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HANDLING SPECIFIC ISSUES OF WASTE HAZARDOUSNESS EVALUATION ACCORDING TO WASTE TYPE

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Abstract

The aim of this article is to demonstrate for one relevant case study how to make a correct waste classification according to the harmonized European laws facing different issues according to the waste type. Waste hazard characterization should be based on data about waste source/origin, waste producing process, waste description, data on the waste appearance, composition as well as results from tailored prescribed analytical tests to complement the necessary information in different producer's management scenarios in order to have a documented characterization. The resulted customized step wise methodological approach should guide any producer to seek specialized information from a third party in case of doubt on waste hazardousness, namely when the generated waste is a "mirror entry" type. The conclusions are presented in relation to the beneficial impact for the waste producer in order to positive responds to the European endeavor of waste improvement management creating the premises to make a transition to a circular economy.

Key words: hazardousness, wastes, waste classification

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1. Introduction

In order to achieve an adequate waste management all over EU countries, of particular interest is the classification of hazardous waste. "Hazardous waste" is defined by the Article 3(2) of the WFD (EC Directive, 2008) as "*waste which displays one or more of the hazardous properties* HP1÷HP15 (English acronym for Hazardous Property) *listed in Annex III" annex* that subsequently has been updated and replaced with the Annex of EU Regulation 1357/2014 (EC Regulation, 2014). The HP1÷HP15 properties can be imparted to the wastes by the content of hazardous substances or compounds. In the EU those hazardous substances or compounds are regulated by: 1) Regulation nr. 1272/2008 (EU Regulation, 2008) for hazardous substances and compounds known also as CLP Regulation (English acronym for Classification, Labeling and Packaging) that adapts for the EU the UN international chemicals classification GHS (English acronym for Globally Harmonized Systems) and 2) REACH Regulation (EC) 1907/2006 (EC Regulation, 2006) that is EU law for the chemicals. CLP Regulation states that hazardous substances and compounds should have assigned for their inherent hazardous properties *harmonized hazard statements codes*. In Annex VI Table 3.1 of CLP Regulation (EC Regulation, 2008) there is the official harmonized classification list of substances using those hazard statements codes. All manufactures/suppliers in their SMDS (English Acronym for Safety Material Data Sheets), have the legal obligation to communicate the data/information about their products by using those harmonized statements codes. With this kind of relevant gathered data/information any producer/holder has the duty to make a self-classification of the waste according to LoW. "Since many wastes are complex mixture of

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many elements and substances and since many elements may occur in several substances, this is not a trivial task – and at present, no guidance is provided by the EU Commission" (Hennebert et al., 2014). Sometimes, producer/holder might be able to find an exact match with an item from LoW and thus to make a correct waste self-classification. Some other times, the endeavor requires specialized knowledge from different areas of activities such as chemistry, analytical chemistry, engineering and especially environment risk assessment. This is usually the case with the so called "mirror entry" type of waste. In LoW "mirror entry" is a pair of at least two alternative entries named Mirror Non-hazardous waste (English acronym MN) and Mirror Hazardous waste (English acronym MH). In usual practice "most of the time no clear difference is made between hazard and risk assessments. Waste should be classified for hazard and managed for risk in its intended use of management scenario" (Hennebert, 2018). The "risk conceptually is described as R= [f(I) x f(P)]-f(D) where: F(I) represents an "intrinsic risk" factor that is a function of the characteristic nature of the agent or dangerous properties of the hazard; f(P) is a "presence" factor that is a function of the quantity of the substance or hazard released into the environment/human environment, and f(D) represents a "defense" factor that is a function of what society can do in terms of both protection and prevention to minimize the harmful effects of the hazard" (Asante-Duah, 2017). That is precisely why the environmental risk assessment should be a useful expertise in order to understand toxicological risk implications for human health and environment (Cuciureanu et al., 2017; Stanescu et al., 2013). As Shukla et al. (2017) "the greatest challenge in environmental toxicology is to understand the effects of mixture toxicity".

Therefore, the possibility that after disposal, due to different interactions, some waste might become hazardous is also considered. In the past, due to lack of an appropriate legislation for waste, misclassified hazardous wastes produced over the years contamination of soil, ground and surface waters. In last years, uncertainty brought by the waste pollution, when misclassification or inappropriate management occurred - emphasized the necessity of sites environmental assessments using reliable pollution evaluation and monitoring methods (Hennebert et al., 2016; Hossain et al., 2017; Oprea et al., 2017; Pecorini et al., 2017; Reichert et al., 2015; Stiernström et al., 2016; Xu and Liu, 2009; Zhang et al., 2010) able to adequately assess and predict the severity of site pollution consequences (Kim and Arama, 2018). Involving equally the general public and industry to work together can facilitate the implementation of timely measures for protecting the environment (Arama, 2007a, 2007b; Arama and Nicolau, 2009a, 2009b, 2009c; Arama et al. 2010a, 2010b; Arama et al., 2015; Arama et al., 2017a, 2017b; Das et al., 2012; Gheorghe et al., 2010; Musee et al., 2006).

