TEHNOLOGIA INOVATIVĂ

REVISTA CONSTRUCŢIA DE MAŞINI - SERIE NOUĂ

Anul 66, Nr. 2 / 2014

- "Tehnologia Inovativa"
printed form: ISSN 2248 - 0420; ISSN-L 2248 - 0420
- "Tehnologia Inovativa"
online form: ISSN 2248 - 0420; ISSN-L 2248 - 0439

EDITOR: ICTCM – CITAf

041303 Bucuresti
Şos. Olteniţei nr. 103, sector 4, O.P. 8
Tel: **021 332.37.70/234**
Fax: **021 332.07.75 / 021 332.31.95**
E-mail: ictcm@ictcm.ro

RESPONSABIL EDITOR
Florica Costin

REDACTOR- ŞEF
Irina Rădulescu

INFORMAŢII, ABONAMENTE:

Revista este evaluată CNCSIS la categoria B+,
apare trimestrial.
Abonamentele se fac direct, prin dispoziţie de plată sau mandat poştal, trimis pe adresa revistei.

CONT – ICTCM:
nr. RO58 RNCB 0075 0352 1240 0001;
BCR sector 4
TIPAR: ICTCM – CITAf

Din sumar

ANUL 66 / 2014 – NR. 2

TEHNOLOGIA INOVATIVĂ

REVISTA CONSTRUCŢIA DE MAŞINI

COLEGIUL DE REDACŢIE

COMITET ONORIFIC

EDITOR
S.C. ICTCM S.A. BUCUREŞTI - CITAf

RESPONSABIL EDITOR
Florica Costin

REDACTOR- ŞEF
Irina Rădulescu

WEBMASTER
Cătălin Sfetcu

CUPRINS

TEHNOLOGIE INOVATIVĂ / INNOVATIVE TECHNOLOGY

DEZVOLTARE DURABILĂ / SUSTAINABLE DEVELOPMENT

MODELARE ŞI SIMULARE / MODELLING AND SIMULATION

ABSTRACTS "INNOVATIVE TECHNOLOGY" 2 / 2014

CORROSION BEHAVIOR OF ELECTODEPOSITED COMPOSITES

Rodica Stancu[1], Aristita Mihalcea[2]
[1] ScoalaGimnaziala 119, Bucharest, ROMANIA,
[2]S.C.ICTCM S.A , Bucharest, ROMANIA

This paper presents experimental date regarding corrosion resistance of composite coatings with Zn-Fe(1-3%), Zn-Sn (20-25%), Zn-Ni(7-15%) metallic matrix and PTFE particles. Deposits were obtained using neutral and alkaline electrolytes. The effect of PTFE particles on corrosion resistance was studied. Characterization of corrosion resistance was studied using salt spray tests according ASTM B 117 and electrochemical corrosion tests in NaCl 5% solution.

CERCETĂRI PRIVIND FUNCŢIONAREA PROTOTIPULUI INSTALAŢIEI DE GAZIFICARE DEŞEURI DE ANVELOPE CU COEFICIENŢI MICI DE EXCES DE AER/ RESEARCH ON THE FUNCTIONING OF GASIFICATION PROTOTYPE SYSTEM FOR WASTE TIRES WITH SMALL EXCESS AIR COEFFICIENTS

Laslu Mihail Gabriel[1], Mihailescu Alin[2], Sarbu Gheorghe[3]
[1] AIM, Bucharest, ROMANIA,
[2] SAN SYSTEMS INDUSTRI Piteşti, ROMANIA,
[3] ICTCM, Bucharest, ROMANIA

The paper presents research done in ENER-PLAST project, which has proposed the achievement of a new reactor for gasification of waste tires which solves the main technical barriers in the development of reactors.
The reactor development is based on the use of pulse jet devices for high power reactor supply raw material, for pneumatic transport of sand used to remove ash from the reactor, heat exchange surfaces for cleaning and filtering the tars from thermochemical process for increasing reactions in active aria.

LABORATORY TESTS REGARDING DIFFERENT INDUSTRIAL AND MEDICAL APLICATIONS FOR THE TECHNOLOGICAL SPECIFIC PARAMETERS FOR THE HVOF PROCEDURE

V. Avramescu, R. Niţă, L. Păun, S. Roşulescu, D. Bobe
S.C. ICTCM S.A. Mechanical Engineering and Research Institute, Bucharest, ROMANIA

The paper has as main objective the determination of the necessary technological parameters for metallization of some workpieces, including some laboratory tests. The performed tests were used to determine the values of technological parameters to be taken into account in the design of the prototype.

