ASPECTS REGARDING A NEW FIELD OF KNOWLEDGE REPRESENTED BY THE METALLURGICAL ECOSOCIOLOGY

Bogdan Florin STROE[1], Avram NICOLAE[2]

This paper deals with the intersystem knowledge as objective of new disciplines, such as: Ecometallurgy, Ecosociology and Econology, which study the events occurring in the convergence areas of the four fundamental systems, i.e. natural-ecological (ECOL), social (SOC), economical (ECON) and technological (TEHN), represented by the metallic materials system META. Some of the treated subjects are: specific intersystem disciplines; characterisation of Metallurgical Ecosociology; the need to study the correlations between the social system (represented by human health) and the technological system (represented by particulate matter generation - PM); historical development of the META system from technological system to ecosociotechnological system; metallurgical research tools for studying the environmental and social events (environmental & social quantities, characterization of particulate matters by concentration and granulometric structure.

Keywords: Ecosociology, health, particulate matter, disease risk

1. Introduction

The durable-sustainable development (DSD) is the concept that currently designs and characterizes the evolution in the *megasystem (MS) of human existence,* result of the *interactions* and *inter-conditionings* occurring in the *convergence* areas of the four fundamental systems: *natural-ecological, social, economical and technological*. The DSD study aims the knowledge of two main targets:

- *the durability*, which measures the *system strength ability in time*, including for the next generations;
- *the sustainability*, which measures the *system's ability to create, sustain and maintain tailored evolution processes within the MS* [1].

The durable-sustainable co-development (DSCD) is the concept that characterizes the evolution in the convergence areas of the four systems [2].

[1] Ph. D. Student, Materials Science and Engineering Faculty, Politehnica University POLITEHNICA of Bucharest, Romania, e-mail: ecomet@ecomet.pub.ro

[2] Prof., Materials Science and Engineering Faculty, Politehnica University POLITEHNICA of Bucharest, Romania, e-mail: ecomet@ecomet.pub.ro

The interdisciplinarity and multidisciplinarity are the main means of studying the DSCD.

The intersystem disciplines are the disciplines studying events developed in the convergence areas of the systems [3]. Thus, the investigations regarding the ecology-economy inter-conditionings (ECOL-ECON correlations) led to the foundation of certain subjects of study, such as *Natural Resource Economics* and *Environmental Economics.* [4, 5, 6] Lately, this correlation has been completed with the *energy* factor*,* fact that characterizes a new sphere of knowledge: the ecology-economics-energy correlations (*ECOL-ECON-ENERG correlations*, or *3E correlations*, or E^3 *correlations*). This area has become the object of study for a new discipline, called *Econology* [7]. In the same context, there are reported a growing number of more and more important concerns regarding the ecological-sociological inter-conditionings (ECOL-SOC correlations), which became the object of knowledge for a new discipline, called *Environmental Sociology* or *General Eco-Sociology* [8, 9].

2. Specific intersystem disciplines. Characterisation of Metallurgical Ecosociology

For the materials engineer (in particular, the *metallurgical engineer*), the disciplines mentioned above become *specific disciplines*, because they deal with events held in the metallurgical industry, as a component of the technological system. Therefore, certain new disciplines have emerged, such as those listed below.

The **Ecometallurgy** is the discipline studying the co-development in the convergence area between the natural-ecological (ECOL) and technological (TEHN) systems, represented by the metallurgical industry (META). It is analysed the operationalisation of technologies and techniques, in order to obtain environmentally efficient products and metal goods [10-12].

The **Metallurgical Ecosociology** is the science studying the co-development in the convergence area of the natural-ecological (ECOL), economical (ECON) and technological (TEHN) systems, represented by metallurgy (META). It examines the technologies and techniques for obtaining environmentally efficient metal products, in terms of increased economic efficiency [7].

The **Metallurgical Ecosociology** studies the co-development in the convergence area of the natural-ecological (ECOL), social (SOC) and technological (TEHN) systems, represented by metallurgy (META) [13, 14]. It analyzes the influence of the technical and technological environmental transformation measures on the quality of life, as shown in Figure 1.

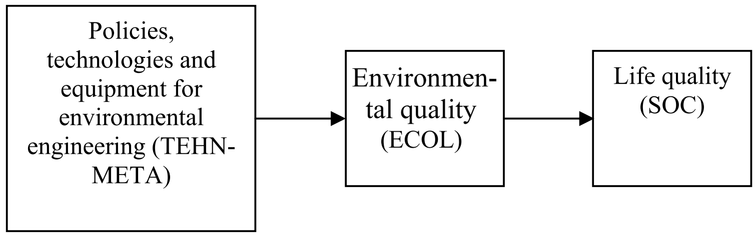

Fig. 1: Flow studied by Metallurgical Eco-Sociology.

