STRATEGIC BUSINESS PLAN

ISO/TC 226
Materials for the production of primary aluminium

EXECUTIVE SUMMARY

Business Environment:

The primary aluminium electrolysis industry produced about 53 million tonnes in 2014 with a total value of 100 billion US$. About 60% of the production cost is in material: Alumina, Fluorides, Carbonaceous materials, Refractory and insulation materials.

Aluminium production takes place at 960°C in an extremely corrosive environment and the quality and consistency of the above mentioned materials is essential for a successful process. These materials are sold freely between suppliers and customers, often in different countries. With test results from shared international ISO standards, the comparison and control is better, and avoids the risk of comparing test results from internal or different national methods that can give different results for the same properties.

The aim of ISO/TC 226 is to obtain unified and complete standard test methods that suppliers as well as customer have agreed to. TC 226 is responsible for 114 ISO Standards of which 33 have been published since 2004. The committee has 2 standards under publication and 6 active work items.

The activity of the committee is illustrated in Fig. 1.

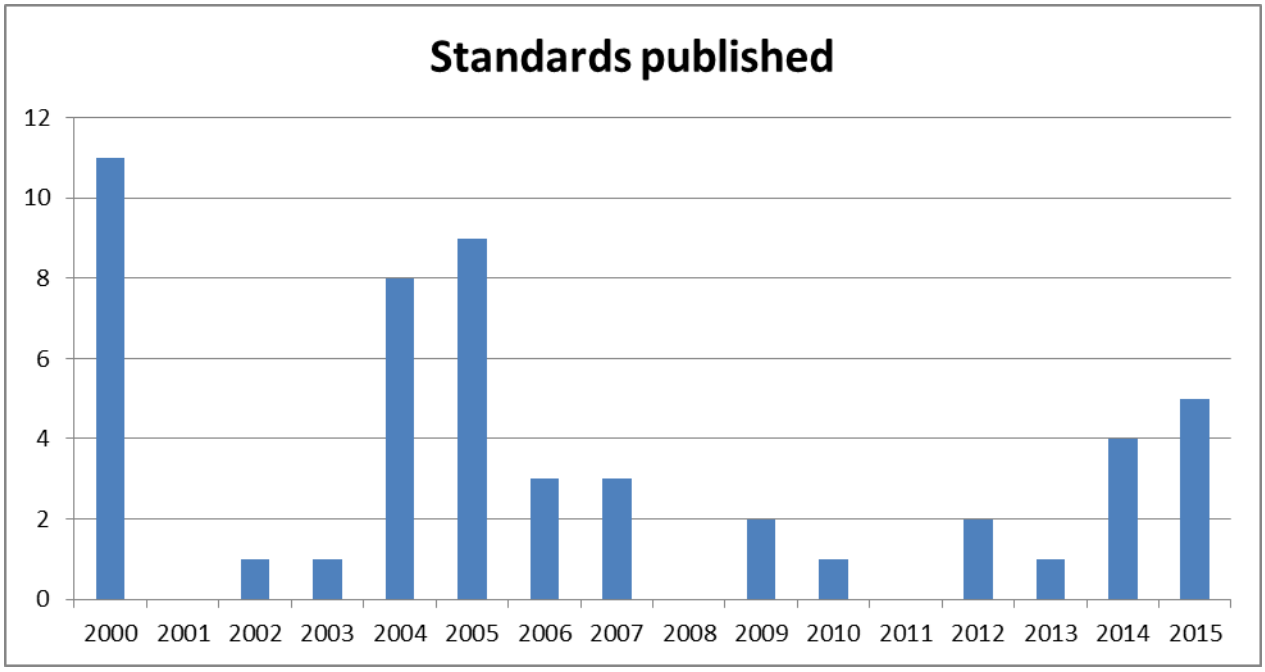

Fig.1. Standards published by ISO TC 226 (Materials for the aluminium industry) since 2000 including 2015 (tentative).

The test methods are useful for quality control, contracts and for development work. The ISO standards have to a large extent been based on modifications of internal methods and national standards. TC 226 has, however, seen it as a special task also to develop international standards that characterize the materials at process conditions. This has been accomplished by involving test laboratories as well as universities in addition to suppliers and aluminium producers. Examples are air and CO_2 reactivity of anodes, sodium expansion of cathode blocks, shrinkage and rammability of paste, penetration of electrolyte into refractories.

Benefits:

The very strict requirements of the international aluminium industry make the benefits of ISO standards essential. For instance, quality changes in lining materials may lead to catastrophic cell failure, changes of alumina may affect the very critical heat balance and metal output, changes in carbon raw materials may need adjustment of anode recipes. ISO standards are also essential safeguards for suppliers.

