# Waste water treatment of brewery industry

# Introduction

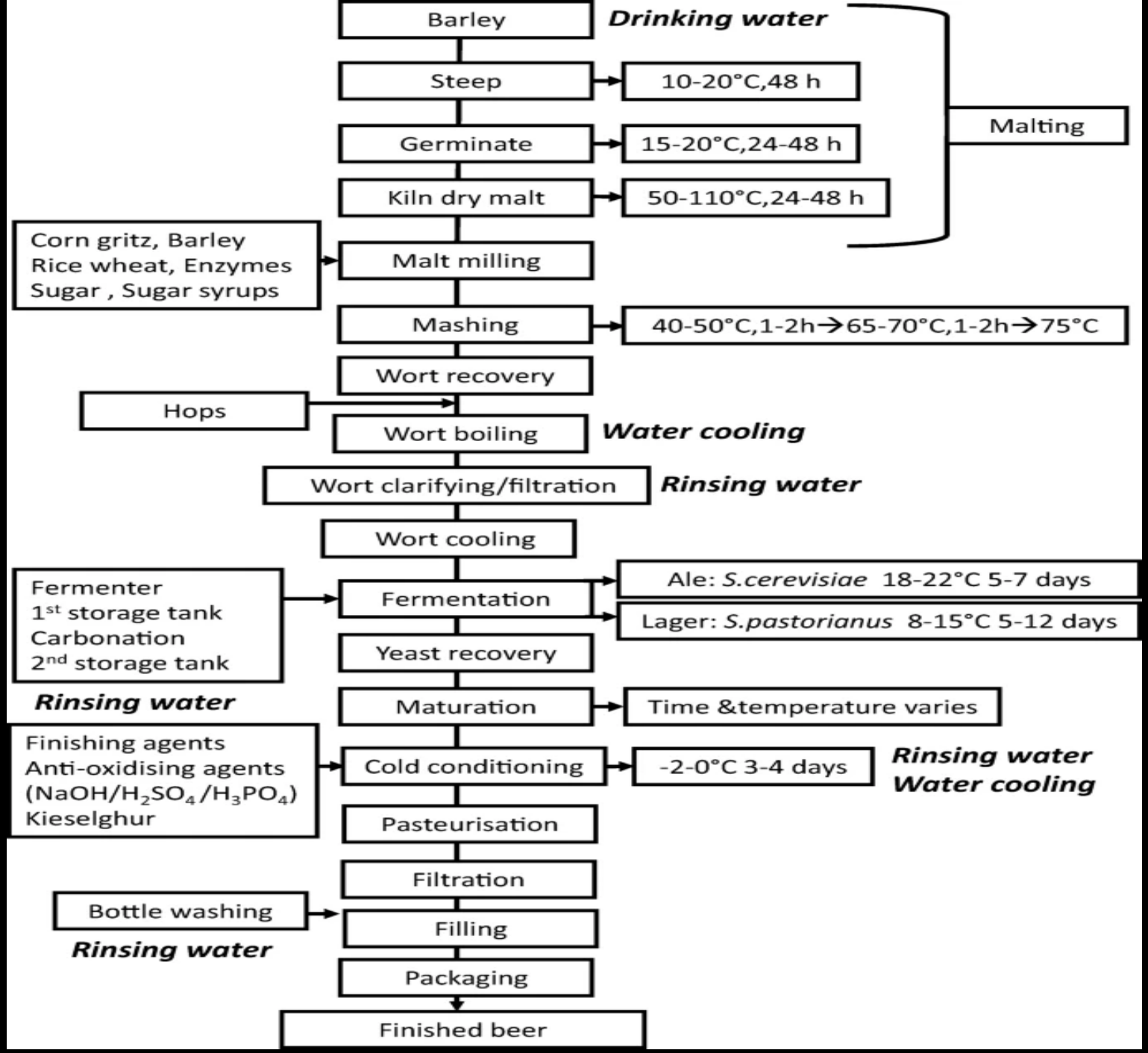
- Breweries are the traditional industry in agro and sector using cost effective techniques to manufacture the best quality product. During the process beer is alternatively possess through three chemical and biochemical reaction(mashing, boiling ,fermentation, and maturation) and tree solid liquid separation (wort separation ,wort clarification, and rough beer clarification ) consequently the water consumption.
- Brewery plants have been known to cause pollution by discharging effluent into receiving stream, ground water and soil Water consumption for breweries generally ranges from 4-8 cubic meters per cubic meter of beer produced.
- Production steps include malt production, wort production and beer production. In the case of ocean and river quality, such pollution is primarily caused by the discharge of in adequately treated industrial and municipal wastewater.
- These waste waters can contain high levels of inorganic pollutants.

