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The Influence of Water Quality on Food Quality and the Treatment of Water for Food Processing

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Abstract

This paper has discussed the influence of quality of water for food processing on the food quality and introduced the source of water for food processing and the existing problems as well as described the basic requirements of water for food processing and the various methods of water treatment.

Keywords: water quality; food quality; method of water treatment

Introduction

The water for food processing mainly includes the water for raw materials, the water for processing and the water for cleaning, etc. the water quality directly affects the food quality. The processing enterprises must ensure that the quality of water for food processing is required to be inspected by hygiene and should meet the related standards of hygiene. In order to ensure the food quality, except that the quality of water for food processing should meet the standards of drinking water, some components in water still need to be strictly controlled. Therefore, a comprehensive understanding of the quality of water for food processing has played an important role in the guarantee of food quality.

The Influence of Water Ouality on Food

The impurities in water will cause a lot of impact on the food quality, mainly including the deterioration of food color, the discoloration, the coloration, the abnormal odor, the abnormal smell, the turbidity, the precipitation, the crystallization, the corruption and some others.

Chromaticity and Turbidity. The chromaticity and the turbidity of water are the basic indexes to test the water quality, which are also the most obvious indexes of sense organs. If the two indexes exceed the allowed figures, it will cause the phenomenons that the product is precipitated, the carbonation is difficult and it is also easy to have the spouting (carbonic acid drink), which will affect the chromaticity of products.

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Abnormal Smell. Because of the physical or chemical factors, many of the water have the abnormal odor itself, which is easy to affect the flavor of the finished products.

Hardness. The hardness of water mainly refers to the concentration of the calcium and magnesium ions in water. The calcium and magnesium ions will produce the carbonate precipitation in the heating process. And when the hardness is higher, it will cause a lot of problems such as the discoloration of finished products, the turbidity, the precipitation, the change of flavor, the reduction of water binding capacity (meat), the hardening (meat, bean products) and so on.

Alkalinity. The alkalinity of water depends on the contents of OH^-、CO_3^{2-} and HCO_3^- which can be combined with H^+ in water. When the alkalinity is higher, it will cause the decline of fragrance, the precipitation, the difficulty of carbonation of CO_2 and the increased dosage of acidity regulations. In the fermentation process, if the alkalinity is too high, it will not be conducive to the growth of yeast.

Others. The pH value will influence the discoloration of food, the precipitation, the deterioration of fragrance and the corrosion of metal equipments. The phenol will cause the abnormal odor. The dissociation chlorine will make the deterioration of finished products' color, the discoloration, the abnormal smell, the abnormal odor and the deterioration of spice. The dissolved chlorine can cause the deterioration of food color, the discoloration, the abnormal smell as well as promote the corrosion of tank wall. The nitrate will produce the abnormal odor and promote the corrosion of tank wall. The organic matter is pollutional and not conducive to the carbonation of CO_2 as well as the spouting produced by finished products (carbonic acid drink). The heavy metals (Fe, Cu, Mn, etc.) will cause the deterioration of color, the change of frangrance, the reversion of flavor and the precipitation as well as promote the decomposition of oxidation rancidity and Vc. The microorganism will cause the corruption and the deterioration.

The Basic Requirements of Water for Food Processing

The water for food processing should meet the sanitation standards of national living drinking water, which can't contain the pathogenic microorganisms. The chemicals in water mustn't be harmful to human health. The radioactive materials in water mustn't be harmful to human health. The sensory properties are good and it must be conducted the disinfection treatment, etc.

The Index of Bacteriology. The pathogenic bacteria should not be contained and the total content of bacteria should be low. The total number of bacteria should not be more than 100 in 1ml water and the coliform shouldn't be detected.

The Index of Toxicology. The content of various toxic ingredients (such as the fluoride, the cyanide, the arsenic, the selenium, the mercury, the cadmium, the lead, the chromium and so on) should not surpass the stipulation index.

