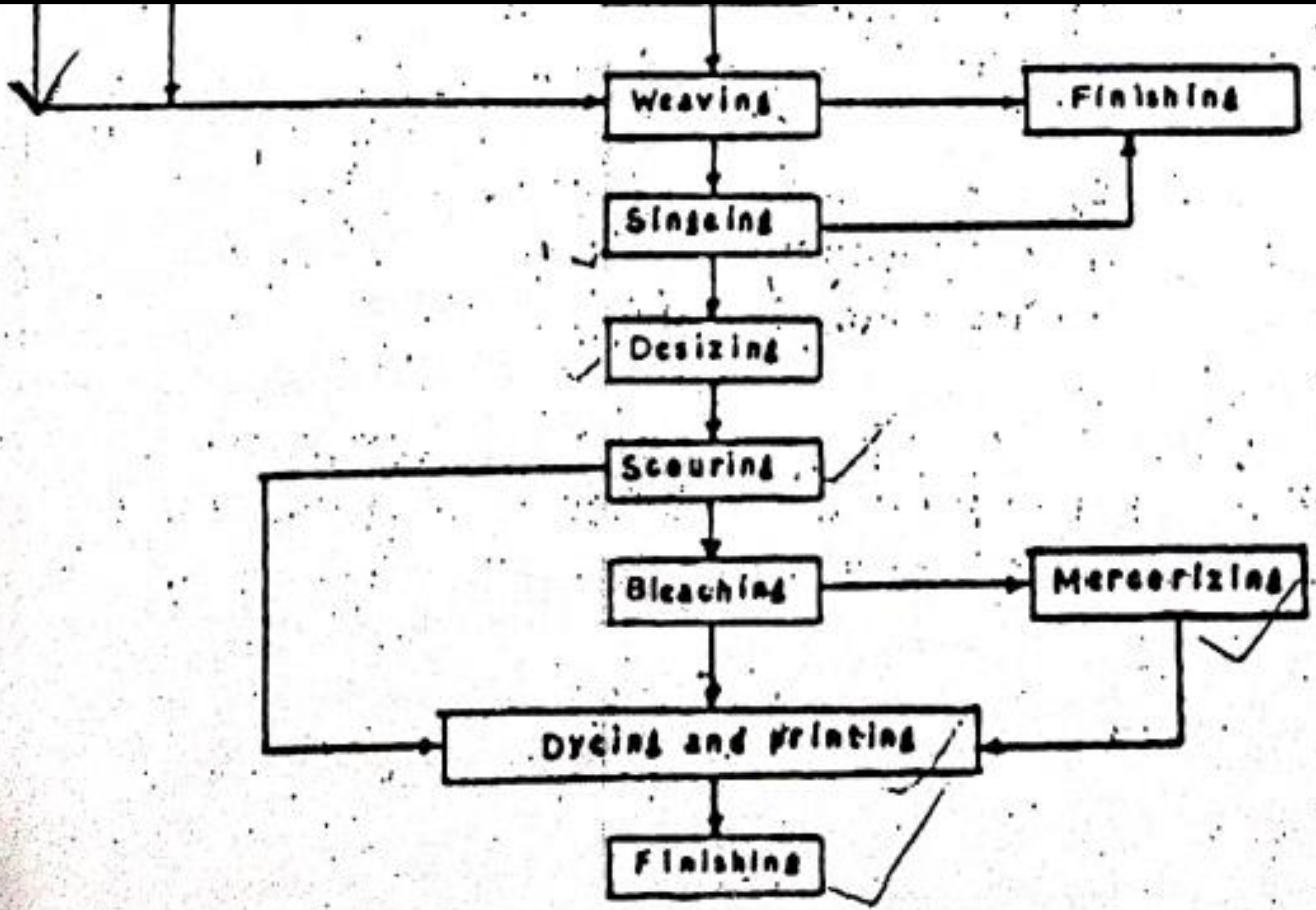


FIG. 13.1 : Flow Diagram of an Integrated Cotton Textile Mill.

Manufacturing, origin of wastewater

- An integrated cotton textile mill produces its own yarn from the raw cotton. Production of yarn from raw cotton includes steps like, opening and cleaning, picking, carding, drawing, spinning, winding and warping. All these sequences arc dry operations and as such do not contribute to the liquid waste of the mill.
- The entire liquid waste from the textile mills comes from the following operation of slashing (or sizing), scouring and desizing, bleaching, mercerizing, dyeing, and finishing.
- In slashing, the yarn is strengthened by loading it with starch or other sizing/substances. Waste originates from this section due to spills, and the floor washings at the weak end. The substitution of low-BOD sizes[1] (such as corboxy methyl cellulose) for the high BOD starch reduces the total BOD of mill effluent by 40-90%.
- A slashing the yarn goes for weaving. The prepared doth now requires scouring and desizing to remove natural impurities and the slashing compounds. Enzymes are usually used in India to hydrolize the starch; acids may also be used for this purpose. Caustic soda; soda ash, detergents etc. are used in scouring in Kier boilers. Replacement of soap used in scouring by low-BOD detergents may reduce BOD load by 35%. About 50% of the total pollution load of the mill is contributed by this section.

- Bleaching operations use oxidizing chemicals like peroxides and hypochlorites to remove natural colouring materials. This section contributes about 10% of the total pollution load.
- Mercerising consists of passing the cloth through 20% caustic soda solution. The process improves the strength, elasticity, lustre and dye affinity. Waste .from this section is recycled after sodium hydroxide recovery. Negligible waste which may come out of this section contributes little BOD but a high degree of alkalinity.
- Dyeing may be done in various ways, using different types of dyes and auxiliary chemicals. Classes of dyes used include vat dyes, developing dyes, naphthol dyes, sulfur dyes, basic dyes, direct dyes etc.
- Vat dyes require caustic soda and sodium hydrosulfite to reduce the dye into a soluble form. This- is oxidized, after the fabric is being impregnated with it, by oxidizing agents like peroxide or chromate, Sulfur dyes are reduced by sodium sulfide and oxidized by chromate. Indigo dyes are also similar to vat dyes, but require only air oxidation.
- When naphthol is applied first to the fabric, dried, and then passed through a developer for chemical coupling to produce dye, the process is called naphthol dyeing. Developing dyes require acid and sodium nitrite and the colour is developed by treating with a developer.

- Color from the dyes vary widely and although those are not usually toxic, they are esthetically objectionable when they impart color in the drinking water supplies. Certain chemicals used in dyeing such as chromium are toxic and they are treated separately.
- Thickened dyes, along with printing gums and necessary auxiliaries, are used for printing and subsequent fixation. After fixation of the prints, the fabric is given a thorough wash to remove unfixed dyes.
- The Finishing Section of the mill imparts various finishes to the fabrics. Various types of chemicals are used for various objectives. These include starches, dextrines, natural and synthetic waxes, synthetic resins etc.
- Therefore a composite waste from an integrated cotton textile mill may include the following organic and inorganic substances : Starch, carboxymethyl cellulose, sodium hydroxide, detergents, peroxides, hypochlorites, dyes and pigments, sodium gums, dextrins, waxes, sulphides, sulfates, soap etc. Depending on the process and predominant dye used, the characteristics of mill waste vary widely.

Characteristics of wastewater

TABLE 13.1 : Composition of composite cotton textile mill waste.

Characteristics	Value
pH	9.8-11.8
Total alkalinity	17.35 mg/l as $CaCO_3$
BOD	760 mg/l
COD	1418 mg/l
Total solid	6170 mg/l
Total chromium	12.5 mg/l

EFFECTS OF ON RECEIVING STREAMS/SEWERS

- The crude waste, if discharged into the streams, causes rapid depletion of the dissolved oxygen of the streams.
- The condition aggravates due to the settlement of the suspended substances and subsequent decomposition of the deposited sludges in anaerobic condition.
- The alkalinity and the toxic substances like sulphides and chromium affect the aquatic life ; and also interfere with the biological treatment processes ; some dyes are also found toxic.
- The colour often renders the water unfit for use for some industrial purposes in the downstream side.
- The presence of sulphides makes the waste corrosive particularly to concrete structures

TREATMENT OF COTTON TEXTILE MILL WASTES

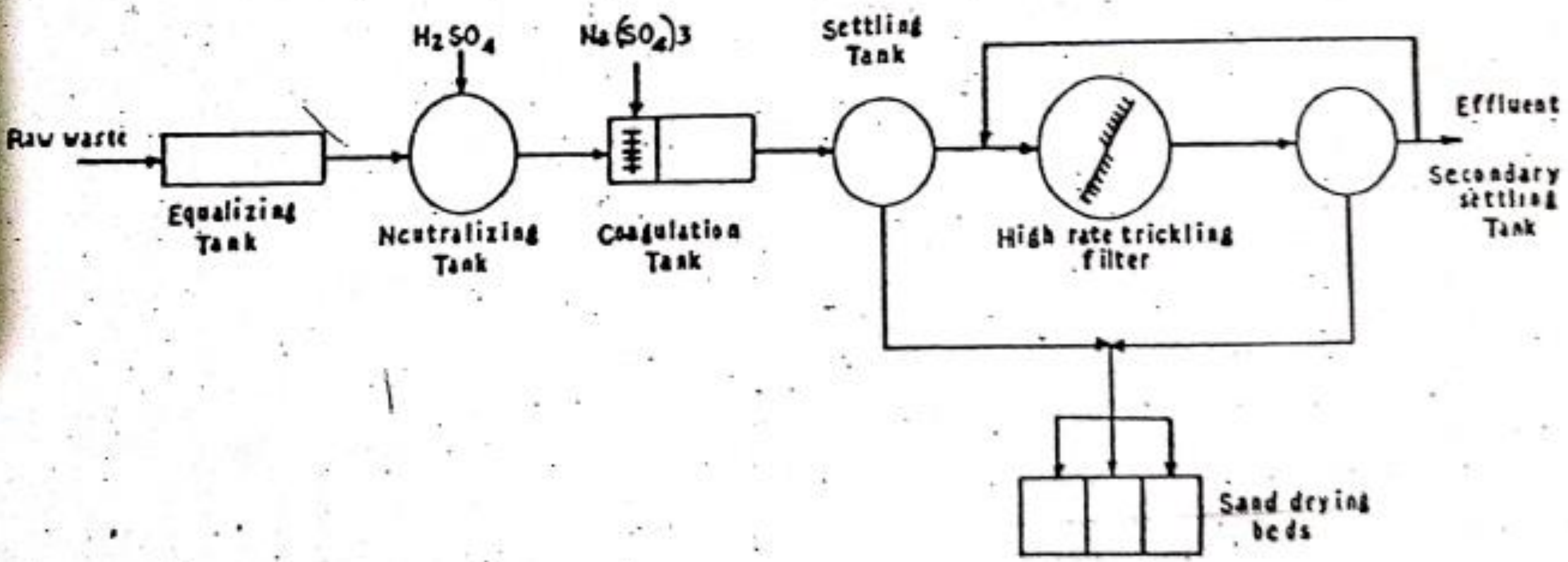


FIG. 13.2 : Flow Diagram for Treatment of Cotton Textile Mill Waste.

Treatment of Cotton Textile Mill Wastes

- Treatment plant should be planned without giving serious consideration for the reduction of the waste volume and strength through the process chemical substitution, chemical and gicase recovery and recycling of water.
- grease recovery ,Caustic recovery, from the Kiering and mercerizing wastes using dialyzers reduces the pollution load to a great- extent. The remaining load reduced by seggregation, equalization, neutralization, chemical precipitation, chemical oxidation and biological oxidation.
- chemical coagulation to reduce BOD. Biological treatment of Kiering or Scouring waste without any pretreatment is found difficult. The dye wastes may be treated economically by biological methods, with prior equalization, neutralisation and chemical oxidation for certain wastes.
- TF, ASP WSP all are found to be very effective.Excellent results were also obtained with "Extended aeration" in treating a strong waste, even without any equalization and pre-treatment ; this method eliminates the necessity of sludge digestion as well.

Tannery industry

Tannery industry

- Skins of cows and buffalos are called "Hides". Skins of goats and sheep are called "Skins". Tanning is the art of converting animal skins into leather. The tannery wastes are characterized by strong color, high BOD, high pH and high dissolved salts.
- 30-40 liters of water is used to process each kilogram of raw hides or skin into finished leather

The tanning process consists of three basic stages

- 1. Preparation of the hides for tanning.
- 2. Tanning proper.
- 3. Finishing.