APPLICATIONS OF THERMAL SPRAYING

V. Avramescu, L. Paun, R. Nita, S. Rosulescu, D. Bobe
Mechanical Engineering and Research Institute, Bucharest. ROMANIA

The article has as main objective the presentation of the working principle of the HVOF procedure, of some domains for using the thermal spraying procedure, of the types of installations used and also of the main advantages which can be obtain by solving of some practical problems from the industry and the production of medical equipments.

MODELE STRATEGICE PRIVIND SISTEMELE DE ENERGIE CARE VOR ASIGURA ENERGIE CURATĂ PENTRU CONSUMATORI/ STRATEGIC MODELS OF ENERGY SYSTEMS THAT WILL PROVIDE CLEAN ENERGY TO CONSUMERS

Oana Diana Radu (Cristea), Laurentiu Vladutoiu
National Institute of Research - Development for Machines and Installations designed to Agriculture and Food Industry - INMA, Bucharest, ROMANIA

The main topics approached conceptually in the present communication are the following:
- strategic models of designing and developing the future safe energy technological structures able to meet the requirements (A.A.A.A. – Accessibility, Availability, Acceptability, Accountability) at the level of the management of all clean resources;

- *the concept of intelligent networks (SMART-GRIDS) that will ensure working states without risks starting with designing the new future energy structures and ending with rendering efficient the energy market, the designing of the archemo-systemic management in the operational researches meant for optimizing the entire stock of material, human, informational resources so that in the future energy systems one should call for virtual, agile and fractal efficient processes allowing the cut of the prices of clean energy delivered to eligible consumers.*

RECYCLING AND RECOVERY OF WASTE ELECTRICAL AND ELECTRONIC EQUIPMENT (WEEE)

Mihai Cornea, Alexandru Rădulescu, Irina Radulescu
University POLITEHNICA Bucharest, ROMANIA

Waste Electric and Electronic Equipment (WEEE) represent waste flows with the fastest growth both nationally and internationally. The uncontrolled disposal of waste is a public health problem of our planet. Treating WEEE must be made only in specialized and authorized centers. The inadequate recycling procedures waste precious metals and recyclable plastic matters, generating energy consumption and damage of the environment as a result of the production of pure matters.

MODELE ALE SISTEMELOR STRATEGICE DE RECONFIGURARE A STRUCTURILOR CIBERNETICE ÎN CONCEPŢIE ROBOTICĂ/ STRATEGIC SYSTEMS MODELS FOR CYBERNETICS STRUCTURES RECONFIGURATION IN ROBOTIC DESIGN

Oana Diana Radu (Cristea), Laurentiu Vladutoiu
National Institute of Research - Development for Machines and Installations designed to Agriculture and Food Industry - INMA, Bucharest, ROMANIA

The main idea of starting work is: researching the creative process involves the practical application of methods and techniques energetiei global clean an attempt to bring solutions to the difficult situation in which the Romanian energy industry.
One of the main objectives of global energy policy is the development of renewable energy as global energy and clean resource that aims in the context of sustainable development, reducing energy consumption, increasing energy security of supply, environmental protection and the development of sustainable energy technologies .

ETUDES THEORIQUES POUR LE COMPORTEMENT DES CAPTEURS DE PRESSION / THEORETICAL STUDIES FOR THE BEHAVIOUR OF PRESSURE SENSORS

Marilena Violeta Giuglea[*], Sebastiano Brida[**], Alexandru Rădulescu[*]
* Université POLITEHNICA Bucarest, ROUMANIE, email: varrav2000@yahoo.com
** Esterline Advanced Sensors, Bourges, FRANCE

Today, thanks to the evolution of computers, we can achieve theoretical experiments (simulations) in place of practical experience to reduce financial costs and time. This article represents a synthesis of the research on simulations for the encapsulation pressure sensors. Micro-electro-mechanical systems are presented, starting with their definition, their importance in the present life and ending with the process of manufacturing a MEMS. In the end, the paper presents the numerical simulations performed using Comsol Multiphysics software and the conclusions due to the numerical results obtained.

