

BS ISO 14388-1:2014



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Soil quality — Acid-base accounting procedure for acid sulfate soils

Part 1: Introduction and definitions, symbols and acronyms, sampling and sample preparation

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National foreword

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The UK participation in its preparation was entrusted to Technical Committee EH/4, Soil quality.

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Soil quality — Acid-base accounting procedure for acid sulfate soils —

Part 1: Introduction and definitions, symbols and acronyms, sampling and sample preparation

*Qualité de l'eau — Méthode de comptage acide-base pour les sols
sulfatés acides —*

*Partie 1: Introduction et définitions, symboles et acronymes,
échantillonnage et préparation des échantillons*



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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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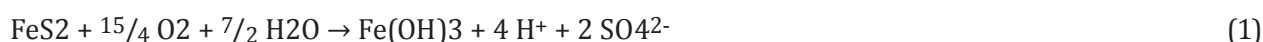
The committee responsible for this document is ISO/TC 190, *Soil quality*, Subcommittee SC 3, *Chemical methods and soil characteristics*.

ISO 14388 consists of the following parts, under the general title *Soil quality — Acid-base accounting procedure for acid sulfate soils*:

- *Part 1: Introduction and definitions, symbols and acronyms, sampling and sample preparation*
- *Part 2: Chromium reducible sulfur (CRS) methodology*
- *Part 3: Suspension peroxide oxidation combined acidity and sulfur (SPOCAS) methodology*

Introduction

Acid sulfate soils are a complex group of predominantly low-lying coastal soils and sediments that contain iron sulfides and/or their oxidation products. Typically, the sulfide present is pyrite (FeS_2); though in some instances, iron ‘monosulfides’ can be important. Acid sulfate soils are most prevalent in tropical and sub-tropical regions, but also occur in temperate and sub-arctic regions. When maintained in reduced and waterlogged conditions, the pyrite and other sulfides in these soils will not oxidize; and when they are in this state, the soils are generically termed potential acid sulfate soils. When these soils are exposed by whatever mechanism of disturbance to atmospheric and dissolved oxygen, the sulfides they contain oxidize to sulfate and ferric ions, producing acid at the same time. The complete oxidation of pyrite by oxygen is generally represented by Formula (1):



However, the oxidation of pyrite does not always go to completion in the short-term, with oxidation products other than ferric hydroxide and sulfuric acid often forming. The iron hydroxy-sulfate mineral *jarosite* [$\text{KFe}_3(\text{SO}_4)_2(\text{OH})_6$], can be a conspicuous product of the oxidation process in acid sulfate soil. These oxidation products, as well as other metal ions from the soil (e. g. aluminium) that are dissolved by the acid can have deleterious environmental, agronomic, and economic impacts. Where the pH of these soils falls to 4 or below (as a consequence of sulfide oxidation), they are generically termed actual acid sulfate soils (AASS). When potential acid sulfate soil contains carbonate or other minerals with an acid neutralizing capacity (ANC) (e. g. calcite in the form of finely divided shell material), they cannot become acidic when they oxidize.

Because of the many possible complex chemical reactions, the characterization of acid sulfate soils using analytical methods can be a complex process, but accurate characterization is crucial to the management of these soils. Chemical analysis provides the data necessary to assess the acid-producing potential of these soils. From these data, acid-base accounting can be used to determine the dosing rate of alkaline ameliorants needed to fully treat any net acidity. Once dosed accordingly, these soils should not generate acidity, thereby minimizing potential adverse impacts on the environment and/or infrastructure.

Conceptually, the best way to assess the acid-producing potential of these soils is through an ‘acid-base accounting’ (ABA) procedure, whereby the ‘potential sulfidic acidity’, ‘existing acidity’, and ‘acid neutralizing capacity’ (ANC) are quantified. These components of the acid-base account can be determined separately by the various methods of test in this series of ISO 14388. Once the individual components are determined, the net acidity can be calculated as:

$$\text{Net acidity} = \text{Potential sulfidic acidity} + \text{Existing acidity} - \text{ANC}$$

A number of approaches exist for the determination of ‘potential sulfidic acidity’ (i. e. the acidity that can be generated by the oxidation of sulfides). The sulfide content can be measured by either reduction methods (e. g. chromium reducible sulfur S_{CR}) or oxidation methods (e. g. peroxide oxidizable sulfur S_{POS}). The sulfidic acidity generated by these soils can then be calculated from the sulfide content determined. Alternatively, the potential sulfidic acidity can be measured directly by titration, following accelerated oxidation of the sulfides with hydrogen peroxide, [e. g. titratable sulfidic acidity (TSA)].

