AP42 Section:	9.13.4
Title:	Comments and letters on Yeast Production from industry and contractor

Note: This material is related to a section in *AP42, Compilation of Air Pollutant Emission Factors, Volume I Stationary Point and Area Sources.* AP42 is located on the EPA web site at www.epa.gov/ttn/chief/ap42/

The file name refers to the file number, the AP42 chapter and then the section. The file name "rel01_c01s02.pdf" would mean the file relates to AP42 chapter 1 section 2. The document may be out of date and related to a previous version of the section. The document has been saved for archival and historical purposes. The primary source should always be checked. If current related information is available, it will be posted on the AP42 webpage with the current version of the section.

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Telephone (919) 677-024
FAX (919) 677-00E

Date: September 7, 1993

Subject: Section 6.13.4--Yeast Production
Food and Agriculture AP-42
EPA Contract 68-D2-0159, Work Assignment 05
MRI Project 3605

From: Tom Lapp
Robin Jones

To: Dallas Safriet
EPA/EIB/EFMS (MD-14)
U. S. Environmental Protection Agency
Research Triangle Park, N.C. 27711

Enclosed is a copy of the final background report and AP-42 Section 6.13.4, Yeast Production. The following discussion describes the manner in which the external review comments from Red Star Yeast were addressed.

Red Star Yeast felt that MRI had used the wrong response factor in converting the data from total VOC's as propane to total VOC's as ethanol. The conversion factor that was originally used to convert the data was 0.47 ppm propane per ppm ethanol. Red Star recommended a conversion factor of 0.65 based on data available from a manufacturer of a flame ionization detector (FID). After reviewing the data supplied by Red Star, it was found that MRI's conversion factor was correct. The conversion factor from Red Star was, in fact not a conversion factor but a response factor based on the interference of the OH group of ethanol and, therefore, did not account for the difference between the number of carbon atoms in propane and ethanol. When the number of carbon atoms also are taken into account, a conversion factor of 0.43 is calculated based on a response factor of 0.65 for ethanol. The conversion factor of 0.43 is essentially the same as the conversion factor of 0.47 previous used by MRI. Therefore, no changes were made to the data as a result of this comment.

A second comment from Red Star Yeast regarded the rating factor for the test reports obtained from Universal Foods Corporation. Red Star Yeast felt that the test reports should be rated a "B" rather than a "D". MRI believes that the data were rated properly because of the large variability in the emissions and the fact that the test data represent emissions from only one batch run. Therefore, the data ratings for the Red Star emission tests were not revised.

A third comment from Red Star Yeast suggested that a footnote be added to the emission factor table to state that site specific data should be used, if available, in lieu of the emission factors. The emission factor rating was poor (E) due to the high degree of variability in the emissions between facilities and between batches within a facility. We concur with this comment and added a note to Table 6.13.4-1 stating that facility-specific data should be used in lieu of the emission factors presented whenever possible.

In addition to the external review comments, MRI examined the possibility of adding emission factors for CO_2 emissions from the fermentation process. One possible methodology for calculating CO_2 emission factors is to base the factors on the VOC emission factors and the stoichiometric relationship between CO_2 and ethanol during anaerobic fermentation. In order to use this stoichiometric relationship it is necessary to determine the total amount of ethanol formed as a result of anaerobic fermentation. The total amount of ethanol formed is the sum of the amount of ethanol emitted via the stack and the amount of ethanol dissolved in the fermentor liquor. The ethanol emission factor can be used to determine the amount of ethanol emitted but the amount of ethanol present in the fermentor liquor will still need to be known. In the absence of any data on the ethanol concentration in the fermentor liquor, one can assume that the fermentor liquor is saturated with ethanol. Assuming saturation conditions, the amount of ethanol present in the fermentor liquor can be estimated. The combination of the batch emissions data and the estimate of the ethanol in the fermentor liquor provides an estimate of the total amount of ethanol formed due to anaerobic fermentation. In turn, an estimate of the amount of CO_2 generated can be obtained. Prior to developing a CO_2 emission factor, an assumption would need to be made regarding the amount of CO_2 remaining in the liquor versus that emitted via the stack. A conservative assumption would be that all the CO_2 generated is emitted.

