

CONTROL TECHNOLOGY ASSESSMENT OF FERMENTATION PROCESSES

WALK-THROUGH SURVEY REPORT

OF

SCHOENLING BREWERY COMPANY  
CINCINNATI, OHIO

SURVEY CONDUCTED BY:  
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DATE OF SURVEY;  
August 10, 1982

REPORT WRITTEN BY:  
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NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH  
Division of Physical Sciences and Engineering  
General Industry Section  
Cincinnati, Ohio 45226

PURPOSE OF SURVEY: To investigate and evaluate Schoenling Brewery Company methods of controlling biohazards emerging from microbial reactions and the hazards posed by the products manufactured.

EMPLOYEE REPRESENTATIVES CONTACTED: Jeff Teetor, Union Representative  
Teamsters - Brewery Workers and Bottlers

EMPLOYER REPRESENTATIVES CONTACTED: J. Robert Piening, Assistant Brewmaster

STANDARD INDUSTRIAL CLASSIFICATION OF PLANT: 2082

ANALYTICAL WORK: None

## ABSTRACT

On August 10, 1982, a preliminary control technology assessment was conducted at the Schoenling Brewery Company, Cincinnati, Ohio. This company produces beer and cream ale by fermentation processes. Assessments were made during the survey of fermentation process engineering controls, industrial hygiene and medical monitoring, the use of personal protective equipment, and work practices. This company had not developed any organized safety and health, industrial hygiene, or medical programs. The report contains recommendations made to strengthen specific areas in order to minimize potential health and safety hazards.

## INTRODUCTION

The public debate over genetic engineering has focused on the possible hazards of genetically modified microorganisms, potential health hazards to workers involved with industrial applications of recombinant DNA techniques, and the potential uses of such technology. Several risk assessment experiments designed to investigate some of the characteristics of proposed host-vector systems which might affect hazard potential have been conducted. Likewise, the benefits of recombinant DNA technology are being as vigorously promoted.

The National Institute for Occupational Safety and Health (NIOSH) is responsible for conducting research, recommending occupational safety and health standards, providing technical assistance to workers and employers, and conducting training, and education programs. NIOSH's responsibility extends to both existing and emerging technology which might impact on worker health and safety. Thus, NIOSH is evaluating the potential occupational hazards involved with distinct applications of biotechnology and recombinant DNA techniques. NIOSH's interest in biotechnology encompasses innate, as well as genetically modified microorganisms, the biological products of these organisms, and the product extraction processes.

This particular research effort was prompted by the anticipated surge of recombinant DNA techniques in various industrial processes. Genetic engineering technology may be utilized in various manufacturing processes in the areas of agriculture, organic chemicals, energy, food processing, and pharmaceuticals. This potential growth and the possibility of uncharacterized occupational exposures indicate the necessity for careful evaluations of health risks. NIOSH is accustomed to examining new technologies for potential occupational hazards and developing recommendations for safeguarding the workers health. Implementation of safeguards and protective engineering controls early in the growth of an industry can only minimize human suffering and avoid expensive retrofitting of production systems.

Under the Occupational Safety and Health Act of 1970, Public Law 91-596, NIOSH was mandated and authorized to conduct research and health studies. Specifically, Section 20(a)7 states that NIOSH shall conduct and publish industry-

wide studies of the effect of chronic or low level exposure to industrial materials, processes, and stresses on the potential for illness, disease, or loss of functional capacity. Thus, this research is pursuant to the development of health standards applicable to a broad range of occupational environments.

In compliance with this mandate, the Engineering Control Technology Branch of the Division of Physical Sciences and Engineering is conducting a study to examine the engineering control techniques being utilized in fermentation processes. This study will attempt to identify effective controls applicable to processes involving potentially hazardous microorganisms, toxic processing chemicals, or biologically active products. Documentation of effective controls and recommendations to minimize exposure in the fermentation industry will be accomplished through this study.

This report contains results of this preliminary study, conclusions, and/or recommendations relevant to the operations at the Schoenling Brewery Company, a producer of beer and cream ale. The NIOSH survey team met with Mr. J. Robert Piening, who is the assistant brewmaster for the company, and Mr. Jeff Teetor, the union representative (Teamsters).

This survey was conducted as one of a series of initial preliminary surveys of firms involved in fermentation processes. Based on the information obtained during these walk-through studies, potential candidates for in-depth survey sites will be selected. The in-depth surveys will make more detailed evaluations of the engineering controls, personal protective equipment utilized, and employee work practices.

## COMPANY AND FACILITY DESCRIPTION

The Schoenling Brewery Company, having been in existence since 1934, is located within a 4-square city block area in downtown Cincinnati, Ohio. The company is independently owned and produces approximately 300,000 bbl/year of beer and cream ale (also limited quantities of 3.2% percent beer). A total of 130 people are employed at the facility, of which, 90 people are involved in production areas; the remaining employees work at administrative and clerical duties.

The company utilizes three workshifts in brew house operations and two in bottling, and other miscellaneous activities. The number of employees per workshift are as follows: one in the brew house; one involved with fermentation operations; two working with the filtration systems; two cleaning fermenting and storage tanks; eight working in racking and packaging operations; and one supervisor.