In this paper our research interest was focused to design an easy to use waste management methodology for the implementation of European harmonized main legal requirements namely: 1) Directive 2008/98/EC (EC Directive, 2008) also referred to as the Waste Framework Directive or WFD - English acronym for Waste Frame Directive and 2) Directive 2000/532/EC (EC Commission Decision, 2000) also referred to as LoW - English acronym for List of Waste. We are proposing a step wise methodological approach that is meant to help producer/holders to find specialized advice for an appropriate wastes classification whenever in doubt about the hazardous character of their produced wastes and to help apply waste hierarchy in their management (Arama and Kim, 2016).

2. Case study

A relevant case study for a "mirror entry" type of waste was considered. It represents monthly sediment coming from a local waste water treatment plant of an industrial professional car washer. The intended producer/holder waste management scenario was to monthly hand over the waste to a specialized waste management firm. The management firm asked to the waste producer *a documented declaration* that the waste is not hazardous through materials and chemicals that monthly waste batches might contain. According to the current applicable law, a waste has to be either hazardous or non-hazardous in the LoW. AH (English acronym for Absolute Hazardous) are hazardous waste entries that are classified without any further assessment. The same is valid for AN (English acronym for Absolute Non-Hazardous) that are non-hazardous wastes. MN (English acronym for Mirror Non-Hazardous) and MH (English acronym for Mirror Hazardous) are wastes requiring further steps in the assessment to assign a correct code.

LoW uses a six digits codes for over 800 different wastes entries, those with asterisk (*) being considered hazardous all others being considered non-hazardous. Mirror entries cannot be automatically considered hazardous or non-hazardous. These wastes have in the LoW: a) a hazardous waste entry (or entries) - marked with an asterisk (*) and b) an alternative paired non-hazardous waste entry (or entries) - without asterisk (*). It should be noted that within LoW a hazardous mirror has either a "specific" or a "general" reference to "hazardous substances".

The hazardous entry is chosen and, the waste is classified as hazardous if this waste contains any dangerous substances at or above legally required level. In those situations, when "mirror entries" are involved and producers/holders are in doubt about their self-classification they can seek advice to check the hazardous substances in relation to different possible waste management alternatives (user scenarios).

For this situation we are proposing the following scheme from Fig. 1 summing up the legal requirements to help producers to make a correct classification. In the presented case study, by applying the general guidance for waste self-classification, the producer classified it under the Chapter *19 - Waste from waste treatment facilities, off-site waste water treatment plants and the preparation of water intended for human consumption and water for industrial use and Sub-chapter 19 08 - Waste from waste water treatment plants not otherwise specified. Within this sub-chapter, the most probable assigned code was 19 08 02 - Waste from disanding.*

However, because the producer knows that it uses three types of commercial products containing substances with hazardous statements codes, he understood that might be in the "mirror entry" type of waste case. He asked us for a third party review and a documented classification applying the precautionary principle.