# Definition of brewery-

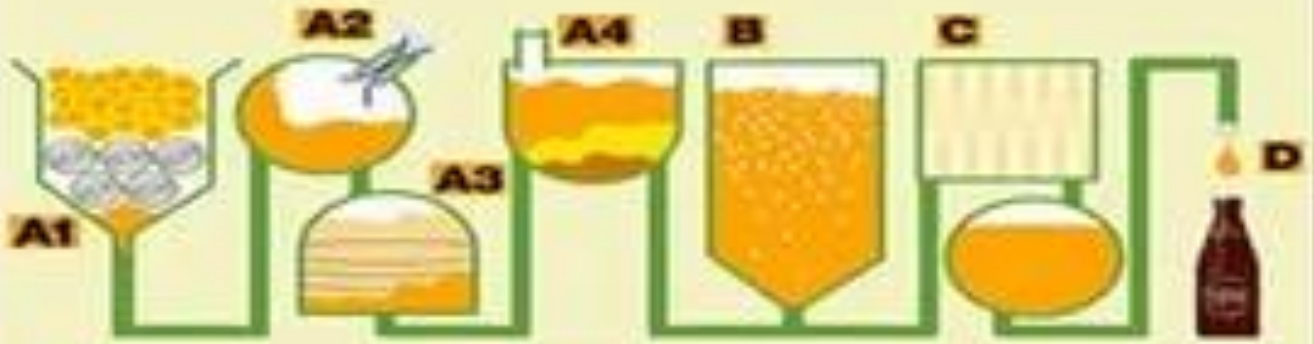
- Brewing is a water-intensive process. Wastewater, sludge and effluents are the negative products from the brewing process considerable efforts have been initiated to reduce the quantity of water used up in the production of a liter of beer by breweries, due to water scarcity and to comply with global water efficiency in beer production.
- Beer making requires good and clean water in large quantities. Reducing the amount of water used in a brewery process does not only reduce the supply costs of water, but also the volume of effluent discharges.
- Wastewater from brewery process are discharged into waterways such as rivers, streams or lakes; discharged directly into municipal sewer system; or into municipal sewer system after the wastewater has undergone some treatment.

# Brewing process

- Beer is a soft drink obtained through alcoholic fermentation, using selected yeasts of the genera Saccharomyces, of wort prepared from malt cereals, mainly barley, and other amylases or sugar-based raw materials, to which were added hop flowers, or their derivatives, and adequate water.


Barley
Drinking water
Steep
10-20°C,48 h
Germinate
15-20°C,24-48 h
Kiln dry malt
50-110°C,24-48 h
Malting
Corn gritz, Barley
Rice wheat, Enzymes
Sugar , Sugar syrups
Malt milling
Mashing
40-50°C,1-2h→65-70°C,1-2h→75°C
Wort recovery
Hops
Wort boiling
Water cooling
Wort clarifying/filtration
Rinsing water
Wort cooling
Fermenter
1st storage tank
Carbonation
2nd storage tank
Rinsing water
Fermentation
Ale: S.cerevisiae 18-22°C 5-7 days
Lager: S.pastorianus 8-15°C 5-12 days
Yeast recovery
Maturation
Time &temperature varies
Finishing agents
Anti-oxidising agents
(NaOH/H2SO4/H3PO4)
Kieselghur
Cold conditioning
-2-0°C 3-4 days
Rinsing water
Water cooling
Pasteurisation
Filtration
Bottle washing
Rinsing water
Filling
Packaging
Finished beer

# Flow Chart Of Beer Production:




- A1 Mill
- A2 Mashing
- A3 Filtration
- A4 Wort Boiling
- B Fermentation
- C Clarification
- D Bottling
- A1 ▸ A4 Wort Production

# Brewery wastewater

- Brewery wastewater is a significant waste or negative product in a brewery process.
- Wastewater is mostly water by weight with other waste materials making up a small option. At other times, large quantities of these other materials may be present that require some form of pre-treatment before discharging the wastewater into the sewage system. The brewing process usually generates large amounts of wastewater that need to be disposed of or treated in the least costly way to meet discharge regulations. Brewery wastewater contains a high biochemical oxygen demand (BOD) as a result of all the organic components such as sugar, soluble starch, ethanol and volatile fatty acids used in the brewing process.
- Brewery wastewater has a high temperature in the range of 25 to 38°C The high pH levels of between 2 and 12 are influenced by the amount and type of chemicals used in the cleaning and sanitation processes, such as caustic soda, phosphoric acid, and nitric acid . Brewery solid waste includes spent grains, spent yeast, diatomaceous earth (DE) slurry and packaging materials.

