ENGINEERING SUPPLY FOR IMPROVING KNOWLEDGES REGARDING SUSTAINABLE DEVELOPMENT OF THE ENVIRONMENT (SDE)

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Abstract: *Lately it does not detect any important progress regarding knowledge of environment sustainable development. This situation is meet in the sphere of scientifically research and in the superior education also. Starting on this situation in the paper we approach engineering ways that can help in this aim. Thus, the environment complex structure is analyzed, the possibility of using for analysis and synthesis of anti-entropy measures or new added value and the style how engineering can accomplish the methodologies of madding environmental balances and life style cycle.*

Key words: *environment, sustainable development, thermodynamic potential, added value, anti-entropy, system theory.*

1. Introduction

For the Faculty of Materials Science & Engineering - Bucharest and, implicit, for the metallic materials engineering (metallurgic engineering), the concept of sustainable development (model) SD is the coherent ensemble of the following dimensions:

- the natural dimension - we can talk about a sustainable development only when the environment created by man is compatible with the natural one;
- the socio-human dimension - everything exits from the an tropic environment should meet the needs of the present and future generations;
- the natural capital preservation dimension;
- the state-political dimension - the recovery of the development strategies & polities, along with the consistency of the optimization criteria applied on all the spheres (regional, national and global) became compulsory;
- the technological knowledge dimension.

Based on the above-mentioned things, the following target becomes preponderantly for metallurgic engineering: "*the preservation of the natural capital along with the preservation and control of the environmental pollution*".

The definition of the *environment* should be adopted in the engineering field, too. According to this definition, *the environment represents the external ensemble of the material (physical-chemical), social and moral conditions in which an organism evolves*.

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2. Some Theoretical Premises Required for the Analyses and Syntheses Regarding the Environment

We propose the theoretical substantiation of the sustainable development of environment (SDE) engineering activities to start from certain premises, as following.

2.1. The complex structure of the environment

Starting from the above definition, the environment should be considered as a complex notion, whose modular structure is presented in Figure 1. When designing a learning plan, one must designate a module to each group of education.

2.2. Correlation between isobar thermodynamic potential and some technical economical indicators

Function of enthalpy (H), temperature (T) and entropy (S), the potential (G) varies within a range located between two process levels or two quality stages of this process, as follows:

$$\Delta G = (\Delta H - T\Delta S).$$

In nature, the self-running processes (spontaneously), without energy consumption, are possible only if the thermodynamic potential decreases, reaching the null level in the equilibrium state. These processes are characterised by the in equation:

$$(G_{final} - G_{initial}) = \Delta G = (\Delta H - t\Delta S) \leq 0. \quad (1)$$

The inverse transformations, where G increases, *are impossible under any conditions.* The thermodynamic analysis of economy-environment systems can generate results as those presented below:

- the metallurgical processes cannot take place spontaneously, so they are not self-running processes. For their running, a special condition is required, which is characterised by the enthalpy consumption, so that $G_{final} < G_{initial}$ (G_{final} should correspond to the state of the product delivered for consumption);

- the increasing variation by enthalpy consumption, $\Delta G > 0$, can be energetically measured as concern the *added value* V_a, in the transformation process of the resource into a product meant for consumption. One can state, for example, that for transforming an usual plate into an enameled one, the new added value can be evaluated by the difference between the thermodynamic potentials of the two states:

$$(G_{enameled\ plate} - G_{usual\ plate}) \sim V_a . \quad (2)$$

2.3. The variation of the (neg)entropy in the environment

The analyses based on the variation of the (neg)entropy in the system are based on the following considerations:

- The entropy (S) is a measure of disorder (degree of randomness or chaos), as concern the organization of matter. The increase of S when G decreases characterizes the spontaneous tendency of the systems towards chaos. The insulated physical systems are continuously subjected to the tendency of entropic decay to chaos, which is maximal in the final state of the natural equilibrium. Due to the exchange of matter, energy and substance, the open systems (the production systems are included) can organize their activity on *anti-entropy* direction, towards minimal levels of entropy. In such situations, the level of ordered organization can be evaluated using another physical quantity, named *negentropy or anti-entropy (nS).* One can sustain that, at a certain moment of the transformation (development), the system becomes a *depositary of entropy* [1].