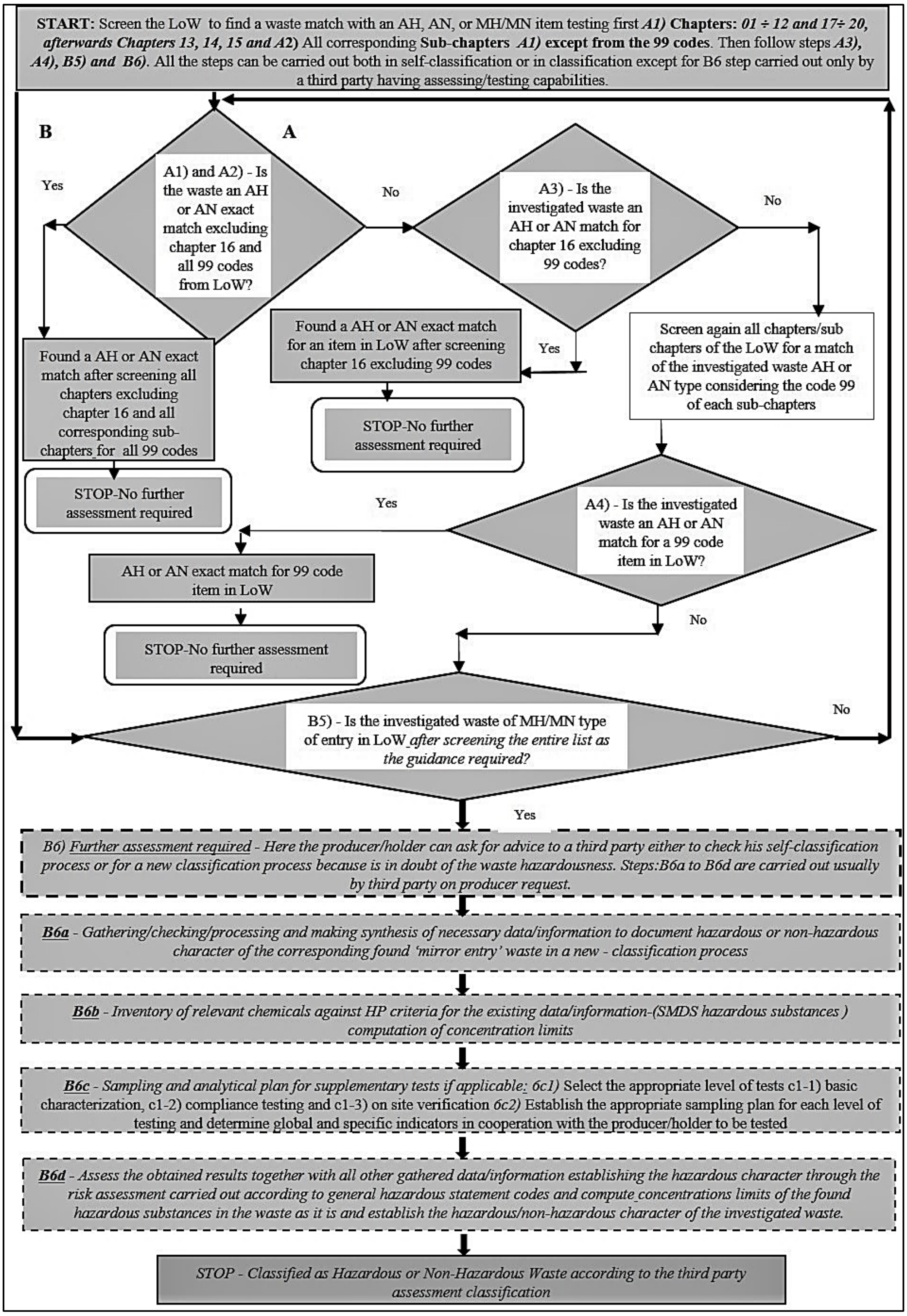

Fig. 1. Stepwise methodological self-classification/classification approach for waste according to LoW and current applicable legislation

We proceeded following a customized procedure (Fig. 1 step B6) to obtain a correct classification, because the producer knows that "waste characterization is an essential requirement in the development of an effective industrial waste management plan" (Misra and Pandy, 2004). Next, there are presented the results and discussions for this case study.

3. Results and discussion

Fig. 2 shows that the waste is coming from the bottom of the local waste water treatment settling tank. Here monthly sediment is produced through sedimentation of the dispersed matters contained in the waste waters from washing and polishing activities in gravitational field (Fig. 2).

The sediment has the aspect of an humid, solid, with a gris dark color, with non-homogeneities given by macroscopic (visible) particles of sand and small soil humid conglomerates. The collected sediment is odorless, has enough initial fluidity to be poured into the sample collection recipient. Over few days, it has the tendency to further produce by gravitational sedimentation a clear, non-opalescent superficial layer of water without any visible organic traces confirming its preponderant inorganic composition (Table 1). We found that the nearest match in the LoW for the investigated waste is *Chapter 19 - Waste from waste treatment facilities, off-site waste water treatment plants and the preparation of water intended from human consumption and water for industrial use, Sub-Chapter 19 08 - Waste from waste water treatment plants not otherwise specified*. The "mirror entry" type of waste under *Sub-chapter 19 08* is the pair: (*MH) - 19 08 13* sludge containing dangerous substances from other treatment of industrial waste water* and (*MN) - 19 08 14 sludge from other treatment of industrial waste water other than those mentioned in 19 08 13**.

We asked for more information about organic/inorganic substances/hazardous substances that might come from the three used commercial products, as well as all kind of other useful data/information that the producer could offer to us in order to document the hazardous or non-hazardous character of the specific investigated waste and we proceeded to the step B6a from the Fig. 1.

