

Fate of aluminium from end-of-life commercial vehicles: preliminary results of a European study.

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Abstract

This paper reports the initial results of a European study aiming at understanding better the fate of aluminium parts / components coming from end-of-life commercial vehicles (CV) in Europe. The fate of CV has been little explored so far and very little information is available. CV leaving the fleet are either exported for re-use, or stored, or dismantled or shredded / sheared. A quantitative approach and a qualitative approach are combined together in order to develop a good snapshot of the current situation. Results are presented, especially for France, and summarised in a Material Flow Analysis diagram.

Keywords

End-of-life (EoL); commercial vehicles (CV); aluminium; recycling; tractors; trailers.

1 INTRODUCTION

Due to increasing economic activity and growing international goods exchanges, quantity of commercial vehicles (CV) like tractors, rigid trucks, trailers and semi-trailers in use in EU-25 is growing. Increased road transport might imply higher greenhouse gas emissions and there are therefore strong incentives to improve commercial vehicles performances, for example by improving engine efficiency or by lightening vehicles [1].

For the latter, Aluminium is currently gaining in popularity for engine parts, components and parts, accessories and for structures / superstructures of CV, and CO₂ emissions reduction and fuel saving are therefore being achieved [2]. However, environmental benefits of using aluminium in CV strongly depend on end-of-life recycling efficiency. Unfortunately, very little has been known so far on end-of-life (EoL) treatment of CV in Europe. This paper presents the initial results of a recent European study that aimed at understanding better the fate of aluminium parts coming from EoL CV [3]. This study has been led by Troyes University of Technology in cooperation with the European Aluminium Association. In particular, this paper concentrates on results concerning France, that is one of the most important countries using aluminium in CV. First, the problematic is exposed. After explanation of the methodology adopted for the study, main results for France are presented. Finally, possible extrapolation / adaptation of the French situation to the EU-25 countries is discussed.

2 PROBLEM SETTING

2.1 Vehicles considered

Two types of CV are considered in this paper:

- Motorised CV, i.e. tractors and rigid trucks,
- Non-motorised CV, i.e. trailers and semi-trailers.

Buses are not considered in this paper.

2.2 An increasing quantity of commercial vehicles on EU-25 roads

Registration of new CV in EU-15

Using ACEA [4] and CLCCR-VDA [5] data, it was possible to compute the quantity of new CV entering the fleet of EU-15 and other Western Europe countries in the past

years. On Figure 1, this quantity is showed for rigid trucks and tractors from 1985 to 2004.

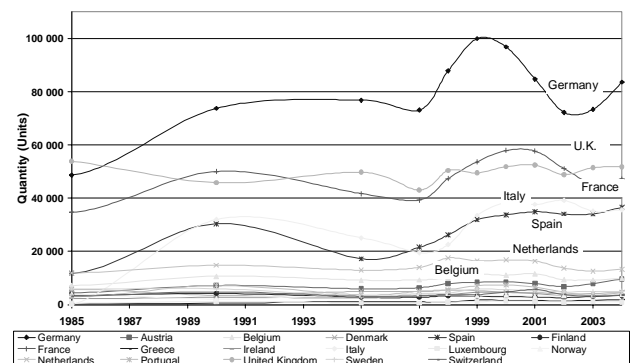


Figure 1: New registration of rigid trucks and tractors in Western Europe from 1985 to 2004.

According to Figure 1, new registrations of motorised CV have been on the whole growing in EU-15 even if strong variations can be observed. These variations seem strongly correlated to the economic activity of countries. For example, in 1998-2000 period, improvement of the economic situation in EU-15 leads to higher registration of CV, first in Germany; this registration growth can then be observed one or two years later in other large CV user countries, i.e. France, UK, Italy, Spain, the Netherlands and Belgium.

A growing activity in new accessing EU-25 countries

Since their accession to EU-25, and even before during its preparation, new EU countries like Poland or Czech Republic, have been strongly developing their commercial goods transport industry. This is mainly due to:

- New commercial exchange axis for these countries, in particular with Germany and France,
- Lower labour costs that turn their activity more competitive than Western neighbours,
- A lower competitiveness of rail goods transport that used to be dominant in the past.