Manufacture and origin of wastewater

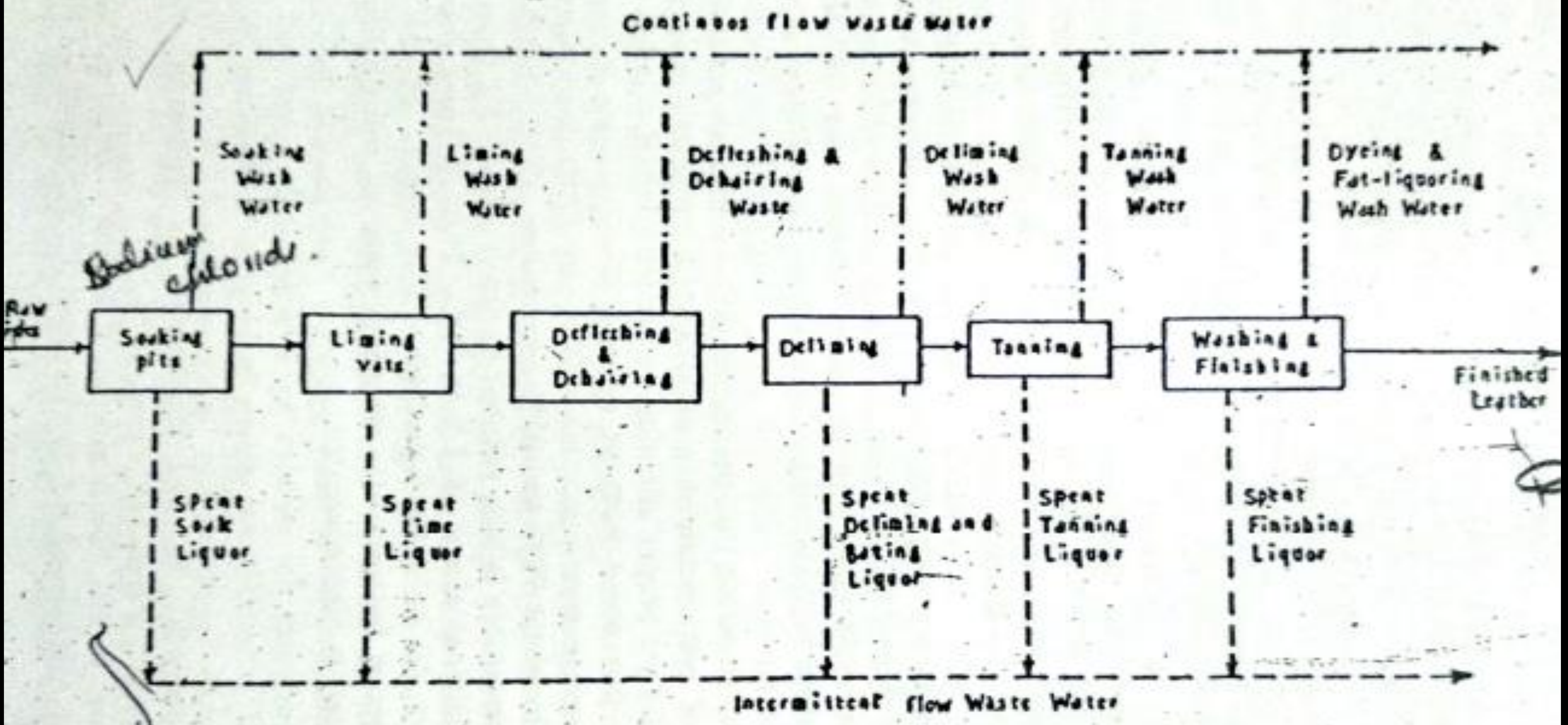


FIG. 12.1 : Flow Diagram of a Vegetable Tanning Process.

- Tannery wastes originate from the beam house and the tanyard.
- beam house - curing, fleshing, washing, soaking, dehairing, lime splitting, bating, pickling and degreasing operations are carried out.
- Tanyard - the final leather is prepared by several processes. These include vegetable or chrome tanning, shaving and finishing.
- finishing operation - bleaching, stiffing and fat liquoring and coloring.
- Curing involves dehydration of the hide by drying it with salt or air in order to stop proteolytic enzyme degradation.
- Its sole purpose is to ensure that the hides and the skins are protected during transit from slaughter house to the tanneries which are generally located some good distance away. It also facilitates storing.

- Fleshing - removes fatty tissues from the skin by mechanical means.
- Washing and soaking remove the dirt, salts, blood, manure and non fibrous proteins and restore the moisture lost during preservation and storage.
- Unhairing by lime, with or without sodium sulfide, - makes skin more attractive & amenable to the removal of trace protein impurities.
- Lime splitting separates the skin into two layers, 1) more valuable grain layer 2) lower or flesh side is called the split.
- Bating prepares hide fir tanning by reducing the pH, reducing the swelling, peptizing the fibers and removing the protein degradation products and generally accomplished with ammonium salts and a mixture of commercially prepared enzymes, the bathing bath renders the grain sticky, slippery, smoother and more porous increases its width and decreases its wrinkles.

- Pickling generally precedes chrome tanning - involves skin treatment with salt and acid to prevent precipitation of the chromium salts on the skin fibers.
- Degreasing -natural grease, prevent formation of metallic soaps and allowing the skin to be more evenly penetrated by tanning liquors.
- Chrome tanning - for light leathers, vegetable tanning - heavy leather products. The process of chrome tanning is of shorter duration and produces more resistant leather
- The second stage of leather making, the tanning proper, the treatment of the hides to make them non putrescible and even soft when dried.
- In chrome tanning process the tanning is done in the same vat after one day of pickling by adding a solution of chromium sulphate.
- After 4 hours of tanning, the leather is bleached with a dilute solution sodium thiosulphate and sodium carbonate in the same bath.

- third stage of finishing - stuffing and fat liquoring followed by dyeing.
  - incorporates oil and grease - soft and resistant to tearing.
  - Dying – uses synthetic dye stuffs.
- Depending on the type of product, either vegatable substances containing natural tanning eg. the extract of barks, wood etc. or inorganic chromium salts.
- Vegetable tanning produces leathers which are fuller, plumper, more easily tooled and embossed and less effected by body perspiration or changes in humidity.

Sources of waste water and their characteristics :

- The waste water from beam house process viz. soaking, liming, deliming etc. are highly alkaline, containing decomposing organic matter, hair, lime, sulphide and organic nitrogen with high BOD and COD.
- The spent soak liquor contains soluble proteins of the hides, dirt and a large amount of common salt when salted hides are processed. The spent liquor undergoes putrefaction very rapidly as it offers a good amount of nutrients and favorable environments for bacterial growth.
- The spent bate liquor contains high amount of organic and ammonia-nitrogen due to the presence of soluble skin proteins and ammonia salts.

Characteristics	Value
pH	4.6-7.1
Total solids	870-3500 mg/lt
BOD	300-200 mg/lt
COD	600-4380 mg/lt
Total suspended solids	220-800 mg/lt
Total Nitrogen	10-40 mg/lt

Effects of waste on receiving water and sewers :

- Tannery wastes are characterized by high BOD, high-suspended solids and strong color. These wastes when discharge as such deplete the dissolved oxygen of the stream very rapidly, due to both chemical and biological oxidation of sulfur and organic compounds.
- A secondary pollution of the stream may occur due to the deposition of the solids near the discharge point and its subsequent putrefication.
- Presence of tannins in the raw water renders it unsuitable for use in certain industries.
- The tannery waste when discharged into a sewer only chokes the sewer due to the deposition of solids, but also reduces the cross- section of the sewer arising out of the lime encrustation.

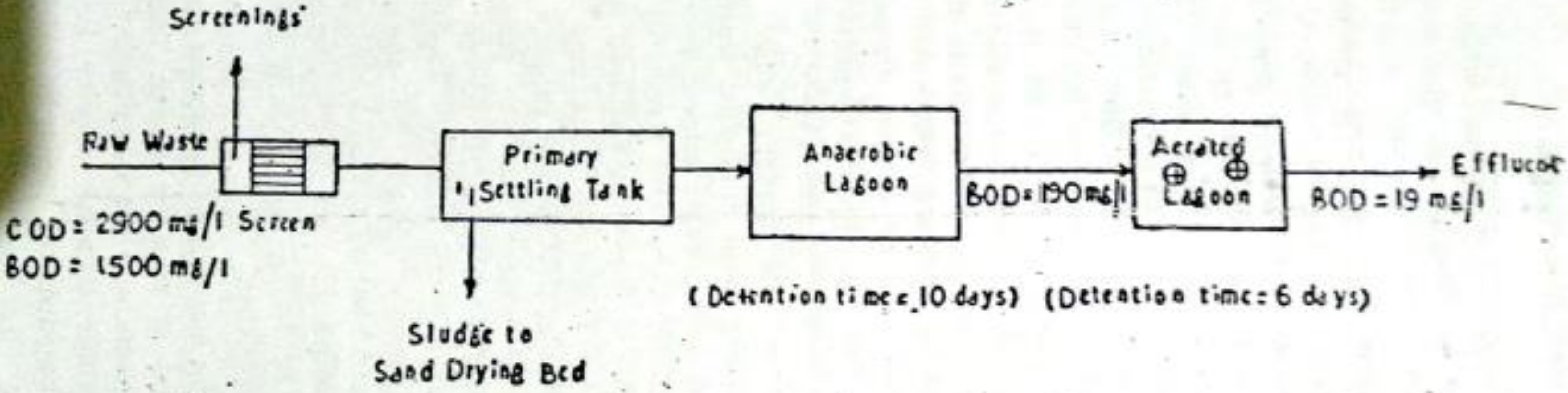


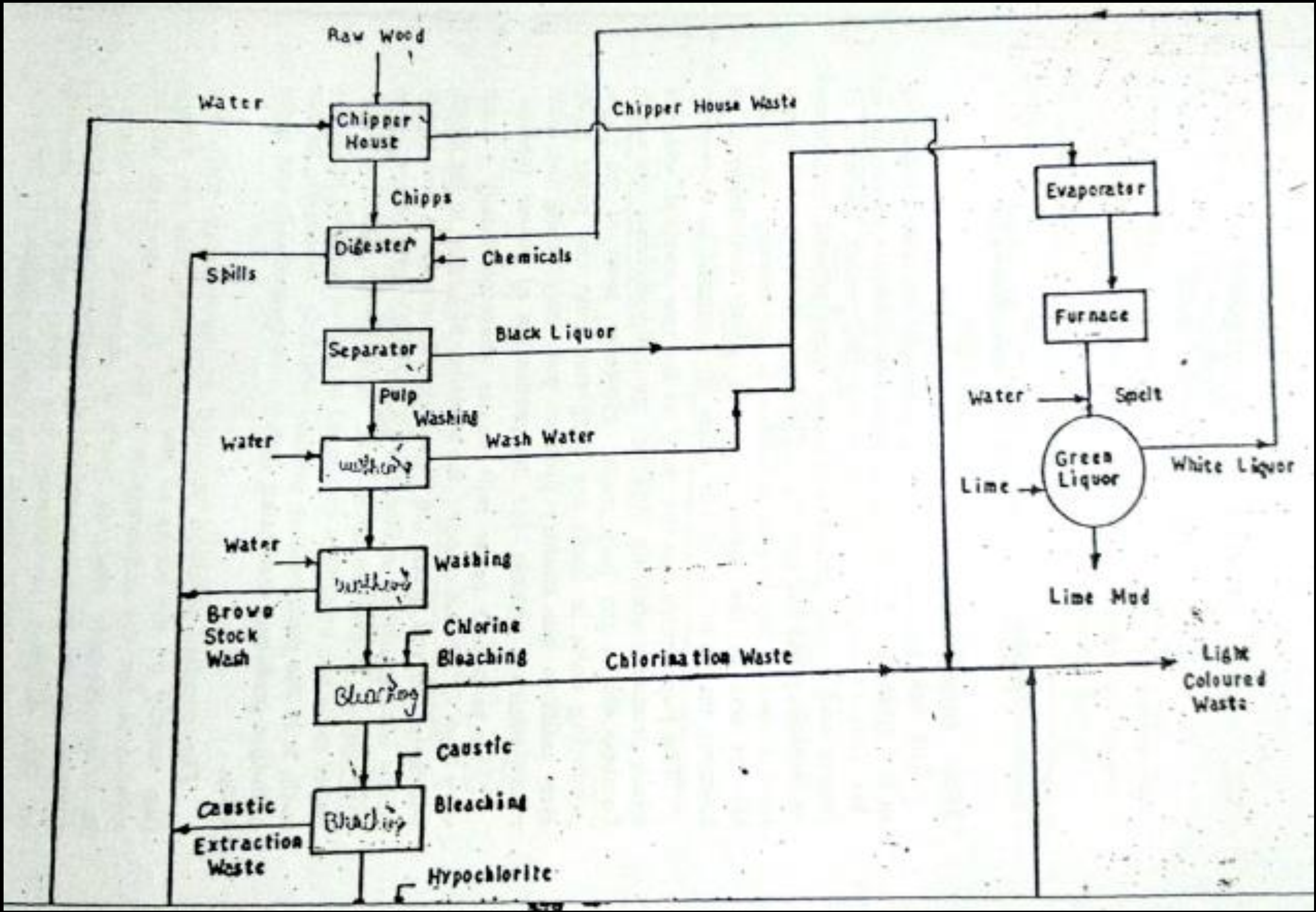
FIG. 12.2 : Flow Sheet for the Treatment of the Combined waste from a Vegetable Tannery.