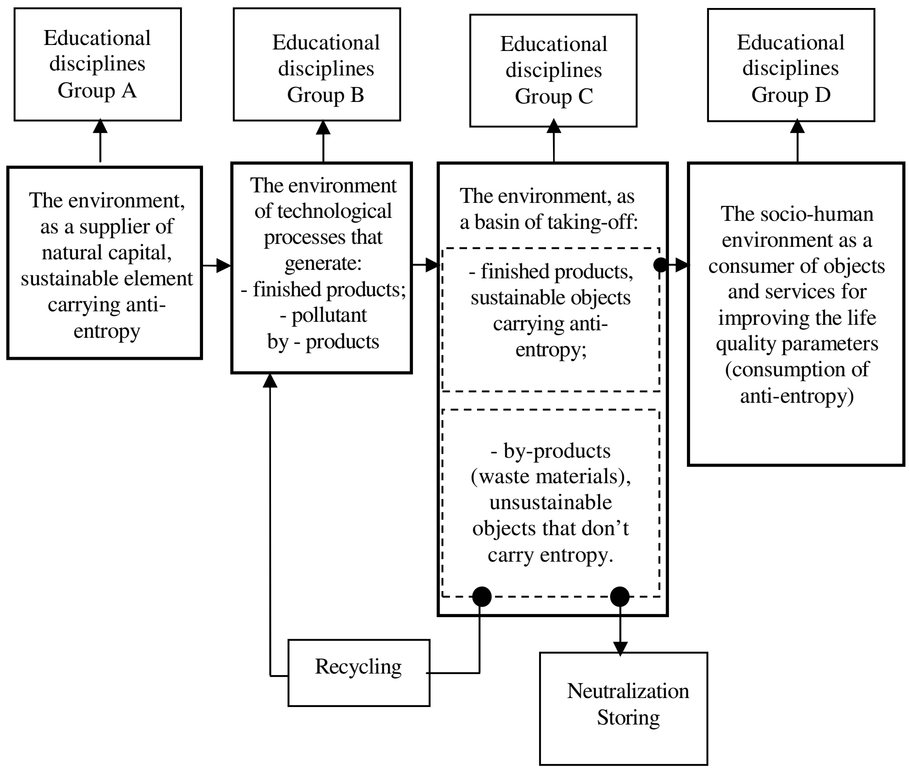

Fig. 1. *The modular structure of the environment*

- Resources (in this case, especially ores and fuels) are a form of ordered space arrangement of materials.
- The human activity is performed on two directions:

- a positive, *anti-entropy one (*by substance, energy and information consumption), which increases the order, e.g., the extraction by concentration of minerals from ores, energy recovery etc.;

- a negative, *entropic one*, which decreases the order (increases the chaos), e.g., the consumption of resources with ordered environment location and, particularly, pollution.

- Pollution, evaluated as waste released into the environment, is an *entropic phenomenon*, which increases the natural disorder.
- The above-mentioned things are graphically illustrated in the diagram presented in Figure 2.

3. The Analysis of the Environment Self-Sustainability

From the metallurgical engineer's point of view, the environment self-sustainability condition is given by the in equations:

$$|nS_t| > |S_w|, \qquad (3)$$

$$|S_w| > |nS_{c.n}| > nS_{p.t.} \qquad (4)$$

Based on the above-mentioned things, we found two main action ways [2]:

a) Specific costs minimization

In this case, the input $(nS_{c.n})$ brought by

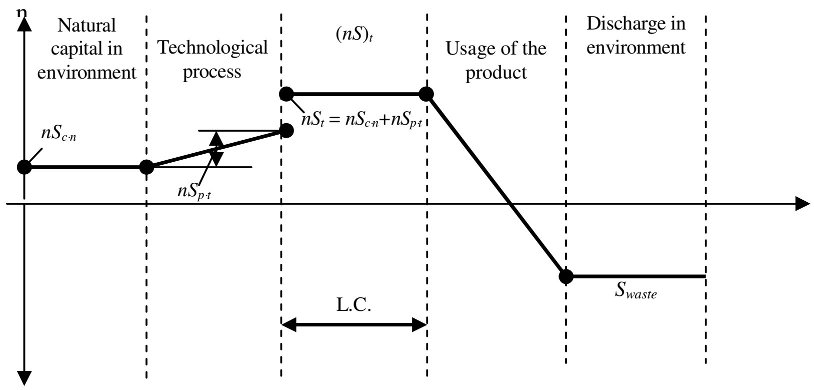

Fig. 2. *The diagram of the anti-entropy variation in the environment: $(nS)_{c.n}$ - is the anti-entropy which was initially extracted from the natural capital; $(nS)_{p.t.}$ - is the anti-entropy which was realized by the technological process; $(nS)_t$ - is the anti-entropy from the product on the market; $(S)_w$ - is the entropy from the scrap (waste material); L.C. - is the life cycle*

the natural capital, decreases. This means that:

$$nS_{c.n} \to 0,$$

or:

$$\left| nS \right|_{p.t.} > \left| S_w \right|. \qquad (5)$$

For the environment engineering applied in metallurgy, this means the necessity of increasing the $\left| nS \right|_{p.t.}$, achievable by:

- increasing the advanced processing degree of the metallic materials (increasing the order degree);
- increasing the added value, V_a (improving the technical-economical parameters).

By analyzing more detailed, an interesting conclusion arose: to avoid the decreasing of, it is required to increase or, with other words, *the decreasing of the specific consumptions should be realized using advanced technologies and modernized installations.*

b) Secondary materials (waste materials) processing

In order to decrease the entropy of the waste materials acting on the environment, S_w, we can do the followings:

- to increase the life cycle of the initial anti-entropy carrier product $(nS)_t$;
- recycling (recirculation);
- neutralization.

4. The Engineering Contribution in Improving the Methodology of Drawing-Up Some Environment Law Instruments and Environment Management

The literature about drawing-up the environment law and management instruments shows that these ones are mainly based on juridical or economical norms [3]. That's why they have an official role and an observing, contemplative and passive character. Further, it can be seen that, in the latest years, no important quality improvements of these norms appeared. To get beyond this situation, i.e. to transform the above-mentioned instruments in operational-active means, the authors consider that *the engineering role in such fields should grow.*

The management and the environment law (M-EL) should be approached based on the following recommendations:

- the engineer (student) should get the knowledge regarding the M-EL legislation;
- the engineer should be involved in the activity of M-EL knowledge dissemination;
- the engineer can offer the technical/ technological solutions for preventing or decreasing the conflicts with the coercive organs (penalties etc.);
- the enriching of the knowledge regarding M-EL should take into account the juridical-engineering convergences in EL.

The environment balance methodology should include also the followings:

- to accept the idea that the polluting substances means *losses from the technological contour to the environment;*
- to draw-up the *eco-balance equation,* based on the conservation law: the sum of the components entered in the contour (C_i) equals the sum of the components evacuated from the technological contour (C_o):

$$\sum C_i = \sum C_o . \quad (6)$$

- to draw-up the *eco-balance table,* where the percentage weights of all the articles to be highlighted;
- to graphically realize the eco-balance, using S*ankey diagrams* (an example can be seen in Figure 3).

If the recirculation of the secondary materials (wastes) is subjected to feed-back, they can have two functions:

a) Materials carryover (secondary materials resources - RMS) and energy carryover (secondary energy resources - RES);

b) Information carryover preponderantly consisting in technological deviations that determined the occurrence of wastes; such information become *instruments of system (self) regulation*.

