

Multilateral Investment Guarantee Agency

Environmental Guidelines for

Breweries

Industry Description and Practices

Beer is a fermented beverage with low alcohol content made from various types of grains. Barley, wheat, maize and other grains can be used (barley predominates). The production steps include:

- Malt production and handling – grain delivery and cleaning; steeping of the grain in water to start germination; growth of rootlets and development of enzymes (enzymes convert starch into maltose); kilning and polishing of the malt to remove rootlets; storage of the cleaned malt.
- Wort production – grinding of the malt to grist; mixing grist with water to produce a mash in the mash tun; heating of the mash to activate enzymes; separation of grist residues in the lauter tun to leave a liquid wort; boiling of the wort with hops; separation of the wort from the trub/hot break (precipitated residues) with the liquid part of the trub being returned to the lauter tub and the spent hops going to a collection vessel; and cooling of the wort.
- Beer production – addition of yeast to cooled wort; fermentation; separation of spent yeast by filtration, centrifugation or settling; and bottling and/or kegging.

Water consumption for breweries generally ranges 4-8 cubic meter per cubic meter (m^3/m^3) of beer produced. Water consumption values for individual process stages are shown in the following table, as reported for the German brewing industry:

Waste Characteristics

Breweries can achieve an effluent discharge of 3-5 meter per cubic meter (m^3/m^3) of sold beer

(exclusive of cooling waters). Untreated effluents typically contain suspended solids in the range 10-60 milligrams per liter (mg/L), BOD₅ in the range 1,000-1,500 mg/L range, COD in the range 1,800-3,000 mg/L, and nitrogen in the range 30-100 mg/L.

Water Consumption Reported For German Brewing Industry

Process step	Water consumption (m^3/m^3 of sold beer)
Gyle (unfermented wort) to whirlpool	2.0 (1.8-2.2)
Wort cooling	0.0 (0.0-2.4)
Ferment. cellar and yeast treat.	0.6 (0.5-0.8)
Filter and pressure tank room	0.3 (0.1-0.5)
Storage cellar	0.5 (0.3-0.6)
Bottling (70% of beer is bottles)	1.1 (0.9-2.1)
Barrel filling (30% in barrels)	0.1 (0.1-0.2)
Waste water from cleaning of vehicles, sanitary, etc.	1.5 (1.0-3.0)
Steam boiler	0.2 (0.1-0.3)
Air compressor	0.3 (0.1-0.5)
Total	6.6 (4.9-12.6)

Numbers have been rounded and values in brackets represent ranges.

Phosphorous can also be present at concentrations in the order of 10-30 mg/L. Effluents from individual process steps are variable. For example, bottle washing results in a large volume but it contains only a minor part of the total organics discharged from the brewery, whereas effluents from fermentation and filtering are high in organics/ biochemical oxygen demand (BOD) but low in volume,

accounting for about 3% of the total wastewater volume but 97% of the BOD. Effluent pH averages about 7 for the combined effluent, but can fluctuate from 3 to 12 depending on the use of acid and alkaline cleaning agents. Effluent temperatures will average about 30°C.

Solid wastes for disposal include: grit, weed seed and grain of less than 2.2 millimeters diameter removed when grain is cleaned; spent grain and yeast; spent hops; broken bottles or bottles that cannot be recycled to the process; and cardboard and other solid waste associated with the process such as kieselguhr (diatomaceous earth used for clarifying).

Breweries do not discharge air pollutants other than some odors.

Pollution Prevention and Control

Pollution prevention and control is best practiced through effective management, maintenance and housekeeping of a process that incorporates water conservation and recycling, energy conservation, and disposal of solid wastes as by-products. Some options that may be considered include:

- use clean-in-place (CIP) methods for decontaminating equipment;
- use high pressure, low volume hoses for equipment cleaning;
- install recirculating systems on cooling water circuits;
- use grit, weed seed and grain from grain cleaning as chicken feed;
- dispose of spent grains as animal feed, either 80% wet or dry after evaporation;
- dispose of wet hops by adding them to the spent grains;
- dispose of spent hop liquor by mixing with spent grains;
- use spent yeast that is not reused for livestock feed;
- add trub to spent grains;
- recover spilled beer and add to spent grains that are being dried through evaporation;
- filter tank bottoms from final fermentation tanks and use as animal feed;
- reduce energy consumption through reuse of wort cooling water as the process water for the next mash
- send broken glass, bottles that cannot be used, and waste cardboard to recyclers

Consideration should be given to the use of non-phosphate containing cleaning agents.