Step B6a. - Gathering/checking/processing and making synthesis of necessary data/information to document hazardous or non-hazardous character of the corresponding found "mirror entry" waste in a new – classification process

This specific waste can contain in its humidity (type of water that is released by drying the sample at the 105°C) parts of the used products from the washing and polishing activities. So, the hazardous investigated organic substances will be found in the humidity of the sediment and their concentrations in the waste, should be checked. The SMDS of the commercial used products - named in this paper: P1, P2, P3 - present in detail all the contained hazardous substances together with their hazard statement codes and mass percentages. The estimative monthly consumptions are as follows: P1 (polishing wax): 4.5 L/monthly, P2 (commercial detergent): 210 L/monthly, P3 (odorizing product): 3 L/monthly. In addition, 9000 L of washing water have been consumed daily for an average of 100 cars which represent about 270 000 L/month. All used products are liquids and their properties justify the consideration of the density of the used water solutions as being equal to that of the water. The gathered data and information about the assessed waste can be synthesized as follows. The sample sediment is an inorganic type of sludge that can be made of lighter and smaller dust particles that are adherent to the car body. Also, it can contain bigger and heavier soil and sand particles that adhere to the cars wheels. As nature, the smaller particles of soil can be particles of clay minerals that are natural aluminum-silicates. Clay minerals are composed essentially of silica, alumina or magnesia or both and hydration water. They can contain also iron that substitutes aluminum and magnesium in varying degree and also appreciable quantities of potassium, sodium and calcium are frequently present.

The amount of each collected batch of waste sediment (sludge) that comes from the desanding phase is approximately 1000 kg/monthly - and its composition is obviously highly variable regarding the metal/heavy metal content that can be part of *different types of aluminum-silicates* (e.g. Si, Al, Na, Ca, Fe, Mg etc.). The waste main content, upon the visual aspect and its origin, seems to be Si, component of sands and of aluminum-silicates particles. That was confirmed by the analytic report of the analyzed average batch sample that showed 248100 mg/kg of dry solids (i.e. approximately 24.8 mass %). In those conditions, the pollution risk assessment from compounds containing heavy metals upon the environmental compartments like soil, surface water and air has not been considered because of the declared intended producer' waste management scenario.

In this scenario, the waste will be transported as it is, in humid state. It will not be abandoned anywhere on the ground in an uncontrolled manner to pollute soil reaching targets like animals and humans through the food chain. It will not be discharged into surface water courses to affect also aquatic ecosystems or animals and humans by oral ingestion and it will never reach in a micron powder state (1÷10 μm) neither in transport nor in disposal phases so that particles to become air borne and reach the atmosphere being breathe by animals and humans. The literature in the field (Chiochetta et al. 2014, Fajcikova et al., 2014, Yang et al., 2018) mentions that "thoracic particle fraction, PM10 delineates a subset of inhalable particles that are thought small enough to penetrate to the thoracic region (including the tracheo-bronchial and alveolar regions) of the respiratory tract.

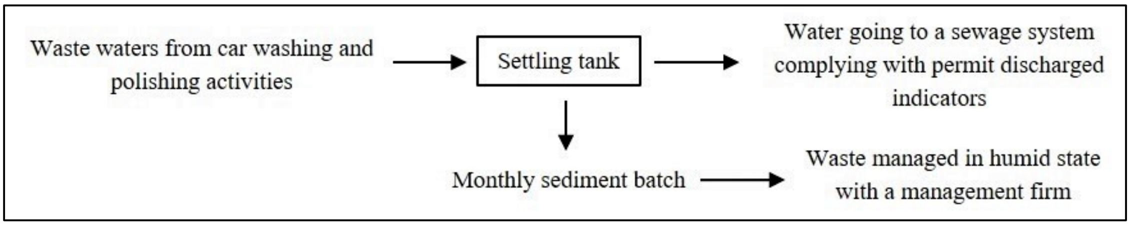

Fig. 2. Waste water treatment plant – settling tank where the monthly sediment batch is collected

In 1997, the EPA extended size-selective sampling to include fine particles indicated by PM 2.5 (particles with a nominal mean aerodynamic diameter ≤ 2.5 μm) and retained PM10 as the indicator for thoracic coarse particles". So, those compounds might be hazardous for the environment compartments like soil, surface water and atmosphere through the heavy metal content only in those situations. The analyzed waste has the analytically determined humidity of 29.8 mass % (Table 1) it is not in powder form and has a coarse sandy granularity visible with naked eye. This information allowed us to exclude the consideration of other not applicable environmental risk scenarios. Consequently, only the concentrations of the hazardous substances from the three used commercial products in the sludge (sediment) humidity will be checked to document the type of hazardous or non-hazardous character of the waste for the appropriate ecological landfill disposal.