Treatment of waste :

- may be classified as physical, chemical, and biological. The physical treatment - screening and primary sedimentation. Screens are required to remove fleshings, hairs and other floating substances. About 98% of the chromium is precipitated in the primary sedimentation tanks and is removed along with the sludge.
- Chemical coagulation, with or without prior neutralization followed by biological treatment. Ferrous sulfate is best coagulant for the removal of the sulfides used for the effective removal of color, chromium, sulfides, BOD and suspended solids from chrome tan wastes.
- Biological treatment = activated sludge process, using acclimatized micro organisms capable to reduce the COD and tannin by about 90%. Trickling filters may also be used.
- The low cost biological methods- oxidation pond and anaerobic lagoons are recommended for small and isolated tanners. For further improvement of the effluent quality the anaerobic lagoons may be followed by an aerated lagoon.

Paper and pulp industry

Manufacturing process flowchart



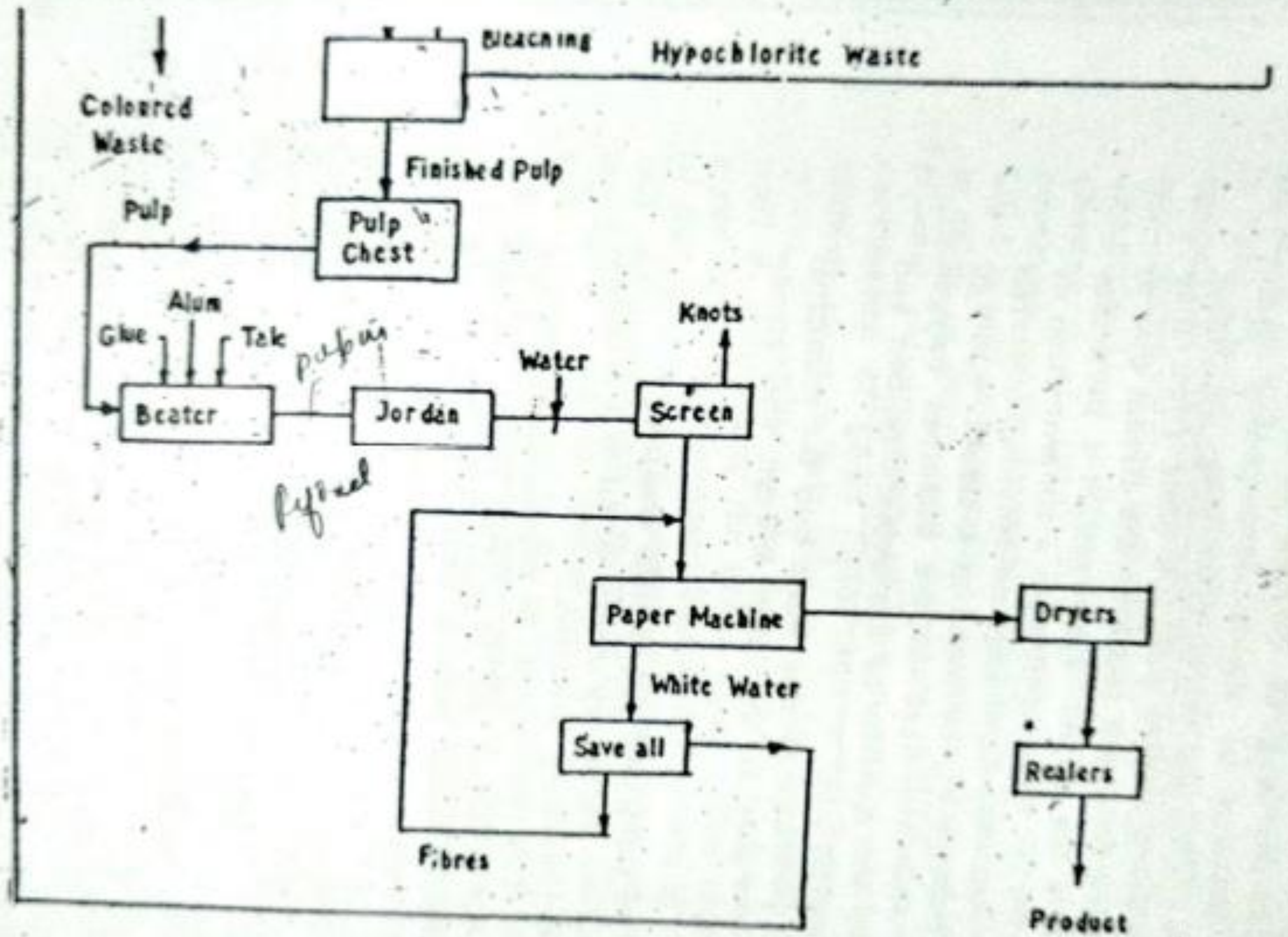


FIG. 10.1 : Simplified Flow Diagram of a Kraft Pulp and Paper Mill.

- manufacturing of paper may be divided into 2 phases - pulp making, and making of final product of paper.
- Pulp making,- the chipped cellulosic raw materials are digested with different chemicals in one tank under high temperature and pressure. The process thus loosens the cellulose fibers and dissolves the lignin, resin and other non-cellulosic material in the raw material
- Kraft process (or sulphate process) of pulp making uses sodium sulphate, sodium hydroxide and sodium sulphide as the digester chemicals
- Sulphite process uses magnesium or calcium bisulphite, and sulphurous acid as the digester chemicals ; sodium hydroxide or lime is used in Alkali process of pulp making.

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- The spent liquor produced by - Black liquor". very rich in lignin content & contains a large amount of unutilized chemicals. Therefore, treated separately for the recovery of chemicals..
- The cellulosic fibre after being separated from the black liquor is washed and then partially dewatered in a cylindrical screen called 'Decker'. A' concentrated wash water may be sent for chemical recovery (in the Kraft process) is known as 'Brown stock wash* or 'Unbleached Decker Waste'.
- The washed cellulosic fibres are then sent for the bleaching in three stages, where chlorine, caustic and hypochlorite are used in successive stages. Waste waters from the first and the last stages are light yellow, while that from the caustic extraction stage is highly coloured.

- The bleached pulp sent - paper mill - the pulp is disintegrated, and mixed with various filler materials like alum, talc etc, and dyes, in an specially made tank known as "Beater". After beating, the pulp is refined in a machine - "Jordan".
- The refined pulp is then diluted to proper consistency for paper making and passed through a screen to remove lumps or knotes. Now this pulp is carried by a travelling belt of fine screen to a series of 'Rolls", where the final product, the paper, is produced.
- The drained water, - "White water" contains fine fibres, alum, talc etc. Usually the fibres 1 are recovered from this waste, and the treated liquid is reused for the wet chipping process.

- The black liquor of the Kraft process is concentrated by evaporation, and then incinerated with the addition of sodium sulphate. The organics like lignin, resin etc are burnt out, and the smelt is dissolved in water. The resulting liquid is known as "Green Liquor". Lime is now added to this liquor, resulting in the formation of ''White Liquor", and "Lime mud", containing chiefly calcium carbonate.
- White liquor contains desired cooking (digesting) chemicals and is sent for use in digester. The lime mud is calcined (by burning) to form ' calcium oxide, which is reused to recaustise other green liquors into white liquors.
- Some very toxic waste material are also generated during chemical recovery from black liquor. Materials like Dimethyle Sulphide, Methyl Mercaptan etc also comes out with digester relief gases, and forms a colourless waste water after condensation.

Characteristics of wastewater

Item	Small Mill	Large Mill
Flow per day	330 m^3/tonne	222m^3/tonne
Colour	—	7800 unite
PH	8.2—8.5	8.5—9.5
Total solids, mg/1	—	4410
Suspended solids, mg/1	900—2000	3300
C.O.D., mg/1	3400—5780	716
B.O.D., mg/1	680—1250	155
C.O.D/BOD ratio	3.9—5.	4.6

Paper and Pulp Mill Waste

	Pollution characteristic	Treatment methods
1.	High BOD	(a) Chemical recovery of lignin
2.	High BOD/COD rate	(b) Lime treatment for colour removal
3.	Strong colour	(c) Physical treatment
4.	High alkalinity	(d) Biological treatment
5.	High sodium content	
6.	Lignin, high resistant to biological treatment	

The Effects of *wastes* on Receiving water

- Crude pulp and paper mill wastes, or insufficiently treated wastes cause very serious pollution problems, when discharged into the streams.
- The pollution extends over a very long stretch, sometimes as long as 80kms in the downstream, due to the presence of slowly decomposing components in the waste, *(*fine fibers often clog the water intake screens in the down stream side)
- A toxic effect may also be induced upon the flora and fauna of the stream due to sulphites and phenols in the waste. However, in a particular case, the waste is found not to be toxic up to a concentration of 35%.
- bottom deposit of Lignin-cellulosic materials near the point of discharge of the waste in a stream undergo slow decomposition and may lead to the dissolved oxygen depletion followed by the creation of anaerobic condition and destruction of the aquatic life.")
- The question of discharge of this waste into the municipal sewers does not arise due to the large amount and strong nature of the waste

Massive Lime Treatment for Colour Removal in Pulp and Paper Mill.

