Environmental Protection Agency

§98.83 Calculating GHG emissions.

You must calculate and report the annual process CO₂ emissions from each kiln using the procedure in paragraphs (a) and (b) of this section.

(a) For each cement kiln that meets the conditions specified in §§98.33(b)(4)(ii) or (b)(4)(iii), you must calculate and report under this subpart the combined process and combustion CO₂ emissions by operating and maintaining a CEMS to measure CO₂ emissions according to the Tier 4 Calculation Methodology specified in §§98.33(a)(4) and all associated requirements for Tier 4 in subpart C of this part (General Stationary Fuel Combustion Sources).

(b) For each kiln that is not subject to the requirements in paragraph (a) of this section, calculate and report the process and combustion CO₂ emissions from the kiln by using the procedure in either paragraph (c) or (d) of this section.

(c) Calculate and report under this subpart the combined process and combustion CO₂ emissions by operating and maintaining a CEMS to measure CO₂ emissions according to the Tier 4 Calculation Methodology specified in §§98.33(a)(4) and all associated requirements for Tier 4 in subpart C of this part (General Stationary Fuel Combustion Sources).

(d) Calculate and report process and combustion CO₂ emissions separately using the procedures specified in paragraphs (d)(1) through (d)(4) of this section.

(1) Calculate CO₂ process emissions from all kilns at the facility using Equation H–1 of this section.
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\[ CO_{2\text{CMF}} = \sum_{m=1}^{k} CO_{2\text{Clim,m}} + CO_{2\text{rm}} \]  

(Eq. H-1)

Where:

- \(CO_{2\text{CMF}}\) = Annual process emissions of \(CO_2\) from cement manufacturing, metric tons.
- \(CO_{2\text{Clim,m}}\) = Total annual emissions of \(CO_2\) from clinker production from kiln \(m\), metric tons.
- \(CO_{2\text{rm}}\) = Total annual emissions of \(CO_2\) from raw materials, metric tons.

- \(k\) = Total number of kilns at a cement manufacturing facility.

(2) \(CO_2\) emissions from clinker production. Calculate \(CO_2\) emissions from each kiln using Equations H–2 through H–5 of this section.

\[ CO_{2\text{Clim}} = \sum_{j=1}^{p} \left[ (Cli_{j}) \times \left( EF_{\text{Clim,j}} \right) \times \frac{2000}{2205} \right] + \sum_{i=1}^{r} \left[ (CKD_{i}) \times \left( EF_{\text{CKD,i}} \right) \times \frac{2000}{2205} \right] \]  

(Eq. H-2)

Where:

- \(Cli_{j}\) = Quantity of clinker produced in month \(j\) from kiln \(m\), tons.
- \(EF_{\text{Clim,j}}\) = Kiln specific clinker emission factor for month \(j\) for kiln \(m\), metric tons \(CO_2\)/metric ton clinker computed as specified in Equation H–3 of this section.
- \(CKD_{i}\) = Cement kiln dust (CKD) not recycled to the kiln in quarter \(i\) from kiln \(m\), tons.
- \(EF_{\text{CKD,i}}\) = Kiln specific CKD emission factor for quarter \(i\) from kiln \(m\), metric tons \(CO_2\)/metric ton CKD computed as specified in Equation H–4 of this section.

- \(p\) = Number of months for clinker calculation, 12.
- \(r\) = Number of quarters for CKD calculation, 4.
- \(2000/2205\) = Conversion factor to convert tons to metric tons.

(i) Kiln-Specific Clinker Emission Factor. (A) Calculate the kiln-specific clinker emission factor using Equation H–3 of this section.

\[ EF_{\text{Clim}} = (Cli_{\text{CaO}} - Cli_{\text{ncCaO}}) \times MR_{\text{CaO}} + (Cli_{\text{MgO}} - Cli_{\text{ncMgO}}) \times MR_{\text{MgO}} \]  

(Eq. H-3)

Where:

- \(Cli_{\text{CaO}}\) = Monthly total CaO content of Clinker, wt-fraction.
- \(Cli_{\text{ncCaO}}\) = Monthly non-calcined CaO content of Clinker, wt-fraction.
- \(MR_{\text{CaO}}\) = Molecular-weight Ratio of \(CO_2\)/CaO = 0.785.
- \(Cli_{\text{MgO}}\) = Monthly total MgO content of Clinker, wt-fraction.
- \(Cli_{\text{ncMgO}}\) = Monthly non-calcined MgO content of Clinker, wt-fraction.
- \(MR_{\text{MgO}}\) = Molecular-weight Ratio of \(CO_2\)/MgO = 1.092.