Step B6b. - Inventory of relevant chemicals against HP criteria for the existing data/information-(SMDS hazardous substances) computation of concentration limits

For this kind of computation, we took the concentration information gathered in step B6a for substances having a hazardous statement codes according to the SMDS commercial products 1, 2, 3. Those concentrations are expressed as min-max concentrations (Table 2 column 2).

We used those data in the hypothesis of maximum concentrations of hazardous substances/compounds in the mixture that constitutes each commercial product. We decided about this proactive approach as being the most protective from the ecological point of view. We performed the computation from Table 3 in the way that is presented in more details next.

We considered each commercial used product 1, 2 and 3 and we made an inventory (Table 3) of its contained hazardous substances having assigned different hazardous statements codes. We screened afterwards each of those hazardous statement codes against different HP criteria. We checked what type of hazardous property might be induced by them to the waste if computed substances' concentrations in the humidity of the waste, where they can reach in the dissolved state following the gravitational sedimentation in the settling tank, are over the stated limits regulated by EU Regulation nr. 1357/2014 and Romanian Law 211 (2011) (L. 2011). Next, an example for how computation has been made considering only HP 4 hazardous property is presented. The same algorithm has been applied for all other waste hazardous properties presented in Table 3. The hazardous property *HP4:"Irritant – skin irritant and ocular lesions"* can be induced to a waste if the waste contains one or more hazardous substances that have one of the following hazardous statements codes that include where applicable hazardous codes for class and category: *H314 - Skin corrosion 1A*, *H315 - Skin irritant 2*, *H318 - Eye damage 1* and *H319 - Eye irritant 2*. When the limit of concentration of those substances is ≥1% in the waste then the waste is hazardous. Related to this given example, for the substances that are classified as *H314 - Skin corrosion 1A, 1B, 1C* there is also the following exception: when their total concentration is ≥ 5 mass % then they are inducing to the waste the hazardous property *HP8: "Corrosive"* not *HP4: "Irritant – skin irritant and ocular lesions"*. We computed the total concentration for the substances classified as H314 - Skin corrosion 1. Actually, only products P1 and P2 have this kind of substances. In *Product 1* we found the substance identified by CAS 64-19-7 - Acetic Acid being in a concentration of <25 mass %. The average monthly consumption of this commercial is about 4.5 L. Total amount of this substance existing in the monthly consumed product of 4.5 L is about 0.011 kg. This substance is contained in the humidity of the sample at the level of 1.222 x 10^{-5} kg representing 1,2221x 10^{-6} in mass%. In *Product 2* we found the substance identified by CAS 1310-73-2 - Sodium Hydroxide being in a maximum concentration of mass 5%. The average monthly consumption of this commercial product is 210 L. Total amount of this substance existing in the monthly consumed product of 210 L is about 10.5 kg. This substance is contained in the humidity of the sample at the level of 0.0116 kg representing 1.161x10^{-3} in mass %. The total mass percentage of substances having the property *H314 - Skin corrosion 1A* in the humidity of waste is about 1.161x10^{-3} %. This result of 0.001% is compared with 1% legal limit (Table 3 – column 3) and the conclusion is that the investigated waste is not dangerous according to the hazardous statement code *H314 - Skin corrosion 1A.* (Table 3 - column 4).

The concentrations of the components that might impart hazardous properties HP1÷HP15 have been computed and tested this way against the regulated limits (Table 3).

It should be noted that taking into account the producer intended management scenario:

1) the hazardous statement codes *H225 - flammable liquid 2* and *H226 – flammable liquid 3* for the substances have not been taken into consideration due to the fact that waste physical state makes improbable to develop those properties, the concentration of the substances with those hazardous statements codes in the humid sludge being at the level of 1.221 10^{-6} in mass (%).

2) the hazardous statement codes *HP400÷HP412* marked with **) in Table 3 for substances that can induce acute or chronic toxicity for the aquatic environment were not assessed also due to the fact that waste will never reach the aquatic environment. Table 3 is summarizing, according to each hazardous found property: HP4, HP5, HP6 and HP13 the quantitative assessment of the waste hazardousness.

The assessment is based: 1) for HP4, HP5, HP6 on sum concentrations of relevant substances and for 2) HP13 is based on comparison of the concentration of each relevant substance individually against concentration limit.