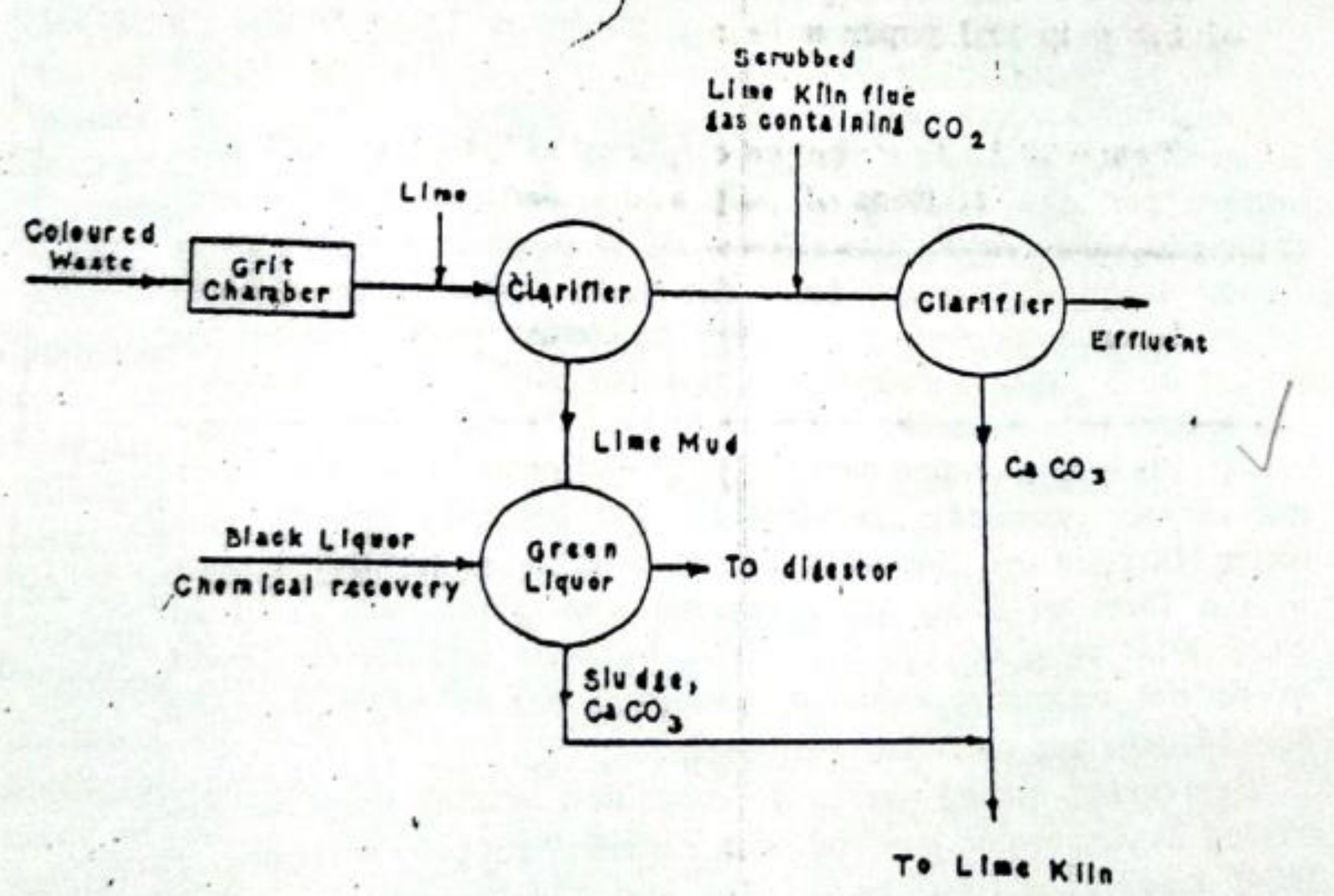

FIG. 10.2. Massive Lime Treatment for Colour Removal in Pulp and Paper Mill.

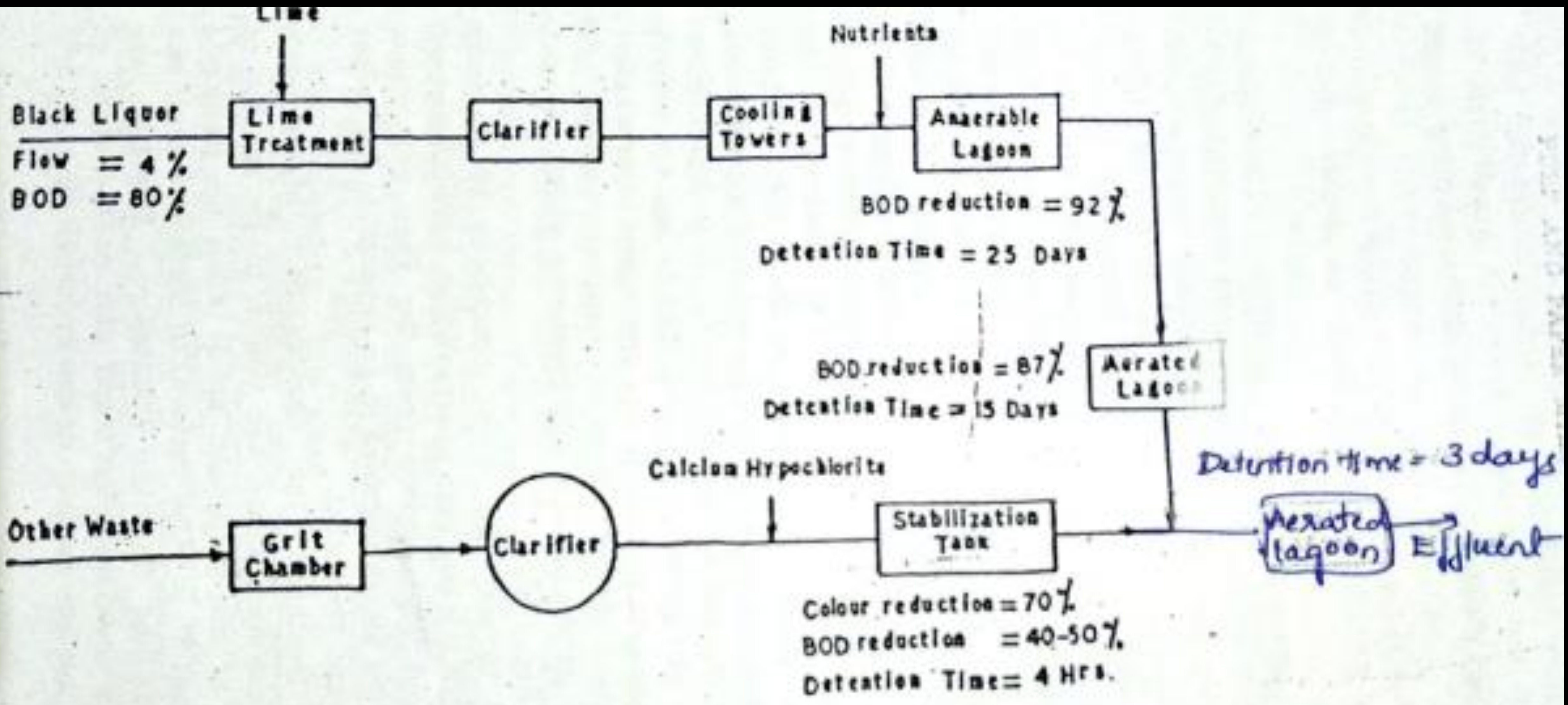

FIG. 10.3 : Flow Diagram for Treatment of Waste of a Typical Pulp Mill

Treatment of pulp and paper mill wastes:

- The treatment of the waste may consist of all of a combination of some of the following processes.
- (a) Recovery : this process the lignin is destroyed, same may also be recovered from the black liquor by precipitation by acidulation with either carbon dioxide or sulphuric acid (Das and Tapadar). These recovered lignins have got various uses in other industries. Lignins may be used as raw material for various other substances like Dimethyl sulphoxide, which is used as spinning solvent for polyacrylonitrile fibres.
- The fibres in the while water from the paper mills are recovered either by sedimentation or by floatation using forced air in the tank.The recovery of lime from the lime mud, by the process of calcination, is not practiced in India, due to undesirable content .of silica in il

- (b) Chemical treatment - for colour removal: The treatment of the green liquor with coloured lime sludge results in the formation of dark brown liquor, containing both desired cooking chemicals and colour-producing component like lignin. This lignin bearing liquor is used as digester liquid,
- (c)Activated carbon for colour removal : can remove 94% colour from the Pulp mill waste.
- (d) Physical treatment for clarification : Mechanically cleaned circular ciarifiers - 70-80% removal of the suspended solids from the combined mill effluent. About 95 to 99% removal of settleable solids in the claiifiers (Gillespie). BOD reduction is 25-40% only.
- (e) Biological treatment of the waste : Considerable reduction of BOD from the waste can be accomplished in both conventional and low cost biological treatment, processes.

Dairy industry

Dairy Industry

Dairy Industry

Sources of Waste

- The liquid wastes from a large dairy originate from the following sections or plants : receiving station, bottling plant, cheese plant, butter plant, casein plant, condensed milk plant, dried milk plant, and ice cream plant. Waste also comes from water softening, plant and from bottle and can washing plants.
- At the receiving station the milk is received from the farms and after inspection the same is emptied into large containers for transport to bottling or other processing plants. The empty cans are rinsed, washed, sterilized and are returned to the farmers.
- At the bottling plant, the raw milk delivered by the receiving station is stored. The processing includes cooling, clarification, nitration, pasteurization, and bottling.
- In the above two sections, the liquid wastes originate out of rinse and washings of bottles, cans and equipment, and thus contain milk drippings and chemicals used for cleaning containers and equipment.
- In a cheese plant, the milk (whole milk or skimmed milk) is pasteurized and cooled and placed in a vat, where a starter (lactic acid producing bacterial culture) and rennet are added.

- This separates the casein of the milk in the form of curd. The whey is then withdrawn and the curd compressed to allow excess whey to drain out. the cheese blocks are cut and packaged for sale. Waste water - include mainly discarded whey and the wash water used for cleaning vats, equipments, floors etc.
- In the creamery process, the whole milk is preheated to about 30°C to separate the cream from the milk. In a butter plant the' cream is pasteurized and may be ripened with a selected acid and a bacterial culture. This is then churned at a temperature of about *7-10°C* to produce butter granules. At a proper time the butter milk is drained out of the chum and the butter is washed and after standardisation, packaged for sale..
- The skimmed milk may now be sent for bottling for human consumptions, or for further processing in the dairy for other products like non fat milk powders. Milk powders are produced by evaporation followed by drying by either roller process or spray process. The dry milk plant wastes consists chiefly of wash waters used to clean containers and equipments.
- The soured or spoiled milk, and sometimes the skimmed milks are processed to produce caseins used for preparation of some plastics. The process involves the coagulation and precipitation of the casein by the addition of some mineral acids. The waste from this section includes whey, washings and the chemicals used for precipitation.

Characteristics of wastewater

TABLE 14.1 : Composition of the waste water of a typical dairy

Item	Value
pH	7.2
Alkalinity	600 mg/l as $CaCO_3$
Total dissolved solid	1060 mg/l
Suspended solid	760 mg/l
BOD	1240 mg/l
COD	84 mg/l
Total nitrogen	84 mg/l
Phosphorous	11.7 mg/l
Oil and grease	290 mg/l
Chloride	105 mg/l

Effects of the Wastes on the Receiving Streams/ Sewers

- As waste is basically organic and slightly alkaline in when fresh. If go into the stream without any treatment, a rapid depletion of DO of the stream occurs, along with growth of sewage fungi covering the entire bottom of the stream the submerged parts of the hydraulic structures within it
- waste is said to carry, occasionally, the bacteria responsible for tuberculosis. Though alkaline in fresh condition, the milk waste becomes acidic due to the decomposition of Lactose into lactic acid under anaerobic condition, particularly after complete oxygen depletion of the stream. The resulting condition precipitates casein from the waste, which decompose further black sludge.
- At certain dilutions the dairy waste is found to be toxic to fishes also. As "the dairies are usually situated in rural areas or in small towns, the question of discharging the dairy waste into the sewers does not arise. In large cities, combined treatment of domestic sewage and dairy waste may be considered if the latter constitutes only 10% in volume of the former. In that case the dairy waste should be discharged in a fresh condition, putrefied waste may cause corrosion of the sewers.

Treatment of the Dairy Wastes:

- Due to low COD : BOD ratio, the dairy wastes can be treated efficiently by biological processes. Moreover, these wastes contain sufficient nutrients for bacterial growth. But for economical reasons, attempt should be made to reduce volume and strength of the waste. This may be accomplished by
  - (i) the prevention of spills, leakages and dropping of milks from cans,
  - (ii) by reducing the amount of water for washes,
  - (iii) by segregating tfie uncontaminated cooling water and recycling the same and
  - (iv) by utilising the butter milk and whey for the production of dairy by-products of good market value.
- Due to the intermittent nature of the waste discharge, it is desirable to provide Equalization tank, with or without aeration, before the same is sent for biological treatment. A provision of grease trap is also necessary as a pretreatment to remove fat and other greasy substances from the waste. An aeration for a day not only prevents the formation of lactic acid, but also reduces the BOD by about 50%.

- Both high rate trickling filters, and ASP can be employed very effectively for a complete treatment but involve much maintenance, skilled personnel, and special type of equipment.
- On the other hand the low cost treatment methods like oxidation ditch, Aerated Lagoon, Waste Stabilization Pond etc. can be employed with simpler type of equipment and less maintenance. Oxidation ditches in India may be designed with a low organic loading (about 0.2 kg/kg of MLSS), high biological mass concentration (in the order of 4000mg/1), and extended period of aeration (in the order of 1.5 days), for BOD reduction of about 95 to 98%.
- In a waste stabilization pond, a BOD reduction of 52 to 74% could be achieved after 12 days of retention and an organic loading of 550 to 585 kg/hectare/day. BOD reduction of about 90% may be obtained with a retention time of 7 days and a depth in the order of 3 m, in an anaerobic lagoon. An organic loading in the order of 0.4S $kg/m^3/day$ is suggested for the above.
- Use of dairy waste for Irrigation after primary treatment in an Aerated lagoon may also be good answer for the disposal of Dairy waste.