The *quality of life* is assessed using social indicators which relate to various aspects regarding the accomplishment of the social needs.

The *health status* is the social system element analyzed in this paper.

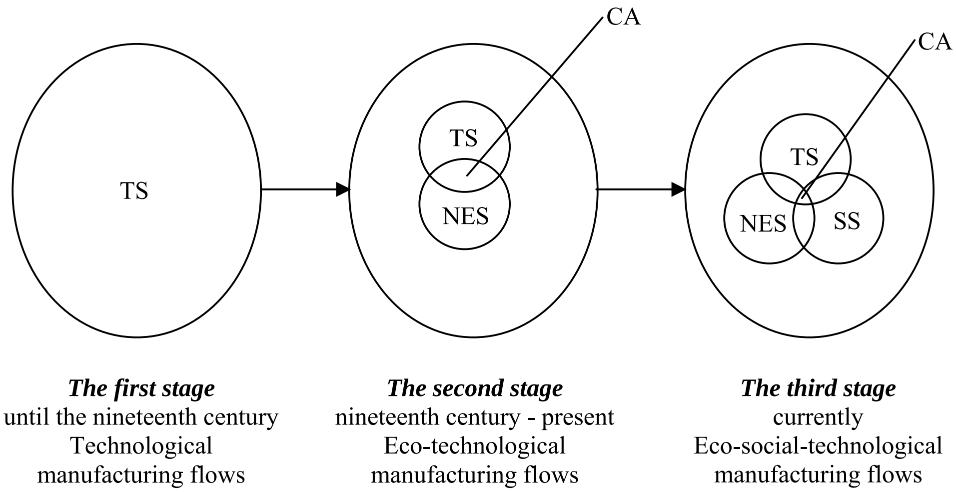

Fig.2*:* The historical evolution of the metallic materials manufacturing flows
CA – convergence area; TS – Technological system; NES – Natural-ecological system; SS – Social system

The Metallurgical Ecosociology is a recent discipline, arising as a result of the *historical development* in the manufacture of metallic materials. Therefore, the analysis of metallic materials manufacturing processes based on the sustainable development principles points out that, historically speaking, they have evolved over time. In this context, it can be stated that the purpose and content of metallic materials manufacture undergone several stages (Fig. 2).

The first stage lasts from the first moments of the manufacture of metallic materials (Bronze Age, Iron Age) to the nineteenth century. The manufacturers of metallic materials were exclusively concerned about the technological performance. Therefore, it can be said that this activity was based on the *technological manufacturing flows*.

The second stage lasts from the nineteenth century to the present. The manufacturers of metallic materials realize the negative impact of their activities on the environment, reason why they are concerned with minimizing this impact. It can be said that, in this period, their work is based on *eco-technological manufacturing flows*.

The third stage is characteristic to the present, when the manufacturers of metallic materials realize the social importance of using such materials. It can be said that in this period we are dealing with *eco-social-technological manufacturing flows*.

Studying DSCD in the ECOL-SOC convergence areas became a major concern for many researchers [15, 16].

The *ECOL-SOC* co*rrelation* represented by the correlation between the *particulate pollutants* (the ECOL component) and *health* (the SOC component) is already an important research topic. [17-23]

For the metallic materials engineers, it becomes important the intersystem discipline called *Metallurgical Ecosociology*.

The ECOL-SOC-META correlation embodied in the *correlation between the population health* (the SOC component) and the *pollution with particulates generated in metallurgy* (the ECOL-META component) is the research theme undertaken by the authors of this paper.

3. Methodological research tools for the environmental and social events

3.1. Eco-social quantities

The study of ECOL-SOC-META correlations requires knowledge of specific investigation tools.

The **eco-social events** are facts (represented by human activities and actions) found in the areas of convergence between the natural-ecological and social systems.

The **ecosociotechnological events** are facts (represented by human activities and actions) found in the areas of convergence between the natural-ecological, social and technological systems.

From the **elements of the natural-ecological system**, we have chosen for this paper the emission and immission of particulate pollutants.

As **social system element,** we have chosen for this paper the health status of the population, in particularly the health status of the steel workers.

The ecosocial status is the quantity characterizing the level of meeting the social needs of the members of a community, in conditions of natural-ecological system pollution.

The ecosocial parameter is the quantity characterizing the process of installing a social effect under ecological changes.

The health status is one of the quantities used to assess the eco-social status.

The degree of disease and the number of diseases are the parameters based on which we can make assessments regarding the health status.

