NeuroToxicology 58 (2017) 173–179

Contents lists available at ScienceDirect

NeuroToxicology

Full length article

A global portrait of the manganese industry—A socioeconomic perspective

Carl Clarke*, Sophie Upson

Risk & Policy Analysts Ltd., Farthing Green House, 1 Beccles Road, Loddon, Norfolk NR14 6LT, UK

ARTICLE INFO

Article history:
Received 4 February 2016
Accepted 22 March 2016
Available online 13 May 2016

Keywords:
Manganese
Socio-economic analysis

ABSTRACT

In 2013/14, Risk & Policy Analysts Ltd undertook the first global study on the socio-economic value of Manganese (Mn). Based on a top-down analysis of the key supply chains for Mn, it outlined the economic importance of Mn ore and alloys in terms of their direct and indirect economic value, as well as their effects on employment (jobs and wages). In 2013, global production of Mn ore was worth an estimated US $ 10.2–11.1 billion. Taking into account multiplier effects in the supply chain, the total economic value of Mn ore production globally in 2013 is estimated at US$ 21–23 billion. Direct employment related to Mn ore production is estimated at 44,000–78,000 people worldwide (with total wages estimated at US$ 2.7–4.6 billion per year), plus 33,000–59,000 jobs are created through indirect and induced employment effects. Meanwhile, the production of Mn alloy contributes around US$ 23 billion per year to the global economy (based on global production of around 19 million mt and 2013 market prices). In total, the value of Mn alloy production worldwide, taking into account downstream multiplier effects in the supply chain, is estimated at around US$ 146 billion per year. Direct employment related to Mn alloy production is estimated at 67,000–86,000 jobs worldwide (with total wages estimated at US$ 613–796 million per year), plus 217,000–278,000 jobs created through indirect & induced employment effects.

In addition, numerous industries/sectors, products and/or applications are heavily dependent on Mn production and use. Mn is a critical raw material input and alloying element for the steel industry, for which there are no known alternatives. It can be argued that without Mn the entire steel industry (based on the current physico-chemical properties of steel) would not exist and, as a result, the value of the steel industry – an estimated US$ 964 billion to US$ 1446 billion in 2013 – is reliant on the continued supply and use of Mn. Besides its use in steel, Mn is also a critical element in the manufacture of dry cell and other batteries (notably, those used in electric vehicles) and the production of aluminium alloys (e.g. for beverage cans). Mn is also a micronutrient needed for plant growth and plays a vital role in agricultural production. It is also essential for maintaining the health and well-being of the human body and is used in food supplements and medicines. Furthermore, its use in developing applications (such as advanced steel products in automotive applications and batteries for electric vehicles) has the potential to provide socio-economic and environmental benefits in the future through enhancing vehicle safety and reducing fuel use/emissions.

© 2016 Elsevier B.V. All rights reserved.

1. Introduction

The socio-economic value of manganese (chemical symbol: Mn) has long been underappreciated by decision-makers and the general public. Yet, the processing of Mn ore and production of Mn alloys – and the associated capital and operating expenditures – make a significant economic and social contribution to local, national and regional economies where these activities take place (as measured by indicators such as gross domestic product (GDP), employment, tax revenues, etc.).

In terms of its use, Mn is a critical raw material input and process additive for the global steel industry, with there being no

Abbreviations: AHSS, Advanced high strength steels; Al, Aluminium; CO_2, Carbon dioxide; CAGR, Compound annual growth rate; EVs, Electric vehicles; EU, European Union; GDP, Gross domestic product; HC FeMn, High carbon ferromanganese; LMO, Lithium–Mn oxide spinel; Mn, Manganese; $MnCl_2$, Manganese(II) chloride; MnO, Manganese(II) oxide; $MnSO_4$, Manganese(II) sulfate; mt, metric tonnes; Mtpa, Million tonnes per annum; Ref FeMn, Refined ferromanganese; SiMn, Silicomanganese; tpa, tonnes per annum; TWIP, Twinning induced plasticity (steels); UK, United Kingdom.

* Corresponding author.
E-mail addresses: carl.clarke@rpaltd.co.uk (C. Clarke), sophie.upson@rpaltd.co.uk (S. Upson).

http://dx.doi.org/10.1016/j.neuro.2016.03.013
0161-813X/© 2016 Elsevier B.V. All rights reserved.

known substitute for Mn in the steelmaking process. This little-known element is also critical in a number of other applications, including Mn batteries, the production of aluminium alloys and is an essential micronutrient needed for plant growth and for maintaining the health and well-being of the human body.

When designing policies, strategies and investment plans, it is important that governments, policymakers, regulatory bodies and other stakeholders recognise these important socio-economic contributions.

2. The socio-economic contribution of Mn to the global economy

In 2013/14, Risk & Policy Analysts Ltd undertook the first global study on the socio-economic value of Mn (RPA, 2015). Based on a top-down analysis of the key supply chains for Mn, it outlined the economic importance of Mn ore and alloys in terms of their direct and indirect economic value,[1] as well as their effects on employment (jobs and wages).

