DIFFERENT STRATEGIES FOR MSW MANAGEMENT IN TWO ROMANIAN CITIES: SELECTIVE COLLECTION VERSUS BIO-DRYING

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This paper presents a comparison of two Romanian towns concerning a case-study related to the adoption of bio-drying as a strategy for the treatment of the residual municipal solid waste. Results show that the production of solid recovered fuel can be a suitable option, alternative to landfilling.

Keywords: bio-drying, incineration, MSW, selective collection, strategies, TBP.

1. Introduction

During the years, the globalization and rapid industrial development has imposed also many changes in the municipal solid waste (MSW) production and management [1,2,3,4,5,6,7,8]. National, regional and municipal governments must face with this problem frequently because all of the past low cost disposal practices are no longer acceptable.

From the 1st of January 2007 Romania became one of the European Union countries. In this context Romania must implement and comply also with all EU regulation regarding the waste management. This is one of the reasons because in Romania different studies on waste management were developed also before and after 2007 [7,9,10,11,12,13,14,15,16].

In this frame and in agreement with the new European directives concerning the implementation of MSW selective collection (SC), valorization of materials and energy recovery, a recent approach based on a one-stream Biological Mechanical Treatment (BMT) was studied and proposed for the Romanian waste management [11,13,17,18,19,20].

The aim of the proposed process, named bio-drying, is to exploit the biochemical exothermic reactions for the evaporation of most of the initial moisture of the waste, with the lowest consumption of volatile solids [11,12,20]. The obtained material can be easily converted in Solid Recovery Fuel (SRF), by a post-refinement with inert separation in concordance with the new technical norm CEN/TS 15359 [21,22].

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In Romania, as in other EU countries, the SC implementation causes a non-homogenous situation between municipalities [23,24,25]. However, since 2006 a part of the Romanian industry has begun to support and apply an environment policy; the industrial activities begun to be strongly linked with the waste management sector. A good example is the one of the Holcim cement factory, one of the most important Romanian plants, that has obtained the ISO 14001 certification [25].

Taking into account all these practices, in this paper two case-studies are analyzed: one from the south and one from the middle part of Romania.

2. Materials and methods

Vâlcea County is one of the 41 counties of Romania, having 2 municipalities, 9 towns and 78 villages. It is located in the south of Romania. The population in this county is about 406,752 inhabitants, producing about 149,200 tons of MSW per year (2012). Presently, the most part of the produced MSW is landfilled. In some parts of the county, SC is implemented. The expected efficiency in the medium term is 35%: in particular, about 6% for the materials with high lower calorific value (LHV) and about 36% for the food waste that is treated in a pilot composting plant [26].

Sibiu County is situated in the middle of the country in the southern part of Transilvania. The present population is about 425,300 inhabitants, more than 65% living in urban areas. The County consists of 53 villages and 11 urban localities (2 municipalities and 9 towns). About 160,000 tons of MSW are produced every year, of which roughly 119,000 tons of household waste, 31,500 tons of waste similar to household waste and approximately 8,800 tons of waste from parks, gardens, markets and street waste. Selective collection is implemented in urban and rural areas through a kerbside system and some collection points. Its efficiency is expected to achieve an efficiency of about 35% in the medium term [27].

In Fig. 1 the composition of residual MSW (RMSW) is presented. Even if the MSW composition and SC efficiency are similar for the presented case-studies, the composition of RMSW is very different being strongly influenced by way that food waste is collected separately according to the planned strategies (35% in the first case versus 12% in the second one).