Distillery industry

Origin and Characteristics of Distilleries Waste

- The beverage alcohol industries utilize different grains, malted barley and molasses as raw materials. the molasses (black strap type) are exclusively used as-raw materials in the industrial alcohol industry
- The final stages being identical, the preparation of the fermenting, medium or mash is slightly different in these two industries.
- In molasses distilleries, the preparation of mash consists of
  - dilution-by water to a sugar content of about 15% pH adjustment to 4.0-4.5 to prohibit bacterial activities nutrient addition.
- The yeast suspension is prepared separately in" the laboratory with part of the diluted molasses and then innoculated into the mash for fermentation under controlled conditions.

- The fermented liquor containing alcohol is then sent to a overhead tank without separation of the solid materials, then degasified, the alcohol is stripped leaving a "spent wash". The crude alcohol is then redistilled and stored.
- Some of the beverage alcohols like gin attain their final form at this stage, some others like whisky require aging in charred oak wood barrels.
- The "spent wash" is the major polluting component of the distilleries and it f reporte to be ten fifteen "times. The final product in volume (the other pollutants include yeast sludge. which deposits at the bottom of fermentation vats.
- In most of the distilleries in India this yeast sludge is mixed with the spent wash and discharged.) Malt house- wastes also contribute towards pollution in beverage alcohol distilleries.
- In addition to these major BOD and solids contributing wastes, floor washes, waste cooling water, and wastes from the operations of yeast recovery or by-products recoveries processes also contribute to the volume of these wastes. The composition of some of the wastes from distilleries are given in Table below

TABLE : 11.2. Characteristics of composited combined waste, spent wash and yeast sludge from different Indian distilleries.

	Yeast sludge	Combined waste	Spent wash	Spent wash
pH	4.8	3.9—4.3	3.5—3.65	4.0—4.5
Temperature, °C	—	—	—	90—95
COD, mg/l	368000	27900—73000	118000	70000—151200
BOD, mg/l	165000	12230—40000	41380	28000—80000
Total solids, mg/l	—	16640—26000	99000	59100—114500
Suspended solids, mg/l	73000	4500—12000	350	1000
Total Nitrogen, mg/l	—	—	1135	14800—19000
Alkalinity	—	380—510	—	—
Colour	—		Dark brown	Dark brown
DO	—	—	NIL	—
Rate of waste flow	—	0.9—1.0 MLD	—	0.82 MLD

Effects on Receiving Streams/Sewers:

- The waste is not toxic to the aquatic life of the receiving stream. But due to their high BOD content, they deplete the dissolved oxygen of the receiving waten this results in anaerobic decomposition of this organic *softGs,* both settled and. suspended, producing a odorus condition over a fairly long stretch of the stream conditions further deteriorate due to the strong growth of sewage fungi The dark colour of the stream renders it unaestnetic.
- "Brewery waste, which is comparatively of lesser strength may be discharged in a fresh condition into the sewers to the extent of 3-5 *%* of the domestic sewage.
- A strongly acidic or putrefied brewery waste will disrupt the normal biological activities of the waste treatment plants. For the sake of safety the brewery waste, if discharged into the sewers, must be screened and pretreated by lime.
- The very high BOD content of the distillery waste makes it non amenable to the aerobic biological treatment, and as such it cannot be discharged into municipal sewerage system directly

Treatment of the Wastes :

- Brewery wastes being comparatively less strong can be treated by aerobic biological treatment, after screening and neutralization. Usually, the biological treatment is accomplished by two stage process for 90-94% BOD reduction.
- When sufficient land is available the brewery wastes may be used for broad irrigation after neutralization to utilize the fertilizing components of the waste.
- Both dosed anaerobic digestion and open anaerobic lgooning has been tried. means of anaerobic treatment. A single—stage digester is usually adopted for the anaerobic treatment when land available is limited.
- Different laboratory studies with different wastes suggest different loading rates of the digester. BOD reduction of 90.8% a BOD loading of 2.5 kg/m^8/day and a detention time of 15 days is suggested in one case

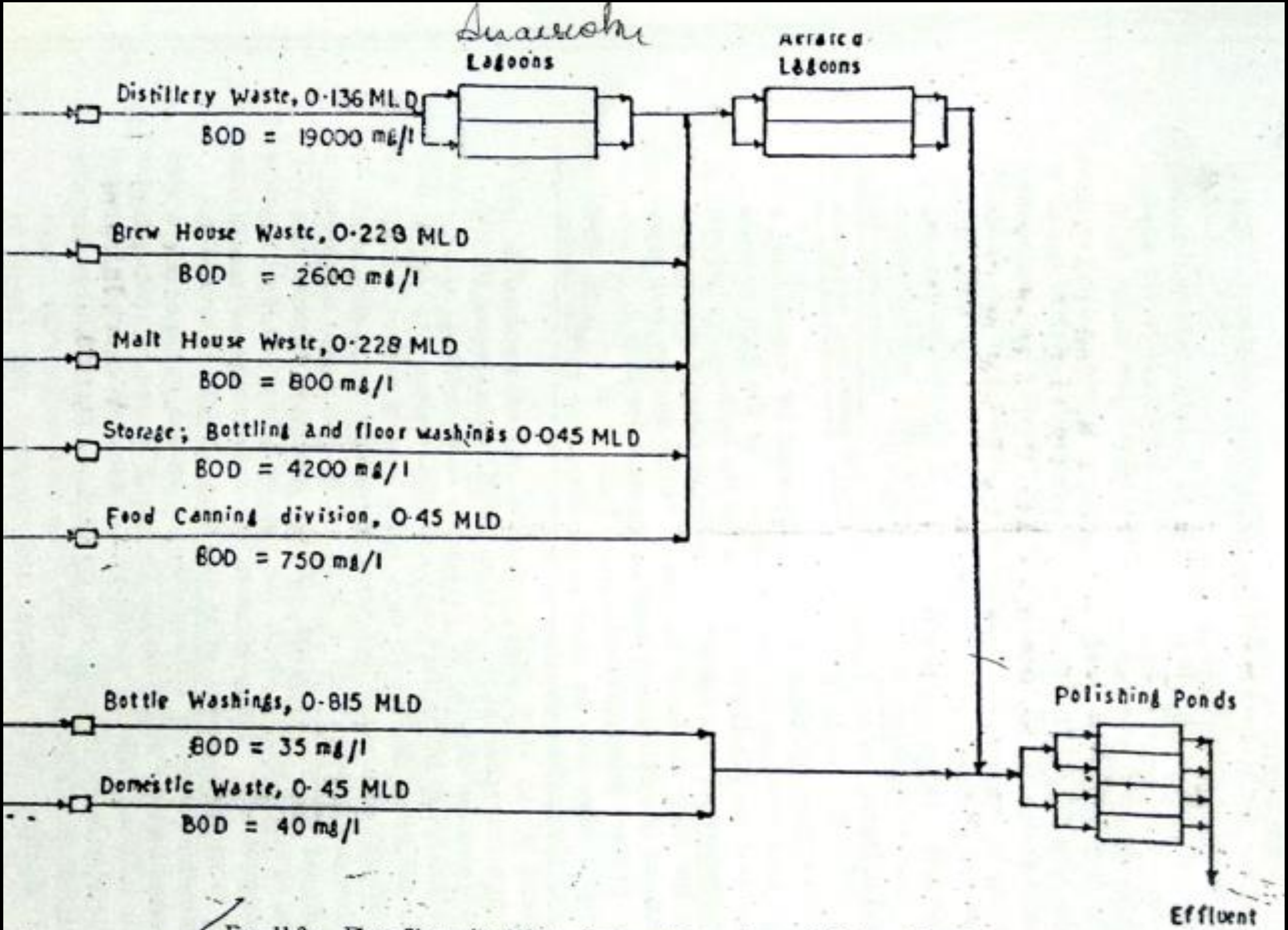

FIG. 11.2 : Flow Sheet for Waste Treatment in a Large Distillery Complex.

- Production of H_2S impairs the anaerobic. Digestion, as soluble "sulphides arc toxic to the .microorganism by the addition of iron salts improves the condition, as^-the ferric sulphides are not toxic, to.the. microorganisms.
- Anaerobic lagooning is a low_cost alternative to the, digesters" when land is available in plenty^Jjhe only disadvantage of anaerobic lagoons is the evolution_Qf.yolatile_gases and obnoxous odour from the ponds.
- odour nuisance can be eliminated by proper anaerobic activity in the lagoon the high sulphate content and low pH is unfavorable for thie methane fermenters, neutralization of the waste establishing a proper condition for their activity 'A greater initial dilution and grea-ter amount of acclimatized. seed sludge nay also help in establishing proper anaerobic activities .at a smaller dose may also be used as an alternative to the costlier .Jiine treatment

- About 90 to 95% BOD reduction can be achieved I n a two stage anaerobic lagoon system. BOD reduction of 85.5% with a detention time of 60 days and a loading rate of 0.67 kg of BOD/m^8/day in the 1st stage, and BOD reduction of 65.5% with a detention time of 40 days and a loading rate of 0.15 kg of BOD/m*/day in the 2nd stage is reported for a particular spent wash" (Subba Rao et. al Effluent of the digesters and the anaerobic lagoons still contain a high BQP, which can not be discharged into the receiving water.
- these effluents can successfully, be treated in oxidation ditches. About 90% BOD removal can be accomplished in aerated lagoons with a detention time of 20-28 *day. Thc* same degree of treatment can bg_achieved with 1 : 1 dilution at a detention time of 15-16 day BOD > removal rate constant was found to
- lagoon or in digester followed by two stage aerobic treatment is also proposed for some distiller)' wastes. In a laboratory study, about 5(x2%_ reduction of BOD is obtained when the distillery waste is used as the medium for growing an adapted variety of yeast

