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Review

Review of Italian experience on automotive shredder residue characterization and management

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ABSTRACT

Automotive Shredder Residue (ASR) is a special waste that can be classified as either hazardous or non hazardous depending on the amount of hazardous substances and on the features of leachate gathered from EN12457/2 test. However both the strict regulation concerning landfills and the EU targets related to End-of-Life Vehicles (ELVs) recovery and recycling rate to achieve by 2015 (Directive 2000/53/EC), will limit current landfilling practice and will impose an increased efficiency of ELVs valorization. The present paper considers ELVs context in Italy, taking into account ASRs physical–chemical features and current processing practice, focusing on the enhancement of secondary materials recovery. The application in waste-to-energy plants, cement kilns or metallurgical processes is also analyzed, with a particular attention to the possible connected environmental impacts. Pyrolysis and gasification are considered as emerging technologies although the only use of ASR is debatable; its mixing with other waste streams is gradually being applied in commercial processes. The environmental impacts of the processes are acceptable, but more supporting data are needed and the advantage over (co-)incineration remains to be proven.

Contents

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1. Introduction

Throughout the European Union about 14 million tons of End-of-Life Vehicles (ELVs) are foreseen by 2015 (GHK/BioIS, 2006). The aim of the Directive 2000/53/EC is to minimize the environmental impact of ELVs by defining procedures concerning the design of vehicles, the requirements for collection and treatment facilities of ELVs and the fulfilment of targets for the reuse of some components, the recycling of secondary materials and energy recovery. The achievement of a total Recycling and Recovery (RR) rate equal to 95 wt%, including a 10 wt% limit for thermal valorization, of an ELV has been stated for 2015.

The ELVs treatment chain begins with pre-shredding operations: a decontamination step (i.e. removal of battery, lubricants and fuel, accounting for about 3–4 wt% of an ELV) (Schmid et al., 2013) and the dismantling of spare parts and recyclable materials (i.e. bumpers, tires, fuel tanks, glasses, accounting for about 5–10 wt% of an ELV) (Schmid et al., 2013) are performed in Authorized Treatment Facilities (ATFs). Once the ELV has been pre-treated, the obtained hulk is then shredded and processed to recover valuable metals (about 60–65 wt% of ferrous alloys and about 3–5 wt% of other metals) (Nourredine, 2007) that are recycled in foundry processes. Conventional shredding facilities actually recycle up to about 70 wt% of an ELV (Santini et al., 2012; Fiore et al., 2012; Schmid et al., 2013) (see Table 1). The residual fraction, accounting for about 20–22 wt% of an ELV, is an heterogeneous material defined Automotive Shredder Residue (ASR) (Fiore et al., 2012; Morselli et al., 2010). Berzi et al. (2013) analyzed dismantling and decontamination operations in 70 Italian ATFs and outlined the vulnerability of these steps in ELVs processing chain: no serial processing lines exist in the considered facilities, and many possible improvements are possible to enhance RR rate and to minimize critical issues about ASR composition, although the negative effect of improved pre-shredding operations on the overall economic convenience of ELVs treatment chain has already been underlined (Ferrao and Amaral, 2006a,b).

In many EU Countries landfilling is currently the most diffused destination for ASR (Kurose et al., 2006), but the final disposal of

Table 1
Estimate of a mass balance for an ELV.

Component	wt%
Hazardous components	3–4[a]
Recyclable components and spare parts	5–10[a]
Ferrous alloys	60–65[b]
Other metals	3–5[b]
Car fluff	20[c]–25[d]

[a] Schmid et al. (2013).
[b] Nourredine (2007).
[c] Fiore et al. (2012).
[d] Morselli et al. (2010).