2.3 Aluminium in commercial vehicles

Since its first use in Parisian buses in 1910, aluminium has been more and more used in CV. It can be used today in [6]:

- Components for trucks (e.g. cabin, doors, powertrain),
- Superstructures, complete or as components (e.g. van box, tipping body, silo, tank),
- Structures (e.g. chassis of semi-trailer),
- Accessories (e.g. fuel tank, wheels, air pressure vessels).

It is estimated that for an average fleet put on the European market today, a tractor contains 250 kg of Aluminium, a rigid truck 500 kg, a semi-trailer 530 kg and a drawbar-trailer 315 kg [7]. Considering that CV leaving the fleet today are 10 to 15 years old, and that at this time they contained around 15% less aluminium than today, the share of aluminium contained in CV leaving the fleet today are those established in Table 2.

	Average weight (kg)	Average quantity of Al in 1990-1995 (kg)	Share of Al in 1990-1995 (%)
Truck	7000	212,5	3,0%
Rigid truck	8500	425,0	5,0%
Trailer	4200	267,8	6,4%
Semi-trailer	7000	450,5	6,4%

Table 1: Weight, aluminium weight and aluminium share in CV leaving the fleet today (i.e. put on the market between 1990 and 1995) [7].

2.4 End-of-life fate of commercial vehicles

At the beginning of the project, not much is known on the fate of CV that leave the fleet of a country as very few reports or statistics are available. A few initial contacts with EoL vehicles and aluminium experts in Europe demonstrated the same lack of knowledge. Many think that most CV end their technical life in other markets, in particular in Africa. Others think that some vehicles, like aluminium-road tankers, end as fixed storage of goods in the transporters yard. The aim of the project is indeed to find out more on this issue.

3 METHODOLOGY

3.1 Literature review

During the literature review, only one study was found dealing with EoL treatment of CV: this study was led in 1998 by ADEME, the French EPA [8]. It was however only dealing with French situation and was not specifically focusing on aluminium-concentrated CV.

3.2 A quick survey

Initial survey of transport companies and manufacturers showed that during its technical life, a CV can have several owners. When a CV is not anymore used in a country, i.e. is not anymore registered in this country, it is considered as "leaving the fleet". When leaving the fleet, a CV can be:

- Either exported for further re-use in another country,
- Or kept on the owner yard for storage of goods,
- Or depolluted and dismantled for parts extraction and re-use,
- Or depolluted and shredded / sheared for material recycling.

This EoL CV treatment network (see Figure 2) does therefore not differ much from personal car treatment. However, the share of CV being re-used, dismantled or recycled is not known and the aim of our study is indeed to estimate it. Using these initial results, we proposed a

methodology mixing a quantitative approach and a qualitative approach to answer this question.

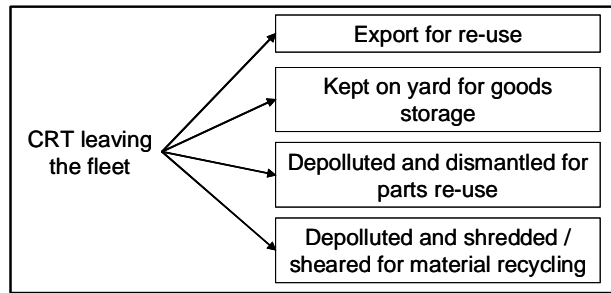


Figure 2. The fate options for commercial vehicles leaving the fleet of a country.

3.3 A quantitative/objective approach

This approach aims at calculating the amount of CV leaving the fleet. The calculation is based on the collection and the analysis of fleet and registration data, using data coming from various sources. This approach is to be started with more easily accessible French data and then to be extrapolated or adapted to EU-25 situation.

From registration and fleet data, it is indeed possible to calculate the number of CV leaving the fleet on a certain Year Y using the following equation:

$$(\text{CRT leaving the fleet}_Y) = (\text{Fleet}_Y) - (\text{Fleet}_{Y+1}) + (\text{New-registration}_Y) \quad (1)$$

Import / export data is also to be collected from customs department to find out how much and where to CV are currently exported.

3.4 A qualitative/subjective approach

Considering that the quantitative approach could not bring enough information for the study, in particular information on differences between aluminium-concentrated and more conventional CV, a qualitative approach has been led simultaneously. This approach is an expert survey and consists in identifying relevant actors along the CV life cycle in Europe (i.e. manufacturers, transport companies, exporters, dismantlers, shredders, aluminium remelters and refiners), and analysing their practices and points of views. This analysis has been led using original questionnaires developed for each type of actors. These questionnaires contained:

- closed questions, e.g. "what quantity of CV do you treat annually?" or "what processes do you apply to them?",
- and open ended questions, e.g. "from your understanding, what is the fate of CV when they leave the fleet in your country?" or "what factors do influence this situation?".

