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The Study of the Balance of Materials and of Waste Management exemplified for Light Industry

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Abstract:

In this paper the authors present an example of material flow (matflow), specific for the light industry. From raw material to the final product and the waste resulted from production, there are presented the main technological stages focusing on the efficiency of managing the entire matflow.

Obviously, in any technological process, there is always a waste component. Because the raw material prices fluctuate within wide limits, recycling waste became an important part of the business, especially in the oil and its derivatives industries. The waste is recycled and sold as raw material. This way, the storage of valuable materials is reduced and the raw material protected.

Keywords: raw material, material flow, industrial waste

1. INTRODUCTION

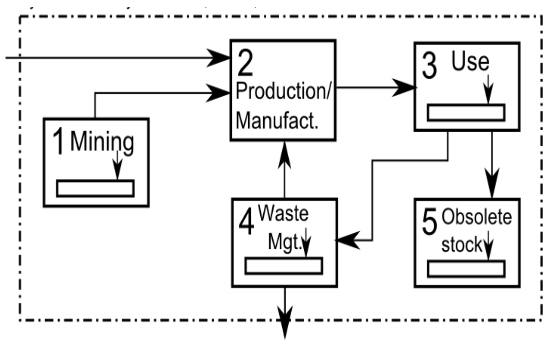
Under flow management means the targeted influencing of the material flows in order to reduce the amount of materials used to intensify their use, to reduce emissions and to ensure its circulation as much as possible, [5].

Material flow analysis (MFA) (also referred to as substance flow analysis; SFA) is an analytical method of quantifying flows and stocks of materials or substances in a well-defined system.

MFA is an important tool to assess the physical consequences of human activities and needs in the field of Industrial Ecology, where it is used on different spatial and temporal scales.

Examples of MFA are accounting the material flows within certain industries and connected ecosystems, determination of indicators of material use by different companies, and developing strategies for improving the material flow systems in form of material flow management, [5].

A general MFA system without quantification, [5]:



Due to large fluctuations and rising prices in raw material, recycling became a necessity.

The whole idea of recycling is not new, but the reason why we should pay attention to it, has changed over decades. Started from the intention of saving raw material, in our days the reason for recycling is much more complex.

In the past, important raw materials had been imported, which led to high prices for the final product. There was also the need that a number of consumer products to be affordable and to be manufactured our own industry [2].

Currently, waste management aims to:
- Lowering the waste quantity deposited at the landfill;
-The withdrawal of the potentially pathogenic hazardous waste;
- Recycling certain waste as raw materials;
- Protecting raw material resources;
- Selective waste collection for recycling;
- End the existing landfills and to implement sorting lines and modern warehouses;
- Inform consumers – individuals and legal entities, about the importance of proper management of waste;
- Encouraging waste recycling.

In the literature, the waste is called ' valuable material ' and they are used as resources.

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Even though, a landfill is designed to operate for a long period of time – 25-30 years – it's high operating and maintenance costs can be an impediment in its early stages. That's why a landfill is usually considered to be a major and expensive arrangement, involving high costs for both – operation and maintenance even from its start [1], [2].

A proper management for the material flow means the shortest way to the final product, with minimum waste of energy and a recycling the offal.

A proper management for the material flow also means [4]:
- efficient usage for the resources;
- lowering the quantity of raw materials and energy needed in the process;
- lowering and the quantity of offal and residual gas;
- recycling as much as possible the waste products.

2. CASE STUDY

2.1 General description of the technological flow

The case study refers to an establishment for the production of the injection of plastic products; the technological flow scheme is as follows [3]:

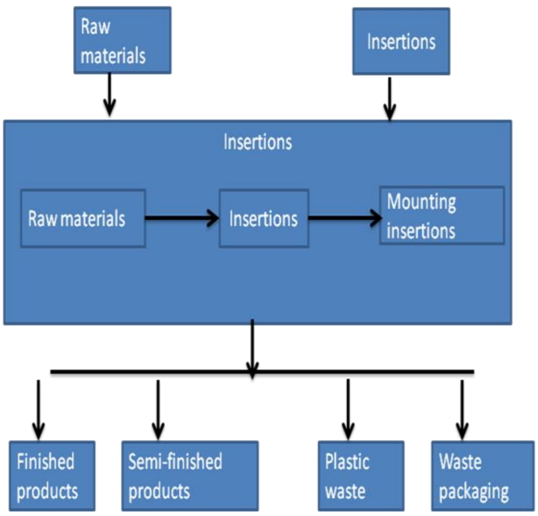

Fig.1. Flow injection process

a) Preparation of production;
   Raw material (plastic granules);
   Other components (inserts);
   Packaging (cardboard, wood, plastic);
   Equipment maintenance;
b) The actual production;
   Preparation raw material;
   Injection;
   Mounting inserts;
   Finishing;
   Packaging;
c) The final result;
   Finished and semifinished products packaging;
   Plastic waste, (from injection);
   Packaging waste;
   Waste generated by maintenance.

2.2 Pollution generators and protecting the environment.

Protection of water resources

Domestic wastewater fall within the limits of normative NTPA 002/2002 and is discharged into public sewers without further pretreatment. Rainwater collected on concrete platforms, (access roads and parking) and roof is decanted, stored and used in maintenance of green areas. Thereby rainwater is infiltrated into the ground. In case of torrential rains, when the storage capacity is exceeded, the excess water is discharged into public sewers for rainfall water [3].

Protection of the atmosphere

The production cycle does not generate dust.

The only emissions source into the atmosphere is exhaust gas from vehicles. It is intended that inside the establishment the vehicle engines, (transport cargo or people) to operate only when is necessary. The material handling is done with electro cars that do not generate dust [3].

Protection of soil and underground

The main potential sources of contamination of the soil and underground is improper storage (inside the establishment) of raw materials, waste and accidental spills of lubricants. To avoid such incidents, the correct packaging of raw materials and finished products is to be checked and they must be stored only under roof. Particular attention will be given to handling chemicals. Also, will be daily checked hydraulic circuits of the capital goods [3].

Protection against noise and vibration

The noise and vibrations from the technological flow and transportation do not exceed any legal limits. If there will be temporary exceeding of these limits, the affected staff will be wearing ear protection [3].

2.3 The Balance of Materials and Waste Management

The tables 1, 2, 3, 4 and 5 show the quantities needed in the technological process for every raw material - from plastic parts to waste products and packaging used in the process (on a volume fraction and total).

Table no.1. Raw materials, annual quantity

Crt no	Type of raw material or material	UM	Annual quantity	The method of packing
1	ABS granules	kg	124000	Carton Packing 1000kg
2	HDPE granules	kg	302000	Carton Packing 1000kg
3	polyamide granules	kg	103000	20kg sacks, 40 sacks / pallet
4	metal bushings	kg	4000	Carton boxes, 5kg / carton
Total amount of raw material		kg	533000	

Table.no.2. Auxiliary raw materials, annual quantity

Crt no	Type of raw material	UM	Annual quantity	Storage conditions
1	Hydraulic oil	kg	4000	Stored in the original packaging (208L steels canister) in the storage area of containment trays oils
2	Oil guides	kg	180	Stored in the original packaging (208L steels canister) in the storage area of containment trays oils
3	Degreasing agent	kg	360	Chemicals stored in cupboard
4	Solution for slag remove	kg	240	
5	Vaseline greasing	kg	360	
6	Bate	kg	24	
7	Heat transfer paste	kg	1.2	
8	Protection of metallic surfaces (antioxidant)			

Table no.3. Packing used annual quantity

Crt no	Name packaging	UM	Annual quantity
1	Carton Packing	kg	130000
2	Plastic Packing	kg	30000
3	Wood Packing	kg	14000

Table no.4. The annual quantity of produced pieces (plastic)

Crt no	Title piece	UM	Annual quantity
1	Plastic piece	kg	460000

Sources of recyclable products are:

- Specific technological processes;
- Packages from raw and auxiliary materials used in the technological process;
- The administrative activities and the employees.

