Bakery Waste Treatment

**Introduction**

The bakery industry is one of the world’s major food industries and varies widely in terms of production scale and process. Traditionally, bakery products may be categorized as bread and bread roll products, pastry products (e.g., pies and pastries), and specialty products (e.g., cake, biscuits, donuts, and specialty bread).

The principles of baking bread have been established for several thousand years. The major equipment includes miller, mixer/ kneading machine, bun and bread former, fermenter, bake ovens, cold stage, and boilers. The main processes are milling, mixing, fermentation, baking, and storage. Fermentation and baking are normally operated at 40oC and 160-260oC, respectively. Depending on logistics and the market, the products can be stored at 4-20oC.

Flour, yeast, salt, water, and oil/fat are the basic ingredients, while bread improver (flour treatment agents), usually vitamin C (ascorbic acid), and preservatives are included in the commercial bakery production process.

Flour made from wheat contains a higher protein and gluten content. Yeast is used to introduce anaerobic fermentation, which produces carbon dioxide. Adding a small amount of salt gives the bread flavor, and can help the fermentation process produce bread with better volume as well as texture. A very small quantity of vegetable oil keeps the product soft and makes the dough easier to pass through the manufacturing processes. Another important component is production is water, which is used to produce the dough. Good bread should have a certain good percentage of water. Vitamin C, a bread improver, strengthens the dough and helps it rise. Preservatives such as acetic acid are used to ensure the freshness of products and prevent staling.

During the manufacturing process, 40-50oC hot water mixed with detergents is used to wash the baking plates, molds, and trays.

**Bakery industry waste sources**

**1. Noise**

Noise usually comes from the compressed air and the running machines. It not only disturbs nearby residents, but can harm bakery worker’s hearing. Ear plugs can help to effectively reduce the suffering. Other noise control measures include the reduction of source noise, use of noise enclosures, and reduction of exposure time.

**2. Air Pollution**

The air pollution is due to emission of volatile organic compounds, odor, milling dust, and the refrigerant agent. The VOC can be released in many operational processes including yeast fermentation, drying processes, combustion processes, waste treatment systems, and packaging manufacture. Themilling dust comes from the leakage of flour powder. The refrigerant comes from the emission leakage of cooling or refrigeration systems. All of these can cause serious environmental problems. The controlling methods may include treatment of VOC and odor, avoidance of using the refrigerants forbidden by laws, and cyclic use of refrigerants.

**3. Wastewater**

Waste water in bakeries is primarily generated from cleaning operations including equipment cleaning and floor washing. Flour, sugar, oil, grease, and yeast are the major components in the waste. Different products can lead to different amounts of waste water produced.

**4. Solid waste**

Solid wastes generated from bakery industries are principally waste dough and out-of-specified products and package waste. Solid waste is the loss of raw materials, which may be recovered by cooking waste dough to produce breadcrumbs and by passing cooked product onto animal farmers for fodder.

**Bakery waste treatment**

Generally, bakery industry waste is nontoxic. It can be divided into liquid waste, solid waste, and gaseous waste. In the liquid phase, there are high contents of organic pollutants including chemical oxygen demand (COD), biological oxygen demand (BOD), as well as fats, oils, and greases (FOG), and SS. Waste water is normally treated by physical and chemical, biological processes.

**Pretreatment systems**

Pretreatment or primary treatment is a series of physical and chemical operations, which precondition the wastewater as well as remove some of the wastes. The treatment is normally arranged in the following order: screening, flow equalization and neutralization, optional FOG separation, optional acidification, coagulation- sedimentation, and dissolved air flotation.

In the bakery industry, pretreatment is always required because the waste contains high SS and floatable FOG. Pretreatment can reduce the pollutant loading in the subsequent biological and/or chemical treatment processes; it can also protect process equipment. In addition, pretreatment is economically preferable in the total process view as compared to biological and chemical treatment.

**1. Flow equalization and neutralization**

In bakery plants, the wastewater flow rate and loading vary significantly with the time. It is usually economical to use a flow equalization tank to meet the peak discharge demand. However, too long a retention time may result in an anaerobic environment. A decrease in pH and bad odors are common problems during the operations.

**2. Screening**

Screening is used to remove coarse particles in the influent. There are different screen openings ranging from a few µm (termed as microscreen) to more than 100mm (termed as coarse screen).

**3. FOG Separation**

As wastewater may contain high amount of FOG, a FOG separator is thus recommended for installation. A FOG can be separated and recovered for possible reuse, as well as reduce difficulties in the subsequent biological treatment.

**4. Acidification**

Acidification is optional, depending on the characteristics of the waste. Owing to the presence of FOG, acid (e.g., concentrated H2SO4) is added into the acidification tank; hydrolysis of organics can occur, which enhances the biotreatability.

**5. Coagulation-Flocculation**

Coagulation is used to destabilize the stable fine SS, while flocculation is used to grow the destabilized SS, so that the SS become heavier and larger enough to settle down. The Coagulation-flocculation process can be used to remove fine SS from bakery wastewater. It normally acts as a preconditioning process for sedimentation and/or dissolved air flotation.

**6. Sedimentation**

Sedimentation, also called clarification, has a working mechanism based on the density difference between SS and the water, allowing SS with larger particle sizes to more easily settle down.

**7. Dissolved Air Flotation (DAF)**

Dissolved air flotation is usually implemented by pumping compressed air bubbles to remove fine SS and FOG in the bakery wastewater.

The wastewater is first stored in an air pressured, closed tank. Through the pressure-reduction valves, it enters the flotation tank. Due to the sudden reduction in pressure, air bubbles form and rise to the surface in the tank. The SS and FOG adhere to the fine air bubbles and are carried upwards.

**Biological treatment**

The objective of biological treatment is to remove the dissolved and particulate biodegradable components in the wastewater. It is a core part of the secondary biological treatment system. Microorganisms are used to decompose the organic wastes.

With regard to different growth types, biological systems can be classified as suspended growth or attached growth systems. Biological treatment can also be classified by oxygen utilization: aerobic, anaerobic, and facultative. In an aerobic system, the organic matter is decomposed to carbon dioxide, water, and series of simple compounds. If the system is anaerobic, the final products are carbon dioxide and methane.

**Solid waste management**

Bakery solid waste includes stale bakery products, dropped raw materials (e.g., dough), and packages. The most simple and common way is to directly transport these to landfill or incineration. Landfill can cause the waste to decompose, which eventually leads to production of methane (a greenhouse gas) and ground water pollution (organic compounds and heavy metals). Incineration of bakery waste can also release nitrogen oxide gases.

Reclamation of the bakery waste can play an important role in its management. The waste consists primarily of stale bread, bread rolls, and cookies – all of which contain high energy and can be fed directly to animals, such as swine and cattle. Another application is to use the waste for production of valuable products. For example, Oda et al. successfully used bakery waste to produce lactic acid with a good conversion efficiency of 47.2%.