A second alternative is to obtain CO_2 data from yeast manufacturing facilities. Red Star Yeast is the only plant that we are aware of that might be monitoring CO_2 data from the fermentor stacks. During a recent conversation with Mr. Alan Bahl of Red Star Yeast, we requested any CO_2 data that are available from the fermentors. Mr. Bahl stated that a limited amount of CO_2 data are available; he indicated that he will forward the available data when he returns from vacation sometime after the Labor Day weekend. As noted above, the VOC emission estimates showed a high degree of variability between facilities as well as between batches within a facility. This variation in emissions makes it unlikely that emission factors developed from CO_2 data from one facility would be representative of the industry.

Given the uncertainty involved in the first methodology and the current lack of any CO_2 data, MRI did not include CO_2 emission factors in the final report. However, we would like to meet with you to discuss this issue. We can delay the finalization of the document until the CO_2 estimating methodologies can be evaluated further and data are received from Red Star., if you believe establishing a CO_2 factor is necessary.

Enclosure

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September 7, 1993

Mr. Alan Bahl
Environmental Engineer
Red Star Yeast & Products
2100 Van Deman Street
Baltimore, MD 21224-6608

Dear Mr. Bahl:

I am writing in response to your comments on the draft AP-42 Section 6.13.4, Yeast Production, dated June 3, 1993 and our recent telephone conversation. I would like to thank you again for taking the time to comment on the report. The purpose of this letter is to inform you of our response to your comments. The following paragraphs present a summary of your comments and our responses.

Red Star Yeast felt that MRI had used the wrong conversion factor in converting the data measured as total VOC's as propane to total VOC's as ethanol. The conversion factor that was used by MRI to convert the data was 0.47 ppm propane per ppm ethanol. Red Star recommended a conversion factor of 0.65 based on data available from the manufacturer of a flame ionization detector (FID). An FID's response is essentially a function of the number of carbon atoms in a compound. However, the response is also affected by the types of bonds and the noncarbon atoms in the molecule. A conversion factor is based upon both the number of carbon atoms in the molecule relative to the calibration gas and the response factor for the carbon bonds. Table 1 presents the response factor information your company submitted from the instrument vendor. A response factor is a means of quantifying the interference associated with the type of carbon bonds and the noncarbon atoms in the compound and does not account for the difference between the number of carbon atoms between compounds. The response factor of 0.65 reported in Table 1 for ethanol is a measure of the amount of interference associated with the OH group in the compound and is not a measurement of the difference in the number of carbons between ethanol and propane. The lower response factor for ethanol means the carbon atoms in the ethanol have a lower response than expected because of the OH bond. However, the conversion factor used to convert data from total VOC's measured as propane to total VOC's reported as ethanol must account for the interference caused by the OH group (response factor) and the difference in the number of carbon atoms between

the two compounds. Therefore, the conversion factor for ethanol based on the reported response factor in Table 1 is as follows:

$$\text{ethanol} = \frac{\text{mole ethanol}}{10^6 \text{ mole gas}}$$

$$y\ \frac{\text{mole ethanol}}{10^6 \text{ mole gas}} = x \left(\frac{\text{moles propane, meas.}}{10^6 \text{ mole gas}}\right)\left(\frac{3 \text{ mole } C_{meas.}}{\text{moles propane, meas.}}\right)\left(\frac{\text{mole ethanol actual}}{2 \text{ mole } C_{meas.}}\right)$$

$$\left(\frac{1 \text{ mole } C_{actual}}{0.65 \text{ mole } C_{meas.}}\right)$$

$$= (X)\left(\frac{3}{2}\right)\left(\frac{1}{0.65}\right)\ \frac{mole\ ethanol}{10^6\ moles\ gas}$$

$$y = \frac{X}{0.43}$$

where:

y = ppm ethanol
x = ppm measured, as propane

The conversion factor of 0.43 ppm propane per ppm ethanol is approximately the same as 0.47 ppm propane per ppm ethanol used by MRI to convert the data. Therefore, no changes were made to the data as a result of this comment.

