Municipal Waste Utilization by Automatic Sorting Technology

Robert Prochazka, Zdenek Donoval, Vladimir Krocko, Miroslav Pristavka,
Pavol Findura, Jan Marecek, Eva Krcalova

Abstract: *The waste could be described as an unnecessary, but not unusable, by-product of human activity. From the point of view of a common human being, the most significant type of waste is municipal waste. This waste is produced by all of us regardless of our social status, wealth or education. It is created during ordinary activities, at home, at work or at school, and it is one of the few kinds of waste which production we can limit by our own responsible approach. The aim of the accession was to describe the measurement of the separation cleanliness. The measured type of waste was iron waste incorporated in plastic waste - PET + drugstore (PP / PE).*

Keywords: *Separation, measurement, waste, production, sorting line*

INTRODUCTION

In total 9.5 million tons of waste is generated per year in Slovakia. Industrial waste is traditionally the largest. Municipal waste accounts for approximately 1.7 million annually, and up to 75% of this wastes end in landfills. Compared to the EU countries, Slovakia belongs to the countries with the lowest annual municipal waste production per capita. The average Slovak produces an average of 327 kg of municipal waste per year but segregates only 23 kg of waste (plastic, glass, paper and metal) compared to EU countries it is very low (the EU average is 111 kg). Lower production of municipal waste per capita is only in Poland, Estonia and Romania. Mostly, about a third of all waste is generated in industrial production (an average of 2.7 million tons per year), construction (an average of 1.67 million tons per year), electricity and gas supply (937-thousand tons) and supply and water purification (747-thousand tons).

The long-term negative trend of waste management in Slovakia is their disposal in landfills. The amount of waste dumped to landfills has increased from 2010 up to now to five million tons, which means that more than half of all waste produced in Slovakia is dumped to landfills. Only 25 percent in average was recycled in the monitored year 2013 to the present. Without an energy utilization, an average of 55-thousand tons of waste is disposed by combustion annually, with only three percent of the energy utilized, which is about 300 thousand tons of waste per year. The high level of disposal of waste in landfills is also the biggest danger in municipal waste management.

Precaution to reduce the volume of municipal waste in landfills

There are many simple solutions to reduce the amount of usable waste in landfills, which include the simplest forms, from decreasing the human consumption to waste sorting, and setting the legislative framework for the state, resp. responsible authorities within the EU with the solution of waste purchase and use as a secondary raw material, which is partly happening but with very low quality and low volume.

Taking into account the fact with respect of ever-increasing consumption of material inputs related to increasing production of commodities to meet the demand, the artificial reduction of municipal waste production per human being or per production company (the producer of waste) is currently unrealistic, the possibilities of reducing and storing is somewhere else.

Slovakia, as an EU Member State, must subsequently take measures to promote recycling itself and to ensure efficient sorting of municipal waste by pre-separation and collection at the centers as one of the easiest and cheapest forms of the initial phase of its disposal. At present, the SR has an obligation for the municipality to introduce and ensure the implementation of classified collection of municipal waste for paper, plastics, metals, glass and biodegradable municipal waste.

In order to meet the recycling target, the level of sorted harvest must be at least 150-170 kg per capita, which will be very difficult to meet by 2020.

It would be helpful to efficiently separate into the specified species, with the highest possible purity and exceed quality, so it can subsequently be used as a potential feedstock for the industry (secondary raw material, fuel, etc.) in the most efficient way. At this time, separating (sorting) centers according to the volume of waste processed are either manual or automatic.

Manual Sorting Centers

The manual sorting (separating or recycling) centers are composed of the necessary number of workers and the minimum amount of technological equipment needed (conveyors, storage cubicles, or pre-sorting sieves, to separate the oversized or undersized fractions) for the separation of visually identifiable waste - by color (PET bottles, oversized plastics, visible fractions such as rubber, glass, etc.) from other parts of the waste. However, they have limited sorting parameters related to the "visibility" factor as well as the quantity of the sorted waste. In general, and according to available data from existing plants of such centers, the worker is able to dispose approximately 30-40 kg of distinguishable waste, which in today's waste production and its need to sort out is a poor solution.

Automatic sorting workstations

Sorting more waste according to the color spectrum or the chemical composition of the waste is currently possible only with an automatic sorting system composed of several machine-process equipment which is controlled by a control system with its own imaging unit to control the process flow of waste treatment based on functional conditions at the same time with a view to ensuring the main safety features.