(B) Non-calcined CaO is CaO that remains in the clinker in the form of CaCO\(_3\) and CaO in the clinker that entered the kiln as a non-carbonate species. Non-calcined MgO is MgO that remains in the clinker in the form of MgCO\(_3\) and MgO in the clinker that entered the kiln as a non-carbonate species.

(ii) Kiln-Specific CKD Emission Factor. (A) Calculate the kiln-specific CKD emission factor for CKD not recycled to the kiln using Equation H–4 of this section.

\[ EF_{\text{CKD}} = (CKD_{\text{CaO}} - CKD_{\text{ncCaO}}) \times MR_{\text{CaO}} + (CKD_{\text{MgO}} - CKD_{\text{ncMgO}}) \times MR_{\text{MgO}} \]  

(Eq. H-4)
Where:

\( \text{CKD}_{\text{CaO}} \) = Quarterly total CaO content of CKD not recycled to the kiln, wt-fraction.
\( \text{CKD}_{\text{CaO}} \) = Quarterly non-calcined CaO content of CKD not recycled to the kiln, wt-fraction.
\( \text{MR}_{\text{CaO}} \) = Molecular-weight Ratio of CO\(_2\)/CaO = 0.785.
\( \text{CKD}_{\text{MgO}} \) = Quarterly total MgO content of CKD not recycled to the kiln, wt-fraction.
\( \text{CKD}_{\text{MgO}} \) = Quarterly non-calcined MgO content of CKD not recycled to the kiln, wt-fraction.
\( \text{MR}_{\text{MgO}} \) = Molecular-weight Ratio of CO\(_2\)/MgO = 1.092.

(B) Non-calcined CaO is CaO that remains in the CKD in the form of CaCO\(_3\) and CaO in the CKD that entered the kiln as a non-carbonate species. Non-calcined MgO is MgO that remains in the CKD in the form of MgCO\(_3\) and MgO in the CKD that entered the kiln as a non-carbonate species.

(3) CO\(_2\) emissions from raw materials. Calculate CO\(_2\) emissions using Equation H-5 of this section:

\[
\text{CO}_{2,\text{rm}} = \sum_{i=1}^{M} \text{rm}_i \times \text{TOC}_{\text{rm}} \times \frac{44}{12} \times \frac{2000}{2205} \quad (\text{Eq. H-5})
\]

Where:

\( \text{rm}_i \) = The amount of raw material \( i \) consumed annually, tons/yr (dry basis).
\( \text{CO}_{2,\text{rm}} \) = Annual CO\(_2\) emissions from raw materials.
\( \text{TOC}_{\text{rm}} \) = Organic carbon content of raw material \( i \) (dry basis), as determined in §98.84(c) or using a default factor of 0.2 percent of total raw material weight.
\( M \) = Number of raw materials.
\( \frac{44}{12} \) = Ratio of molecular weights, CO\(_2\) to carbon.
\( \frac{2000}{2205} \) = Conversion factor to convert tons to metric tons.

(4) Calculate and report under subpart C of this part (General Stationary Fuel Combustion Sources) the combustion CO\(_2\) emissions from the kiln according to the applicable requirements in subpart C.

§98.84 Monitoring and QA/QC requirements.

(a) You must determine the weight fraction of total CaO and total MgO in CKD not recycled to the kiln by each kiln using ASTM C114-09, Standard Test Methods for Chemical Analysis of Hydraulic Cement (incorporated by reference, see §98.7). The monitoring must be conducted quarterly for each kiln from a CKD sample drawn either as CKD exiting the kiln or from bulk CKD storage.

(b) You must determine the weight fraction of total CaO and total MgO in clinker from each kiln using ASTM C114-07 Standard Test Methods for Chemical Analysis of Hydraulic Cement (incorporated by reference, see §98.7). The monitoring must be conducted monthly for each kiln from a clinker sample drawn from bulk clinker storage.

(c) The total organic carbon contents (dry basis) of each raw material must be determined annually using ASTM C114-09 Standard Test Methods for Chemical Analysis of Hydraulic Cement (incorporated by reference, see §98.7) or a similar industry standard practice or method approved for total organic carbon determination in raw mineral materials. The analysis must be conducted on sample material drawn from bulk raw material storage for each category of raw material (i.e., limestone, sand, shale, iron oxide, and alumina). Facilities that opt to use the default total organic carbon factor provided in §98.83(d)(3), are not required to monitor for TOC.

(d) The quantity of clinker produced monthly by each kiln must be determined by direct weight measurement using the same plant instruments used for accounting purposes, such as weigh hoppers or belt weigh feeders.

(e) The quantity of CKD not recycled to the kiln by each kiln must be determined quarterly by direct weight measurement using the same plant instruments used for accounting purposes, such as weigh hoppers, truck weigh scales, or belt weigh feeders.