The degree of disease is the parameter that characterizes the health effects of pollution.

The risk of disease (written *R.D.* in this paper, for short) represents a measure of *disease probability* for environmental reasons.

The *disease risk curve (D.R.C.)* *is the locus of points that represent risks of disease for the various analyzed situations.*

The trend in the disease risk is given by the direction of the risk curve.

3.2. The characterisation of particulate matters

The ***particulate matters,*** also known as *particulate materials or particulate elements, or PM* for short (the initials of the English name *particulate matter*), are the solid components finely dispersed in the gaseous environment.

The properties of particulate materials generated in the metal materials industry are already the subject of many papers [24-29]. Of all the properties, only two have been considered in this paper.

3.2.1. The granulometric structure

The **granulometric structure of the particulate matters** is the property characterizing the distribution of particles by class size, mass or number. Analytically, it is characterized by defining size classes (fractions) and assigning weights (usually percentage) referring to the mass or number of the particulate matters.

The particulate matters are symbolized on the basis of the mainly size fraction (Table 1).

Table 1

Proper classification of the total suspended particulate matters

Name	Symbol	Particulate matter size [μm]
Coarse particulate matters	PM 35	more than 10
Large particulate matters	PM 10	2.5 – 10
Fine particulate matters	PM 2.5	0.1 – 2.5
Ultra-fine particulate matters	PM 0.1 or UFP_s	less than 0.1

The granulometric spectrum *(g.s.),* based on the diagram shown in Fig. 3, represents the successively and decreasingly presentation of the grain-size fractions.

The spectrum shifting to the right means the increasing trend of the fine and ultrafine fractions.

The spectrum shifting to the left means the increasing trend of the large fractions.

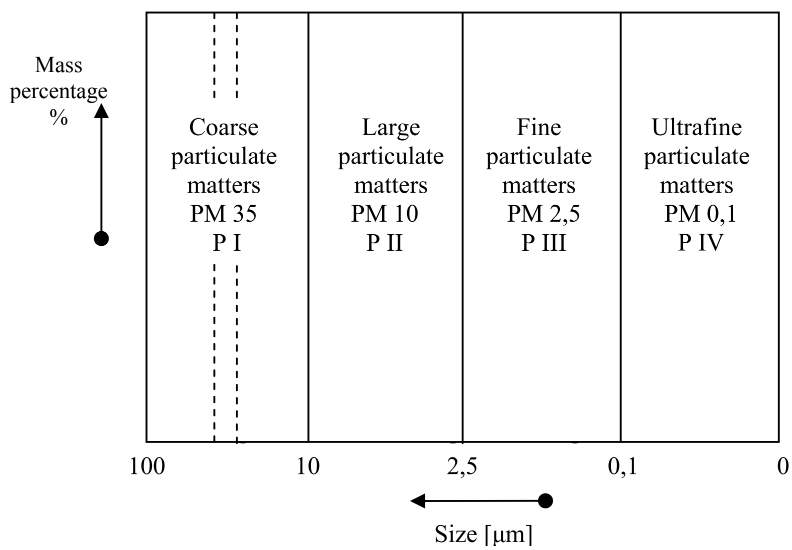

Fig. 3: Granulometric spectrum diagram

3.2.2. Concentration

The particulate matter concentration, c_p, measures the mass of the particulate matters existent in the mass or volume unit, for the three major environmental factors (air, water, soil). It is measured in [μg/m^3] or [μg/kg].

Depending on the analysis place, the concentration may have different meanings (Fig. 4).

The technological concentration, is the concentration measured within the contour of the technological processes. It characterizes the technological pollution (primary).

The concentration treatment, is the concentration measured within the thermal system, which provides gas cleaning before discharging into the fundamental environmental factors. It can be also called *chimney concentration*.

The **dispersion concentration,** is the concentration measured at a given distance from the contour of air cleaning, resulting from the phenomena of natural dispersion into the environment factors.

The deforming concentration (parasite) is the concentration generated by other sources, but which, at a given distance from the contour of air cleaning, overlaps the dispersion concentration.