The composition of such a sorting line is normally assembled with technological equipment such as:

- unpacking device (if the raw material comes in pressed packages),
- transport systems (conveyors, hopper-dump parts - transport and shipment of waste stream / flow),
- sieves (separation of over-limiting or subliminal parts of waste for further processing),
- vibration systems (uniform distribution of waste before automatic sorting),
- automatic sorting devices (so-called NIR / VIS systems),
- collection boxes with removals,
- pressing equipment (hydraulic vertical presses, pressing containers).

Automatic sorting can be set up to a waste processing rate of 10 t / h on a single separation device. In the case of larger flows, the supply channel can be divided and additional separation devices can be added. However, such a speed is several times higher than manual sorting and is sufficient for complete waste treatment. Just for comparison, work on 1 automatic sorting machine in a 3-shift operation will generate a stream of nearly 90,000 tons of waste, which is the production of a 500,000 city.

The cleanness of the automatic separation is 95%, manual separation is used to achieve 100% purity.

MATERIAL AND METHODS

In the month of 12/01/2018 in area of company VÚMZ SK, s.r.o, we had the NIR Finder optical sorting machine, a metal waste machine, 1200 table width, belt speed at 3.6 m / s, optical scanners from Tomra Sorting,s.r.o. and measured one of the main sorting parameters - cleanliness of sorting. The type of waste we measured was iron waste incorporated in plastic waste - PET + drugstore (PP / PE).

Fig. 1 Autosort automatic sorting system by Tomra

The conditions for separating of the sorted material were not ideal since the machine was placed after its production only on the ground and the distribution of the two waste streams (sorted and residual - the REST) was not standard in the installation as it is in the installed technological line (NIR are placed by default above the removal conveyors with dispensing portions that collect all the firing parts).

Tracked parameters during measurement

- • Noise
- • Vibration
- • Sorting clarity along with contamination in the sorted portion of the waste stream

Number of repeated measurements: 3

Speed steps: 5 (40% / 55% / 70% / 85% / 100%)

Volume and weight of sorted materials:

- PET / drugstore: 2.1 kg
- Metal material: 3.0 kg
- Condition Correction: 20%

Functional automatic sorting system

In present several systems of mechanical separation are currently used, depending on the form and character of materials (flotation, air separation, camera systems, laser, X Ray, etc), but the most widely used municipal waste sorting system is a method of optical separation of waste based on artificial preexposure of waste stream, its subsequent scanning by infrared (IR) rays and pneumatic firing of the detected materials to a designated position (collection chamber with a convex conveyor). This system of scanning, evaluating and subsequently firing the sorted waste into the target spaces is an indispensable way of automatic sorting with such high purity and speed in present time.

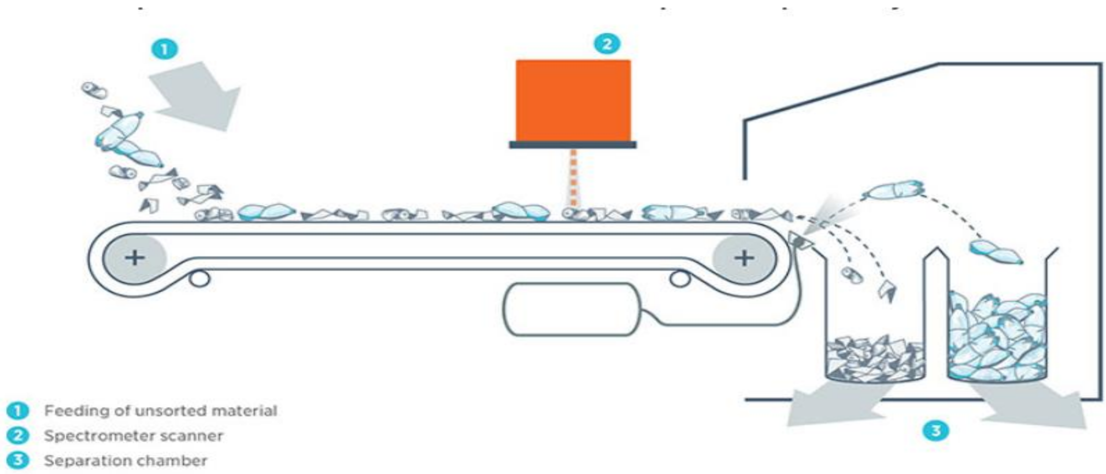


Fig. 2 The principle of the optical sorting

The principle of NIR operation / principle

The input material is evenly fed to the acceleration conveyor belt where it is detected by the AUTOSORT scanner unit and the optional EM sensor scanning the entire width of the belt in the sorting line. If one sensor detects the sorting material, it instructs the control cabinet to start blowing through the right valves of the valve block at the end of the acceleration conveyor belt. The sorted material is air-drawn through the separating cylinder inside the expansion chamber, "Section of the expansion chamber showing the partition wall". The rest will fall on the lower conveyor belt or the hopper.