The relevancy of the consulted actors has been ensured when starting surveying recognised aluminium and CV experts, and then leading an enquiry among them to identify other relevant and willing to cooperate partners. Around 20 actors were interviewed and visited in Belgium, France, the Netherlands, Poland and Spain.

3.5 Combination of the two approaches

On the basis of the quantified results of the first approach, presented under the format of a Material Flow Analysis (MFA) chart, it has been possible to apply expert views on missing information or on aluminium-specific information. The application of the expert views has been made as transparently as possible.

The combination of the two approaches leads to MFA charts for France and EU-25 countries, for two types of CV (motorised and not-motorised) and for vehicles as well as aluminium material alone.

4 INITIAL RESULTS OF THE QUANTITATIVE APPROACH FOR FRANCE

4.1 Availability and quality of data

According to equation (1), three types of data are necessary to compute the quantity of CV leaving a country fleet:

- The number of new registration on a certain year: this data was obtained from ACEA and CLCCR [4, 5]; it was considered as reliable;
- The importance of the fleet on a certain year and on the year after.

For the latter, two sources of information exist in France:

1. data supplied by the Ministry of Transport statistics, relying on the date of first registration and on average life duration,
2. data supplied by the DRIRE (Regional Direction for Industry, Research and the Environment, affiliated to the Ministry of Industry and the Ministry of Environment) that sums-up the number of compulsory technical check done for each type of vehicle on a certain year.

Variations between the two types of figures vary between 1% and up to 20% for motorised and non-motorised CV with an average of 10%. Technical check data is considered as more reliable and accurate because it is based on real statistics and not theoretical values. It is therefore chosen for the study.

4.2 Results

The number of motorized and non-motorized CV leaving the fleet from 1999 to 2003 has been computed. Figure 3

compares the number of non-motorized vehicles leaving the fleet in France with new registration of non motorized CV.

The analysis of the previous graph shows a clear correlation between number of CV registration (i.e. economic situation improvement, see 2.2) and the number of CV leaving the fleet of a country. This can be explained by the fact that with good economic activity, many transport companies wish to renew their fleet. Some companies do replace their used CV by new ones, some other replace their used CV by newer, and more CV leave logically the fleet.

Between 1999 and 2003, there is a trend to a slight decrease of the number of CV leaving the fleet in France, in particular for rigid trucks and for trailers. This might be explained by longer life expectation for CV.

4.3 Exports data

Import / export data has been collected from the customs department. It was shown that very small quantities of used CV were imported in France in the last years to be re-used. However, large quantities of used CV were exported. Table 1 summarises quantities of tractors / rigid trucks and trailers / semi-trailers exported from France in 2004. In the same table, these figures are compared to the number of new CV registration and to the number of CV leaving the fleet.

It can be concluded that around 84% of tractors / rigid trucks leaving the fleet in France are exported and that 54% of trailers / semi-trailers leaving the fleet are exported.

Poland is a major country for CV export followed by several EU-15 countries, Africa, and Russia. Number of CV exported to EU-15 countries should be handled with care as it was found out that many traders from countries like Belgium, Germany, the Netherlands do import many CV for immediate re-export, in particular to Russia, Africa and new EU-25 accessing countries.