TC 226 also addresses environmental and health issues: A recent standard for the specific surface of alumina is in the process for publication. This property is decisive for cleaning pot gases containing fluorides by dry adsorption. The committee is also concerned about important health issues such as dusting and beryllium oxide content in alumina.

Priorities:

The majority of the ISO standards for pitch and carbonaceous material have been completed and the emphasis is on ISO standards for alumina and revitalization of the fluoride ISO standards. However, a continuous improvement of existing standards will occur as better and less time consuming methods are developed. New materials and equipment may also necessitate new methods. ISO standards may currently be in competition with national standards, but with the establishment of a complete set of ISO standards and ISO's international status, it is expected that ISO standards will prevail in international trade and gradually be adopted as national standards.

1 INTRODUCTION

1.1 ISO technical committees and business planning

The extension of formal business planning to ISO Technical Committees (ISO/TCs) is an important measure that forms part of a major review of business. The aim is to align the ISO work programme with expressed business environment needs and trends and to allow ISO/TCs to prioritize among different projects, to identify the benefits expected from the availability of International Standards, and to ensure adequate resources for projects throughout their development.

1.2 International standardization and the role of ISO

The foremost aim of international standardization is to facilitate the exchange of goods and services through the elimination of technical barriers to trade.

Three bodies are responsible for the planning, development and adoption of International Standards: ISO (International Organization for Standardization) is responsible for all sectors excluding Electrotechnical, which is the responsibility of IEC (International Electrotechnical Committee), and most of the Telecommunications Technologies, which are largely the responsibility of ITU (International Telecommunication Union).

ISO is a legal association, the members of which are the National Standards Bodies (NSBs) of some 140 countries (organizations representing social and economic interests at the international level), supported by a Central Secretariat based in Geneva, Switzerland.

The principal deliverable of ISO is the International Standard.

An International Standard embodies the essential principles of global openness and transparency, consensus and technical coherence. These are safeguarded through its development in an ISO Technical Committee (ISO/TC), representative of all interested parties, supported by a public comment phase (the ISO Technical Enquiry). ISO and its Technical Committees are also able to offer the ISO Technical Specification (ISO/TS), the ISO Public Available Specification (ISO/PAS) and the ISO Technical Report (ISO/TR) as solutions to market needs. These ISO products represent lower levels of consensus and have therefore not the same status as an International Standard.

ISO offers also the International Workshop Agreement (IWA) as a deliverable, which aims to bridge the gap between the activities of consortia and the formal process of standardization represented by ISO and its national members. An important distinction is that the IWA is developed by ISO workshops and fora, comprising only participants with direct interest, and so it is not accorded the status of an International Standard.

2 BUSINESS ENVIRONMENT OF THE ISO/TC

2.1 Description of the Business Environment

The Technical Committee on "Materials for the production of primary aluminium" develops standards on test methods for testing of all important properties of alumina, fluorides and carbonaceous materials, and selected properties of refractory and insulation materials needed for the safe and economic production of primary aluminium.

The testing standards defined by TC 226 play an important role in the various industries that produce the raw and constructional materials as well for the primary aluminium producer as they provide objective criteria for evaluating the products and their characteristics. This is particularly true in the manufacture of primary aluminium since the determination of whether these products meet the required properties can only be conducted by means of testing of those materials, before the production process.

The TC 226 standards naturally have a direct influence on the manufacture of testing machines and equipment, calibrating apparatuses, auxiliary devices and various measuring tools including small computers. Interest is not limited to the industrial sector, however, as researchers in academic fields utilise materials testing technology to pursue valuable scientific and technological research topics.

Testing is carried out on alumina, fluorides, carbonaceous materials, refractory and insulation materials metals for three different reasons. First, it is carried out for quality control, to ensure that a material conforms to a specification or that it has been correctly processed. Second, it is carried out to provide information that can be used to optimize the recipe for the production of primary aluminium. Third, it is carried out as part of investigations into the causes for failures in production.

At present, however, the testing methods used in these different industrial and regional sectors do not always rely on the relevant ISO standards, mainly due to different traditional backgrounds. The industries concerned are beginning to rely more and more on ISO standards as they recognise the benefits of using standards that can be considered truly unified across the global market.

2.2 Quantitative Indicators of the Business Environment

Aluminium ore, most commonly bauxite, is plentiful and occurs mainly in tropical and sub-tropical areas: Africa, West Indies, South America and Australia. There are also some deposits in Europe. Bauxite is refined into aluminium oxide (alumina) and then electrolytically reduced into metallic aluminium. Primary aluminium production facilities are located all over the world, often in areas where there are abundant supplies of inexpensive energy, such as hydroelectric, gas or coal power.