VBPS is a mechanical superstructure of the valve block. Allows the valve block (s) to be diverted from the conveyor belt to allow easy cleaning and servicing. The valve block moves with the force of compressed air. The VBPS air pressure regulator unit is connected to the main air supply for the AUTOSORT. The VBPS control cabinet provides two terminals with different pressures.

The VBPS control cabinet includes all electrical parts and a control valve for filling one or the other air cylinder chamber.

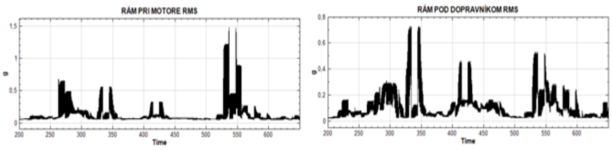
RESULTS

The measurements showed the dependence of the purity, noise and vibration levels monitored on the speed so that the best value was achieved at 55% and 100% of revolutions.

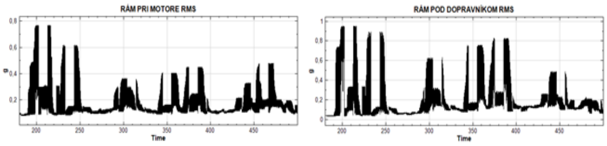
However, during standard operation at 100% of revolutions are usually transported approximately 2 times higher material (waste) amounts - the flow - of processed waste stream, the result clearly indicates, that best sorting is set at a speed close to the maximum. This is happening in praxis and the technicians of the sorting machine set the units to the highest possible operating speed of the conveyor belt for obtaining best scanning and sorting results.

Otáčky :				OPTICKÉ TRIEDENIE				HLUČNOSŤ				
	otáčky (m/s)			netriedený tok		triedený tok						
				Fe	PET	Fe	PET	LA	LACq	LAmax	LCpeak	
		meranie 1		0,91	1,00	1,95	1,09					
40%	1,44	korekcia Fe k množstvu	1,05	0,95	1,00	2,05	1,09					
		korekcia k ost.vplyvom		**0,54**	1,00	**2,46**	1,09					
		účinnosť separácie / kontaminácia				82%	52%	67,20	88,20	98,10	111,60	dB
55%	1,98	**meranie 2**		0,95	1,13	1,77	0,96					
		korekcia Fe	1,10	1,05	1,13	1,95	0,96					
		korekcia k ost.vplyvom		**0,66**	1,13	**2,34**	0,96					
						78%	46%	70,10	93,00	98,90	112,20	dB
		meranie 3		1,57	0,94	1,17	1,15					
70%	2,52	korekcia Fe	1,09	1,72	0,94	1,28	1,15					
		korekcia k ost.vplyvom		**1,46**	0,94	**1,54**	1,15					
						51%	55%	66,00	92,00	99,70	111,80	dB
85%	3,06	**meranie 4**		1,25	0,99	1,55	1,10					
		korekcia Fe	1,07	1,34	0,99	1,66	1,10					
		korekcia k ost.vplyvom		**1,01**	0,99	**1,99**	1,10					
						66%	53%	72,30	96,00	101,90	113,10	dB
100%	3,60	**meranie 5**		0,98	1,06	1,82	1,03					
		korekcia Fe	1,07	1,05	1,06	1,95	1,03					
		korekcia k ost.vplyvom		**0,66**	1,06	**2,34**	1,03					
						78%	49%	71,50	96,00	102,80	113,50	dB

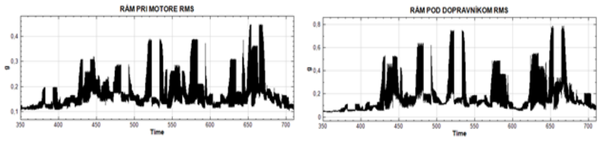
vibrácie (meranie 1)



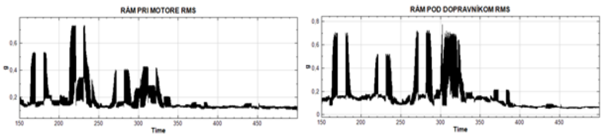
vibrácie (meranie 2)



vibrácie (meranie 3)



vibrácie (meranie 4)



vibrácie (meranie 5)