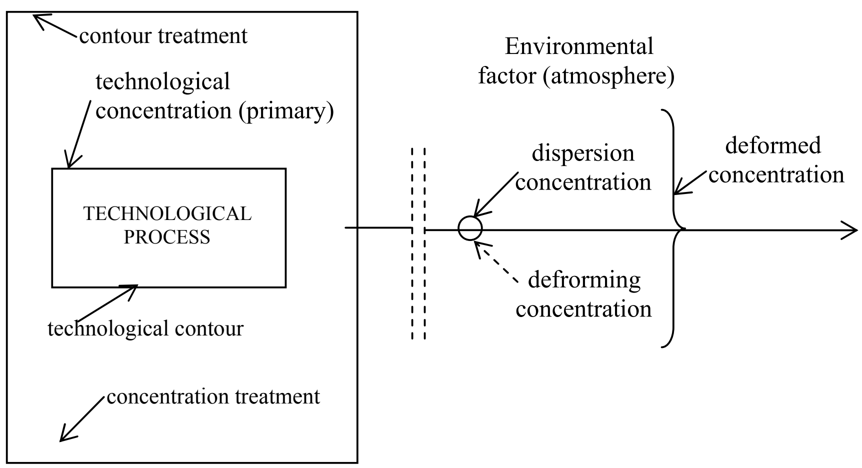

Fig. 4: Types of concentrations recorded in the generation and dispersion of metallurgical particulate matters

The deformed concentration, is the concentration measured at a given distance from the contour of air cleaning, which represents the overlapping between the dispersion concentration and the concentration of the particulate matters generated by other sources (deforming concentration).

The specific concentration, $c_{p.s}$ is the concentration defined by the equation:

$$c_{p.s} = \frac{c_p}{P} \quad ; \quad \left[\frac{\mu g \cdot year}{m^3 \cdot t} \right] \qquad \textbf{(1)}$$

where *P* is the metal material production, expressed in [t/year]. The use of such an index would have the following advantages:

- it would also introduce in analyses the economic system, represented by *P*, which is an important economic indicator;
- it would highlight the fact that the status of pollution depends also on the production of material made in the year taken into consideration for performing our analyses.

4. Future research directions

In the subsequent papers, we are going to present the results of experiences on the concrete correlations found in the ECOL-SOC-META area. Some papers highlighting the ECOL-SOC correlations have already appeared, or, more specifically, highlighting the correlations between health and particulate matters [17, 18, 30-32].

It is possible to establish ECOL-SOC-META correlations, because there are direct correlations between the trend of the disease risk curve and the various properties of the particulate matters (Fig. 5).

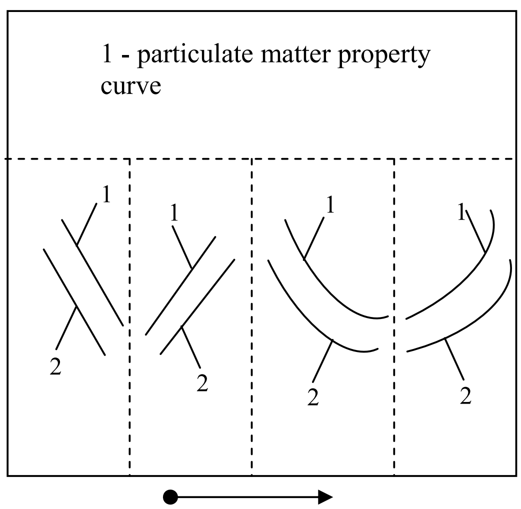

Fig.5: Trends of variation for various sizes

5. Conclusions

In the DSCD conditions, it becomes necessary that, within the MS made of four systems (natural-ecologic, social, economic and technological), the materials engineer (representative of the technological system) to penetrate the other systems and to contribute to the development of global knowledge.

In the above context, the inter- and multi-disciplinary gain a particularly significance, based on which the intersystem disciplines are operationalised.

The metal materials engineer must contribute to the development of certain specific intersystem disciplines, such as: Ecometallurgy, Metallurgical Econology and Metallurgical Ecosociology.

Within the Metallurgical Ecosociology, we have to investigate the ways through which the technological processes and plants can lead to a positive change of the correlation between health and particulate matter pollutants.

R E F E R E N C E S

[1] *A Vadineanu.*, Managementul dezvoltării: o abordare ecosistemică (Management of development: an ecosystemic approach), Publisher: Ars Docendi, Bucharest, 2004.

[2] *B. F. Stroe, A. Nicolae*, Knowledge transfer in the convercing fields of codevelopment, Metalurgia International, 18, nr. 8, 2013, p.146-149.

[3] *B. F., Stroe A. Nicolae*, Is it productive, for the sustainable development, to place the Econology on a priority position over the other scientific branches?, Acta Technica Napocensis, Series EESDE, no. 4, 2012, p.27,.

[4] *A. Iancu*, Creşterea economică şi mediul înconjurător (Economic growth and the environment), Publisher, Politica, Bucharest, 1973.

[5] *C. Negrei*, Instrumente şi metode în managementul de mediu (Tools and methods in the environmental management), Publisher: Economică, Bucharest, 1999.