# Wastewater Characterization

- The composition of brewing effluents can fluctuate significantly as it depends on various processes that take place within the brewery, but the amount of wastewater produced depends on the water consumption during the process.
- In general, water consumption per volume of produced beer attain 4.7 m3/m3 but it should be pointed that the wastewater to beer ratio is often 1.2 m3/m3to 2 m3/ m3less because part of the water is disposed of with by-products and lost by evaporation.
- Organic components in brewery effluent are generally easily biodegradable and mainly consist of sugars, soluble starch, ethanol, volatile fatty acids, etc., leading to a Biological Oxygen Demand (BOD)/COD a ratio of 0.6 to 0.7.The pH levels are determined by the amount and the type of chemicals used at the CIP (clean in place)units (e.g. Caustic soda, phosphoric acid, nitric acid). Nitrogen b and phosphorous levels are mainly depending on the handling of raw material and the amount of spent yeast present in the effluent.

# Wastewater treatment

- Waste water treatment can involve physical, chemical or biological processes or combinations of these processes depending on the required outflow standards. A generalized layout of a waste water treatment plant. The first stage of waste water treatment takes place in the preliminary treatment plant where material such as oils, fats, grease, grit, rags and large solids are removed.
- Primary settlement is sometimes used prior to biological treatment.
- Biological treatment of waste water takes place in fixed media or suspended growth reactors using activated sludge, bio – filtration, rotating biological contactors, constructed wetlands or variants of these processes. Nitrification/ denitrification and biological phosphorus removal can be incorporated at this stage and will reduce nutrient concentrations in the outflow.

- Chemical treatment is used to improve the settling abilities of suspended solids prior to a solids removal stage or to adjust the properties or components of waste water prior to biological treatment (e. G. pH adjustment, reduction of heavy metals or nutrient adjustment).
- DISCHARGE REQUIREMENTS
- The effluent discharge limit a brewery has to comply with depends on local environmental legislation. It is obvious that in case of discharging to a municipal sewer discharge limits are less stringent than when the effluent is to be discharged into a sensitive receiving surface water body (river, Lake, Sea, etc).
- Removal of organic compounds (COD chemical oxygen demand) from the wastewater is important to avoid anaerobic conditions in the receiving waters. Nutrients like nitrogen (N) and phosphorous (P) should be removed to avoid algae bloom disturbing the receiving waters ecosystem.