CORROSION BEHAVIOR OF ELECTODEPOSITED COMPOSITES

Rodica Stancu[1], Aristita Mihalcea[2]
[1] ScoalaGimnaziala 119, Bucharest, Romania, rodicastancu71@gmail.com
[2]S.C.ICTCM S.A , Bucharest, Romania, aristitamihalcea@yahoo.com

REZUMAT
Lucrarea prezintă date experimentale privind rezistenţa la coroziune a acoperirilor compozite cu matrice metalica Zn-Fe(1-3%), Zn-Sn (20-25%), Zn-Ni (7-10%) şi particule de PTFE. Depunerile au fost obţinute din electroliţi neutri şi alcalini. A fost studiat efectul particulelor de PTFE asupra rezistenţei la coroziune şi a tipului de matrice metalică. Caracterizarea rezistenţei la coroziune s-a realizat efectuând teste de coroziune accelerată în ceaţă salină conform ASTM B 117 şi teste electrochimice de coroziune în soluţie de NaCl 5%.

ABSTRACT
This paper presents experimental date regarding corrosion resistance of composite coatings with Zn-Fe(1-3%), Zn-Sn (20-25%), Zn-Ni(7-15%) metallic matrix and PTFE particles. Deposits were obtained using neutral and alkaline electrolytes. The effect of PTFE particles on corrosion resistance was studied. Characterization of corrosion resistance was studied using salt spray tests according ASTM B 117 and electrochemical corrosion tests in NaCl 5% solution.

CUVINTE CHEIE: electrodepunere, compozite, aliaje de zinc cu PTFE, aliaje de zinc, depuneri rezistente la coroziune

KEYWORDS: electrodeposition, composites, zinc alloys with PTFE, zinc alloys, corrosion resistant deposits

1. INTRODUCERE

Progresul continuu din industria acoperirii metalelor în întreaga lume caută să răspundă cât mai bine problemelor de coroziune. Aplicaţiile compozitelor electrochimice sunt date atât de proprieăţile conferite de matricea metalică, cât şi de faza dispersă.

Astfel, pe lângă proprietăţile anticorozive pe care le conferă aliajele Zn-Fe, Sn-Zn şi Zn-Ni, s-a încercat îmbunătăţirea proprietăţilor autolubrifiante ale acoperirii prin includerea unui lubrifiant uscat în depunerea metalică.

Particulele de PTFE îşi menţin proprietăţile mecanice pe un domeniu foarte larg de temperatură comparativ cu alte tipuri de particule lubrifiante. Teflonul are coeficientul de frecare cel mai scăzut dintre materialele solide cunoscute (0,05).

Energia de suprafaţă scăzută a acestor materiale împiedică obţinerea unor acoperiri aderente pe suprafeţe metalice. [1] Aceasta poate fi evitată prin codepunerea lor cu un metal.

Reducerea coeficientului de frecare datorită caracteristicilor particulelor de PTFE prezintă avantaje în multe aplicaţii. Această generaţie de acoperiri este utilizată acolo unde se cere un coeficient de ferecare scăzut şi în acelaşi timp rezistenţă în diferite medii corozive.

Lucrarea prezintă date experimentale privind rezistenţa la coroziune a acoperirilor compozite cu matrice metalica Zn-Fe(1-3%), Zn-Sn (20-25%), Zn-Ni (7-10%) şi particule de PTFE. A fost studiat efectul particulelor de PTFE asupra rezistenţei la coroziune şi a tipului de matrice metalică. Caracterizarea rezistenţei la coroziune s-a realizat efectuând teste de coroziune accelerată în ceaţă salină conform ASTM B 117 şi teste electrochimice de coroziune în soluţie de NaCl 5%.

2. EXPERIMENTĂRI

Compoziţia şi condiţiile de depunere pentru electroliţii alcalini şi neutri sunt prezentaţi în tabelul 1.

Soluţiile au fost preparate cu substanţe p.a. utilizând apă distilată. Menţinerea particulelor în suspensie s-a realizat folosind un agitator magnetic, viteza de rotaţie fiind de 7 rot./minut.