Existing acidity might be present in the soil as a result of previous oxidation of sulfides. If this acidity is in exchangeable and/or soluble forms, it is termed ‘actual acidity’. It is measured by titrating a 1 mol/l potassium chloride (KCl) soil suspension to pH 6,5 and is termed ‘titratable actual acidity’ (TAA). Soil suspensions with $\text{pH}_{\text{KCl}} \geq 6,5$ are deemed to have no actual acidity. Additional existing acidity can also reside in sparingly soluble iron and aluminium hydroxy-sulfate phases such as jarosite. This component of the existing acidity is termed ‘retained acidity’. It can be estimated by determining net acid-soluble sulfur (SNAS) or residual acid-soluble sulfur (SRAS); it is usually measured on soil with a $\text{pH}_{\text{KCl}} < 4,5$, and/or where jarosite has been identified.

If a soil has a $\text{pH}_{\text{KCl}} > 6,5$, it can contain some ANC (e. g. in the form of CaCO_3 from shell). The ANC can be determined by various methods [e. g. inorganic carbon (C_{IN}), using a combustion furnace, or acid digestion followed by titration of unreacted acid (ANC_{BT})].

These individual components can be combined into analytical suites that streamline the process of acid-base accounting. [Figure 1](#) shows the possible options to take for the analysis of acid sulfate soils. The two principal analytical suites, the chromium suite and the SPOCAS suite are conceptualized in [Figures 2](#) and [3](#) respectively.

The chromium suite combines the measurement of S_{CR} with various measures of existing acidity and ANC using a decision-tree based on the value of pH_{KCl} . In soils where $pH_{KCl} > 6,5$, and hence there is a chance of ANC being present, ANC can be estimated by various methods such as (C_{IN}) analysis and ANC by back titration (ANC_{BT}). Where $pH_{KCl} < 6,5$, the soil contains existing acidity. This can be measured by TAA. If $pH_{KCl} < 4,5$, the soil can also contain retained acidity in addition to the actual acidity. The retained acidity can be determined as S_{NAS} in accordance with ISO 14388-2, using the decision-tree approach ([Figure 2](#)). In this manner, a full acid-base account can be made of the soil. In many instances, a S_{CR} measurement by itself does not constitute a proper acid-base account.

The Suspension Peroxide Oxidation Combined Acidity and Sulfur (SPOCAS) method combines the calculation of S_{PO5} and TSA with measurement of alkali cations (calcium and magnesium) solubilised by the peroxide digest. In soils where acid neutralizing capacity exceeds the potential acidity of sulfides present (i. e. soils are 'self-neutralizing'), a titration using hydrochloric acid can be performed to quantify this excess acid neutralizing capacity (ANC_E). The complete SPOCAS method also measures existing acidity in the form of TAA and estimates retained acidity held in sparingly soluble iron and aluminium minerals from the measurement of S_{RAS} in the soil residue remaining after peroxide digestion.

The 'SPOCAS' suite uses the SPOCAS method as the basis for determining an acid-base account. Like the chromium suite, a decision-tree type process is followed ([Figure 3](#)). Various components of soil acidity and/or alkalinity are determined, depending on pH. Once the decision-tree process is completed, the various components can be used to calculate an acid-base account.

The chromium suite approach has the advantage of being a cheaper and faster suite of analyses, and is better at estimating sulfide content at low levels and/or in highly organic samples, whereas the SPOCAS suite gives a more complete set of data (e. g. including alkali cations), allowing greater interpretation of what is occurring in a soil or soil profile.