Approximately four tonnes of bauxite is required to produce two tonnes of alumina, and two tonnes of alumina are required to produce one tonne of aluminium metal.

The basis for all modern primary aluminium smelting plants is the Hall-Héroult Process, invented in 1886. Alumina is dissolved in an electrolytic bath of molten sodium aluminium fluoride within a large carbon or graphite lined steel container known as a "pot". An electric current is passed through the electrolyte at low voltage, but very high current, up to 600,000 amperes. The electric current flows between a carbon anode (positive), made of petroleum coke and pitch, and a cathode (negative), formed by the upper surface of the liquid aluminium which was electrolytically produced.

On average, around the world, it takes some 14 kWh of electricity to produce one kilogram of aluminium from alumina. Design and process improvements have progressively reduced this figure from about 21 kWh in the 1950's.

Table 1 The reported primary aluminium production (Thousands of Metric Tons) according to figures from the International Aluminium Institute (collected May 2015). The Total includes an estimated 500-700 metric tons not reported.

Year	Africa	North America	South America	Asia (ex China)	West Europe	Central Europe	Oceania	GCC	China	Total	Daily Average
2001	1252	4785	1828	2044	3554	3408	1941		3043	22933	738
2002	1254	4938	2036	2064	3592	3495	1982		3913	24440	786
2003	1288	5035	2078	2252	3712	3649	2009		5033	25980	841
2004	1562	4692	2154	2497	3924	3789	2054		6066	27794	896
2005	1594	4916	2182	2852	3990	3836	2062		7116	29714	959
2006	1703	4875	2281	3184	3825	3867	2077		8455	31587	1019
2007	1661	5147	2335	3395	3920	4070	2118		11441	35429	1145
2008	1567	5316	2438	3589	4243	4263	2108		12599	37465	1208
2009	1535	4362	2299	4014	3415	3770	2019		12293	34851	1129
2010	1593	4290	2111	2284	3465	3884	2083	2456	15985	39493	1279
2011	1648	4537	2010	2317	3698	3946	2108	3174	17961	42455	1381
2012	1486	4427	1882	2318	3308	3962	2006	3348	21096	45263	1463
2013	1655	4519	1750	2233	3229	3679	1926	3551	23214	47736	1540
2014	1604	4199	1411	2197	3208	3442	1868	4405	25010	49324	1592

Aluminium can be alloyed with other materials to make an array of metals with different properties. The main alloying ingredients are silicon, mangan, zinc, copper and magnesium. Other metals are also used.

Aluminium can be rolled into plate, sheets, or wafer thin foils the thickness of a human hair. The rolling process changes the characteristics of the metal, making it less brittle and more ductile.

Aluminium can be cast into an infinite variety of shapes. The statue of Eros in London's Piccadilly Circus erected in 1893 is cast aluminium.

Aluminium can be extruded by heating it to around 500ºC and pushing it through a die at high pressure to form intricate shapes and sections.

Aluminium can be forged by hammering to make stress-bearing parts for aircraft and internal combustion engines.

Aluminium can be joined by welding, adhesive bonding, riveting or screwing. It can be formed by bending or superplastic moulding. It can be milled or turned on a lathe.

The properties of the metal can be modified through heat treatment or mechanical working.

The appearance can be modified by surface treatments such as anodising or powder coating.

Anything made of aluminium can be recycled repeatedly by melting and used to make similar products again. The recycling of aluminium requires only 5% of the energy to produce secondary metal as compared to primary metal and generates only 5% of the green house gas emissions. Scrap aluminium has significant value and commands good market prices.

Aluminium is a multipurpose material. The figures below show percentage of the world's primary aluminium which was used for various applications in 2011 (1998).

- 38 % (26 %) Transportation (automotive, comersial aircraft, railroad, ship and boat, trucks, buses)

- 25 % (20 %) Construction (bridges and infrastructure, windows and door frames, roofing and exterior cladding, heatoing and ventilation)

- 16 % (20 %) Packaging (drinks cans, foils)

- 14 % (9 %) Electricity (transmission lines, transmission towers, accessories)

- 7 % (25 %) Others (consumer durables, machinery/equipment, sports equipment, furniture)

3 BENEFITS EXPECTED FROM THE WORK OF THE ISO/TC

The very strict requirements of the international aluminium industry make the benefits of ISO standards essential. For instance, changes in lining materials may lead to catastrophic cell failure, changes of alumina may affect the very critical heat balance and the metal output, changes in carbon raw materials may need adjustment of anode recipes. ISO standards are also essential safeguards for suppliers.

