Latest Progress in IPCC Methodology for Estimating the Extent of PFC Greenhouse Gases Co-evolved in the Aluminium Reduction Cell and Challenges in Reducing these Emissions

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Abstract

In recent years, the primary aluminium industry has increasingly found that perfluorocarbon (PFC) greenhouse gases can be co-evolved in reduction cells during normal operation, i.e. without an anode effect (AE) that is typically defined as when cell voltage exceeds 8 V. Other than during an AE, PFC co-evolution rates are invariably low. However, because of the long duration of these 'low voltage' emissions they can contribute as much than 90 % of a smelter's total PFC output, depending on cell technology, practices and operating conditions. These emissions help explain some of the discrepancy between 'top-down' global atmospheric estimates of PFCs vs. 'bottom-up' industry estimates via the International Aluminium Institute (IAI). To provide a more complete estimate of total greenhouse gas emissions, the Intergovernmental Panel for Climate Change (IPCC) is updating its PFC accounting guidelines for the aluminium industry, covering both anode effect and low voltage emissions – respectively termed 'high voltage anode effect' (HVAE) and 'low voltage anode effect' (LVAE) emissions in the guidelines. The following paper summarises some of the latest progress in this. While the updated 2019 IPCC Refinements provides an important first step in estimating all PFCs co-evolved in the aluminium reduction cell, this paper also explores some of the challenges that remain – firstly in finding a more scientific basis to estimate low voltage PFCs for future IPCC methodologies; and secondly but more importantly, for smelters to determine strategies to detect and mitigate low voltage emissions when they occur.

Keywords: Perfluorocarbons, greenhouse gas emissions, IPCC methodology, anode effect PFCs, low voltage PFCs.

1. Introduction

This article discusses the latest progress and challenges in the global effort to account for PFCs from aluminium smelting, particularly with the inclusion of low voltage PFCs (termed 'low-voltage anode effects' or LVAEs) in updated greenhouse gas (GHG) accounting guidelines from the Intergovernmental Panel for Climate Change (IPCC). It follows on from a detailed investigation of the fundamental mechanisms and underlying causes of all PFC coevolution – from anode effects (AEs) and during 'normal' cell operations (low voltage PFCs) in two ICSOBA articles by Welch et al. ("Part 1" and "Part 2") [1 - 2]. Part 2 in particular describes the impact of changes in cell design that have resulted in low-voltage PFCs becoming more prevalent in modern aluminium reduction cells.