Sugar industry

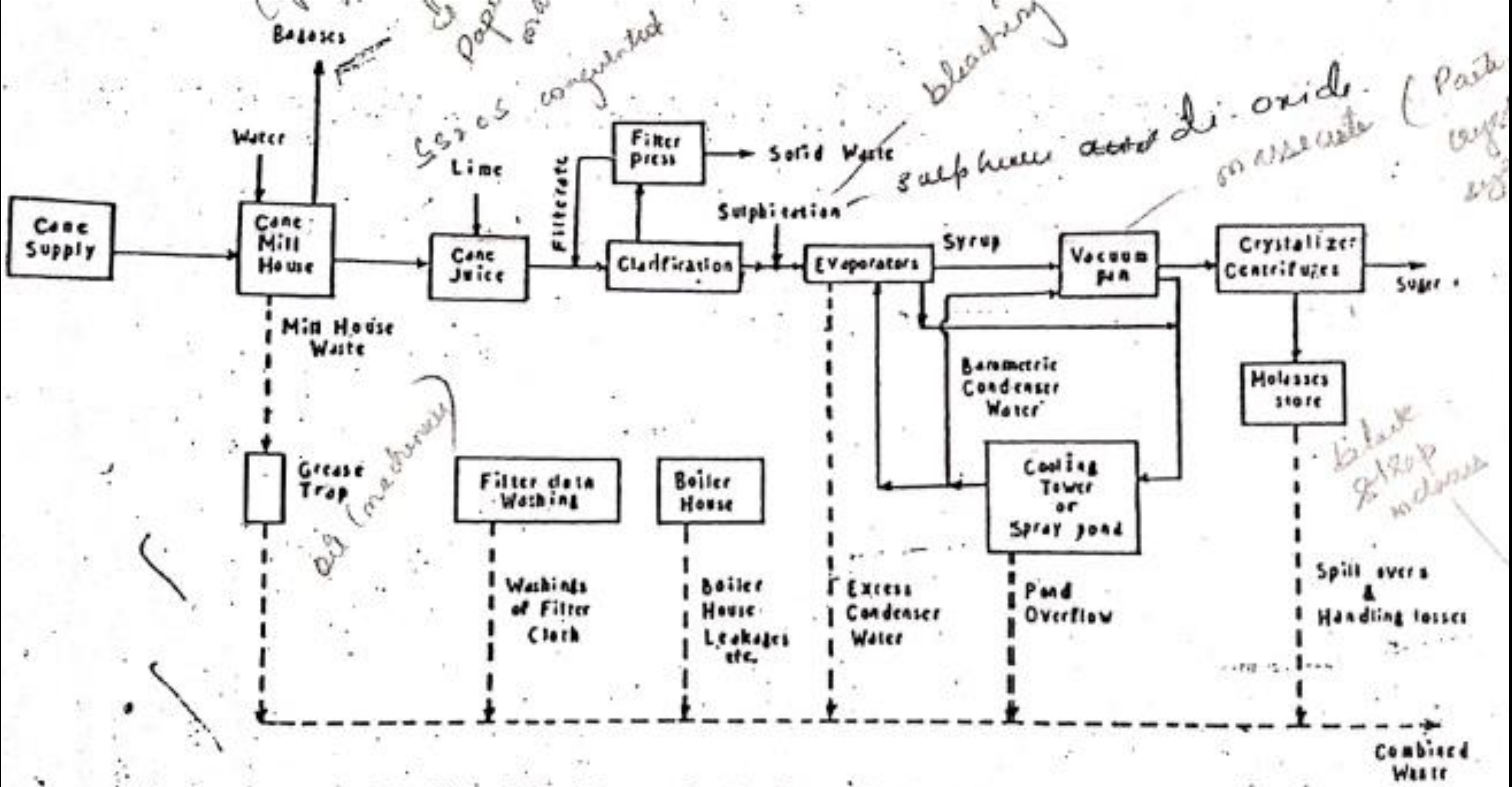

FIG. 16·1 : Flow Diagram for the Sugar Manufacturing Process.

Manufacturing Process:

- The sugar canes are cut into pieces and crushed in a series of rollers to extract the juice, in the 'mill house'. The milk of lime is then added to the juice and heated, when all the colloidal and suspended impurities are coagulated; much of the colour is also removed during this lime treatment. The coagulated juice is then clarified to remove the sludge. The/clarifier sludge is further filtered through filter presses, and then disposed off as solid waste.
- The filtrate is recycled to the process, and the entire quantity of clarified juice is treated by passing sulphur dioxide gas through it - "sulphitation process" ; colour of the juice is completely bleached out due to this process.
- The clarified juice is then preheated and concentrated in evaporators and vacuum pans. The partially crystalized syrup from the vacuum pan, known ;is 'massecuite' is then transferred to the crystallizers, where complete crystallization of sugar occurs. The massecuite is then centrifuged, to separate the sugar crystals from the mother liquor. The spent liquor is discarded as 'black strap mollases'. The sugar is then dried and bagged for transport.
- The fibrous residue of the mill house, known as 'bagasses' may be burnt in the boilers, or may be used as raw-materials for the production of paper products. The black strap mollases may be used in the distilleries.

TABLE 16.1 : Characteristics of Sugar Mill Wastes (as given by ISI)

Characteristics	Mill-house waste	Filter cloth washings	Condenser water	Boiler house & floor washings	Combined waste (excluding condenser water)
Rate of flow, litres per tonne of cane crushed	730	360	1640	230	—
pH	6.7	9.5	—	7.2	4.6-7.1
COD, mg/l	—	—	—	—	600-4300
BOD, mg/l (5 day 20°C)	210	1765	—	5150	300-2000
Total solids, mg/l	1760	6970	—	5130	870-3500
Total volatile solids, mg/l	—	—	—	—	400-2200
Total suspended solids, mg/l	910	4000	—	120	220-800
Total nitrogen mg/l	—	—	—	—	[illegible]
COD/BOD ratio	—	—	—	—	[illegible]

Sources and the Characteristics of the Wastes:

Wastes from the mill house include the water used as splashes to extract maximum amount of juice,- mill house waste contains high BOD due to the presence of sugar, and oil from the machineries.. The filter cloths, used for filtering the juice, need occasional cleaning. The wash water thus produced though small in volume, contains high BOD and suspended solids.

A large volume of water is required in the barometric condensers of the multiple effect evaporators and vacuum pans. The water is usually partially or fully recirculated, after cooling through a spray pond. This cooling water gets polluted as it picks up some organic substances from the vapour of boiling syrup in evaporators and vacuum pan. The water from spray pond when overflows, becomes a part *of the* waste water, and usually of low BOD in a properly operating sugar mill.

But because of poor maintenance and bad operating conditions, a substantial amount of sugar may entrain in the condenser water ; is discarded as excess condenser water. These discharges contribute substantially to the waste volume and moderately to BOD in many sugar mills.

Effect of the Waste on Receiving Water:

- The fresh effluent from the sugar- mill, decomposes rapidly after few hours of stagnation. It has been found to cause considerable difficulties when their effluent gets an access to the water courses, particularly the small and non-perennial streams in the rural areas.
- The rapid depletion of oxygen due to biological oxidation followed by anaerobic stabilization of the waste causes a secondary pollution of offensive odour, black colour, and fish mortality.
- No question of the discharge of this waste into the sewers arises, as most of the sugar mills are situated in the unsewered rural areas.

Treatment of the Wastes :

- Volume of mill house waste can be reduced by recycling the water used for splashing. Dry cleaning of floors or floor washings using controlled quantity of water will also reduce the volume of waste to certain extent.
- Overloading of the Evaporators and the vacuum pans, and the extensive boiling of the syrup lead to a loss of sugar through condenser water; this in turn increases both volume and strength of the waste effluent.
- The reasonable COD/BOD ratio of the mill effluents indicate that the waste is amenable to biological treatment. However, generally it is found that, the aerobic treatment, with conventional activated sludge process and trickling filters, is not too efficient, even at a low organic loading rate.
- A maximum BOD reduction of 51% is observed in a pilot plant study, where both Trickling filter ,and activated sludge process were tried. In view of the high cost of installation and supervision of the treatment units, and the seasonal nature of the operation of this industry, it is generally observed that the conventional aerobic treatment will not be economical in this country

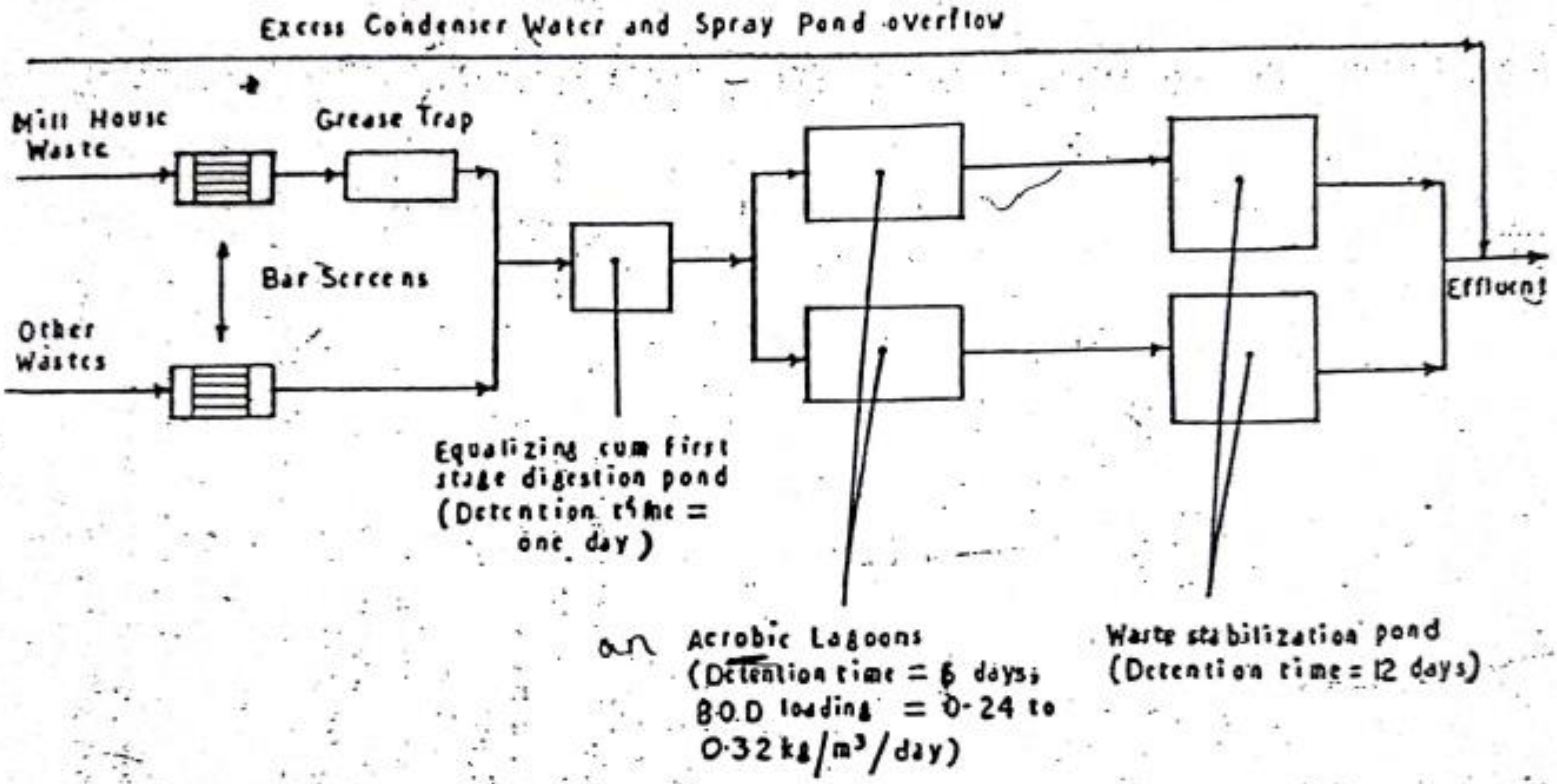

FIG. 16. 2 : Flow Diagram for complete treatment of Sugar Mill Waste.

- Anaerobic treatment of the effluent, using both digesters and lagoons, have been found to be more effective and economical. A BOD reduction of about 70% was observed in a pilot plant study with an anaerobic digester, where BOD loading was 0.65 $kg/m^3/day$ with a detention time of 2.4 days at a controlled temperature of 37°C. In the same study, the BOD reduction was found to be 60% in an anaerobic lagoon, where ;i BOD loading of 0.23 $kg/m^s/day$ and detention time of 7 days was provided.
- In another laboratory study, a BOD reduction of 88.9% was observed in an anaerobic digester with a detention time of 2 days and controlled temperature of 36 ± 1°C, at a higher BOD loading of 1.79 $kg/m^s/day$. The diluents of the anaerobic treatment units are found to contain sufficient nutrients (nitrogen and phosphorous). As such further reduction of BOD can be accomplished in aerobic waste stabilisation ponds.
- Where sufficient land is available, a two stage biological treatment, with anaerobic lagoons followed by aerobic waste stabilisation ponds, is recommended for Indian conditions. The mill effluent, however, is to be pretreated primarily in bar screens and grease trap., it is expected that the BOD reduction in the anaerobic process will be in the order of 60%, while overall BOD reduction may be in the order of 90%