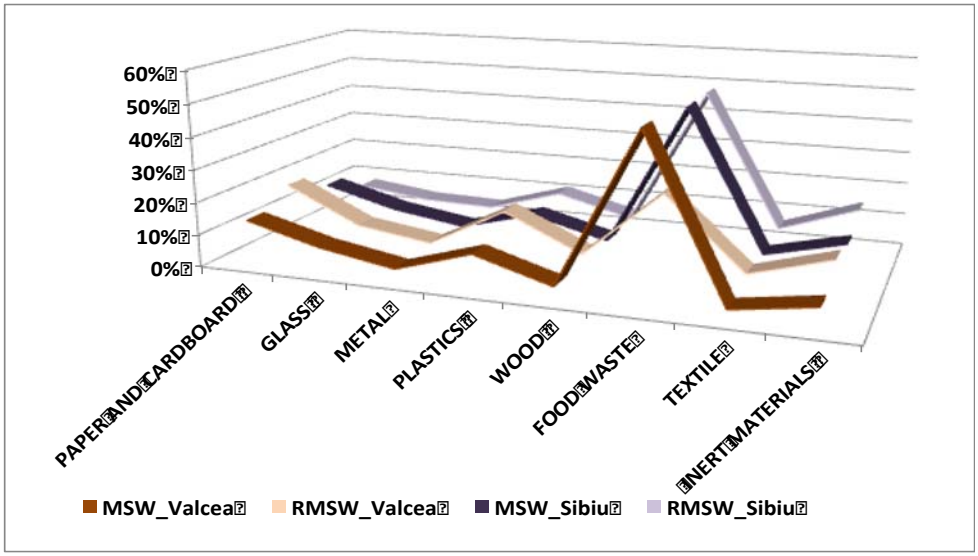

Fig. 1. RMSW for Valcea and Sibiu County

In both cases, the utility of a bio-drying (BD) facility for the RMSW treatment with the possibility of SRF generation, and the role of "Take-Back-Programs" (TBP) in order to produce SRF-like products from discarded light packaging, were considered and analyzed [17,20,28,29].

In the case of SRF production, this is obtained by a post-refinement of BD with inert separation. In the presented case-studies it was considered an efficiency of 100% as a first approximation.

Based on the ultimate analysis of each fraction of the generated waste, an estimation of LHV using direct and indirect methods was performed [30,31]. For the LHV of the bio-dried material and of SRF and SRF-like products a bio-chemical model was used [20,32,33,34].

3. Results and discussion

The two strategies (SC coupled with BD and/or TBP) pose a present-future goal for which an assessment of the real performances can be made only after a few years of implementation. The EU goal to decrease biodegradable material landfilling and increase recycling/recovery can be achieved by the introduction of the proposed strategies.

In Table 1 the results for the Valcea and Sibiu Counties, when a BD treatment is applied to the expected RMSW are presented. The main consequence of the process is an increase of the LHV and the mass volume decrease thanks to the exothermy of the process as a consequence of the volatile solids oxidation [20,32].

Table 1

Effects of BD applied in the two case studies

	Valcea County					Sibiu County				
	RMSW	BD	SRF	Mass loss	Post-treatment residues	RMSW	BD	SRF	Mass loss	Post-treatment residues
LHV [MJ/kg/]	9.5	11.8	16.0	-	-	7.1	8.5	11.3	-	-
%				25	24				26	23

From Table 1, it can be seen the importance of food waste separate collection. For the Valcea County, the LHV increase obtained thanks to the BD process is high as the percentage of food waste in RMSW is about 27%, that is a suitable value for the BD process. Also in the case of Sibiu County BD offers a clear advantage opening to a SRF production that can be interesting for co-combustion in cement factories.

In Table 2 the values of TBP from SC, taking into account the efficiency of the processes applied to paper and cardboard, plastics and wood for obtaining second material, are reported. The TBPs role is important as the residues generated from the related recycling activities of the selectively collected products, can be valorized for LHV increase of RMSW and for minimizing the landfill volume.

Table 2

TBP weights in the two case studies [21,29]

	Valcea County	Sibiu County
Paper and cardboard	4.0%	9.1 %
Plastic	6.3%	10.2 %
Wood	1.8%	2.4 %

In Fig. 2 the LHV of the all products, MSW, RMSW, BD, SRF, SRF(TPB) are reported. The SRF obtained from RMSW and TBP in the two case-studies, and the RMSW, were considered as SRF-like products.

In Table 3 the obtained class for the SRF and SRF-like products, and also the indication for their utilization are reported [21,22].

For the construction of a BD plant it must be taken into account the facility investment, the operating and maintenance costs. What is clearly different from direct combustion is the lower initial cost of the strategy.

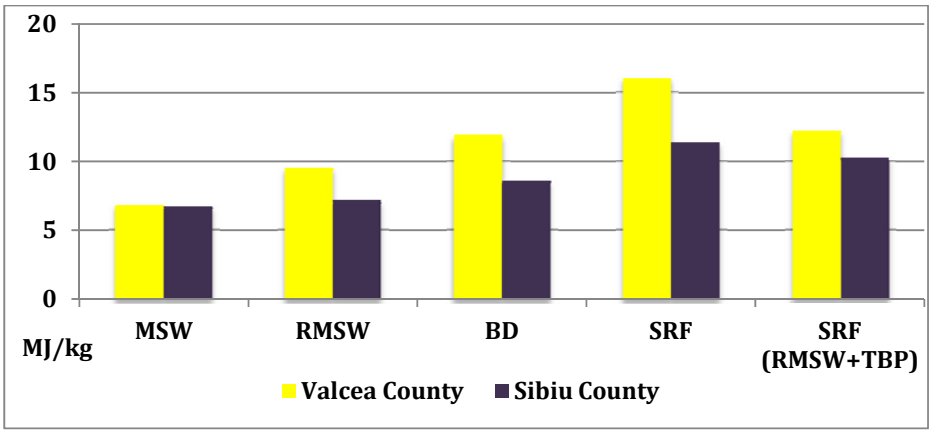

Fig. 2. LHV for all waste and SRF-like in Valcea and Sibiu County

Table 3

Generable SRF classification [21,29]

	Valcea County	Sibiu County	
MSW	5	5	Cement Factory
RMSW	5	5	
BD(MSW)	5	5	
SRF	4	4	Incineration
SRF (RMSW+TBP)	5	4	Cement Factory / Incineration

The capital cost of BD is significantly lower than the classical incineration, resulting more interesting in regions like Romania where the present economic scenario limits the availability of consistent investments at a beginning of a waste management plan.

