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Category: 42 – Non-CTG Bakeries

STATE OF CALIFORNIA

M E M O R A N D U M

TO: TRG Members

DATE: APRIL 19, 1982

THRU: Bill Loscutoff, Chief
Industrial Strategy Development Branch

SUBJECT: VOC Emissions from Bakeries

From: Air Resources Board
David Craft

A. CONCLUSIONS AND RECOMMENDATIONS

State wide, 17 tons per day of ethanol are emitted from bakeries. The staff conducted a study of the 24 bakeries in California which each produce over 10,000 tons of bread per year. It is technically feasible to install carbon adsorbers to control emissions from the baking ovens and leavening rooms. Alternatively, exhaust gas recalculation and/or reconfiguration of the oven burners can reduce oven emissions. Further study is needed, however, to establish control equipment design criteria and to determine the economics of control. In particular, source testing of oven vents and leavening areas is needed.

B. EMISSIONS

In 1978, EPA developed estimates of emissions from bread production.[1] Ethanol is formed from the digestion of sugars by yeast as the bread is leavened, or raised, and baked. Source tests revealed that 77% of the total emissions originate from the oven while the breads are baking, and 23% are emitted from steps prior to baking, particularly the dough leavening process. Ninety-five percent of the total organic compound emissions are ethanol, while the remaining 5% are other alcohols and aldehydes.

The emission factors developed were:

$\left(\frac{0.5 \text{ lb EtOH}}{1000 \text{ lb bread}}\right)$ Straight dough process (chemically leavened using baking powder)

$\left(\frac{5.0 \text{ lb EtOH}}{1000 \text{ lb bread}}\right)$ Sponge dough process (yeast leavened)

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[1] Nonmethane Organic Emissions from Bread Producing Operations EPA-450/4-79-001, December 1978.

The sugar content generally ranges between 5-10%, and averages about 7%. However, the EPA emission factors were determined for breads having sugar contents of approximately 5%. Consequently, these emission factors may be low.

Emission estimates for five air basins were developed on the basis of per capita bread consumption and on the basis of actual bread production. A detailed breakdown of emissions by air basin is given in Figure A by population and Figure B by survey of large bakeries. The staff estimates that 17 tons per day, or 6300 tons per year, are emitted statewide from bakeries producing 10,000 tons of bread per year or more. A typical large bakery produces about 10,000 tons of bread per year and emits at least 100 tons of ethanol per year.

C. EMISSION CONTROL TECHNOLOGY

Possible control strategies are:

1) Carbon adsorption of exhaust gases from the leavening room and/or the baking oven;

2) Incineration of exhaust gases from the baking ovens by ducting them back to the baking oven burners; and

3) A combination of the above.

Ethanol recovery from the leavening room and the baking ovens is technically feasible with carbon adsorbers. Alternatively, separate carbon adsorbers could be used for the ovens and the leavening room. If a separate adsorber was used for the leavening room, the leavening room air could be continuously recycled through the adsorber. However, some drying of the leavening dough could occur. If drying occurs, the recycled air should be humidified. In addition, the recycle stream should also include a portion of fresh air.

It may be more cost-effective to reduce oven emissions by recirculating the oven exhaust gases to the oven burners to be incinerated. Partial control can be achieved by proper positioning of the oven burners. If the burners are positioned above the bread, the ethanol leaving the bread will naturally rise into the burner flame. Source testing is needed to determine the emission reductions which can be achieved for various burner arrangements and for exhaust gas recirculation.

Further source testing of both the leavening room and the baking ovens is needed to size and estimate the cost of control equipment.

Attachments

Attachment

FIGURE A

ETHANOL EMISSION ESTIMATES FROM BAKERY OPERATION, BASED ON POPULATION

Air Basin	1979 Population	VOC Emission Estimate [1] TPY	TPD
San Diego	1,805,648	570	1.56
Bay Area	4,980,566	1,571	4.31
South Coast	10,124,000	3,194	8.75
Sacramento Valley	1,358,124	428	1.17
San Joaquin Valley	1,888,153	592	1.63
Totals		6,354	17.4

[1] EPA Suggested Emission Factor: 0.631 lb. EtOH/person year

Sample Calculations (San Diego):

$$= (1{,}805{,}648 \text{ persons}) \times \left(\frac{0.631 \text{ lb EtOH}}{\text{person year}}\right) \times \left(\frac{1 \text{ ton}}{2{,}000 \text{ lb}}\right)$$

$$= 570 \text{ TPY} \times \left(\frac{1 \text{ year}}{365 \text{ days}}\right) = 1.56 \text{ TPD}$$

Attachment

FIGURE B

ETHANOL EMISSION ESTIMATES FROM BAKERY OPERATIONS BASED ON SURVEYS OF LARGE BAKERIES

By Facility/Air Basin —

Air Basin	No. of Large Bakeries	Tons of Bread Baked per Year	VOC [4, 5] Emissions TPY	TPD
San Diego	3	?	?	?
Bay Area [1]	6	163,500	817.5	3.24
South Coast	12	?	?	?
Sacramento Valley [2]	1	22,554	120.0	0.48
San Joaquin Valley [3]	2	35,100	176.0	0.70

[1] Data submitted by BAAQMD.

[2] Data submitted by Sacramento County APCD.

[3] Data submitted by Fresno County APCD.

[4] EPA Suggested Emission Factor:

$$\left(\frac{0.5 \text{ lb EtOH}}{1000 \text{ lb bread}}\right)$$

(assuming straight dough process, i.e., chemically leavened), and

$$\left(\frac{5.0 \text{ lb EtOH}}{1000 \text{ lb bread}}\right)$$

(assuming sponge dough process, i.e., yeast leavened)

The emission estimates were calculated assuming the sponge dough process. of the bakeries surveyed all use predominantly (if not exclusively) the sponge dough process.

[5] Assuming 252 operation days/year.