Steel industry

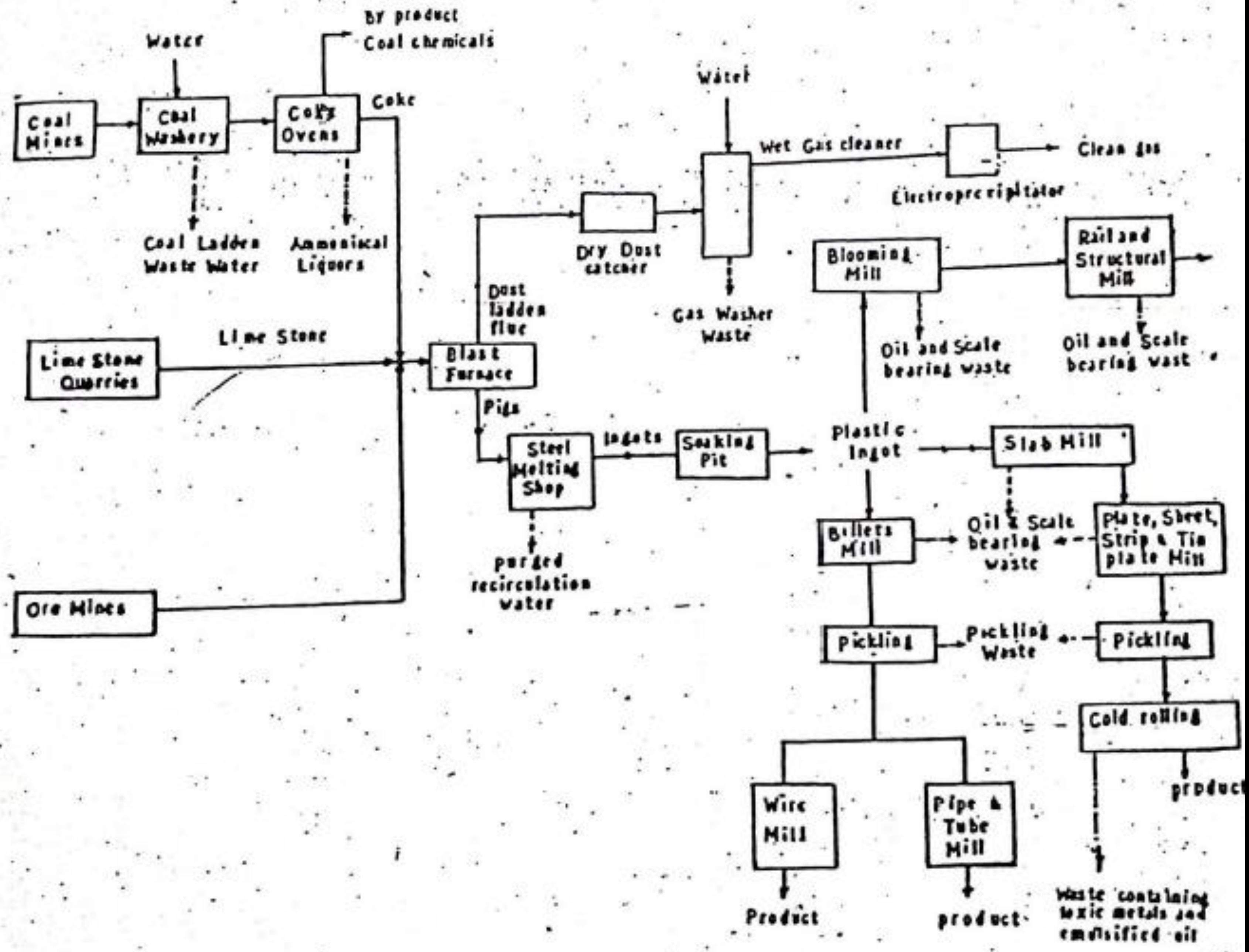

FIG. 17.1 : Flow Diagram for Major Operation in an Integrate Steel Plant.

Origin of waste

Coal washery and its wastewater

- The coal needs some processing to use in coke ovens. The main objective is removal of solid foreign matter present. Generally the processes include crushing, screening and wet washing of coal.
- In wet process the coal is separated from the impurities using the principle of differential settling. Water used for washing is recycled and re-used after sedimentation. But in spite of all care taken to ensure maximum reuse, appreciable quantity of wash water containing coal fines and other impurities like shale, clay and small amounts of other minerals like calcite, gypsum, kaolin, pyrite etc, comes out as waste.

Coke ovens and their wastewater

- The production of coke - carbonization of bituminous coal by heating in the absence of air at a temperature (900-1100^{o}C) in an oven, which drives off all volatile portions in the coal. The evolved gas containing the volatile matters is collected through the stand pipes and is cooled in stages.

- In first stage the gas is cooled to about to 80ºC by spraying cold liquor over the gas, produces mainly tar as the condensate. Second stage by a further cooling to about 30ºC, condensate containing additional tar and ammonia liquor is produced. These two condensate liquors after the separation of tar in a tar-decantor, are recycled as sprays. The excess liquor "ammonia liquor", containing mainly ammonia and various other compounds is subjected to distillation for the recovery of ammonia, the waste is sent for further treatment.
- In the third stage, the gas is compressed and cooled for further recovery of chemicals The coal after being carbonized is removed from the oven and quenched by cold water. About 30% of the quenching water is evaporated while the remaining water containing coke fines comes out as waste. This wastewater is usually recirculated through settling ponds and does not present any pollution problem.
- **Blast furnace and its wastewater** Blast furnace is a basic unit in an integrated steel plant. Essentially the blast furnace process consists of charging iron ore & coke as fuel, limestone & dolomite as fluxing material into the top of the furnace & blowing heated air into the bottom. Pig iron is the metallic product of this unit. Appreciable quantity of water is used in blast furnace for the purpose of cooling & gas cleaning operations.

Steel melting and its waste

- In the steel melting, the pig iron obtained from the blast furnace is further treated to produce ingots. The basic principle involved is the oxidation of unwanted impurities in the pig iron which lead to the production of steel ingots.
- Water requirement in the steel melting processes lies in keeping the furnace body cool. And as such this water remains uncontaminated & is reused

Rolling mills & their waste

- The steel ingots obtained from the steel melting are rolled to different products in the rolling mills. However, the ingots are heated first in the soaking pits until these are plastic enough for economic reduction by rolling. Ingots are usually rolled into blooms, billets or slabs depending upon the final product.

- These rolled blooms, billets and slabs are then cooled & stored & subsequently sent to another mill, where these are re-rolled to produce finer products. During the process of rolling of ingots, blooms, billets and slabs, lots of scales are given off and are collected in the scale flume, below the roll tables.
- These scales are flushed down with high pressure water and are collected at the scale pit. The rolls also get heated up during the process, and cool with liberal supply of water. This water also joins the waste water flow through flume. Naturally it carries a lot of oil and grease.

TABLE 17.1 : Characteristics of a coal washery waste in an integrated steel plant.

Items	Values
Flow	0.18 m^3 per tonne of coal washed.
Total solids	1000-25000 mg/l (normal range 5500-6000 mg/1)
Suspended solids	800-24700 mg/l
Dissolved solids	200-300 mg/l
Hardness	230 mg/l as $CaCO_3$
Alkalinity	86 mg/1 as $CaCo_3$
Chlorides	13 mg/1
pH	7.4-7.8

TABLE 17.4 : Characteristics of typical Blast Furnace Waste Water

Item	Value
Volume of waste	0.5 m^3/tonne of iron produced
pH	7.3-8.2
Total suspended solids	1000-10500 mg/l
Total dissolved solids	346-500 mg/l
Total Hardness	80-118 mg/l as $CaCO_3$
Total Alkalinity	380 mg/l as $CaCO_3$
Chlorides as Cl	210-250 mg/l

Effects of the steel plants waste on receiving water

- Pollutants that of main concern in integrated steel plant waste are suspended solids, cyanides, acids, ammonium compounds, phosphates, phenols, oils etc..
- If the spent ammonical liquor is discharged into a stream without any treatment, the phenol alone can disturb the ecology of the receiving stream.
- It carries several elements which are toxic to aquatic life, among them some are objectionable to human consumption.
- When phenol bearing water is chlorinated, chlorophenols will be formed. These chlorophenols are detected by taste in drinking water even at a concentration of 0.005mg/L.
- The black suspended solids of an untreated waste discharge pollute the bed & the banks of the stream with a thick deposit.
- The reason for eutrophication in stream is generally attributed to the presence of excess amount of phosphates in the effluent.

Treatment of wastewater Conventional Method

- Primary treatment consists of temporarily holding the sewage in a quiescent basin where heavy solids can settle to the bottom while oil, grease and lighter solids float to the surface. The settled and floating materials are removed and the remaining liquid may be discharged.
- Secondary treatment removes dissolved and suspended biological matter. Secondary treatment is typically performed by indigenous, water-borne micro-organisms in a managed habitat. require a separation process to remove the micro-organisms from the treated water prior to discharge.
- Tertiary treatment is sometimes defined as anything more than primary and secondary treatment. Treated water is sometimes disinfected chemically or physically (for example, by lagoons and microfiltration) prior to discharge into a stream, river, bay, lagoon or wetland, or it can be used for the irrigation of a golf course, green way or park. If it is sufficiently clean, it can also be used for groundwater recharge or agricultural purposes.

Ozonation method

- The incoming raw sewage pass through a bar screen chamber to remove coarse suspended solids, fibers, plastics etc. and is collected into a septic tank / holding tank. The tank will have 24 - 48 hours holding capacity, with suitable compartments to separate the heavy sludge solids present in the incoming sewage.
- A sewage transfer pump will transfer the raw effluent into a manual self cleaning filter, and then pressure sand filter & then onward to an ozonator. Ozone will be injected into the raw sewage and mixed in to a contact chamber / holding tank. The ozone will oxidize the organics present in the
- sewage, thereby reducing the BOD / COD levels of the sewage to acceptable limits. The ozonated effluent will be filtered through a pressure sand filter to remove trace suspended solids / turbidity, etc. The outlet water can be reused suitably for toilet flushing, gardening, etc.

Cement Industry

- **Raw materials** It is a compound made up of calcium oxide & silicon di oxide along with aluminium oxide, ferric oxide & magnesium oxide. Raw materials required for the manufacture of cement are lime, sand clay, shale, iron -ore & blast furnace slag.
- **Cement Manufacturing Process Phases** Production of cement completes after passing of raw materials from the following six phases. These are;

    1. Raw material extraction/ Quarry
    2. Grinding, Proportioning and Blending
    3. Pre-heater Phase
    4. Kiln Phase
    5. Cooling and Final Grinding
    6. Packing & Shipping

Cement Manufacturing Process Phase 1: Raw Material Extraction

- Cement uses raw materials that cover calcium, silicon, iron and aluminum. Such raw materials are limestone, clay and sand. Limestone is for calcium. It is combined with much smaller proportions of sand and clay. Sand & clay fulfill the need of silicon, iron and aluminum
- Generally cement plants are fixed where the quarry of limestone is nearby. This saves the extra fuel cost and makes cement somehow economical. Raw materials are extracted from the quarry and by means of conveyor belt material is transported to the cement plant.
- There are also various other raw materials used for cement manufacturing. Example: shale, fly ash, mill scale and bauxite. These raw materials are directly brought from other sources because of small requirements.

- Before transportation of raw materials to the cement plant, large size rocks are crushed into smaller size rocks with the help of crusher at quarry. Crusher reduces the size of large rocks to the size of gravels.

Cement Manufacturing Process Phase II: Proportioning, Blending & Grinding :

- The raw materials from quarry are now routed in plant laboratory where, they are analyzed and proper proportioning of limestone and clay are making possible before the beginning of grinding. Generally, limestone is 80% and remaining 20% is the clay. Now cement plant grind the raw mix with the help of heavy wheel type rollers and rotating table.

- Rotating table rotates continuously under the roller and brought the raw mix in contact with the roller. Roller crushes the material to a fine powder and finishes the job. Raw mix is stored in a pre-homogenization pile after grinding raw mix to fine powder.
- **Cement Manufacturing Process Phase III: Pre-heating Raw Material** After final grinding, the material is ready to face the pre-heating chamber. Pre-heater chamber consists of series of vertical cyclone from where the raw material passes before facing the kiln. Pre-heating chamber utilizes the emitting hot gases from kiln. Pre-heating of the material saves the energy and make plant environmental friendly.
- **Cement Manufacturing Process Phase IV: Kiln Phase** Kiln is a huge rotating furnace also called as the heart of cement making process. Here, raw material is heated up to 1450 ^{o}C. This temperature begins a chemical reaction “decarbonation”.

- In this reaction material (like limestone) releases the carbon dioxide. High temperature of kiln makes slurry of the material. The series of chemical reactions between calcium and silicon dioxide compounds form the primary constituents of cement i.e., calcium silicate. Kiln is heating up from the exit side by the use of natural gas and coal. When material reaches the lower part of the kiln, it forms the shape of clinker.
- **Cement Manufacturing Process Phase V: Cooling and Final Grinding** After passing out from the kiln, clinkers are cooled by mean of forced air. Clinker released the absorb heat and cool down to lower temperature. Released heat by clinker is reused by recirculating it back to the kiln. This too saves energy. Final process of 5th phase is the final grinding. There is a horizontal filled with steel balls.