4. Conclusions

The present paper shows some balances related to the pre-treatment of RMSW before energy recovery referred to two Romanian case-studies. Results demonstrate that even considering the expected efficiencies of SC in the medium term, the amount of food waste in the RMSW will be suitable for a BD treatment. This suitability offers the advantage of reducing the initial investments for the management of the RMSW, with an option that exploits the presence of industrial plants in the territory.

This scenario is not limited to Romania, as the effect of growing efficiencies of SC is modifying the characteristics of the RMSW in many territorial boundaries. If a cement factory is present and the construction of an incinerator is

not viable, the analyzed option should be taken into account for decreasing the landfilled volumes of waste.

Finally, the presented results show that SC is compatible with BD when its efficiency is not extreme.

REFERENCES

[1]. *A.N. Sarkar,* "Promotion of eco-innovation to leverage sustainable development of eco-industry and green growth". Int. J Ecol Deve., **vol. 25**, n. 2, 2013, pp. 71-104.

[2]. *Bringhenti, J.R., Zandonade, E., Günther, W.M.R.* "Selection and validation of indicators for programs selective collection evaluation with social inclusion". Resour Conserv Recy., **vol. 55,** n.11, 2011, pp. 876-884.

[3]. *A. Albu, P.Ivan,* "Waste management between authorities policies and residents perception". Quality - Access to Success, **vol. 14**, n. 1, 2013, pp. 441-447.

[4]. *E.C. Rada, I.A. Istrate, M. Ragazzi,* "Trends in the management of residual municipal solid waste". Environ Technol., **vol. 30**, n.7, 2009, pp. 651-661.

[5]. *E.C. Rada, M. Ragazzi, P. Fedrizzi* "Web-GIS oriented systems viability for municipal solid waste selective collection optimization in developed and transient economies". Waste Manage., **vol. 33,** n. 4, 2013, pp. 785-792.

[6]. *V. Torretta,* "Environmental and economic aspects of water kiosks: Case study of a medium-sized Italian town", Waste Management, **vol. 33**, n. 5, 2013, pp. 1057-1063.

[7]. *S. Ciuta, V. Torretta, E. Trulli, T. Apostol,* "Comparison between two cases study on water kiosks", UPB Scientific Bulletin, Series D: Mechanical Engineering, **vol. 74**, n. 4, 2012, 211-218.

[8]. *M. Vaccari, V. Torretta, C.* Collivignarelli, "Effect of improving environmental sustainability in developing countries by upgrading solid waste management techniques: A case study", Sustainability, **vol. 4**, n. 11, 2012, pp. 2852-2861.

[9]. *E. Sandilescu,* "The contribution of waste management to the reduction of greenhouse gas emissions with applications in the city of Bucharest". Waste Manage Res., **vol. 22**, n. 6, 2004, pp. 413-426.

[10]. *M. Ogak, K. Yoshizumi, J. Motonaka, T. Yabutani, Y. Nakamoto, R., Stanescu, M., Plesca,* "Studies on the environmental improvement in Romania". Int J Modern Physic B., **vol. 20**, n. 25-27, 2006, pp. 4243-4248.

[11]. *E.C. Rada, M. Ragazzi, V. Panaitescu, T. Apostol,* "Experimental characterization of municipal solid waste bio-drying". WIT Transactions on Ecology and the Environment **vol. 92**, 2006, pp. 295-302

[12]. *M. Ragazzi, E.C. Rada, V. Panaitescu, T. Apostol*, "Municipal solid waste pre-treatment: A comparison between two dewatering options". WIT Transactions on Ecology and the Environment, **vol. 102**, 2007, pp. 943-949

[13]. *E.C. Rada, M. Ragazzi, T. Apostol,* "Role of Refuse Derived Fuel in the Romanian industrial sector after the entrance in EU". WIT Transactions on Ecology and the Environment, **vol. 109**, 2008, pp. 89-96

[14]. *E.C. Rada, I.A. Istrate, V. Panaitescu, M. Ragazzi, T.M. Carlioru, T. Apostol,* "A comparison between different scenarios of Romanian municipal solid waste treatment before landfilling". Environ Eng Manje J., **vol. 9**, n. 4, 2010, pp. 589-596.

