WISCONSIN DEPARTMENT OF NATURAL RESOURCES
NOTICE OF FINAL GUIDANCE & CERTIFICATION

Pursuant to ch. 227, Wis. Stats., the Wisconsin Department of Natural Resources has finalized and hereby certifies the following guidance document.

DOCUMENT ID

AM-19-0023

DOCUMENT TITLE

Calculating Emission Limits Set Forth in Section NR 415.05(1), Wis. Adm. Code

PROGRAM/BUREAU

Air Management

STATUTORY AUTHORITY OR LEGAL CITATION

Section 285.63, Wisconsin Statutes; Chapter NR 415, Wisconsin Administrative Code

DATE SENT TO LEGISLATIVE REFERENCE BUREAU (FOR PUBLIC COMMENTS)

September 23, 2019

DATE FINALIZED

October 21, 2019

No comments were received during the comment period 23SEP2019 to 14OCT2019

DNR CERTIFICATION

I have reviewed this guidance document or proposed guidance document and I certify that it complies with sections 227.10 and 227.11 of the Wisconsin Statutes. I further certify that the guidance document or proposed guidance document contains no standard, requirement, or threshold that is not explicitly required or explicitly permitted by a statute or a rule that has been lawfully promulgated. I further certify that the guidance document or proposed guidance document contains no standard, requirement, or threshold that is more restrictive than a standard, requirement, or threshold contained in the Wisconsin Statutes.

Gail E. Good

October 16, 2019

Signature

Date

DNR GUIDANCE DISCLAIMER

This document is intended solely as guidance and does not contain any mandatory requirements except where requirements found in statute or administrative rule are referenced. Any regulatory decisions made by the Department of Natural Resources in any matter addressed by this guidance will be made by applying the governing statutes and administrative rules to the relevant facts.

CORRESPONDENCE / MEMORANDUM STATE OF WISCONSIN

DATE: July 24, 1985 FILE REF: 4530-1

TO: Bureau and District Air Staff

FROM: Dean Packard - AM/3

SUBJECT: Calculating Emission Limits Set Forth in Section NR 415.05(1), Wis. Adm. Code

The emission limits set forth in sec. NR 415.05(1), Wis. Adm. Code are given in terms of pounds of particulate matter per 1,000 pounds of gas. This memo clarifies the Department's practice to consider the weight of the gas including water vapor and other gases at stack conditions unless the emission limit applicable to the source specifically identifies that "dry gas" is used in determining the allowable limit.

To simplify the calculation of the weight of the gas it is generally assumed that the density of the stack gas is the same as the density of air. If it is shown that stack gases differ significantly from air a correction involving the molecular weights of the stack gases and air should be made. The density of air at standard temperature (68^oF) and pressure 29.92 inches of Hg) is 0.075 lb/ft^3. To calculate the density of air at stack conditions the following equation is used:

$$\frac{68^oF + 460^oF}{S.T. + 460^oF} \times \frac{0.075\ lb}{ft^3} \times \frac{MW\ gas}{29} = \text{density of Air at S.C. in } \frac{lb}{ft^3}$$

S.T. = Stack Temperature in ^oF

M.W. = Molecular Weight (this is a correction for gases differing significantly from the molecular weight of air)

S.C. = Stack Conditions

It is assumed that the stack is at standard pressure. This is an assumption which will make very little difference in the actual weight of the air.

It is assumed that the stack gases have the same molecular weight as normal air. Obviously when the stack gas has constituents other than normal air using the molecular weight of air will give gas weights which are larger or smaller than the actual weight of the gas in the stack. The presence of $C0_2$ or $S0_2$ will increase the density slightly and the presence of H_20 vapor will decrease the density slightly. It is assumed that the stack gases have the same molecular weight as normal air.

English	SI (metric)
68^oF	20^oC
29.92 in Hg	
0.075 lb/ft^3	

The examples below indicate some typical stack gas compositions and their appropriate densities. These densities are compared with the density of dry air and a percent error is calculated.

The density of stack gas from a drying operation where the ratio of air:water is 9:1 is 4% less than the density of dry air. Therefore, an emission calculation based on the density of dry air will be 4% greater than the emissions calculated when based on the density of the actual stack gas.

The density of stack gas from a lime kiln where the ratio of air:water:$C0_2$ is 85:5:10 is 4% greater than the density of dry air. Therefore, an emission calculation based on the density of dry air will be 4% less than the emissions calculation when based on the density of the actual stack gas.

The density of stack gas from a coal fired process where the ratio of Air:Water:$C0_2$:$S0_2$ is 78:6:12:4 is 9.3% greater than the density of dry air. Therefore the emission estimate assuming the density of dry air will be 9.3% less than the emission estimate when the density of the actual stack gas is used.

Most of the time the error involved in using the density of dry air to calculate the weight of the exhaust gas will be in the $\pm$ 5% range. When $S0_2$ is present the error in calculating allowable emission could be as high as a minus 10%.

We have found that this degree of error is acceptable for preliminary review calculations for permits and plan reviews. When actual compliance is determined by source emission tests, the actual density of the stack gas is calculated and used to calculate the actual weight of gas. Therefore, the estimates which are made in preliminary determinations of permits and plan reviews do not affect the determination of actual compliance with the emission limitation when actually measured.

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Calculation of Various Gas Densities

The calculation of the density of various gas mixtures at standard conditions follows:

A. 100% Air

Density = 0.075 lb/scf

B. 100% H_20

$$\text{Density} = \frac{\text{lb-mole } H_20}{386.3 \text{ ft}^3}$$

386.3 ft^3 is the volume occupied by 1 lb-mole of a gas[1].
1 lb-mole H_20 = 18 lb.

$$\text{Density} = \frac{18 \text{ lb}}{386.3 \text{ ft}^3} = 0.047 \text{ lb/scf}$$

C. 100% $C0_2$

$$\text{Density} = \frac{44 \text{ lb}}{386.3 \text{ ft}^3} = 0.114 \text{ lb/scf}$$

D. 100% $S0_2$

$$\text{Density} = \frac{64 \text{ lb}}{386.3 \text{ ft}^3} = 0.166 \text{ lb/scf}$$

E. 90% Air, 10% CO_2 (by volume)

$$\text{Density mixture} = 0.9 \left(0.075 \frac{\text{lb}}{\text{scf}}\right) + 0.1 \left(0.114 \frac{\text{lb}}{\text{scf}}\right) = 0.079 \text{ lb/scf}$$

The error is +5.3%

F. 90% Air, 10% H_20 (by volume)

$$\text{Density mixture} = 0.9 \left(0.075 \frac{\text{lb}}{\text{scf}}\right) + 0.1 \left(0.047 \frac{\text{lb}}{\text{scf}}\right) = 0.072 \text{ lb/scf}$$

This is an error of 4%

[1]This is at standard conditions of 68°F and 29.92 inches Hg.

Gas Mixture Densities

G. 85% Air, 10% $C0_2$, 5% H_20 (by volume)

Density mixture = $0.85(0.075 \frac{lb}{scf}) + 0.1(0.114 \frac{lb}{scf}) + 0.05(0.047 \frac{lb}{scf})$

= 0.078 lb/scf

This is an error of 4%

H. 78% Air, 4% $S0_2$, 12% $C0_2$, 6% H_20 (by volume)

Density mixture = $0.78 (0.075 \frac{lb}{scf}) + 0.12 (0.114 \frac{lb}{scf}) + 0.04 (0.166 \frac{lb}{scf})$

$+ 0.06 (0.047 \frac{lb}{scf})$ = 0.082 lb/scf

This is an error of 9.3%

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