Table 1. Sample analytic determination and analytical used methods

Nr. Crt.	*Indicator*	*U.M. (Unit of measurement)*	*Determined Values*	*Used Method of Determination*
1	pH	pH units	6.9	ISO 10390:2015
2	Water content**	%	29.8	SR* ISO 11465:1998
3	TOC (Total Organic Carbon)	% d. s. (dry solids)	1.96	SR ISO 10694:1998, SR* EN 13137:2002, SR* EN 15936:2013
4	Silicium	% d. s. (dry solids)	24.81	SR* EN ISO 15309:2008

**SR is the Romanian abbreviation for "Standard Roman"*

Table 2. Dangerous properties according to Regulation (EU) No.1357/2014

Com-mercial product No. /Compo-nents CAS No.	*Compo-nents' Product Concen-tration range*		*Hazardous Statement of the components according to CEE 67/548 and according to Regulation (EU) No. 1357 /2014*															
1)	*(2)*		*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*	*(10)*	*(11)*	*(12)*	*(13)*	*(14)*	*(15)*	*(16)*	*(17)*	*(18)*
	min. %	***max. %***	***H225 **)***	***H226 **)***	***H290***	***H302***	***H304***	***H314***	***H315***	***H317***	***H318***	***H319***	***H332***	***H336***	***H400 **)***	***H410 **)***	***H411 **)***	***H412 **)***
Commercial product No. 1(polishing wax) - components																		
1.1. CAS No. 112-34-5	**12.5**	**15**										**x**						
1.2. CAS No. 28065-97-6	**5**	**7**				**x**									**x**			
1.3. CAS No. 854040-17-7	**3**	**5**							**x**			**x**						**x**
1.4. CAS No. 9004-78-8	**1**	**3**				**x**					**x**							

***) is for the hazardous statements codes that have not been considered due to waste physical state and specific considered waste management scenario.*

1.5. CAS No 100-52-7	**1**	**3**				**x**												
1.6. CAS No.68783-78-	**0.5**	**1**				**x**					**x**					**x**		
1.7. CAS No. 68647-72-3	**<0.25**	**-**		**x**			**x**		**x**	**x**					**x**	**x**		
1.8. CAS No. 127-51-5	**<0.25**	**-**								**x**							**x**	
1.9. CAS No. 141-78-6	**<0.25**	**-**	**x**									**x**		**x**				
1.10. CAS No. 64-19-7	**<0.25**	**-**						**x**										
Commercial product No. 2 (commercial detergent) - components																		
2.1. CAS No. 29329-71-3	≥5	<7			**x**	**x**						**x**						
2.2. CAS No. 68081-91-4	≥5	<7							**x**			**x**						
2.3. CAS No. 1310-73-2	≥3	<5						**x**										
2.4. CAS No. 64-02-8	≥1	<3				**x**					**x**		**x**					
2.5. CAS No. 112-34-5	≤1	<3										**x**						
Commercial product No 3 (commrcial odorizant) - components																		
3.1. CAS No. 69011-36-5	≥5	<7				**x**					**x**							

3.2. CAS No. 56539-66-3	**≥1**	**<3**										**x**						

Results from the performed computation showed that the waste is not hazardous due to the contained hazardous substances from the commercial used products. In addition, we considered necessary to support the non-hazardous character of the investigated waste with few supplementary tests. In cooperation with the producer, we initiated also a testing analytical plan in order to choose the relevant indicators needed to be used in the final waste classification decision.

StepB6c. - Sampling and analytical plan for supplementary tests if applicable:

As the literature in the field mentions (Stiernström et al., 2016) "harmonized European standards relevant for the assessment of hazardous waste classification however are lacking". In this respect the present proposed scheme is trying to help producer to seek advice for a relevant analytical plan tailored on its needs. We established also the analytical procedures to be used in order to find relevant results of defendable quality (Darbra et al., 2008). For those proposed analytical tests, the sample should be representative for the investigated waste both at spatial and temporary level. The chosen general characterization of the waste can be done with some non-specific, global indicators that can give an "estimation" about the waste composition. Those indicators can be for example: Total Organic Carbon – (English acronym TOC), Suspended Solids, Extractable Substances, and Leachable Substances/Percolating Substances. For this present case study we have chosen the TOC indicator as relevant in order to have a global, non-specific characterization of the organic content (Table 1). Apart from these global indicators for a waste characterization we can use also different specific indicators depending on the type of waste. One example are heavy metals. In any investigated waste those heavy metals are expected to be contained in different compounds/species.