[6] *V. Soroceanu*, Creşterea economică şi mediul natural (Economic growth and the natural environment), Publisher: Economică, Bucharest, 2000.

[7] *A. Nicolae , I. Borş, C. Predescu, M. Nicolae, V. Şerban, A. Predescu, A. Predescu, A. Berbecaru*, Econologie metalurgică (Metallurgical Econology), Publisher: Printech, Bucharest, 2009.

[8] *L. Nistor*, Sociologia mediului înconjurător (Environmental Sociology), P.U.C., Cluj-Napoca, 2009

[9] *E. R. Dunlop, W. Michelson*, Handbook of Environmental Sociology, Green Wood Press, London, 2006

[10] *A. Nicolae, C. Predescu, M. Nicolae, M. Licurici, M. Bordea, M. G. Sohaciu, G. Calea, D. Parpala*, Convergențe juridico-inginereşti în dreptul mediului (Legal and engineering convergences in the environmental law), Publisher: Printech, Bucharest, 2005

[11] *A. Nicolae, C. Predescu, A. Berbecaru, M. Nicolae*, Opportunities to analyse the pollution in metallurgical industry, The Annals of “Dunărea de Jos” University of Galați, 29, ISSN 1453-083X, 2011, p.76-80.

[12] *A. Nicolae, C. Predescu, M. Nicolae, P. Vizureanu, A. Vasiliu, A. Mihnea*, Operaționalizarea conceptului D.D. în siderurgie (Operationalisation of the S.D. concept in siderurgy), Publisher: Printech, Bucharest, 2006
[13] *A. Nicolae, B. F. Stroe*, Ecosociologie metalurgică, (Metallurgical Ecosociology), Matrix Rom Publisher House, Bucharest, 2012
[14] *B. F. Stroe, A. Nicolae*, Contributions regarding the development and operationalisation of Metallurgical Ecosociology, Metalurgia International, 17, nr. 6, p.98-101, 2012
[15] *E. S. Guzman, de Molina Navarros*, Ecosociologia: algunos elements teorias paralel analisys, Esp. Investg. Social, no. 5, 1990, p.2-10.
[16] *L. King, D. Ms Carthy*, Environmental Sociology, Green Wood Press, London, 2005
[17] *A. M. Moldoveanu*, Poluarea aerului interior (Indoor air pollution), Martix Rom Publisher House, Bucharest, 2007
[18] *Ianc P., Suceveanu G.*, Future of Siderurgy: trend and politics, Buletin IRCSID, 21, nr.3, p 1-20, 2013.
[19] *R. Stănescu Dumitru, R. C. Artenie, M. Tat*, Evaluarea expunerii profesionale la pulberi (Assessment of occupational exposure to particulate matter), Viața Medicală Publishers House, Bucharest, 2002
[20] *R. Stănescu Dumitru*, Agenți nocivi în mediul industrial (Toxic agents in the industrial environment), Viața Medicală Publishers House, Bucharest, 2008
[21] *C. Mandravel, R. Stancu Dumitru, V. Chiosa*, Relații între structură, proprietăți şi activitatea biologică aplicată la poluanții industriali (Relationships between structure, properties and biological activity applied to industrial pollutants), Publisher House Universitatea, Bucharest, 2003
[22] U.S.-E.P.A., Integrate Science Assessment for Particulate Matters, EPA 600/R-OB/139F, 2009
[23] W.H.O. (O.N.S.)-C.C.E.H.B.O., Health risk of particulate matter from long-range transboundary pollution, Copenhagen, 2002.
[24] ***, Second position paper on particulate matter (final draft), CAFÉ, Working Group on Particulate Hatter, 2004.
[25] ***, BAT – Reference document for iron and steel production, Industrial Emissions Directive, 2010/75/EU-IPPC, 2010.
[26] *T. Sofitic*, Characterization of electric arc furnace dust, J. Hazard Mat., B109, 2004, p.59-70.
[27] *M. Pelino*, Dust of EAF, Waste Management, 22, 2002, p.945.
[28] *C. Hilman*, Solution for dust and sludge in metallurgy, Stahl und Eisen, 128, no.5, p.32, 2006.
[29] *T. Emi*, Seetharanron, Dust evolution, Scandinavian J. of Metallurgy, 29, 2002, p.185.
[30] *A. C. Pope*, Daily mortality and PM10 pollution, Archives of Env. Health, 47, 1999, p.211-217.
[31] *J. M. Samet*, Fire particulate air pollution and mortality in New. England, J. of Medicine, 2000, p-1742-1749.
[32] ***, Air quality in Europe, EPA-TR 12/2011, Luxemburg, 2011.