The Index of Chemistry. It is required that the potential of hydrogen should be suitable, which generally refers the pH value is from 6.5 to 8.5 and there is also having the crisp feeling in the mouth as well as meeting the certain degree of hardness. At the same time, the content of iron ion, the manganese ion, the zinc ion, the copper ion and some others should be limited.

Appearance. It is required to be colorless, odorless and not containing some materials which could be seen, i.e. there is no suspended solid, the water floating material, the sediment, the microorganism, the immature larva and some others.

The Source of Water for Food Processing and the Existing Problems

At present, the water for food processing mainly refers to the natural water and the natural water includes the surface water and the underground water.

The surface water flows through the ground, containing some impurities such as the clay, the sand, the weeds, the humus, the calcium magnesium salts, other salts and bacteria, etc. In recent years, because of the

development of industry, a large number of wastewater containing some harmful ingredients is dispersed into the rivers, which has polluted the surface water.

After the infiltration and the filtering of stratum, the underground water contains little silt, suspended solids and bacteria. The water quality is relatively clear, but it has been integrated into various soluble minerals, such as the bicarbonate of calcium, magnesium and iron. Its salt content is generally from 100mg/L to 5000mg/L. The hardness is approximately from 2mEq/L to 10 mEq/L and the higher hardness is about from 10 mEq/L to 25 mEq/L.

The natural water has constantly contacted with the outside world in the cycle process of nature, which has made the various substances in air, land and underground rock layers dissolved or mixed. Then the water has been polluted in different degrees.

Water Treatment

In order to make the upscale food, the first thing is to have the fine water. And the water treatment may enable the common water to achieve the requirements of water for food processing. The suspended impurities in water can be removed by two ways, namely the water clarification and the filtration. The removal of dissolved impurities in water can employ the lime soda method, the ion exchange method, the electrodialysis and reverse osmosis method, i.e. the water softening and the demineralization.

Clarification of Water. In order to ensure the requirements of water for food processing, some clarification methods such as the coagulation, the flocculation and the precipitation are usually employed to remove the suspended solids in water. The coagulants used in water treatment mainly include the potassium and some others. The chemistry name of potassium is sulfate aluminum, which is a duplicate salt and whose molecular formula is $(KAl(SO_4)_2)\cdot 12H_2O$ or $K_2(SO_4)_3Al_2(SO_4)_3\cdot 12H_2O$. $Al_2(SO_4)_3$ has the hydrolysis in the water to form the aluminum hydroxide colloid, which has the neutralization and the adsorption and that can absorb the natural colloid and the suspended solids in water. The colloid particles in water are gradually condensed into a thick floccus and then sinking. In the process of sedimentation, the suspended solids are also wrapped into them and simultaneously subside. The amount of potassium alum is generally 0.001～0.02%.

Filtration of Water. The filtration refers to the process that when the water flows through a porous medium or a medium with pore structure (such as the sand), some suspended solids or colloid impurities in water will be trapped in the pores or holes or the surface of medium, which can separate the impurities from the mother liquor.

The filtrating equipment of water generally refers to the water quality filter. The filter is equipped with the sand layer and the activated carbon layer. The water will flow from the inlet, and then it will flow through the mesh, the pre-filters, the sand and the activated carbon layer. Finally the water will outflow from the outlet. When the water quality filter is used for some time, it is necessary to deal with the sand layer and the activated carbon layer. When the water consumption is fewer, the sand filter is generally employed. The sand filter is the approved product in the water treating equipments. The water having certain pressure flows into the vessel and enters the inner cavity through the pores on sand filter. Then the impurities in water will be separated outside the sand filter, which can achieve the goal of purifying the water.

Water Softening. In order to meet the requirements of the quality of water for food processing, it is required to reduce the dissolved ionic components. The methods of water softening include the thermal softening method, the lime softening method, the lime-soda softening method and the ion exchange softening method.