Breweries have a favorable steam to electricity ratio and consideration should be given to inclusion of cogeneration in the design and operation of the brewery.

Treatment Technologies

Where the brewery does not discharge to a municipal sewer then primary and secondary treatment of the effluent is required. Primary treatment facilities may include: pH adjustment; roughing screens; grit settling chambers; and a clarifier. Choices of processes to remove BOD₅ in a secondary treatment stage include: anaerobic treatment followed by aerobic treatment and activated sludge systems.

Sludges from the clarifier are dewatered and disposed through incineration, or to an approved landfill.

Where the brewery is permitted to discharge to a municipal sewer, pretreatment may be required to meet municipal bylaws and/or to lessen the load on the municipal treatment plant. In some cases, sewer discharge fees imposed on effluent volume, and on the suspended and BOD₅¹ loads, by the municipality may encourage the brewery to install its own treatment facility.

Modern plants using good industrial practices are able to achieve the following in terms of pollutant loads: Water conservation and recycling will allow water consumption to be controlled to a minimum. A new brewery should target on achieving an effluent range of 3-5 m³/m³ beer produced. Provision for recycle of liquors and reuse of wash waters will help reduce the total volume of liquid effluent. A new brewery should target on achieving a treated effluent that has less than 0.3 kilograms (kg) of BOD₅/m³ beer produced and 0.3 kg of suspended solids/m³ beer produced (assumes discharge to receiving waters).

Odor emissions can be minimized if exhaust vapors are condensed before they are released to the atmosphere or if they are sent to the boiler and burned.

¹ Biochemical oxygen demand measured over 5 days.

Emission Guidelines

Emission levels for the design and operation of each project must be established through the Environmental Assessment (EA) process, based on country legislation and the *Pollution Prevention and Abatement Handbook* as applied to local conditions. The emission levels selected must be justified in the EA and acceptable to MIGA.

The following guidelines present emission levels normally acceptable to the World Bank Group in making decisions regarding provision of World Bank Group assistance, including MIGA guarantees; any deviations from these levels must be described in the project documentation.

The guidelines are expressed as concentrations to facilitate monitoring. Dilution of air emissions or effluents to achieve these guidelines is unacceptable.

All of the maximum levels should be achieved for at least 95% of the time that the plant or unit is operating, to be calculated as a proportion of annual operating hours.

Liquid Effluents

The following effluent levels should be achieved:

Effluents from Breweries

<i>Parameter</i>	<i>Maximum value milligrams per liter (mg/L)</i>
PH	6 - 9
BOD ₅	50
Chemical oxygen demand (COD)	250
Total suspended solids (TSS)	50
Oil and grease	10
Ammonia nitrogen (NH ₄ -N)	10
Phosphorus (P)	5
Temperature increase	Less than or equal to 3°C ¹

¹ The effluent should result in a temperature increase of no more than 3 degrees Celsius at the edge of the zone where

initial mixing and dilution takes place. Where the zone is not defined, use 100 meters from the point of discharge.

Note: Effluent requirements are for direct discharge to surface waters.

Ambient Noise

Noise abatement measures should achieve either the following levels or a maximum increase in background levels of 3 dB(A). Measurements are to be taken at noise receptors located outside the project property boundary.

Ambient Noise

Receptor	Maximum Allowable L _{eq} (hourly), in dB(A)	
	Daytime 07:00 - 22:00	Nighttime 22:00 - 07:00
Residential; institutional; educational	55	45
Industrial; commercial	70	70

The emission requirements given here can be consistently achieved by well-designed, well-operated and well-maintained pollution control systems.

Monitoring and Reporting

Monitoring of the final effluent for the parameters listed above should be carried out at least once per month, or more frequently if the flows vary significantly.

Monitoring data should be analyzed and reviewed at regular intervals and compared with the operating standards so that any necessary corrective actions can be taken. Records of monitoring results should be kept in an acceptable format. These should be reported to the responsible authorities and relevant parties, as required, and provided to MIGA if requested.

Key Issues

The following box summarizes the key production and control practices that will lead to compliance with emission requirements:

- Implement sound maintenance and housekeeping procedures.
- Minimize water consumption and effluent generation through recycle and reuse of process streams.
- Dispose of process solid wastes as by-products for animal feed.
- Send broken and reject bottles, and waste cardboard to recycling plants.
- Maintain effluent treatment facilities to operating design specifications.

Further Information

The following are suggested as sources of additional information (these sources are provided for guidance and are not intended to be comprehensive):

World Bank, Environment Department. 1997. "Industrial Pollution Prevention and Abatement: Breweries." Draft document.