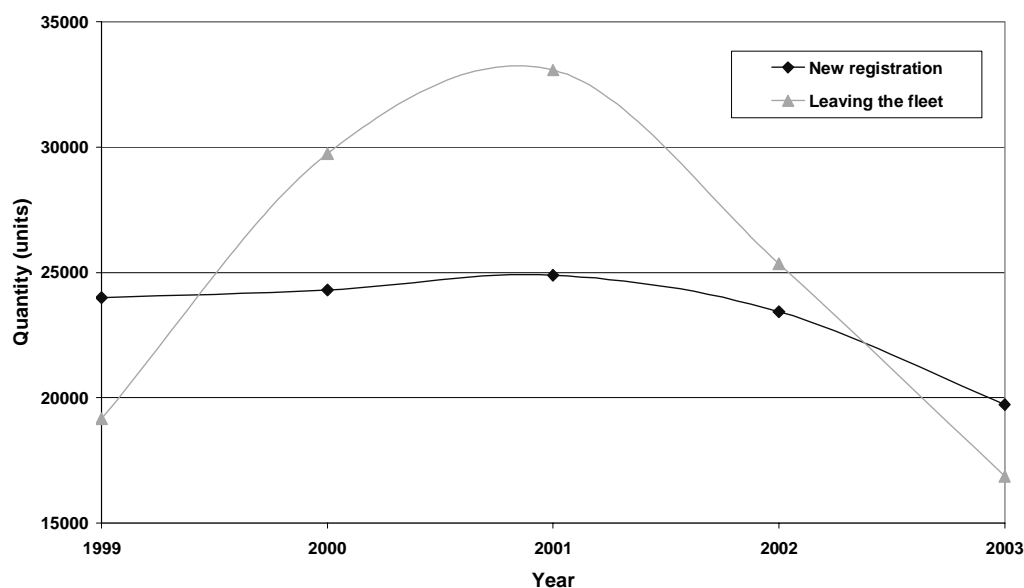


Figure 3. Number of trailers and semi-trailers entering and leaving the fleet in France from 1999 to 2003.

Type of CV	CV flows	Number (2004 data)	Destination for export
Tractors & rigid trucks	New registration	44065	Poland (21%), Belgium (11%), Germany (9%), Spain (8%), Italy (5%), Netherlands (5%)
	Leaving the fleet	35475	
	Export of used vehicles	29677	
Trailers + Semi-Trailers	New registration	20777	Poland (20%), Germany (9%), Spain (8%), Togo (7%), Netherlands (6%), Belgium (5%), Russia (5%)
	Leaving the fleet	16415	
	Export of used vehicles	8855	

Table 3. Number of tractors / rigid trucks and trailers / semi-trailers registered, leaving the fleet and exported in / from France in 2003.

5 INITIAL RESULTS OF THE QUALITATIVE APPROACH FOR FRANCE

5.1 Number of interviews

In order to understand better the fate of CV when they leave the fleet, all types of actors of the CV life cycle should be consulted. For this, 14 interviews / visits have been led in France among CV manufacturers (3), transport companies (2), dismantlers (3), shredder and metal traders (4) and exporters (2). This survey has been led between July 2005 and January 2006.

5.2 Main findings

We summarise here the main findings of the surveys we led in France:

For CV in general

- Motorised CV manufacturers know that vehicles have got several lives: during the first life, the CV is intensively used for long distance trip; during the second life, it is used less intensively for shorter distances; it is sometimes exported to Eastern Europe or Africa for a third life. Unfortunately, manufacturers do not know much about quantities orientated to various streams and about process applied to them;
- Non-motorised CV manufacturers do not have any knowledge of the fate of vehicles when they leave the fleet;
- CV re-seller / exporters know well re-use networks: most of their market is located in France, but up to 30% of CV are re-exported, mainly to Poland, Russia, and Africa; countries like Poland are however now starting to prefer newer CV;
- CV dismantlers extract valuable parts and components from EoL vehicles, up to 50% of the vehicle weight; there is a market for re-usable parts in France and in other countries, firstly Poland, but also Russia and Africa; the remaining carcass is usually orientated to shredders and metal traders;
- Shredders sometimes accept EoL CV in their processes; some parts (e.g. cabins) are usually shredded, others are flame-cut or sheared; some

others (e.g. motors) are currently treated by hammer processes.

For aluminium-dominated CV

- According to CV re-seller / exporters, no Aluminium-concentrated vehicles and parts are exported to Africa; this is due to the lack of know-how and equipment (e.g. welding) for aluminium parts maintenance in this region; those vehicles are therefore mainly exported to new accessing countries, in particular Poland, but also to Russia/Ukraine;
- Considering the value of aluminium in the scrap market, the use of aluminium-concentrated trailers to store goods in yards is supposed to be very rare;
- According to some transport companies and some metal traders, a lot of aluminium-concentrated trailers and semi-trailers are, after their total use in France, cut into pieces in the transport company yards and directly sold to aluminium remelters; another share is sold to metal traders to be cut and sold to remelters or refiners; another share is sold to metal traders and orientated to shredding and sorting processes, to be finally sold to aluminium refiners; however, considering that aluminium trading has got a lot of informal activity, it is extremely difficult to assess quantities going to all these streams. The situation is summarized in Figure 4.