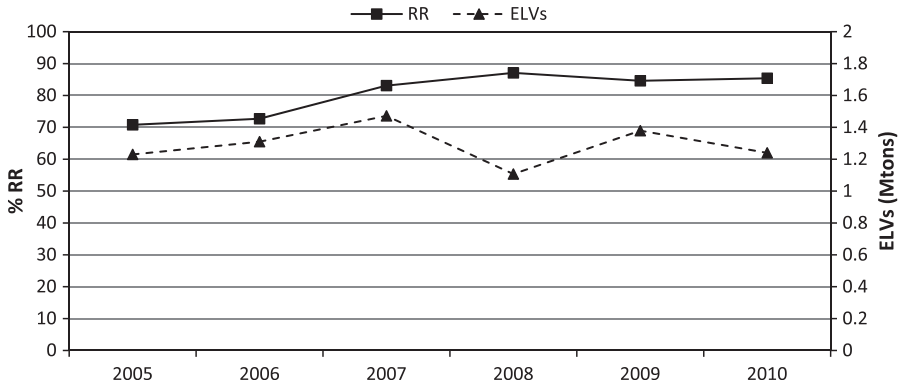

Fig. 1. Trends of ELVs and recycling and recovery (RR) rate between 2005 and 2010 (Eurostat, 2013).

Table 2
Vehicles circulating in Italy by age (ENEA, 2011).

Age	2000			2005			2009		
years	Gasoline	Diesel	Total	Gasoline	Diesel	Total	Gasoline	Diesel	Total
0–1	1.461.835	755.791	2.217.769	941.162	1.353.625	2.294.815	1.265.869	950.977	2.216.894
1–2	1.692.516	725.706	2.418.366	1.281.049	1.413.219	2.384.914	1.086.676	1.131.132	2.217.942
2–3	1.868.119	562.962	2.431.152	1.196.016	1.183.836	2.380.105	1.121.718	1.443.943	2.565.723
3–4	1.987.936	428.965	2.417.049	1.355.538	1.040.363	2.396.144	989.642	1.397.792	2.387.514
4–5	1.424.895	277.457	1.702.407	1.577.890	911.092	2.489.171	936.668	1.329.606	2.266.314
5–6	1.503.633	158.488	1.662.139	1.614.170	835.513	2.449.865	946.961	1.331.746	2.278.974
6–7	1.462.454	128.087	1.590.562	1.614.107	687.197	2.301.435	1.148.529	1.087.963	2.236.704
7–8	1.461.868	116.355	1.578.269	1.754.784	523.973	2.278.819	1.278.286	934.928	2.213.432
8–9	2.044.041	149.078	2.193.354	1.837.102	391.609	2.228.838	1.454.238	793.702	2.248.100
9–10	1.894.351	90.946	1.985.355	1.259.418	245.244	1.504.709	1.456.873	705.066	2.162.095
10–11	1.794.618	104.106	1.898.814	1.177.742	134.942	1.416.006	1.314.152	536.361	1.850.627
11–12	1.595.867	163.386	1.759.370	971.315	103.197	1.280.955	1.352.765	383.271	1.736.067
12–13	1.239.549	201.952	1.441.581	1.082.201	86.509	1.168.737	1.339.197	271.213	1.610.511
13–14	918.486	205.641	1.124.189	1.320.783	102.562	1.423.427	805.824	156.030	961.889
14–15	723.029	166.671	889.762	982.704	56.432	1.039.156	762.203	82.697	844.916
15–16	584.729	144.819	729.596	846.796	61.787	908.612	651.539	60.830	712.382
16–17	467.587	121.978	589.614	696.238	88.541	784.842	562.518	49.353	611.886
17–18	404.325	73.681	478.050	503.631	107.691	611.349	660.895	59.170	720.105
18–19	334.356	69.918	404.326	360.701	107.913	468.628	487.915	39.797	527.730
19–20	309.944	55.020	365.010	272.817	88.056	360.894	429.752	45.357	475.129
>20	2.601.386	96.502	2.707.081	2.201.216	287.592	2.496.064	2.944.942	574.832	3.526.856
Tot.	27.775.524	4.797.509	32.583.815	24.847.380	9.810.893	34.667.485	22.997.162	13.365.766	36.371.790