Thermal softening method.The solubility of the two representative carbonate hardness compounds which refer to the calcium bicarbonate and the magnesium bicarbonate will drop with the increase of temperature. When the temperature is 100℃, they will decompose the calcium carbonate and magnesium

carbonate precipitation. Most of the calcium ions and the magnesium ions in water will be removed with the precipitation of calcium carbonate and magnesium hydroxide. The employment of heating method only removes the carbonate hardness without removing the non-carbonate hardness. In addition, the solubility of calcium bicarbonate and the magnesium bicarbonate is still small even at 0℃. Therefore, if the all magnesium salt types (including the calcium sulfate, the magnesium sulfate, the calcium chloride, etc) can be converted into calcium bicarbonate and magnesium bicarbonate precipitation and then they are removed, it will play a softening effect. In order to convert the non-carbonate hardness into carbonate hardness, it is necessary to add some chemical reagents. And the common chemical reagents refer to the lime and the soda ash.

Lime softening method.This method is suitable to the raw water which doesn't request the highly softening in which the carbonate hardness is higher and the non-carbonate hardness is lower. Meanwhile, it can be also used in the pretreatment of ionic exchange water treatment. The quicklime will be configured into the milk of lime (the main component is calcium hydroxide) and it is required to use the milk of lime to remove the calcium bicarbonate, the magnesium bicarbonate and the carbon dioxide in water. Through the lime treatment, some of the iron and silicon compounds in water can be also removed. And after the lime treatment, most of the temporary hardness in water can be got rid of. And the residual temporary hardness can be reduced to a value which is between 0.4mEq/L and 0.8mEq/L. The residual alkalinity is reduced to a value which is between 0.8mEq/L and 1.2mEq/L. The organic matters are removed 25% and the silicate compounds are reduced 30~35%. The residual quantity of iron in raw water is less than 0.1mg/L.

Lime-soda softening method.This method is suitable to the water in which the total hardness is greater than the total alkalinity. And the lime is employed to remove the hardness of carbonate in water as well as the soda ash is used to get rid of the hardness of non-carbonate. The residual hardness of soft water after processing is from 0.25mEq/L to 0.35mEq/L.

Ionic exchange softening method.The ion exchanger has been widely used in the processing of raw water which contains soluble salts. For example, RSO_3H can be dissociated into RSO_3^- and H＋ in water and R_4NOH can be dissociated into R_4N^++OH- in water. The raw water contains some cations such as the potassium ions, the sodium ions, the calcium ions and the magnesium ions as well as some anions such as the sulfate ions, the chloride ions, the bicarbonate ions and $HSiO_3^-$. When the raw water flows through the cation resin layer, the cations in water are adsorbed by resin. The cation H^+on resin is replaced into the water and the anions in water are adsorbed by anion resin. The anion OH^- is replaced into water and the cations and anions in water are all adsorbed by resin. The $H^+$and OH^- in ion exchange resin are into the water, which can achieve the purpose of water softening.

Electrodialysis method.Through the ion exchange membranes which have choice permeability and good electrical conductivity and under the action of direct current field, the electrodialysis technology refers to the phenomenon that the cations and anions in raw water can separately achieve the purification through the anion exchange membrane and the cation exchange membrane according to the principle that opposite charges attract and like charges repel. At present, the common electrodialysis contains the vertical and the horizontal forms. The basic components include the board of fresh water and dense water rooms, the ion exchange membrane, the electrodes, the water separators and the locking devices, etc. The assembly forms of electrodialysis contain the singe type, the single multi-stage tandem type and the multiple tandem type, etc.

Reverse osmosis method.The reverse osmosis refers to the phenomenon that the solvent (water) in solution has been separated through the reverse osmosis membrane. At present, the common reverse osmosis membranes include the cellulose acetate membrane (CA membrane) and the aromatic polyamide fiber membrane, etc.