The work was approached from two different points of view in order to obtain a comprehensive view of Mn and its economic role: it looked at both the economic contribution of Mn and the benefits to key stakeholders of Mn. In terms of the economic contribution of Mn, the study employed production and economic data, as well as modelling tools using a very conservative and narrow definition of the Mn industry in order to avoid over-estimating its economic contribution. In terms of the key benefits to stakeholders, the research focused on quantifying the benefits of Mn by asking, "*What would be the costs to stakeholders if they were forced to switch to substitute products that are not based on Mn?*". For this, the unique and specific physical and chemical properties of Mn and the qualities that it imparts to major categories of products that are based on it were identified. While there are some areas where other materials can replace Mn with only a small incremental cost or performance penalty, in most instances the use of substitutes would result in significant cost increases or performance losses.

Table 1 provides a summary of the types of socio-economic impacts that are associated with the production and use of Mn; those considered by the study are indicated with the letter 'a'.

The findings of the first global study on the socio-economic value of Mn were as follows:

In 2013, global production of Mn ore was worth an estimated US $ 10.2–11.1 billion. Taking into account multiplier effects in the supply chain, the total economic contribution of Mn ore production globally in 2013 is estimated at US$ 21–23 billion.

The production of Mn alloy contributes around US$ 23 billion per year to the global economy (based on global production of around 19 million mt and 2013 market prices). In total, the value of Mn alloy production worldwide, taking into account downstream multiplier effects in the supply chain, is estimated at around US$ 146 billion per year.

Direct employment related to Mn ore production is estimated at 44,000–78,000 people worldwide, plus 33,000–59,000 jobs created through indirect and induced employment effects. Total wages paid to workers employed directly in Mn ore production are estimated at US$ 2.7–4.6 billion per year.

Direct employment related to Mn alloy production is estimated at 67,000–86,000 jobs worldwide, plus 217,000–278,000 jobs created through indirect & induced employment effects. Total wages paid to workers employed directly in Mn alloy production have been estimated at US$ 613–796 million per year.

It is important to note that the above figures are an underestimate of the true value of Mn. There are other benefits (e.g. tax revenues, capital expenditure, etc.) that have not been calculated at this stage (as indicated in Table 1).

3. The socio-economic value of Mn in key applications

Mn is one of the most widely used and versatile naturally-occurring elements in the world and has numerous applications that benefit our daily lives. Mn is a critical raw material input and process additive for the steel industry and the continued growth of this industry relies on Mn. Indeed, demand for Mn ore and alloys depends directly on the needs of the steel industry and it can be observed that international consumption of Mn ore is closely associated with the emerging economies, with China accounting for over half of total global consumption.

Besides steel, Mn has a number of other important uses that make significant contributions to national and global economies each year. For example, Mn is a critical element in the manufacture of dry cell and other batteries (notably, those used in electric vehicles), the production of aluminium alloys (e.g. for beverage cans) and in consumer electronics (e.g. television circuit boards). Mn is also a micronutrient needed for plant growth and plays a vital role in agricultural production. It is also essential for maintaining the health and well-being of the human body and is used in food supplements and medicines.

The socio-economic value of Mn in some of its key applications is discussed further below.

3.1. Mn in steelmaking

By far, the most important use of Mn worldwide is as a process additive and alloying material in steelmaking. Mn is intentionally present and used as an alloying element to improve mechanical properties in almost all types of steel and is a residual constituent of all others, making it the most prevalent alloying agent, after carbon. The economic value of Mn in the context of steel making derives from two key aspects:

- Firstly, in its use as an alloying material, there are no known alternatives to Mn in the steel making process; and
- Secondly, Mn is the most cost-effective hardenability intensifier, which is why it is used in all standard treatable steels. While Mn is not as effective as nickel in stabilizing the austenitic structure of certain steels (more Mn is required to achieve the same effect), Mn has the advantage of being much less expensive and its effects can be reinforced by combining it with nitrogen. Achieving an austenite structure within steel is important for increasing hardenability of the material.

Overall, it could be argued that, without Mn, the entire steel industry (based on the current physico-chemical properties of steel) would not exist and, as a result, the value of the steel industry – an estimated US$ 964 billion to US$ 1446 billion in 2013 – is reliant on the continued supply and use of Mn.

Mn is therefore critical to the production of steel in general and also vital for achieving the key properties required for specialist steel products and their use in down-stream applications, which are expected to increase with future technological developments.

3.1.1. Advanced high strength steels

Advanced High Strength Steels (AHSS) provide a superior combination of ductility and strength compared to conventional high strength steels, demonstrate a high fatigue endurance limit

[1] The production of Mn ore provides two main types of economic value: its direct economic value, where this equates to the market value of Mn ore, as determined by market prices and quantities produced (output); and its indirect economic value, where this refers to the value generated in the supply chain by the production of Mn ore (estimated using input–output multipliers).

Download English Version:

https://daneshyari.com/en/article/5560879

Download Persian Version:

https://daneshyari.com/article/5560879

Daneshyari.com