In this respect Hennebert et al. (2013), whose research interest was to find a European harmonized analytical plan for waste characterization, emphasize that for the purpose of waste classification, the current practice to report the obtained total content of analytically determined elements is by "stoichiometric" transforming them in "possible" mineral compounds or species "estimated" by the assessor to be found in waste. This "estimation" should be based on a thorough assessment of data/information about the investigated waste gathered from the producer or from any other reliable source of information. Actually, those "estimated" compounds/species are considered to be checked for hazardous properties (hazardous statement codes) to see if they can induce hazardous properties to the waste, by assessing them against HP waste criteria according to the current legislation. One can obtain this way a "rough estimation" of the hazardous waste composition. For our specific case study, balancing among analytical costs of supplementary tests and the declared waste management scenario, we made the decision to determine the amount of Si in the batch waste sample based on the following knowledge and information. As we have already presented the Si can be in the form of sand particles with formula SiO_2 and in the form of natural aluminum-silicates having as general formula $xAl_2O_3ySiO_2H_2O$. So, the Si content can be reported by stoichiometric transformation both in SiO_2 and in any of the many types of natural aluminum - silicates that we can choose. The question is "what appropriate mineral is to choose?" Given the present case study, we decided that clay type of aluminum-silicates will be the most appropriate type for our specific case study. One example might be montmorillonite with formula $(Na, Ca)_{0.33}(Al\ Mg)_2(Si_4O_{10})(OH)_2.mH_2O$, and another example might be kaolinite with formula $Al_2SiO_5(OH)_4$. We gave specifically those examples to emphasize that in those two different types of clay, the Si amount can vary from one to four Si atoms. Also, the amount of hydration water that is usually lost at higher temperature (above 105°C the temperature at which we determined the humidity - Table 1) and higher pressure conditions can vary also very much from one mineral to another. So those compounds, by definition, can have water in their structure. Because the waste is collected after one month sedimentation at the bottom of the settling tank and because usually clay types particles for example can take in a lot of water having well known swelling properties - for e.g. 1 g of montmorillonite clay mineral can absorb 170 mg of water as the literature shows (Zhang et al., 2014) - for the current necessities any "stoichiometric" transformation of the determined amount of Si in those kind of "possible" minerals or compounds will close the mass balance in an acceptable manner. How much Si can be reported by transforming it to SiO_2 and how much in "possible" aluminum – silicates will not change the inorganic character of the waste as the TOC analysis Table 3 – confirmed. The total organics accounts only for 2 masses %. Indicators that have been analytically determined in order to characterize and classify present waste and the corresponding working standardized analytical methods used are presented in Table 1.

Table 3. Computations of HP4, HP5, HP6 and HP13 properties

Waste Hazarous Property (English abreviation HP) according to Regulation No. 1357/2014	***Codes of hazardous statement and concentration limit for the components - identified by chemical name and (CAS No.) – found in the commercial used products (generic named in this table P1, P2, P2 ; near each substance exists a note „alone" or in „presence of other hazardous statements codes" with relevance for possible cumulativ effect***	***Testing of the substance(s) concentration(s) from P1, P3, P3 found in waste, against the limit values in brackets* from column (2)***	***Yes/No hazardous waste conclusion according to the hazardous statement code mentioned in column (2)***
(1)	*(2)*	*(3)*	*(4)*
HP 4 „Irritant –skin irritant and eye damage" waste which on application can cause skin irritation or damage to the eye	**H314:Skin corr 1 (≥1 %)*** **a)** Acetic Acid (CAS 64-19-7) **in P1** - H314 alone; **b)** Sodium Hydroxide (CAS 1310-73-2) **in P2** - H314 alone	***Total substances' conc. from P1+P2 $1.161.10^{-3} < 1\%$***	**No hazardous waste *(H314)***
	H315:Skin irrit 2 and H319:Eye irrit 2 (≥ 20%)* **a)** Salts of aliphatic ammines **in P1** - H315 in the presence of H319 and H412; **b)** Ethoxylated alcohols C12÷C18 (sodium salts) (CAS 68081-91-4) **in P2** - H315 in the presence of H319	***Total substances' conc. from P1 $1.65.10^{-3} < 20\%$***	**No hazardous waste *(H315 and H319)***
	H315:Skin Irrit 1 (≥1%)* **a)** Orange Extract Aroma (CAS 68647-72-3) **in P1** - H315 in presence of H226, H304, H317, H400, H410	***Total substances' conc. From P1 $1.221.10^{-6} < 1\%$***	**No hazardous waste *(H315)***
	H318: Eye damage2 (≥1%)* **a)** Ethoxilated phenols (CAS:9004-78-8) **in P1** - H318 in the presence of H302; **b)** Ditalow diamonium chloride (CAS 68783-78-8**) in P1** - H318 in the presence of H302, H410; **c)** EDTA Ethylene Diamino Tetra Acetic acid (CAS 64-02-8) **in P2** – H318 in the presence of H302, H410; **d)** Iso-tridecanol ethoxylate (CAS 69011-36-5) **in P3** - H318 in the presence of H302	***Total substances' conc.from P1+P2+P3 $7.42.10^{-4} < 1\%$***	**No hazardous waste *(H318)***
	H319:Eye irrit 2 (≥1%)* **a)** Butoxidiglicol:CAS:112-34-5 **in P1** - H319 alone **b)** Acetate de ethyl (CAS 141-78-6) **in P1** - H319 in the presence of H336; **c)**Methoxy-methyl butanol (CAS 56539-66-3) **in P3** - H319 alone	***Total substances' conc.from P1+P3 $1.821.10^{-5} < 1\%$***	**No hazardous waste *(H319)***
HP5 „Specific Target Organ Toxicity (STOT)/Aspiration Toxicity When substances calssified as STOT are present in a waste , an individual substance has to be present at or above the concentraion limit for the waste to be classified as hazardous by HP5	**-H371 or H373 or H304(≥10%)*** **a)** Orange Aroma Extract (CAS 68647-72-3) **in P1** H371/H373 /H304 in the presence of H226, H315, H317, H400, H410;	***Total substances' conc.from P1 $1,221.10^{-6} < 10\%$***	**No hazardous waste *(H304)***
	H336 identical with H335: (≥20%) * **a)** Acetate de ethyl (CAS 141-78-6) **in P1 –** H336(H335) in the presence also of H319, H225*	***Any substance with conc.from P1 $1,221.10^{-6} < 20\%$***	**No hazardous waste *(H336(≡H335))***
HP6 „Acute Toxicity waste which can cause acute toxic effect following oral or dermal adminstration, or inhalation exposure" H302 Oral acute toxicity 4)	**H302:(≥25 %)*** **a)** Oleic acid compound with (Z) octadec-9-ethilen-diammine (1:1) CAS 28065-97-6 **in P1** - H302 the presence of H400; **b)** Ethoxylated Phenol (CAS 9004-78-8) **in P1** - H302 in the presence of H318; **c)** Benzaldehide (CAS 100-52-7) **in P1** - H302 alone; **d)** Ditalow diamonium chloride, CAS 68783-78-8 **in P1** - H302 in the presence of H318 and H410	***Total substances' conc.from P1+P2 $1,708.10^{-3} < 25\%$***	**No hazardous waste *(H302)***