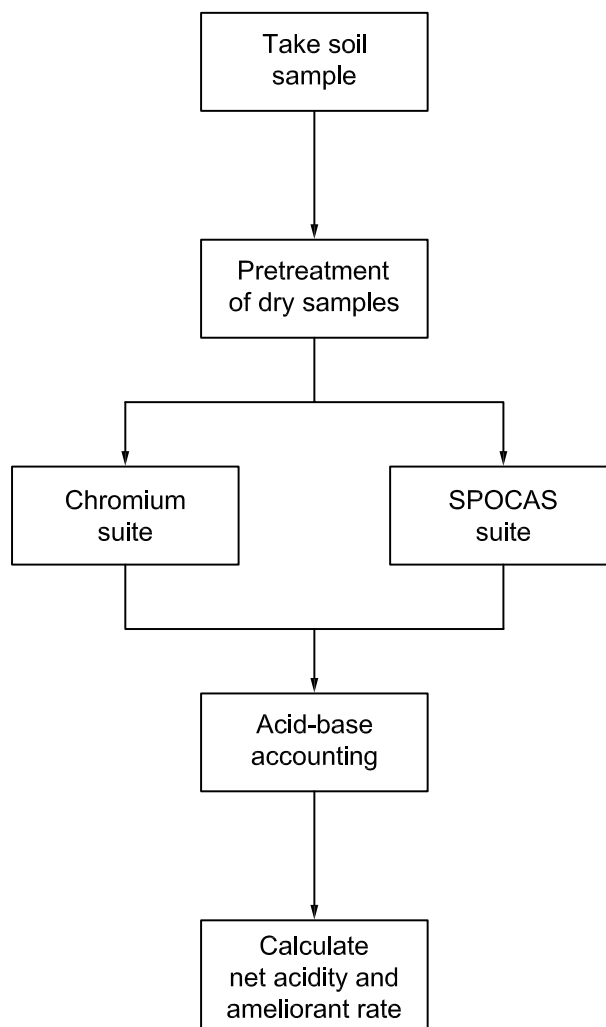
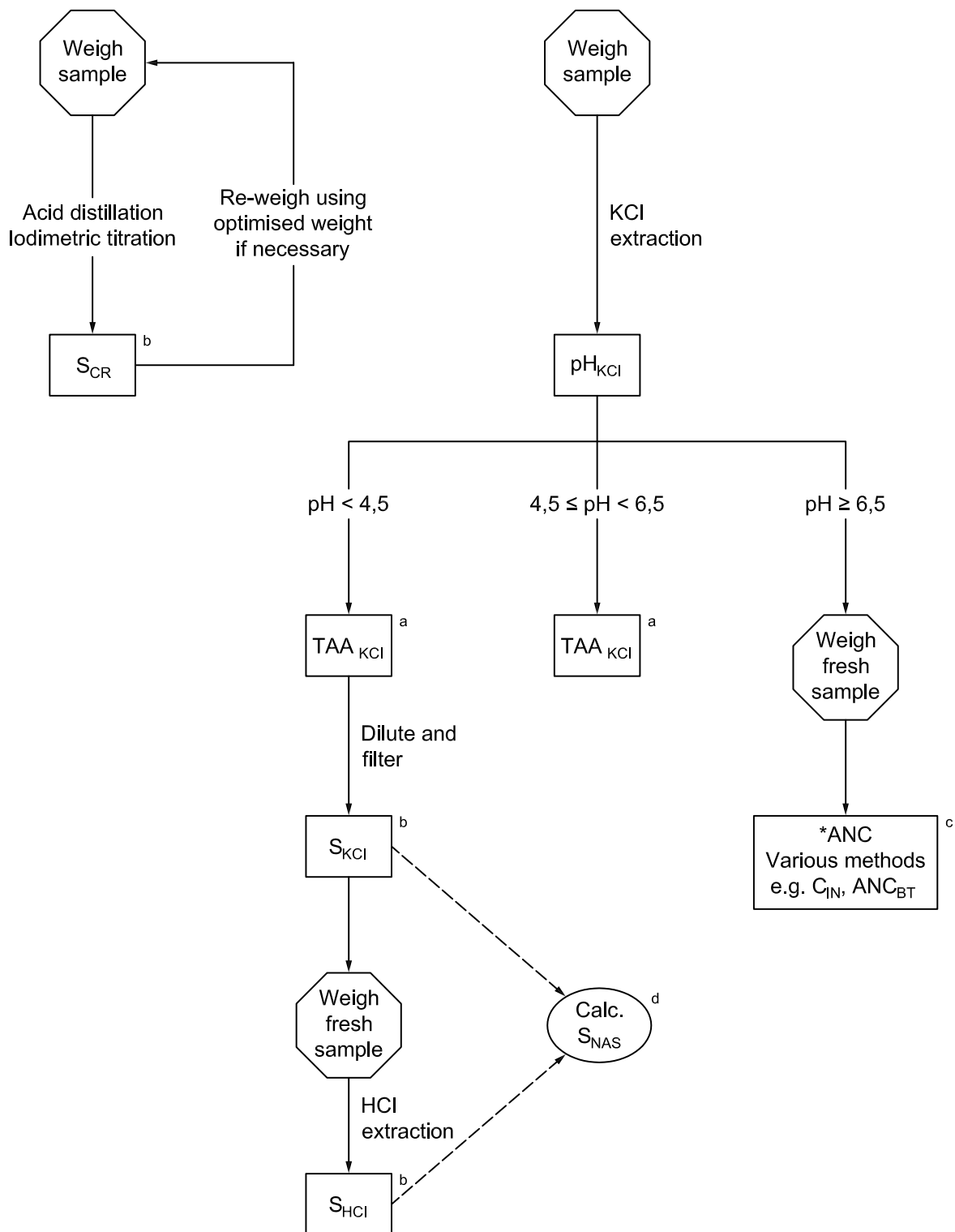


