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Influence of recycling rate increase of aseptic carton for long-life milk on GWP reduction

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Abstract

Tetra Pak, through intensive cooperation with its supply chain, increased the post-consumer recycling rate of the aseptic packaging for long-life milk in the last 10 years. In continuation of a previous study that presented a superior overall performance in terms of reduction of the consumption of natural resources, air emissions and most of the water emissions, the objective of the present work was to apply life cycle assessment (LCA) to measure the global warming potential (GWP). The system was assessed using as functional unit 1000 liters of milk packaged in Tetra Pak Aseptic containers. The reduction of greenhouse gas emissions was calculated for recycling rates of 2%, 22%, 30%, 40% and 70% of the post-consumer residues in Scenarios I (only cardboard recycling) and II (total aseptic laminate recycling). Scenario I showed a 14% reduction in GWP, representing 26 kg of avoided CO_2 equiv. emitted due to the efforts of Tetra Pak to increase the recycling rate from 2% (2000) to 22% (2004). If it will be possible to increase the recycling rate to 70% of post-consumer packages in the future, a 48% reduction of GWP could be attained. Methane exhibited the greatest mass reduction among the greenhouse emissions, since it is emitted during the production of cardboard and also as a result of anaerobic degradation in landfills. The total reduction of the energy requirements of the system due to the increase of the recycling rate (from 2% to 22%) is 154 MJ/1000 liters, a saving of 7%. Scenario II (which considers additional polyethylene and aluminum recycling) has a smaller effect on GWP reduction than Scenario I, since PE/AL represent only 25% of the total mass of the container. The major benefit of the recycling of aseptic cartons is the reduction of the amounts of virgin materials required and the consequent reduction of air emissions. The results of this study can be used to encourage the collection of post-consumer milk cartons as part of environmental education programs.

Keywords: GWP; Aseptic carton; Package; Cardboard; Recycling; Landfilling; Air pollutants; Emissions; Scenario analysis

1. Introduction

1.1. The greenhouse effect and climatic changes

The warming of the earth's atmosphere is a phenomenon that results from natural processes caused by the entrance of electromagnetic radiation emitted by the sun (a source of radiation and visible light) and re-emission of thermal radiation (infrared radia-

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tion) of the planet Earth (a body that accepts, dissipates and reflects the energy coming from the generating source).

Changes in the atmospheric abundance of greenhouse gases and aerosols, in solar radiation and in land surface properties alter the energy balance of the climate system. Intensification of anthropogenic activities from the industrial revolution onwards has dramatically increased the emission of certain gases into the atmosphere, which interact at the molecular level with the thermal radiation emitted by the Earth. This phenomenon has been named greenhouse effect and is measured by the global warming potential.

According to scientific research on the greenhouse effect, the global temperature of the planet has shown a rising tendency throughout the past century. Measurements recorded up to now suggest that the average temperature of the Earth's surface has risen about 0.74 °C (IPCC, 2007a).

For the next two decades a warming of about 0.2 °C per decade is anticipated for a range of SRES—IPCC special report on emission scenarios. Also, increases in global average temperatures as associated with extreme climatic effects (floods, storms, hurricanes and droughts) and alterations in the variability of hydrologic phenonema (changes in rainfall patterns, advancing of the sea on rivers), jeopardizing life on Earth (a threat to biodiversity, agriculture, health and the well being of the human population) (IPCC, 2007a).

By mid-century, annual average river runoff and water availability are projected to increase by 10–40% at high latitudes and in some wet tropical areas, and decrease by 10–30% over some dry regions at mid-latitudes and in the dry tropics, some of which are presently water stressed areas. Approximately 20–30% of plant and animal species assessed so far are likely to be at increased risk of extinction if increases in global average temperature exceed 1.5–2.5 °C (IPCC, 2007b).

Between 1970 and 2004, global emissions of CO_2, CH_4, N_2O, HFCs, PFCs and SF_6, weighted by their global warming potential (GWP), have increased by 70% (24% between 1990 and 2004), from 28.7 to 49 Gtonnes of carbon dioxide equivalents—$GtCO_2$ equiv. (IPCC, 2007c).

The main anthropogenic gases causing the global warming phenomena are carbon dioxide (CO_2), methane (CH_4), chlorofluorocarbons (CFCs) and nitrous oxide (N_2O). Troposphere water vapor is the gas with the greatest individual effect on global warming. However, its concentration depends less on anthropogenic activities than of the natural contributors (evapotranspiration, volcanoes, etc.).

Emission volumes are only a quantitative indicator of the presence of the gases in the atmosphere since the actual contribution of each substance to the cumulative global warming of each gas should be weighted by its molecular weight, by the time of permanence in the atmosphere and the cumulative effect of each gas.

The weighting of these factors provide the global warming potential (GWP), calculated by the Intergovernmental Panel on Climate Change—IPCC (IPCC, 2001).

1.2. Background

The market share of ultra high temperature (UHT) milk has grown quickly over the last 15 years in Brazil with a concomitant decrease of pasteurized milk sales, attaining more than 4.8 billion liters, mainly in consequence of the extended shelf life provided by the aseptic carton pack (Datamark, 2006).

Although the composite nature – carton/polyethylene/aluminum – of Tetra Pak packages is essential for long-life protection of perishable products, on the other hand, this same nature has hindered the recycling of post-consumer packages for many years, since recycling processes designed for multilayer composite materials required the development of special technologies to separate the layers they are made of. Combining local collection incentives with the development of new technologies to separate the fibers from the aluminum/polyethylene portion of the original packages and produce useful by-products could make the recycling of this kind of packaging more cost-efficient. Increasing the recycling rate is essential to minimize the disposal of residues in landfills, restrain emissions and allow the recovery of part of the raw materials used in the manufacture of the original packages.

Tetra Pak has long been committed to running its business in a sustainable manner. As one of its policies, all Tetra Pak packages have to be suitable for recycling. New developments include the identification of appropriate recycling technologies. Tetra Pak supports customers to find environmentally acceptable solutions for their packaging material waste, and is committed to facilitate and promote local collection and recycling activities for post-consumer carton packages. In the last decade, Tetra Pak has established a series of partnerships with universities, recyclers and suppliers throughout the aseptic packaging supply chain to optimize the environmental management of this packaging.

The Packaging Technology Center-CETEA accomplished the first Brazilian LCA study relative to packages