	e) Sodium salt of biphosphonic acid (1 hidroxy-ethyliden) (CAS 29329-71-3) **in P2** – *H302 in the presence of H290 and H319;* **f)** EDTA Acid Ethylene Di-amino Tetra Acetic (CAS 64-02-8) **in P2** - *H302 in the presence of H318 and H332*		
	H332:(≥22.5%)* **a)** EDTA Acid Ethylene Diamino Tetra Acetic (CAS 64-02-8) **in P2** - *H302 in the presence of H302 and H318*	***Total substances' conc.from P2*** $7.10^{-4} < 22.5\%$	**No hazardous waste *(H332)***
HP 13 „Sensitising" waste which contains one or more substances known to cause sensitising effects to the skin or the respiratory organs. H317 or H334 ≥10%	H317 or H334 (one individual substances ≥10%) * **a)** Alfa – iso-methyl ionone (CAS 127-51-5) in P1 – H317 the presence of H 411 Orange; **b)** Aroma Extract (CAS 68647-72-3) in P1 - H317 in the presence of H226, H304, H 315, H 400, H410	***Each substance' conc.from P1*** $1{,}221.10^{-6}<10\%$	***No hazardous waste (H317)***

After performing the B6d. step we concluded: the waste is non-hazardous.

The initial classification code *19 08 - Waste from waste water treatment plants not otherwise specified* that was linked to the mirror entry corresponding to the pair:*(MH) - 19 08 13*- sludge containing dangerous substances from other treatment of industrial waste water* and *(MN) - 19 08 14 - sludge from other treatment of industrial waste water other than those mentioned in 19 08 13** can be linked now to the *(AN)* waste entry code *19 08 02 - Waste from disanding,* having the corresponding documented proves and evidences.

4. Conclusions

The aim of our research was to synthesize the current legal provisions into a methodology with an attached logic scheme for correct waste classification and to give a relevant example to show how producer/holder can carry out its self-classification when enough data and assessment capabilities exist or can seek advice to a specialized third party.

The estimated impact on the holders is that applying this proposed methodology they will be able to better respond to the updated requirements of the ISO 14001: 2015 (ISO, 2015) applied to the waste characterization in order to assess the risk of hazardous substances in different waste management scenarios. Optimizing the classification of hazardous waste is of special importance for waste management across all European countries in order to implement model of circular economy in the endeavor to recover anything valuable that can be recovered from waste, to reduce the volume to be disposed so that a maximum protection for environment and human health to be achieved.

Relevant case studies for all kind of waste environmental management scenarios will be considered in future papers showing how the proposed methodology can be implemented supporting sustainable development principles.

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