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The environmental and economic consequences of the developments of lead stocks in the Dutch economic system

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Abstract

This article investigates the developments of lead stocks in the Dutch economy and the consequences of such developments for the environment and the economy. The analysis is based on a dynamic substance stock model that combines physical and socio-economic elements. The model estimates lead demand in different applications as a result of the developments in the socio-economic variables. In addition, it estimates the current and future size of lead stocks, the future outflow of discarded lead applications and related emissions, and the availability of lead for future recycling based on the life span, corrosion rate and recycling rate of the lead applications. The results show that the lead inflow is determined by the demand for its individual applications, which in turn are mainly determined either by per capita GDP or by population growth. In future, the societal stock is expected to change from a lead sink to a lead source. The future availability of lead for recycling will exceed its demand. This implies that lead demand in The Netherlands can be met completely by secondary sources. If a similar trend can be found in other countries, a situation of oversupply may arise with adverse consequences for the recycling business and ultimately for the emissions of lead to the environment.

Keywords: Substance flow analysis; Dynamic stock modeling; Socio-economic; Lead; Recycling; Resources

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1. Introduction

Over the last century, the increase of the global population and the growth of the economic activities have been accompanied with an increase of materials demand, and consequently with an increase of extracting, processing, using and waste treatment activities. This has raised the concern about the depletion of resources and the emissions during resources life cycle especially those of heavy metals.

Environmental policies aiming at the reduction of the emission of heavy metals include end-of-pipe processes, but also more integrated measures like the stimulation of recycling and the phasing out of hazardous intended (e.g. lead in gasoline) or not-intended (e.g. cadmium in phosphate fertilizer) applications. Although these policy measures seem to be effective on the short term, their effectiveness on the long term is questionable. A well-known example concerns cadmium recycling. On the short term, recycling may reduce cadmium emissions, however, on the long term these emissions will increase due to the fact that the inflow of cadmium into the economy is supply driven (Huppes et al., 1992). This implies that a reduced demand does not result in a reduced supply. A comparable example concerns mercury. The demand for mercury has decreased so much as a result of a strict policy, that its supply can be covered completely from by-product sources, such as from the purification of natural gas. In this case, policies aimed at phasing out or recycling mercury applications therefore will lead to an increase of its stock in society (Maxson et al., 1991).

This article investigates the dynamic behavior of lead stocks in the Dutch economy. Lead has been chosen because it is one of the most extensively used heavy metals in the economic processes on the one hand, and because of its toxic characteristics and its accumulation in the economy on the other hand (Scoullos et al., 2001). In The Netherlands, policy aims at a reduction of lead emissions by phasing out certain lead applications and increasing recycling. On the short term, the phasing-out policy has resulted in a reduction of lead emissions (Tukker et al., 2001), while recycling has led to a reduced landfill of lead containing waste. On the long term, however, both types of measures may have unexpected and undesirable side effects, comparable with cadmium and mercury.

The present article investigates the consequences of the past and future developments of lead stocks on the long-term lead management. The cases of cadmium and mercury as mentioned above have been analyzed using substance flow analysis (Van der Voet, 1996). These analyses are based on static modeling. It is argued, however, that for long-term management, information is required on the dynamic behavior of substances in the economy (Guinée et al., 1999). Recently, it is acknowledged that including the dynamics in the system is connected to the inclusion of stocks in society (Bergbäck and Lohm, 1997). The dynamics of such stocks are very important for the generation of future waste and emissions. Considering stocks so far has resulted in a few specific substance stock inventories or models (Boelens and Olsthoorn, 1998; Kleijn et al., 2000). The analysis in this article is carried out using a general dynamic substance stock model that combines physical and socio-economic elements.

The article is structured as follows. Section 2 will outline the dynamic stock model. In Section 3, a description is presented of the lead applications and the past and future inflows,