A second comment from Red Star Yeast regarded the rating factor for the test reports conducted by Universal Foods Corporation. Red Star Yeast felt that the test reports should be rated a "B" rather than a "D" because valid test methods were used to obtain the test data. Although valid test methods were used to obtain the test data, emissions were only measured over the course of one batch cycle. Given the knowledge that the emissions from the source are highly variable, it is important to measure emissions across multiple batch cycles in order to quantify the degree of variability in the emission estimates. Therefore, MRI believes that the data were rated properly because of the large variability in the emissions and the fact that the test data represent emissions from only one batch run. Therefore, the data ratings for the Red Star emission tests were not revised.

A third comment from Red Star Yeast suggested that a footnote be added to the emission factor table that stated that site specific data should be used, if available, rather than rely on the emission factors. The emission factor rating was poor (E) due to the high degree of variability in the emissions between facilities and different batches within a facility. We concur with this comment and added a note to Table 6.13.4-1 stating that

facility-specific data should be used in lieu of the emission factors whenever possible.

In conclusion, I would like to thank you for agreeing to submit any available data on carbon dioxide emissions from the fermentors. If you have any comments or additional concerns, please feel free to call me at (919) 677-0249, ext. 5351.

Sincerely,

Tom Lapp

for Robin Jones
Chemical Engineer

cc: Dallas Safriet
Tom Lapp
Roy Neulicht

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PACE ENVIRONMENTAL PRODUCTS
A Division of PACE Associates, Inc.

Hydrocarbon Response Factors
6/90

Component	Resp.-Factor JUM-1	Resp.-Factor JUM-2
Methane	1.02	1.04
Propane	1.00	1.00
Acetylene	0.92	0.94
n-Butane	0.98	0.98
n-Hexane	0.85	0.00
n-Heptane	0.91	0.95
iso-Ootane	0.99	0.98
cyclo-Hexane	0.93	0.94
Methanol	0.69	0.68
Ethanol	0.65	0.67
iso-Propanol	0.82	0.81
Benzene	1.05	1.05
Toluene	1.02	1.03
4-Ethyltoluene	0.88	0.89
p-Xylene	0.91	0.90
Acetone	0.72	0.73
Diethylether	0.75	0.77
Acetic Acid	0.58	0.55
Acetic Acid Ethylester	0.70	0.72
Acetic Acid Isobutylester	0.88	0.89
Dichlormethane	1.09	1.06
Chloroform	0.82	0.78
1, 1, 1,-Trichlorethane	1.06	1.02
Trichlorethane	1.03	1.01
Tetrachlorethene	1.22	1.20
Chlorbenzene	1.01	1.04
Number of Compounds	26	26
Average	0.903	0.903
Standard Tolerance	0.154	0.152

Data Compiled By :Tuff
Analyzer Type :Model VE-7
Fuel Type :100% H_2
Calibration Gas :Propane

RED STAR®

Received 7/19/93 RM

FEDERAL EXPRESS DELIVERY

July 8, 1993

Dallas W. Safriet
Emission Inventory Branch (MD-14)
U.S. Environmental Protection Agency
Research Triangle Park, NC 27711

RE: Section 6.13.4 Yeast Production Draft to AP-42

Dear Mr. Safriet:

Red Star Yeast appreciates the opportunity to participate in the drafting of the standards to be published in the supplement to AP-42. The following comments are presented based on the revised draft report from MRI dated June 3, 1993.

1. On page 15 of the report, the concentration of propane is converted to ethanol based on effective carbon content. Red Star researched this issue during discussions with various state environmental agencies throughout the U.S. The final resolution was provided by the manufacturer of the F.I.D.s which Red Star has purchased. J.U.M. Engineering stated that the method of conversion based on effective carbon was invalid. As the enclosed information states, the only valid method of determining the response factor is to perform laboratory testing of the compound of concern. As you can see, the conversion factor for the J.U.M. F.I.D. is 0.66 which is very different from the 0.47 noted in the report. Therefore, Red Star feels that the report should be changed to reflect this.