- Clinker reach in this rotating drum after cooling. Here, steel balls tumble and crush the clinker into a very fine powder. This fine powder is considered as cement.
- During grinding gypsum is also added to the mix in small percentage that controls the setting of cement.
- **Cement Manufacturing Process Phase VI: Packing and Shipping** Material is directly conveyed to the silos (silos are the large storage tanks of cement) from the grinding mills. Further, it is packed to about 20-40 kg bags. Only a small percent of cement is packed in the bags only for those customers whom need is very small.

- **Cement Manufacturing Process Flow Chart** After explaining the complete process of cement making, flow chart would be like that.
- **Sources of effluent** Cooling water- It can be recycled after cooling as it does not contain harmful materials Wet scrubbing effluent - Wet scrubbing of kiln dust yields an effluent that has a high pH value, alkalinity, suspended & dissolved solids like sulfate & potassium predominates.

Industrial Process Wastewater Treatment

- In cement industries water is used only for cooling operation of manufacturing process. Generally waster used for cooling purpose is recycled and reused in the process.
- Process wastewater with high pH and suspended solids may be generated in some operations. Screening and for suspended solid reduction is done by using settling basin and clarifier.
- Water treated from waste water treatment plant should use for green belt development. This green belt also helps in minimizing noise pollution.

- At lime mining site and cement plant contaminated streams of rain water should be directed to the waste water treatment plant and should use for industrial process. Storm-water flowing through pet-coke, coal, and waste material stockpiles exposed to the open air may become contaminated.
- Rain water should be protected from contacting from coal depot clinker and lime and fly ash storage area to prevent contamination by covering the storage area and should collect at some tank for further use in dust suppression system at plant.
- If storm-water does contact storage yard than it may indicate presence of high value of sulphate in soil and toxic metals like Zinc, Lead and Chromium in the dust and high TDS value in ground water.

Pharmaceutical industry

- Pharmaceutical industry produces varied type of products. They range from vitamins, synthetic drugs to antibiotics. The raw materials used are includes both organic and inorganic compounds.
- Some of the pharmaceutical plants do not generate any liquid effluents, while some others discharge little quantities of strong waste & others let out larger volumes. Due to these wide variations a generalization cannot be drawn on the effluents of pharmaceutical industry.
- Most of the antibiotics such as penicillin. Streptomycin, lysine, sulfaquinazoline, nicarbazine & vitamins such as B1, B2, B12 and many steroids are prepared in the fermentation. The most waste produced in the fermentation process is the spent beer liquor.
- The spent beer liquor is the fermented broth remaining after the recovery of antibiotics and other valuables. It contains large amounts of organic materials, proteins and other nutrients and consequently the BOD of these effluents is abnormally high

Characteristics of wastewater

Five main pharmaceutical wastes and their characteristics are as follows

A. Strong fermentation beers (small in volume but having 4000 to 8000 mg/L BOD)
B. Inorganic solids (waste slurry with little BOD)
C. Washings of floor and equipment (large percentage of total volume and BOD from 600 to 2500 ppm)
D. Chemical waste - solution or solvents which exert a substantial BOD when diluted with other wastes
E. Barometric condenser wastewater - resulting from solids and volatile gases being mixed with condenser wastewater causing 60 to 120 ppm BOD

Effect on streams

- The antibiotic wastes impart objectionable odors to stream and inhibit biological population and action. If they are discharged into sewer, they must be properly diluted, otherwise they affect the sewage treatment.
- The volume and composition vary from unit to unit. Approximately 1000 to 3000 litres of waste will be discharged per 100 kg of products manufactured. No specific conclusion on the characteristics of the effluents can be drawn. In general, they are either highly acidic or highly alkaline and possess a high BOD and COD. Some of the effluents contain toxic substances like cyanides.
- If the wastes are discharged into stream, they deplete the dissolved oxygen immediately. These are corrosive due to their high acidity/alkalinity. Further, some of the substances present in them are toxic to aquatic life

Treatment of wastewater Antibiotic wastes

- Equalization, neutralization and clarification are the essential steps involved in the primary treatment
- Anaerobic digestion and controlled aeration are proved to be the effective secondary treatments. Activated sludge and oxidation ditch are also employed in some pharmaceutical manufacturing units.
- The effluent from secondary treatments may be passed on to sand filters to produce effluent of better quality Sometimes, the antibiotics wastes are evaporated and incinerated.
- Residues from penicillin and other antibiotics are dried and used in stock food. It is reported that a vacuum dried mycelium from the manufacture of penicillin can be digested to produce methane while reducing the organic matter content by about 55%.

Treatment of Synthetic drug wastes

- The type of treatment largely depends on the products manufactured. Due to the varied characteristics of wastes from different sections of the plant, a careful pilot plant study is essential.
- Segregation of different waste streams is a preliminary step in the treatment.
- Acidic wastes are neutralized with lime. Odor producing wastes are chlorinated. Cyanide bearing effluents are subjected to alkaline chlorination.
- Secondary treatments include biological oxidation with acclimatized micro organisms

Food processing industry (Breweries, wineries waste)

- breweries and wineries produced beer and wine respectively as large no of products are obtained in distilleries. The range of products from distilleries includes industrial alcohols, rectified spirit absolute alcohol, Silent spirit, beverage alcohol etc.
- 1. All the above products are obtained through the biochemical process of fermentation by yeast using carbohydrates as raw materials and
- 2. All the products contain ethyl alcohol in different proportions
- In all the industries mentioned above are all characteristically of high BOD and they present a threat to the environment when discharge in to the water sources or an to the land without treatment. Due to their varying potential pollution all the three industries will be discussed separately

Manufacture of Beer

consists of two stages

1. Preparation of molt from grains like barley.

2. Brewing the barley.

- In the malt making the barley grain are steeped (soaked) to bleach out color and then made to sprout under aerobic conditions. The grain malt is then dried and stored after screening the sprouts out.
- The malt from the malt house is then transported to the brewing section , where the wort, the medium for fermentation is prepared by mixing the course grain malt with hot water and by transforming the starch to sugars boiling in hops.
- The wort is then inoculated with a prepared suspension of yeast which common the sugar to alcohol. When the fermentation is complete, the yeast and mall residue is filtered out and finally the beer is carbonated before packing for sale.

Origin and characteristics of Breweries wastes

- Brewery wastes originate during preparation of the malt as well as brewering the barley. The spent water from the steeping process of the mall house is one source. This waste includes the water soluble substances of the grain that are diffused into it which contains a large amount of organic soluble solids indicated by a high BOD (400-800mg/lt) and low suspended solids concentration.
- In the brewing plant, the major pollutant is the fermentation residue or the spent grains. This contains high suspended solids and also a high BOD. Wastes also originate in the preparation of yeast suspension (i.e Pre fermentation section) from washing of containers, equipments & floors and in the process of by product recovery from the spent grains.
- Large volume of almost unpolluted water also comes up as waste cooling water. While the molt house waste is usually alkaline in nature , the brewing plant is generally acidic.

Manufacture, origin and characteristics of wineries wastes

- The wineries utilize the fruit juices as the raw materials. So the first operation in any winery is the pressing of fermentable juice from the fruits like grape. The waste from this operation resembles that from the canning industry and includes the spent fruits or Pomace , wastage of fermentable juice and floor wash wastes etc.
- The second stage in any winery consists of fermentation of this juice employing the method describes earlier. The wine attains its final form at this stage and requires only blending and battling for sale. The waste from this stage comes from fermenting, spillages, floor washing etc & resembles that from a brewery.
- In the third stage i.e the brandy plant, wine of either type or the fermentation residue in the wine making is distilled to obtain brandy. Depending upon the source of the brandy, the waste may have low to very high solid concentration and resembles distillery waste very much.

Effects on receiving streams/ sewers

- All the wastes are not toxic to the aquatic life of the receiving stream. But due to their high BOD content, they depict the DO of the receiving water. This results in anaerobic decomposition of this organic solids, both settled & suspended, producing a mal odorous condition over the fairly long stretch of the stream.
- The conditions further deteriorate due to the growth of sewage fungi. The dark color of the stream renders it unaesthetic. Brewery waste, which is comparatively of lesser strength, may be discharged in a fresh condition into the sewers to the extent of 3-5 % of the domestic sewage.
- The strong acidic or putrefied brewery waste will disrupt the normal biological activities of the waste treatment plants. For the sake of safe the brewery waste, if discharged into the sewers must be screened & pre treated by lime.
- The very high BOD content of the distilled waste makes it non amenable to the aerobic biological treatment and as such it cannot be discharged into municipal sewerage system directly.

Treatment of food processing industry

- Brewery wastes being comparatively less strong can be treated by aerobic biological treatment, after screening and neutralization. Usually, the biological treatment is accomplishes by two stage process for 90-94% BOD reduction.
- A flow sheet of one such brewery waste treatment plant employing high rate trickling filters is shown in fig. When sufficient land is available, the brewery waste may be used for broad irrigation after neutralization to utilize the fertilizing components of the waste
- The yeast sludge from distilleries which contains very high suspended solids & BOD & in rich in proteins, carbohydrates, vitamins may be treated separately for by product recovery.

- But in practice they are mixed & discharge along with the spent wash. Both closed anaerobic digestion & open anaerobic lagoon has been tired in India.
- A single stage digester is usually adopted for anaerobic treatment when land available is limited. Production of hydrogen sulphide impairs the anaerobic digestion, as soluble sulphide are toxic to the microorganisms. It has been found that conversion of soluble sulphides to insoluble ferric sulphide by the addition of iron salts improves the condition as the ferric sulphides are not toxic to the micro organisms.
- Anaerobic lagooning is a low cost alternative to the digester when land is available plenty. disadvantage is the evolution from the ponds.

- The odor nuisance can be eliminated by establishing a proper anaerobic activity in the lagoon. As the high sulphate content & low pH is unfavorable for the methane fermentors, neturalization of the waste helps in establishing a proper condition for their activity. A greater initial dilution and greater amount of acclimatized sludge may also help in establishing proper anaerobic activities.
- Effluent of the digesters and the anaerobic lagoons still contains a high BOD, which cannot be discharged into the receiving waters. These effluents are successfully be treated either in aerated lagoons or in oxidation ditches. About 90% BOD removal can be accomplished in aerated lagoons. Aerated lagoon effluent requires further treatment in a polishing lagoon of about 24hrs detention time.
- Single stage anaerobic treatment either in lagoon or in digester is followed by 2 stage aerobic treatment is also proposed for distilleries wastes.

By product recovery

- The yeast sludge from the distilleries contains the degradation product of the dead yeast organic debris from the malts like proteins, fats, vitamins & carbohydrates. On the other hand the spent wash contains all the above nutrients unfermented sugars, amino acids, caramels, ammonium phosphate etc. here 2 types of byproduct. ie., Nutrient rich animal feed & the potassium rich fertilizers may be recovered in distillery.
- The segregation of yeast sludge for processing the animal feed is practiced in some distilleries which in turn reduces the insoluble BOD load of the waste. Yeast powder of pharmaceutical grade can also be obtained from a yeast sludge & spent wash mix,
- while the animal feed derived from the debris waste and from the spent wash of distillers is usually considered as useful cattle feed. Care should be taken in the use of animal feed derived from the spent wash of the molasses distilleries. The latter contains a large no of inorganic substances and produce a laxative effect on the cattle's. The repeated soaking of the liquid waste & drying under direct sunlight produces a very good feed for fish.

- Whatever may be the desired by product, the liquid waste is first screened, evaporated & then dried distillery waste. The evaporating & concentration of soluble wastes is accomplished in different types of evaporates. The concentrated waste is then dried on conventional spray & drum driers. This product is known as dried distillery soluble (DDS) which is normally used as an animal feed.
- The DDS can further be incinerated in health (at temp $< 700^{0}$C) to produce in organic ash rich in potassium salts can be further be purified by sequence of operations like leaching, filtration, & acidifying by sulphuric acid. It is further concentrated in vacuum evaporates and finally crystallization of KCL and sulphates is done.
- Condensing water arising out of the process of evaporation of spent wash still contains a high BOD & should be treated before its disposal.