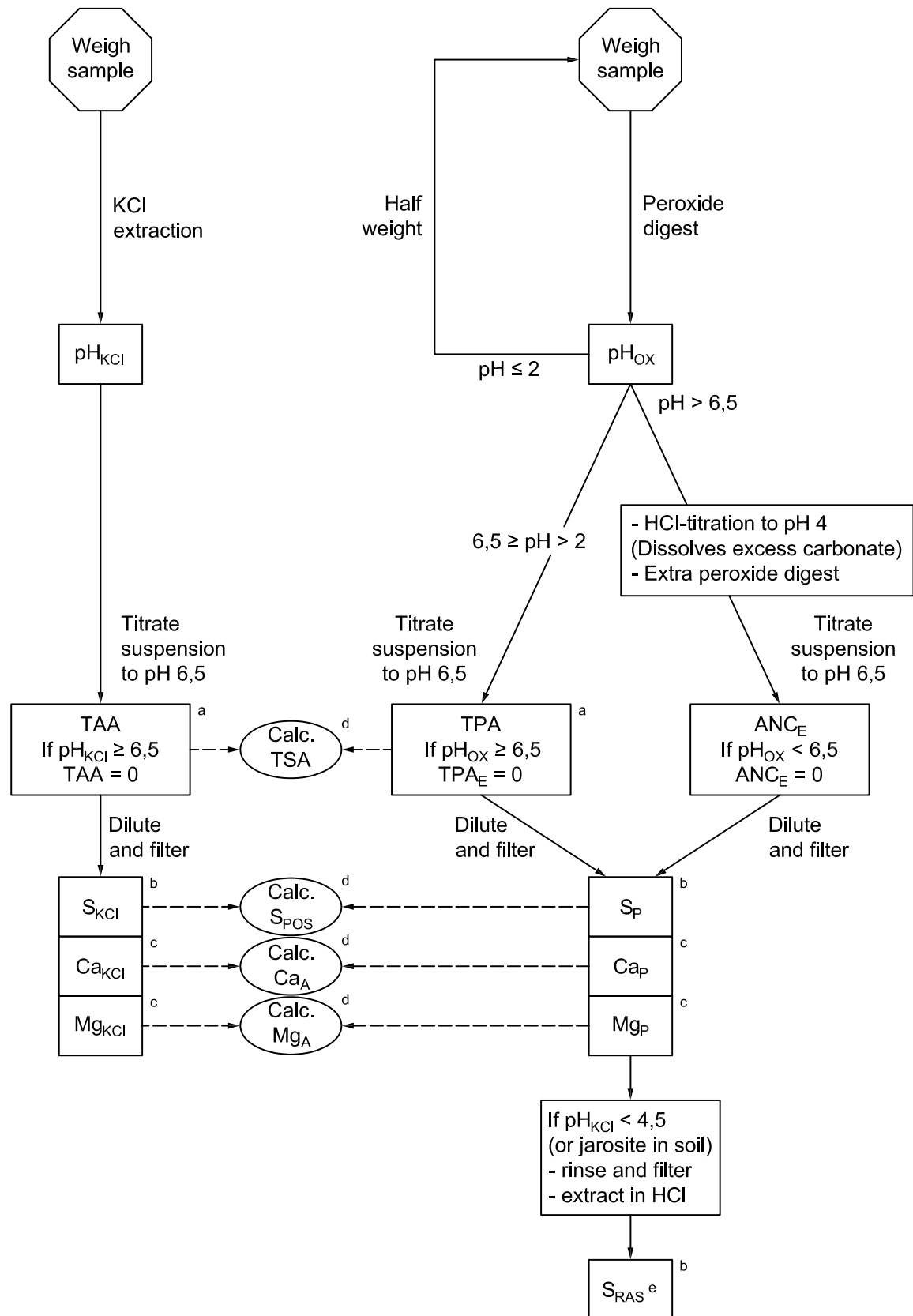
Figure 1 — Flow diagram of acid sulfate soil analysis



Key

- a acidity titration
- b sulfur determination
- c acid neutralising determination
- d calculated parameter

Figure 2 — Chromium suite flow diagram



Key