2. The report uses results from a few emission stack tests each of which MRI gives only a "D" rating. Red Star disagrees with this classification of its emission tests. The "D" rating is "...given to tests that are based on a generally unacceptable method..." However, MRI states that the proper methods were followed. Therefore, it seems that the data should be given a rating of "B." In addition, the Maryland Department of the Environment and the Wisconsin Department of Natural Resources have accepted these tests results as valid. MRI's contention that the results do not represent multiple runs in the same vessel is correct. However, the "D" rating does apparently not apply to these situations. Red Star is of the opinion that the emission tests are valid, as has been agreed to by the state agencies.

RED STAR® YEAST & PRODUCTS
A DIVISION OF UNIVERSAL FOODS CORPORATION
2100 VAN DEMAN STREET, HOLABIRD INDUSTRIAL PARK, BALTIMORE, MD 21224-6608
(410) 633-8575 FAX (410) 633-6481

3. As discussed in item 2., MRI believes that the emission factors are of poor quality primarily due to a lack of multiple testing of the same sources. However, in 6.13.4.5, the emission factors are presented without any note of this. This is very misleading to the persons who will have to use this guidance in the future. EPA must note in 6.13.4.5 that the emission factors were developed based on substandard data. EPA must also note that there is a tremendous amount of variation (up to 6000%) in the emissions from different fermenters and even in the different batches from the same fermenter. EPA must state that the emission factors are extremely unreliable and that any facility-specific information will provide far superior data.

Again, Red Star appreciates the opportunity to comment on this document. However, given the importance that AP-42 factors carry and the data that was used to develop the yeast production factors, Red Star believes that EPA should make several changes to the supplement.

If you have any questions, please don't hesitate to contact me at (410)633-8575.

Sincerely,

Alan Bahl

Alan Bahl
Environmental Engineer

PACE ENVIRONMENTAL PRODUCTS
A Division of PACE Associates, Inc.

FAX TRANSMITTAL

TO: Bill Krill
Universal Foods

FROM: Larry Pollack
PACE ENVIRONMENTAL PRODUCTS

DATE: December 13, 1991

Per your conversation with Larry Pollack, enclosed by fax is a list of the JUM Hydrocarbon Response Factors.

Should you have any further questions, please feel free to call.

Sincerely,

PACE ENVIRONMENTAL PRODUCTS

Myra Goldberg

Myra Goldberg

F03991.000

1196 Easton Road • Horsham, PA 19044 • (215) 957-1144 • FAX (215) 957-1186

PACE ENVIRONMENTAL PRODUCTS
A Division of PACE Associates, Inc.

Hydrocarbon Response Factors
6/90

Component	Resp.-Factor JUM-1	Resp.-Factor JUM-2
Methane	1.02	1.04
Propane	1.00	1.00
Acetylene	0.92	0.94
n-Butane	0.98	0.98
n-Hexane	0.85	0.00
n-Heptane	0.91	0.95
iso-Octane	0.99	0.98
cyclo-Hexane	0.93	0.94
Methanol	0.69	0.68
Ethanol	0.65	0.67
iso-Propanol	0.82	0.81
Benzene	1.05	1.05
Toluene	1.02	1.03
4-Ethyltoluene	0.88	0.89
p-Xylene	0.91	0.90
Acetone	0.72	0.73
Diethylether	0.75	0.77
Acetic Acid	0.58	0.55
Acetic Acid Ethylester	0.70	0.72
Acetic Acid Isobutylester	0.88	0.89
Dichlormethane	1.09	1.06
Chloroform	0.82	0.78
1, 1, 1,-Trichlorethane	1.06	1.02
Trichlorethane	1.03	1.01
Tetrachlorethene	1.22	1.20
Chlorbenzene	1.01	1.04
Number of Compounds	26	26
Average	0.903	0.903
Standard Tolerance	0.154	0.152

Data Compiled By :Tuff
Analyzer Type :Model VE-7
Fuel Type :100% H_2
Calibration Gas :Propane

PACE ENVIRONMENTAL PRODUCTS
A Division of PACE Associates, Inc.