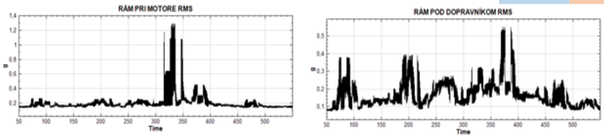


Fig. 3 Measurement results of selected sorting parameters on NIR / Finder

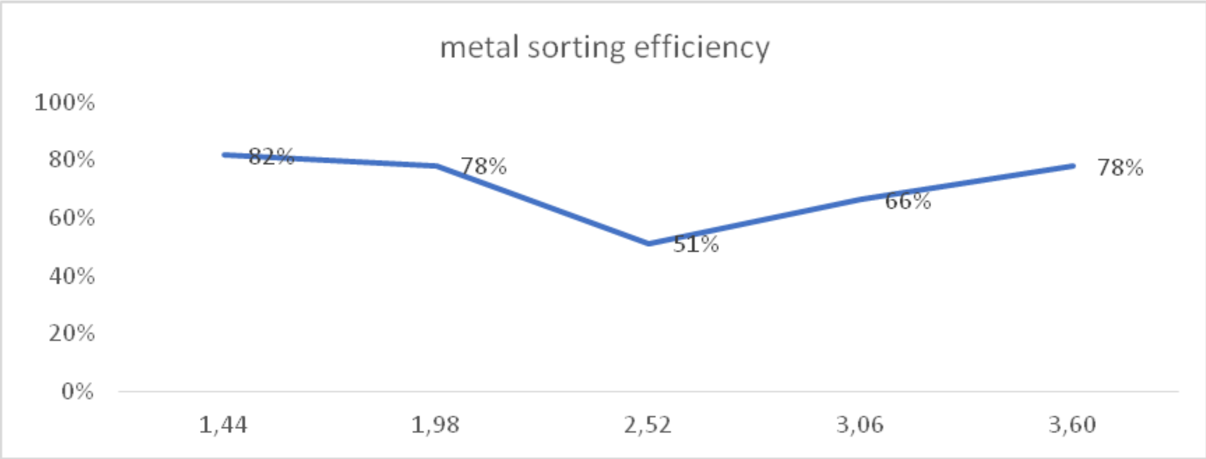


Fig. 4 Graphical representation of outputs / results gain from the measurements

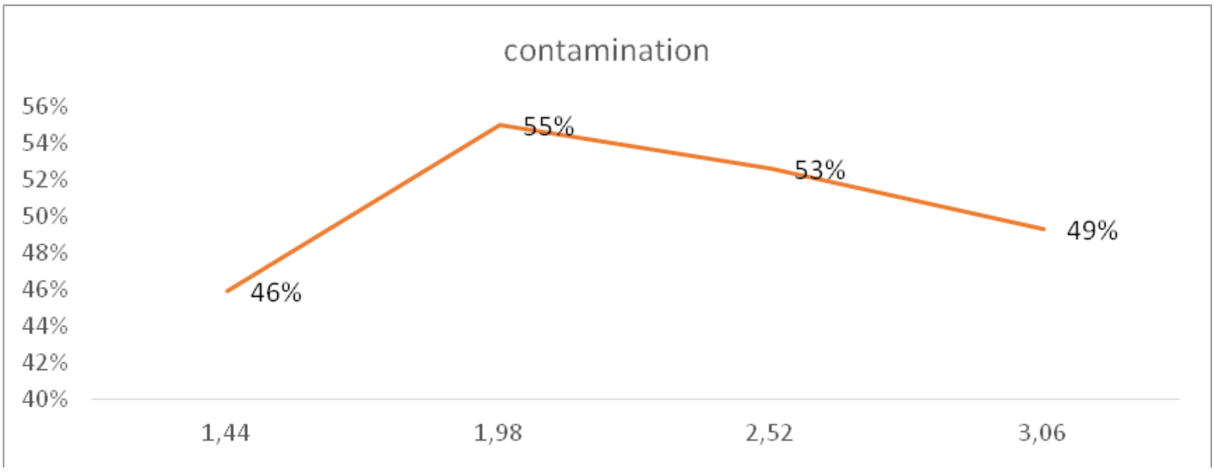


Fig. 5 Graphical representation of outputs / results gain from the measurements

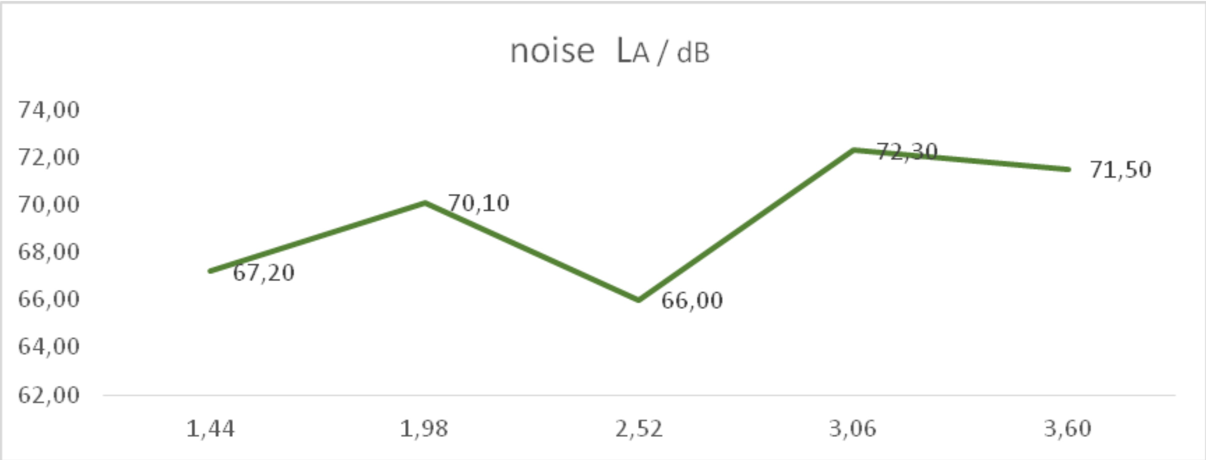


Fig. 5 Graphical representation of outputs / results gain from the measurements

CONCLUSION

In the submitted report, we looked at the condition of municipal waste management, currently pointing to the role of the responsible authorities and the preparation of Slovak legislation, respectively EU directives.

The condition of municipal waste management in Slovakia is quite unfavorable compared to other neighbor or highly-developed countries . Most of the waste instead of being used as a recoverable item for the needs of industry as a secondary raw material or in energy as a fuel (TAP) ends mostly in landfills.

The report describes possibilities of municipal waste evaluation aiming not to abolish, but reduce volume of the landfilled waste to a possible minimum. The most promising is its disposal by sorting. For the volume of waste processed in the best investment CAPEX / operating costs OPEX ratio against to the volume of technologically processed waste flow, automatic sorting appears as the best solution. As an example is introduced the most promising system of classification using IR-based optical heads, followed by evaluation and pneumatic blasting into designated channels for further conveying and processing.