The structural styles of reverse osmosis devices mainly include the plate and frame type, the tube type, the spiral type and the hollow fiber type, etc. The technical process of reverse osmosis devices usually

employ the first-level or second-level reverse osmosis. The first level refers that the water quality requirements can be achieved only by a reverse osmosis. And the second level refers that the water quality requirements can be achieved by two reverse osmosises. In addition, there are also some multi-stage reverse osmosis desalinations, but they are rarely used.

Disinfection of Water. In the process of water treatment, most of the substances such as the suspended solids and the microorganisms are removed, but there are still some microorganisms remaining in the water. Therefore, it is necessary to carry out the water disinfection.

The disinfection of water is to kill the pathogenic bacteria and other harmful microorganisms in water, which can prevent the hazards of infectious diseases. However, the disinfection of water can't kill the all microorganisms in water. There are a lot of water disinfection methods. In the process of food production, the commonest disinfection methods employed by water treatment are the chlorination disinfection, the ozone disinfection and the UV disinfection.

Chlorination disinfection.The common chlorination disinfection mainly includes the chloramines, the bleaching powder and the sodium hypochlorite. When the chloramine is employed to disinfect, the amount of chlorine and ammonia should be added according to the proportion. And the general range is from 2:1 to 5:1. When the proportion of chlorine and ammonia is less than four and there is still some residual ammonia, it will prevent the chlorine stink.

The available chlorine content of the general bleaching powder is 25%~35%, and when it is used, it will be estimated as 25%. The disinfection of bleaching powder refers that the hypochlorous acid is produced in the water. The bleaching powder is always matched with a concentration of 1~2% and it can be also drily thrown. The sodium hypochlorite has the strong sterilization ability. The aqueous solution is very pure, which doesn't increase the water hardness. Therefore, it is better than the bleaching powder. And the main shortcoming refers that the cost is too high.

Ozone disinfection.Ozone (O_3) is a particularly strong oxidant. The instant sterilization nature of ozone is superior to chlorine. At the normal temperature, the ozone is a gas which brings the blue color. But in usual it looks colorless and the liquid ozone is dark blue. It is easier to dissolve in the water than the oxygen. However, because we can only obtain the ozone with a low differential pressure, so the concentration is quite low. The oxidizing power of ozone is very strong, so the inorganic and the organic matters in water (including the microorganism) are all oxidized by the ozone. As the ozone is unstable, so it is required to take it at any time and carry out the application on the spot. In most cases, the dry air or the oxygen is employed to carry out the high-pressure discharge so as to produce the ozone. And the sterilization of ozone is 15~30 times faster than the one of chlorine.

UV disinfection.The light is started from the blue-green color of spectrum. When the wavelength is 4900A~1400A, it will have the sterilization ability and the 2600A is the best. After the irradiation of UV on microorganisms, the protein and the nucleic acid of microorganism can absorb the spectrum energy, which will lead to the denaturation of protein and the death of microorganism. As for the clean transparent water, the UV has certain penetrability, so it can carry out the water disinfection. The effect of UV disinfection reduces with the increase of the treating water amount. Generally speaking, when the underground water is disinfected by the 30 watt lamps, the lamps will disinfect no more than 15 cubic meters water per hour. The time of UV disinfection as well as the contact time is short and the sterilization ability is strong. At the same time, the equipment is simple and the operation management is convenient, which is advantageous for the automatic control. However, it doesn't have the ability of continuous sterilization, the service life of lamp is too short and the cost is too high.

Conclusion

At present, as the natural conditions are poor, the pesticides and the fertilizers are irrational used, the animal industry and the aquaculture are rapidly developed, a large number of animal husbandry and poultry

manure is not well handled, the waste hasn't well recycled and used and the industrial production has also caused great pollution, all of them have greatly influenced the resource and the quality of water for food processing. With the prominence of food safety issues, the phenomenon that strengthens and focuses on the safety of water for food processing has become more and more obvious.

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