[15]. *V. Torretta, M. Ragazzi, I.A. Istrate, E.C. Rada,* "Management of waste electrical and electronic equipment in two EU countries: A comparison", Waste Manage., **vol. 33**, n. 1, 2013, pp.117-122.

[16]. *I. Ianos, D. Zamfir, V. Stoica, I. Cerleux, A. Schvab, G. Pascariu,* "Municipal solid waste management for sustainable development of Bucharest metropolitan area". Environ Eng Manage J., **vol. 11**, n. 2, 2012, pp. 359-369.

[17]. *R.M. Negoi, M. Ragazzi, T. Apostol, E.C. Rada, C. Marculescu,* "Bio-drying of romanian municipal solid waste: An analysis of its viability". UPB Sci Bull., **vol. 71**, n. 4, serie C, 2009, pp. 193-204

[18]. *E.C. Rada, M. Venturi, M. Ragazzi, T. Apostol, C. Stan, C. Marculescu* "Bio-drying role in changeable scenarios of Romanian MSW management". Waste Biomass Valor., **vol. 1,** n 2., 2010, pp.271-279.

[19]. *M. Ragazzi, E.C. Rada, D. Antoloni,* "Material and energy recovery in integrated waste management systems: An innovative approach for the characterization of the gaseous emissions from residual MSW bio-drying". Waste Manage., **vol. 31**, n. 9-10, 2011, pp. 2085-2091.

[20]. *E.C. Rada, M. Ragazzi, A. Badea,* "MSW Bio-drying: Design criteria from A 10 years research". UPB Sci Bull., **vol. 74**, n. 3, serie C, 2012, pp. 209-216.

[21]. *M. Ragazzi, E.C. Rada,* "RDF/SRF evolution and MSW bio-drying". WIT Transactions on Ecology and the Environment, **vol. 163**, 2012, pp. 199-208

[22]. *E.C. Rada, G. Andreottola,* "RDF/SRF: Which perspective for its future in the EU". Waste Manage., **vol. 32**, n. 6, 2012, pp. 1059-1060

[23]. *S. Raicu, D. Costescu, E. Rosca, M. Popa,* "Optimal planning of selective waste collection". WIT Transactions on Ecology and the Environment, **vol. 150**, 2011, pp. 785-794.

[24]. *C. Leitol,* "Resource efficiency of hungarian recycling systems". Pollack Periodica, **vol. 7**, n. 2, 2012, pp. 117-127.

[25]. *M. Ragazzi, E.C. Rada,* "Effects of recent strategies of selective collection on the design of municipal solid waste treatment plants in Italy", WIT Transactions on Ecology and the Environment, **vol. 109**, 2008, pp. 613-620.

[26]. www.cjvalcea.ro/proiect.htm, Access in April 2013.

[27]. http://www.cjsibiu.ro/portal/Sibiu/CJSibiu/portal.nsf/AllByUNID/00007686?OpenDocument, Access in April 2013.

[28]. *A. Atasu, L.N. Van Wassenhove, M. Sarvary,* "Efficient take-back legislation", Prod Oper Manage., **vol. 18,** n. 3, 2009, pp. 243-258.

[29]. *G. Ionescu, E.C. Rada,* "Material and energy recovery in a Municipal Solid Waste System: Practical Applicability", Int J Environ Resour, **vol. 1**, n. 1, 2012, pp. 26-30.

[30]. *T.J. Buckley E.S., Domalski,* "Evaluation of data on higher heating values and elemental analysis for refuse-derived fuels", Proceedings of National Waste Processing Conference, 1988, pp. 77-84.

[31]. *M.Z. Ali Khan, Z.H. Abu-Ghararah,* "New approach for estimating energy content of municipal solid waste", J. Enviorn Eng., **vol. 117,** n. 3, 1991, pp.376-380.

[32]. *E.C. Rada, A. Franzinelli, M. Taiss, M. Ragazzi, V. Panaitescu, T. Apostol,* "Lower heating value dynamics during municipal solid waste bio-drying", Environ Technol., **vol. 28**, n. 4, 2007, pp. 463-469.

[33]. *F. Viganò, S. Consonni, M. Ragazzi, E.C. Rada,* "A model for mass and energy balances of bio-Drying", 19th Annual North American Waste-to-Energy Conference, NAWTEC19 , 2011, pp. 63-70.

[34]. *C.A. Velis, P.J. Longhurst, G.H. Drew, R. Smith, S.J.T. Pollard,* "Biodrying for mechanical-biological treatment of wastes: A review of process science and engineering", Bioresour Technol., **vol. 100,** n. 11, 2009, pp. 2747-2761.