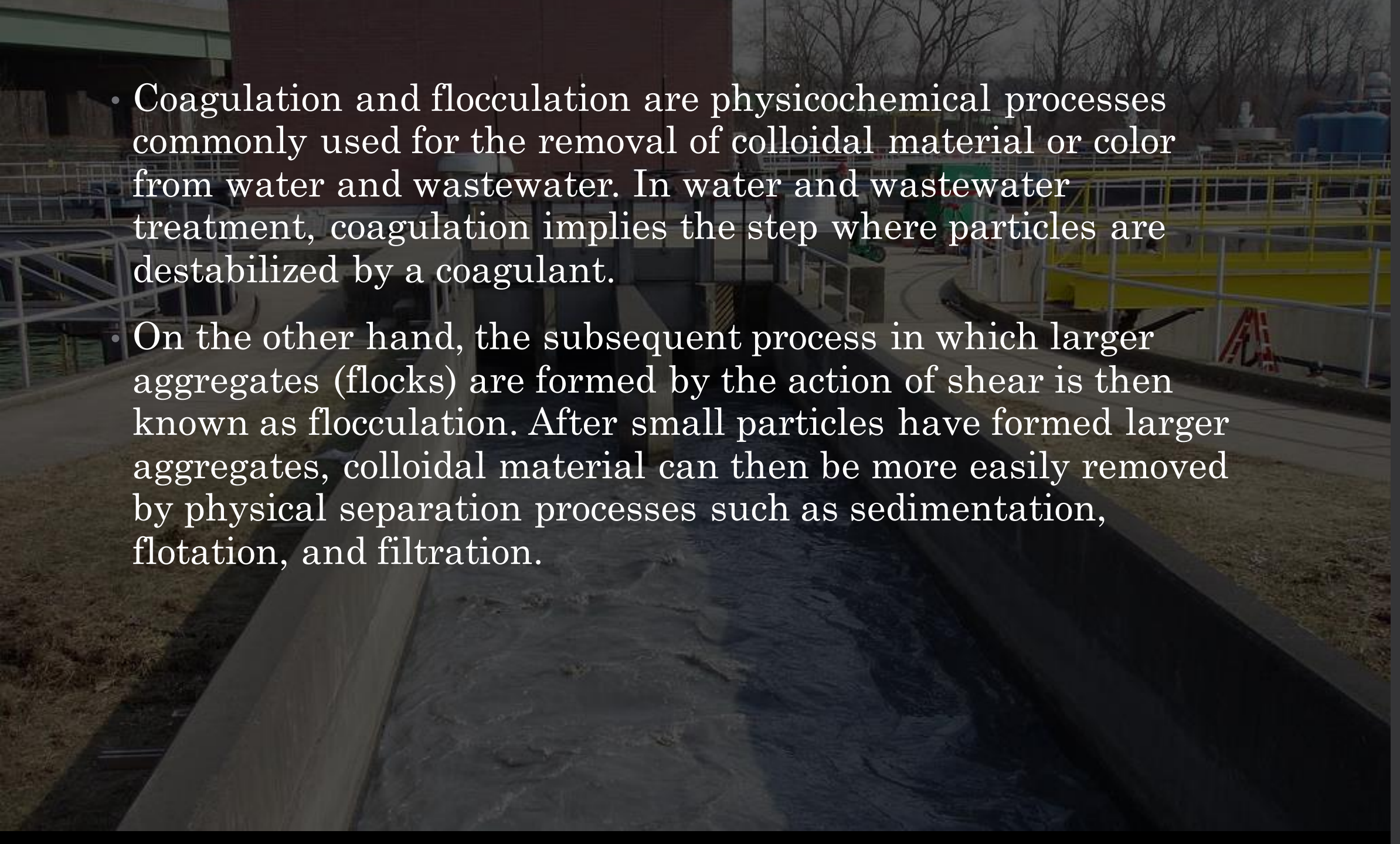
# Wastewater treatment options

- Different environmental and socio-economic criteria can be considered when deciding on a wastewater treatment plant for a brewery industry. The aim is to select a process that is flexible enough to cope with large fluctuations in organic load and characteristics of such waste waters, while keeping capital and operating costs as low as possible. Because organic matter concentration in brewery effluent is significant, a high input of energy for aeration is required.
- Preliminary: - this includes simple processes such as screening (usually by bar screens) and grit removal (through constant velocity channels) to remove the gross solid pollution.
- I. Primary: usually plain sedimentation; simple settlement of the solid material in sewage can reduce the polluting load by significant amounts.
- II. Secondary: for further treatment and removal of common pollutants, usually by a biological process.
- III. Tertiary: usually for removal of specific pollutants e.g. nitrogen or phosphorous, or specific industrial pollutants.

# Methods

- Physical Methods
- Among the first treatment methods used are physical unit operations, in which physical forces are applied to remove contaminants. Physical methods remove coarse solid matter, rather than dissolved pollutants. It may be a passive process, such as sedimentation to allow suspended pollutants to settle out or float to the top naturally. In general, these methods have yielded little success; most often resulting in incomplete contaminant removal and/or separation. For example, sedimentation has been found to be unsatisfactory even with the addition of coagulants and other additives.

- Chemical Methods- Different chemicals can be added to the brewery wastewater to alter the water chemistry. Chemical pretreatment may involve pH adjustment or coagulation and flocculation. The acidity or alkalinity of wastewater affects both wastewater treatment and the environment. Low pH indicates increasing acidity while a high pH indicates increasing alkalinity.
- The pH of wastewater needs to remain between 6 and 9 to protect organisms. Waste $CO_2$ may be used to neutralize caustic effluents from clean-in-places (CIP) systems and bottle washers. The waste $CO_2$ can also be used as a cheap acidifying agent for decreasing the pH of alkaline waste waters before the anaerobic reactor, thus replacing the conventionally used acids.
- Neutralization with $H_2SO_4$ and HCl acids is usually not recommended because of their corrosive nature and sulfate and chloride discharge limitations, which may add to the cost of effluent treatment operations.



- Coagulation and flocculation are physicochemical processes commonly used for the removal of colloidal material or color from water and wastewater. In water and wastewater treatment, coagulation implies the step where particles are destabilized by a coagulant.
- On the other hand, the subsequent process in which larger aggregates (flocks) are formed by the action of shear is then known as flocculation. After small particles have formed larger aggregates, colloidal material can then be more easily removed by physical separation processes such as sedimentation, flotation, and filtration.

# Biological treatment

- The biology of waste water treatment is based on the consumption of organic matter by micro- organisms which include bacteria, viruses, algae and protozoa.
- For aerobic bacteria, oxygen is required in breaking down the substrate. Anaerobic bacteria operate in the absence of oxygen.
- Facultative micro-organisms have the ability to operate aerobically or anaerobically. Anaerobic bacteria thrive in the absence of oxygen and, in urban waste water treatment plants, are most often encountered under septic conditions where oxygen is not available or has become depleted, for example in long sewers or in sludge storage tanks. Foul odors are associated with generally septic conditions.
- Anaerobic processes are most commonly used for the pretreatment of high strength industrial wastes and for the digestion of sludge's. Higher life forms in the waste water treatment food chain include protozoa and rotifers.

# Thank you