## PROCESS DESCRIPTION

The Schoenling Brewery Company utilizes premalted barley, a corn adjunct carbohydrate source, and hops (which impart the characteristic aroma and bitterness to beer) in the production of their beer and cream ale products. The malted barley is milled to expose the starches present in the grains. This milled malt is combined with water (termed the main malt mash) in a mash tub and allowed to steep for one hour to permit the activation of proteolytic enzymes. In a separate operation, the corn grits and a small amount of malt are mixed with water in an adjunct cooker. This cooker mash is brought to a boil to prompt the gelatinization of starch; the enzymes from the malt aid liquefaction and breakdown of the starches into dextrins.

The cooker mash is pumped into the main malt mash producing an increase in the temperature. During this temperature elevation,  $\alpha$ -amylase enzymes attack the starch molecules randomly breaking them into small molecular chain groups. Subsequently, these small chains are partially hydrolyzed by  $\beta$ -amylase enzymes removing maltose from the linear portions of the chains. What is not converted to fermentable sugars creates the flavor, body, and some of the calories present in beer. This final malt mash, called wort, is filtered utilizing a process resembling a sieve and conveyed into a brew kettle. The residual grain is sparged with water to displace remaining wort between particles, extract the dissolved solids, and bring the volume in the brew kettle to the appropriate level (200 bbl). Spent grains are transported to a facility that will convert them to cattle feed. The wort (along with the addition of the hops in three stages) is boiled in the brew kettle for one hour and then transferred to a hot wort tank where it is cooled by a heat transfer operation. Oxygen is added to the wort before being pumped into the fermenting tank to promote the multiplication of the yeast cell population.

A batch fermentation process is employed to convert the fermentable sugars to ethanol, carbon dioxide, and other minor by-products. The wort is transferred via pipe from the hot wort tank to the fermenting tank, while simultaneously being inoculated with a yeast stock culture (Saccharomyces uvarum). In the fermenting tank the yeast cells multiply until the dissolved oxygen supply has been depleted. The yeast then anaerobically ferments the available maltose,

glucose, and maltotriose saccharides to ethanol and carbon dioxide. After 12 to 18 hours of fermenting, recovery of the carbon dioxide is initiated. The gas is compressed and stored as a liquid to be later utilized in the recarbonation of the final beer product. Complete conversion of the fermentable sugars takes 5 to 7 days. The batch is cooled to approximately 32°C to produce a "young" beer. Cooling settles the yeast to the bottom of the fermenting tank where it can be recovered and used to inoculate other wort batches. The yeast is combined with cattle feed as a protein augmentor. The young beer is transferred to storage tanks from the fermenter to be cured for one to four weeks.

At the conclusion of the proper curing period, the beer passes through filters for final clarification and a chill proofing enzyme is added to prevent hazing. The final product is recarbonated and then bottled or put into kegs.



DESCRIPTION OF INDUSTRIAL HYGIENE, SAFETY,  
AND MEDICAL PROGRAMS

The company does not employ any industrial hygienists or medical personnel. No environmental monitoring has been conducted in the production areas. The company does have a safety officer who is responsible for safety concerns at the plant. Employees are provided with work clothes, safety glasses, ear plugs, and a clothing change and shower area. When handling ammonia, used in the refrigerant systems, gloves, and respirators are provided. Self-contained breathing apparatuses are available for emergency use.

All employees are required to take a pre-employment physical examination; however, there are no periodic medical evaluation updates. There is a physician on call from the Queensgate Medical Center and if a serious situation should arise, employees are taken to the Cincinnati General Hospital.

## EVALUATION OF THE PLANT CONTROLS AND PROGRAMS

There are limited chemical or biological hazards that employees can be subjected to in the manufacture of a beer product. There is no documented information concerning the biological hazard potential of brewers yeast available to warrant the use of special containment devices. However, there is a potential for those workers cleaning out the fermentor tanks, after the beer has completed its fermenting cycle, to be exposed to the carbon dioxide produced by the yeast in the sugar to alcohol conversion. The fermentor tanks are ventilated for approximately 1/2-hour with an exhaust system prior to the entrance of the tank cleaners. This system consists of a flexible "elephant trunk" duct attached to a stationary exhaust fan. The ductwork can access multiple tanks. The company does not test the fermentor for oxygen deficiency or elevated carbon dioxide levels to ensure that vessel entry is safe. Workers are expected to use their own judgement in evaluating the air quality inside the tanks. A "buddy" system is employed so that one man is available for assistance should the other become involved in a problem situation.

## CONCLUSIONS AND RECOMMENDATIONS

The Schoenling Brewery Company exhibits a relaxed attitude toward the development of detailed safety and health programs. The impetus for this attitude is the contention that employees are working with chemicals and viable organisms posing limited hazards in the occupational environment.

The carbon dioxide, produced by the yeast in the sugar to ethanol reaction, has the potential to create hazards in the workplace. The concentration of carbon dioxide in the blood affects the rate of breathing. Overexposure through inhalation may cause rapid breathing, rapid beating of the heart, headache, sweating, shortness of breath, dizziness, mental depression, visual disturbances, shaking, unconsciousness, and death. Personnel with cardiovascular or pulmonary disease may be at an increased risk when subjected to elevated levels. Since carbon dioxide has no odor, and no quantitative information is available relating its irritant effects to air concentrations, this gas has been treated as a material with poor warning properties.

To better protect the workers cleaning out the fermentation tanks, some form of carbon dioxide and oxygen deficiency detection device needs to be employed before entrance into the contaminated air space. All other controls adequately attenuate the hazards presented within this segment (breweries) of the fermentation industry. This plant is not a good candidate for an in-depth study.