The evaluation of the life cycle (ECV), as an MM instrument, should become an objective function depending, for example, on:

- the characteristics of the materials and productions (i.e.: how the corrosion resistance influences the C.V.);
- reliability elements;
- maintenance elements.

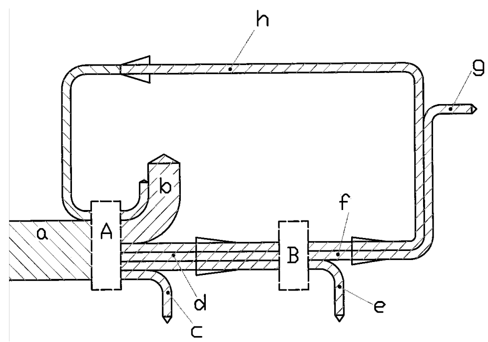

Fig. 3. *The Sankey diagram for eco-balance: A*) *the technological contour of the process; B*) *the processing contour of the secondary materials; a*) *raw materials; b*) *useful materials; c*) *raw materials lost in the primary stage; d*) *secondary materials to be recycled; e*) *secondary materials lost in the secondary stage; f*) *secondary materials usefully recycled; g*) *secondary materials recycled in external contours; h*) *secondary materials recycled in the own contour*

A new feature for waste (secondary materials) recirculation

Till now metallurgical engineer has studied two scrap functions, generally, and of those recycled, in particular: ecological function and economical function. It must be made a new possible function: waste as an *informational instrument*.

Taking into account the knowledge of systems theory and information theory three aspects it will be treated:

a) The simplest representation of a production system and a natural system (*S*) is the one represented in Figure 4.

Following their impact on systems, pollutants induce imbalances in their best performance. In this context that we must consider engineering as perturbations pollutants in a system to be (self) set.

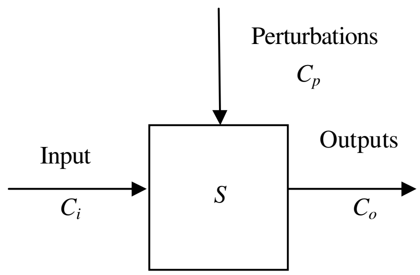

Fig. 4. *Schedule a system*

b) If the route followed by waste recycled (Figure 5), it might be studied as a feed-back circuit, $C_{f.b}$.

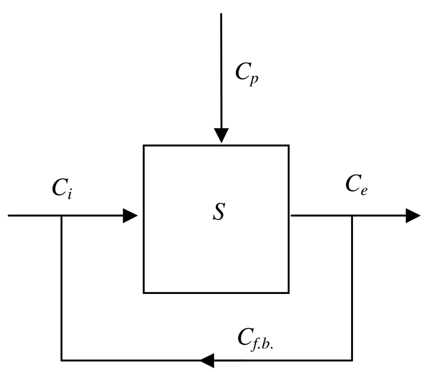

Fig. 5. *The route of recirculation of waste (secondary materials)*

c) Generating qualitative and quantitative waste is due to technological and technical malfunctions. This means that waste includes technical and technological dysfunction. Through its recycling can improve the way information technology standards and technical process.

5. Conclusions

The knowledge and application of the new types of analyses are necessary for the phenomena based on the thermodynamics laws, the kinetics theory of the industrial processes and the entropy & energy theory applied for optimizations of correlations in the "economical-ecological-resources" field.

References

1. Georgescu-Roegen, N.: *Legea entropiei şi procesul economic* (*The Entropy Law and the Economic Process*). Bucureşti. Editura Politică, 1979.
2. Nicolae, A., ş.a.: *Operaţionalizarea conceptului DD în siderurgie* (*The Application of the DD Concept in the Steel-Making Process*). Bucureşti. Editura Printech, 2006.
3. Nicolae, M., ş.a.: *Proceduri de analiză în managementul ecometalurgic* (*Analysis procedures for eco-metallurgical management*). Bucureşti. Editura Fair Parteners, 2002.