The report presents the measurements made on the Finder optical sorting machine produced by the Slovak technological and production company VÚMZ SK, registered in Nitra Sorters were equipped with optical heads supplied by Tomra Sorting Solutions / Germany.

Received measurements showed the direct influence of the set revolutions – the speed of the input conveyor , so that the best figures were achieved at the mid and maximum speeds. However, for the parameter of the conveyed and processed stream, the main parameter is influenced by the volume of the treated waste flow.

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CONTACTS

Róbert Procházka, Department of Quality and Engineering technologies, Faculty of Engineering, Slovak University of Agriculture in Nitra, Slovakia, Tr. A. Hlinku 2, 949 76 Nitra, Slovakia, xprochadzka@is.uniag.sk

Zdenek Donoval Department of Quality and Engineering technologies, Faculty of Engineering, Slovak University of Agriculture in Nitra, Slovakia, Tr. A. Hlinku 2, 949 76 Nitra, Slovakia, xdonoval@is.uniag.sk

Miroslav Prístavka, Department of Quality and Engineering technologies, Faculty of Engineering, Slovak University of Agriculture in Nitra, Slovakia, Tr. A. Hlinku 2, 949 76 Nitra, Slovakia, miroslav.pristavka@uniag.sk

Pavol Findura, Department of Machines and Production Biosystems, Faculty of Engineering, Slovak University of Agriculture in Nitra, Slovakia, Tr. A. Hlinku 2, 949 76 Nitra, Slovakia, pavol.findura@uniag.sk

Ján Mareček, Department of Agricultural, Food and Environmental Engineering, Faculty of AgriSciences, Mendel University in Brno, jan.marecek@mendelu.cz

Eva Krčálová, Department of Agricultural, Food and Environmental Engineering, Faculty of AgriSciences, Mendel University in Brno, eva.krcalova@mendelu.cz