The aim of TC 226 is to develop unique international standard testing methods that can provide rational and reliable property data in order to facilitate clear and easy technical judgement and business decision-making in international trade through the provision of a common international scale. In fact, generally speaking, the properties of alumina, fluorides, carbonaceous materials, refractory and insulation materials cannot be obtained as simple fixed values applicable to all situations. Thus, the standard test procedures have been established according to the need for different material evaluations for different application purposes.
The standard test methods developed by TC 226 provide such user benefits as assurance of easy technical judgement and business decision-making based on reliable materials data that has been obtained through rational and common test methods. This prevents eventual complications of property data obtained from incompatible test standards, and hence provides systematic and correlated data for different properties evaluated by relevant methods of tests defined under the same philosophy.

TC 226 addresses environmental and health issues for example a recent standard for the surface of alumina. This property is decisive for the recirculation of fluoride pot gas by adsorption. WG 3 is also concerned about important health issues as dusting and beryllium oxide content in alumina.

4 REPRESENTATION AND PARTICIPATION IN THE ISO/TC

4.1 Countries/ISO members bodies that are P and O members of the ISO committee

4.2 Analysis of the participation

The P members of TC 226 reflect a reasonable distribution among regions of the world, except North America and Africa. However some P-members could preferably participate more actively in the daily work of TC 226.

5 OBJECTIVES OF THE ISO/TC AND STRATEGIES FOR THEIR ACHIEVEMENT

5.1 Defined objectives of the ISO/TC

The majority of the ISO standards for pitch and carbonaceous material are completed and the emphasis is on ISO standards for alumina and revitalization of the fluoride ISO standards. However, a continuous improvement of existing standards will occur as better and less time consuming methods are developed. New materials and equipment may also necessitate new methods. ISO standards may currently be in competition with national standards, but with the establishment of a complete set of ISO standards and ISO's international status, it is expected that ISO standards will prevail in international trade and be gradually adopted as national standards

5.2 Identified strategies to achieve the ISO/TC's defined objectives

- To use national developed standards as basis whenever possible.
- To revise standard test methods whenever a new or improved method is developed, to always have the best method possible available for the users.
- To continue having close contact with test laboratories and research institutes.
- To have an effective and simple structure of the committee

6 FACTORS AFFECTING COMPLETION AND IMPLEMENTATION OF THE ISO/TC WORK PROGRAMME

Good relationship with ISO technical officer, and good support and help from ISO/CS on all formal matters are essencial.

7 STRUCTURE, CURRENT PROJECTS AND PUBLICATIONS OF THE ISO/TC

This section gives an overview of the ISO/TC's structure, scopes of the ISO/TCs and any existing subcommittees and information on existing and planned standardization projects, publication of the ISO/TC and its subcommittees.

7.1 Structure of the ISO committee

TC 226 is organized into 5 working groups each dealing with the following topics: WG 1 Pitch, WG 2 Solid carbonaceous materials, WG 3 Smelter grade alumina, WG 4 Smelter grade fluorides, WG 6 Petroleum coke.

7.2 Current projects of the ISO technical committee and its subcommittees

7.3 Publications of the ISO technical committee and its subcommittees

2013 1/2 Article in International Aluminium Journal

Lorentz Petter Lossius and Jean-Claude Fischer; *"Meeting of the ISO Committee for Analysis of Materials for Primary Aluminium in Switzerland October 2012",* Report Plenary Meeting Sierre

2015 Paper TMS Light Metals 2015

Raymond Brown, Jean-Claude Fischer, Xujin Xue, Lin Wu, Andreas Schnittker, Nigel Turner, Harald A. Øye, Lorentz Petter Lossius; *"Standard development work in ISO Technical Committee 226 "Materials for the production of primary aluminium"*, Light Metals 2015, Proc. of the 144th TMS Annual Meeting, Orlando, Florida

Abstract

Standard work aims to ensure that reliable analysis methods are available. ISO standards are commercially important and are recognised and used by suppliers and customers around the world. Reliable analysis enables the suppliers to describe their materials using common standards for well-established material properties, and the standards are a support for smelters when evaluating and comparing sources of materials.

ISO Technical Committee 226 maintains 110 standards on sampling and analysis covering smelter grade alumina, smelter grade fluorides, pitch, petroleum coke and solid carbon bodies including anodes and cathodes. The main work is done through dedicated work groups, one for each of the material groups. The need for modernisation of the standards is continuous as instruments improve and raw materials change. The paper will describe the committee, the work groups, current projects and ISO work in general. The paper is co-authored by Convenors and technical experts from the work groups. Aims of this paper are; to interest potential technical experts to participate in committee projects, and to encourage metal producing companies to support the important work that their participating staff makes within the committee.

Reference information

Glossary of terms and abbreviations used in ISO/TC Business Plans

General information on the principles of ISO's technical work