FAX TRANSMITTAL

DATE: August 17, 1992

TO: Allen Bahl
Universal Foods Corp.

FROM: Pat Heacock

As per your conversation with Larry Pollack, enclosed, by fax, please find the German Cover Sheet and the Response Factors from the TUV Report. Enclosed also is a corrected circuit diagram for the PACE Model 1400.

The originals will also be sent to you by US Mail.

If you have any questions, please give us a call.

Sincerely,

PACE ENVIRONMENTAL PRODUCTS

Pat Heacock

Patricia Heacock

PH/s

Encl.

F04007.000

1196 Easton Road • Horsham, PA 19044 • (215) 957-1144 • FAX (215) 957-1186

TÜV Norddeutschland

B E R I C H T

über die Eignungsprüfung einer Meßeinrichtung für die Überwachung der Emissionen von organisch gebundenem Kohlenstoff (Gesamtkohlenstoff)

Im Auftrage der Firma

J.U.M. Engineering Ges.m.b.H.
Ingenieurgesellschaft für
Umweltschutz-Meßtechnik
Ingolstädter Str. 61p
8000 München 45

Inhaltsverzeichnis

Technischer Überwachungs-Verein
Norddeutschland e.V.

B E R I C H T

über die Eignungsprüfung einer Meßeinrichtung für die Überwachung der Emissionen von organisch gebundenem Kohlenstoff (Gesamtkohlenstoff)

Auftraggeber: Firma
J.U.M. Engineering Ges.m.b.H.
Ingenieurgesellschaft für
Umweltschutz-Meßtechnik
Ingolstädter Str. 61p
8000 München 45

Meßgerät: FID VE 7
Gesamtkohlenstoff-Analysator
0 - 25 [mg/m³]

Anlagenart: Müllverbrennungsanlage mit Naßwäscher

Untersuchungen: Nov. 1988 bis Juli 1990

Technischer Überwachungs-Verein Norddeutschland e.V.
Große Bahnstraße 31, 2000 Hamburg 54

Abteilung: Umweltschutz
Bericht-Nr.: 128CG01970
Bearbeiter: Dr.rer.nat. W.A. Redmann
Telefon: 040/8557-352

Hamburg, den 29. August 1990

TÜV Norddeutschland

Zusammenfassend ist festzustellen, daß die vorgefundenen Ergebnisse innerhalb der geforderten Standardabweichung von 15 % vom Mittelwert lt. Mindestanforderungen (1) liegen.

Zur Erweiterung des FID-Einsatzbereiches wurden zusätzlich weitere Response-Faktoren bestimmt und die Stoffliste entsprechend ergänzt.

Komponente	Resp.-Faktor JUM-1	Resp.-Faktor JUM-2
Methan	1,02	1,04
Propan	1,00	1,00
Acetylen	0,92	0,94
n-Butan	0,98	0,98
n-Hexan	0,85	0,86
n-Heptan	0,91	0,95
iso-Oktan	0,99	0,98
Cyclohexan	0,93	0,94
Methanol	0,69	0,68
Ethanol	0,65	0,67
iso-Propanol	0,82	0,81
Benzol	1,05	1,05
Toluol	1,02	1,03
4-Ethyltoluol	0,88	0,89
p-Xylol	0,91	0,90
Aceton	0,72	0,73
Diethylether	0,75	0,77
Essigsäure	0,58	0,55
Essigsäureethylester	0,70	0,72
Essigsäureisobutylester	0,88	0,89
Dichlormethan	1,09	1,06
Chloroform	0,82	0,78
1,1,1-Trichlorethan	1,06	1,02
Trichlorethen	1,03	1,01
Tetrachlorethen	1,22	1,20
Chlorbenzol	1,01	1,04
n	26	26
Mittelwert	0,903	0,903
Standardabweichung	0,154	0,152
rel. Standardabw. (%)	17,0	16,8