Note: This is a reference cited in *AP 42, 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 reference number, the AP42 chapter and section. The file name "ref02_c01s02.pdf" would mean the reference is from AP42 chapter 1 section 2. The reference may be from a previous version of the section and no longer cited. The primary source should always be checked.

AP-42 Section 7.1 File
Reference 10
5/83 version

PRIMARY
ALUMINUM PRODUCTION
AP-42 Section 7.1
Reference Number
11

REYNOLDS ALUMINUM

REYNOLDS METALS COMPANY • RICHMOND, VIRGINIA 23261

October 20, 1982

Mr. Arch MacQueen
Air Management Technology Branch (MD-14)
U. S. Environmental Protection Agency
Research Triangle Park, North Carolina 27711

Re: AP-42 Emission Factors
Prebake Primary Aluminum Plants

Dear Mr. MacQueen:

This letter is in response to our conversation of September 27, 1982, regarding emission factors which Reynolds Metals Company recently recommended to be included in the EPA document entitled "Compilation of Air Pollutant Emission Factors, Third Edition," commonly referred to as "AP-42". The recommended factors pertain to sulfur dioxide emissions from prebake primary aluminum plants. Pursuant to our conversation, the description of the "C", "S", and "K" variables included in the emission factors have been modified slightly. The revisions are included in Attachments 1 and 2. Attachment 3 includes sample calculations to demonstrate the use of the factors.

Attachment 1 describes the recommended factor for calculating the total sulfur dioxide emission rate from a prebake aluminum reduction plant. These emissions include those which are emitted during the anode baking process and during the electrolytic reduction of aluminum oxide (alumina) to aluminum. The emission factor indicates that the total sulfur dioxide emissions are primarily dependent on two variables. These variables include the percentage of sulfur contained in the unbaked electrolytic anode ("S") and the amount of anode consumed during electrolysis expressed as pounds per pound of aluminum produced ("C").

The electrolytic anode used in the aluminum reduction process is produced by mixing petroleum coke and pitch binder in suitable proportions so as to produce a paste. This paste is then press-formed into the final shape of an anode. After insertion of a steel electrical bus bar, the anodes are baked at a high temperature for a period of time sufficient to produce the desired product. Both the petroleum coke and the pitch binder used in producing the anode paste contain small amounts of sulfur. When the amounts of coke and pitch used to make an anode, as well as the sulfur content of each constituent, are known, the percentage of sulfur contained in the unbaked anode can be calculated directly. In determining sulfur dioxide emissions, an assumption is made that all sulfur contained in the consumed anode is volatilized during the electrolytic process to form sulfur dioxide.

The values of "S" and "C" are variable from company-to-company and even from plant-to-plant. However, their values usually can be reasonably estimated for a given plant by using data supplied by coke and pitch suppliers and by incorporating historical plant data which indicate production rates and anode consumption rates.

AP-42 currently lists emission factors for uncontrolled sulfur dioxide emissions from anode baking furnaces (1.4-4 lb/ton) and prebake reduction cells (60.0 lb/ton). These factors indicate that the sulfur dioxide emissions from the anode bake plant represent 2.3 to 6.3 percent of total plant uncontrolled sulfur dioxide emissions. Reynolds believes that, based on previous data, the anode bake plant emissions may represent as much as 20 percent of the total plant emissions. In any event, it is important to realize that the proportion of anode bake plant emissions relative to total plant emissions will also likely vary from company-to-company and from plant-to-plant. Therefore, if a breakdown of total sulfur dioxide emission is desired so as to distinguish between anode bake plant and reduction cell emissions, Reynolds recommends the emission factors included in Attachment 2 as an appropriate means of approximation. By using these factors, a plant can utilize historical data and other previous experience to assign a realistic value to "K" for the particular plant in question. This procedure provides for sufficient flexibility in determining anode bake plant and reduction cell emissions as is necessary to accommodate industry-wide fluctuations in their respective proportions to total plant emissions.

Reynolds believes that, in the absence of source sampling data, emission factors represent a valid means of reasonably estimating current or anticipated emissions from a facility. However, it must be recoginized that oftentimes there are a number of factors, both controllable and uncontrollable, which may affect emission quantities from a given source. Therefore, it is desirable to pinpoint the most influential of these factors, and where possible, incorporate them in the process of estimating emissions. Reynolds further believes that the emission factors shown in Attachments 1 and 2 accomplish this goal and provide a potential user with a relatively simple and accurate means of estimating sulfur dioxide emissions from prebake primary aluminum plants.

I am, of course, available to provide additional information or answer any further questions you may have regarding this matter. Please do not hesitate to contact me at (804) 281-2788 if I can be of any further assistance.

Very truly yours,

T. F. Albee

T. F. Albee
Environmental Engineer
Environmental Control Department

Copy: R. G. Rhoads - EPA
L. C. Tropea, Jr. - RMC

Attachments

/plb

Attachment I

Calculation of Total Sulfur
Dioxide Emission Rate from Prebake
Aluminum Reduction Plant

Total Uncontrolled $SO_2$ Emissions[(1)] = C(2000) x S(.01)(2)

= 40(C)(S) lb/ton

= 20(C)(S) kg/Mg

Where,

C = Anode consumption, during electroylsis lb. anode consumed/lb Al produced

S = Percent sulfur in anode before baking

[(1)]Does not account for fuel burning emissions.

## Attachment 3

Sample calculations for
Prebake Aluminum Reduction Plant
Emission Factors

1. Determine "S"

   From coke supplier, coke sulfur content = 4%
   From pitch supplier, pitch sulfur content = 1%

   Desired anode mix established by plant management = 85% coke, 15% pitch

   therefore,
   $S = 0.85(4) + 0.15(1)$
   $S = 3.55\%$

2. Determine "C"

   From plant production records,

   0.5 lb anode required per lb aluminum produced

3. Determine total uncontrolled $SO_2$ emissions

   $E = C(2000) \times S(.01)(2) = 71.0$ lb/ton

4. Determine "K"

   From historical plant data or company experience,

   80% of total sulfur dioxide emissions are emitted from reduction cells.
   Remainder, 20%, are emitted from anode bake plant.

   $K = 80\%$

5. Determined uncontrolled $SO_2$ emissions from the anode bake plant

   $E = 40(C)(S)1-.01K) = 14.2$ lb/ton

6. Determine uncontrolled $SO_2$ emissions from the prebake reduction cells

   $E = 0.4(C)(S)(K) = 56.8$ lb/ton

7. Check

   $14.2 + 56.8 = 71.0$