The management of the different types of waste products from the establishments is as follows:

- Waste paper / cardboards are collected separately and stored in a metal container (V = 11 m3/container) outside the plant containers that belong to the company to which this waste is recovered;

- Metal waste stored on the premises, in plastic bins (V = 240 L / bin), and are taken for recycling by a specialized company;

- Plastic offal (semi-finite/finite scrap pieces, etc.) are collected in metal containers (V = 1 m3) and also recovered by a specialized company;

The types and quantities of waste are shown in the table below.

Table no.5. Types and quantities of waste generated (quantities)

Crt no	Type of waste	Waste Code (HG 856/2002)	UM	Annual quantity
1	Waste plastics	07 02 13	kg	37310
2	Waste cardboard	15 01 01	kg	20160
3	Plastic packaging waste	15 01 02	kg	1550
4	Waste wood packaging	15 01 03	kg	150
5	Domestic waste	20 03 01	kg	21000
6	Metal waste	16 01 17	kg	300
7	Oils	13 01 13*	kg	420
8	Pressurized gas cylinders	16 05 04*	kg	41
9	Absorbers	15 02 02*	kg	410
Total of waste			kg	81341

*) Special waste

The loss of raw material and the efficiency of using the raw material are determined by the equation:

$$P_{mat.prim} = M_{prim.tot} - C_{piese.tot} - D_{plastic} \quad (1)$$

$$\eta = \frac{M_{prim.tot} - P_{mat.prim}}{M_{prim.tot}} \cdot 100 \quad (2)$$

where:
$P_{mat.prim}$ - loss of raw material [kg];
$M_{prim.tot}$ - the total amount of raw material (plastic) [kg];
$C_{piese.tot}$ - total quantity of parts produced (plastic) [kg];
$D_{plastic}$- plastic waste [kg];
η - efficiency of use of raw material [%].
Percentage of plastic waste compared total raw material:

$$\eta_D = \frac{D_{plastic}}{M_{prim.tot}} \cdot 100 \quad (3)$$

and the recycling rate is determined by the relationship:

$$C_r = \frac{C_{DE}}{C_{TD}} \cdot 100 \quad (4)$$

where:
Cr- recycling rate [%];
CTD - total waste [kg];
CDE - waste recycling [kg].

for:
Mprim.tot = 529000 kg;
Cpiese.tot = 460000kg;
Dplastic = 37310kg;

follows:
Pmat.prim = 31690kg;
η = 94.00%
η_D 7.05%

Table no.6. Recycling waste fractions

Crt no	Type of waste	Generated annually [kg]	Recycled annually [kg]	C_r [%]
1	Waste plastics	37310	37310	100
2	Waste cardboard	20160	19888	98.65
3	Plastic packaging waste	1550	1520	98.06
4	Waste wood packaging	150	110	73.33
5	Domestic waste	21000	0	0
6	Metal waste	300	300	100
7	Oils	420		
8	Pressurized gas cylinders	41		
9	Absorbers	410		

Special ossal from items 7, 8 and 9 are no subject to recycling; they are collected and neutralized by specialized companies. To calculate a global recycling rate was not taken into account household type waste, from the staff. This waste can be collected separately as common waste and recyclable waste [2]. However, it is recommended to be studied together with the waste of industrial origin. From the items 1, 2, 3, 4, 6 result a global rate recycling $C_{rglobal}$ = 99.42%

3. CONCLUSIONS AND RECOMMENDATIONS

From the presented data, the large amount of offal generated from the technological process is to be noticed. The material flow control is important in order to value these waste products.

Aims to be achieved:
- Minimizing as much as possible the amount of waste generated by technological process optimization;
- Implementing production technologies that requires minimal energy consumption;
- Sorting the various types of waste and offal still on the line;
- Proper training for personnel regarding waste collection;
- Contracts with recycling companies so that waste is recovered economically advantageous (if it can be taken directly without intermediaries processors);
- Choosing suitable size containers for selective waste collection so that handling and transportation costs to be minimal;
- Reusing, if possible, as raw material for its own production the offal.

The authors consider that an overall recycling rate is an indicator of the flow analysis. Following each material flow can however give an optimization data required.
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