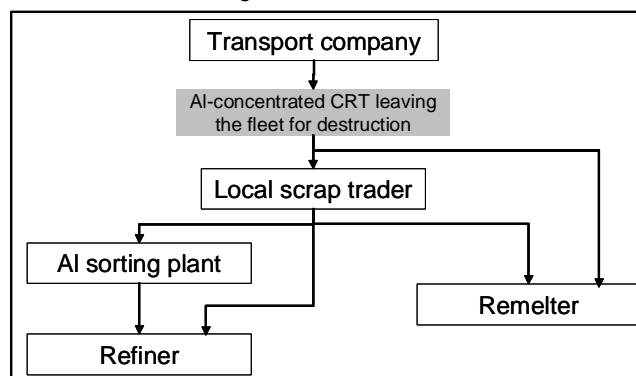


Figure 4. Synoptic of Aluminium-concentrated non-motorised CV flows after their use in France.

5.3 Summary of the French situation

Quantitative and qualitative information has been combined in order to establish a preliminary Material Flow Analysis of aluminium coming from several types of CV leaving the fleet in France. As an illustration, the MFA diagram of aluminium coming from trailers and semi-trailers in France in 2003 is presented in Figure 5.

6 EXTRAPOLATION / ADAPTATION TO EU-25

Similar quantitative and qualitative approaches have been led for the whole EU-25 region. Results are not presented here but will be the object of further publications.

Some important aspects of the EU-25 study are presented below:

- Data for the fleet, the new registration and technical checks are not available for CV in all EU-25 countries; as first approximation, some extrapolation procedures are therefore to be used, mainly using population and CV fleet data and ratios for these countries;
- Situation of EU-15 countries and the 10 new accessing countries should be clearly distinguished for the CV fate: new accessing countries do absorb in their fleet much more used vehicles than EU-15

countries; a large share of the used vehicles actually come from EU-15 markets;

- Some national preferences exist for the use of different types of CV: for example, rigid trucks and trailers are much more popular in Germany and Spain than they are in France; some national preferences do exist also for end-of-life treatment.

7 SUMMARY

This paper presented the initial results of a European study concerning the fate of aluminium. The study mixed quantitative (i.e. analysis of statistics) and qualitative (i.e. experts survey) approaches. The combination of the two approaches leads to Material Flow Analysis charts that reveal a first snapshot of current fate of CV leaving the fleet.

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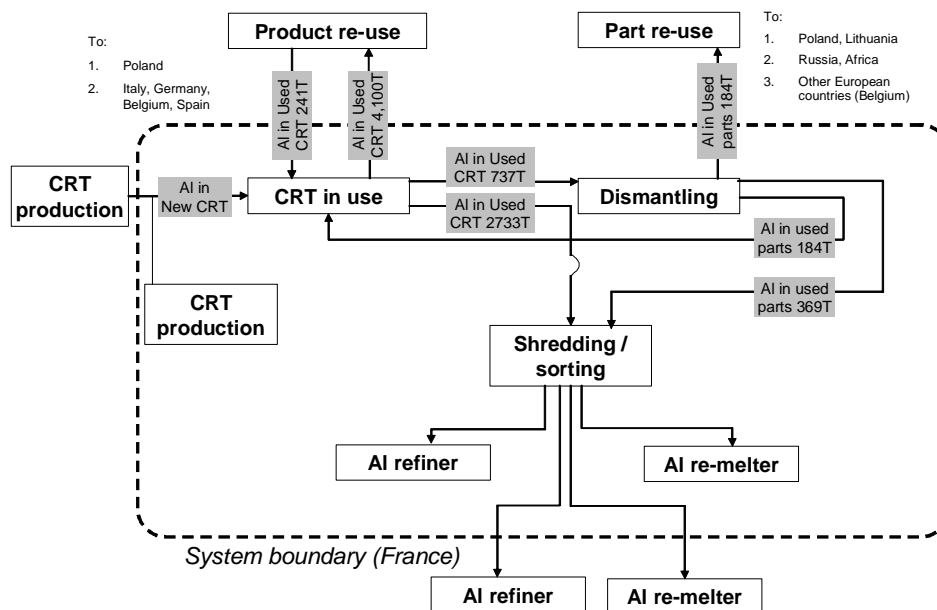


Figure 5. Simplified aluminium life cycle diagram, for aluminium contained in trailers and semi-trailers leaving the commercial vehicles fleet in France in year 2003.