Depunerile s-au realizat pe substrat de oţel, iar ca anod a fost utilizat oţel. Depunerile au fost supuse testelor de coroziune accelerată în ceaţă salină conform ASTM B 117 şi testelor electrochimice de coroziune în soluţie de NaCl 5%. Toate probele au avut o grosime de 10-15 μm. S-au efectuat şi teste pe probe care au fost tratate cu o soluţie organică de închidere a porilor.

Curbele de polarizare anodică au fost realizate într-o celulă necompartimentată cu trei electrozi: electrodul de lucru – oţel acoperit cu depuneri compozite, contraelectrod de platină, electrod de referinţă – electrodul de calomel saturat; conectaţi la un potenţiostat/galvanostat Radiometer PGP 201 controlat de software Voltalab 21. Toate experienţele s-au desfăşurat fără dezaerare. Curbele anodice de polarizare s-au realizat în soluţie de NaCl 5%, potenţialul fiind scanat pe domeniul ±250 mV faţă de potenţialul de echilibru cu viteza de 50mV/s.

Tabelul 1. *Compoziţia chimică, condiţiile şi parametrii de lucru pentru obţinerea depunerilor de nanocompozite electrodepuse*

Nr. Crt.	Tip depunere	Compoziţia chimică a electrolitului	Concentraţia
1	Zinc - Fier	Oxid de zinc Hidroxid de sodiu Adaos AN 31 Complex de fier Suspensie PTFE	10-12 (g/l) 125-130 (g/L) 3 – 12 (mL/L) 10 – 60 (mL/L)
2	Zinc - Nichel	Oxid de zinc Hidroxid de sodiu Adaos AN 31 Complex de nichel Suspensie PTFE	10-12 (g/L) 125-130 (g/L) 3 – 12 (mL/L) 5 – 10 (mL/L) 10-60(mL/L)
3	Staniu -zinc	Sn^{2+} Zn^{2+} CH_3COONa $CH_2OH(CHOH)_4COONa$ Acid ascorbic Gelatină NaOH Suspensie PTFE pH Temperatura	2 - 25 g/l 2,5-12,5g/ 20 g/l 120-160 g/l 10-20 g/l 2-4 g/l 20 g/l 10 – 60 (mL/L) 6,5-7 40-60 ^{0}C

3. REZULTATE ŞI DISCUŢII

Acoperirile compozite Sn-Zn-PTFE fără pasivare au rezistat aproximativ 700 ore de ceaţă salină înaintea apariţiei punctelor de coroziune. Studiul de literatură a indicat că prezenţa diferiţilor ioni metalici în electrolitul de depunere conduce la creşterea concentraţiei particulelor codepuse. [2-4]

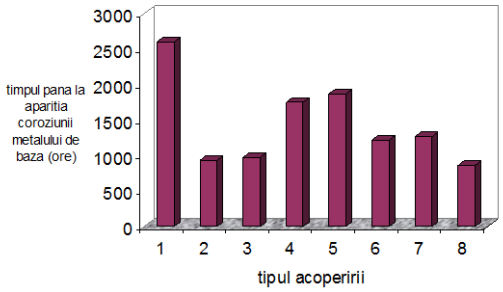


Figura 1. *Rezultatele comparative ale testelor de ceaţă salină pentru acoperirile compozite*

1) Zn-$Ni_{alc.}$ pasivat galben irizat;
2) Zn-$Fe_{ac.}$pasivat galben irizat;
3) Sn-Zn pasivat galben irizat + tratament de închiderea porilor;
4) Sn-Zn(CoMo) pasivat galben irizat + tratament de închiderea porilor;
5) Sn-Zn(CoMo) –PTFE pasivat galben irizat + tratament de închiderea porilor;
6) Sn-Zn-mică pasivat galben irizat + tratament de închiderea porilor;
7) Sn-Zn(CoMo) – grafit pasivat galben irizat + tratament de închiderea porilor;
8) Sn-Zn-PTFE pasivat galben irizat.

Astfel, s-a observat că ionii de Co^{2+} adăugaţi la electrolitul neutru de Sn-Zn favorizează depunerea staniului (0 g/l Co^{2+} $\Rightarrow$ 40% Sn, 60% Zn; 1 g/l Co^{2+} $\Rightarrow$ 70% Sn, 25% Zn), dar şi a particulelor de PTFE.

O concentraţie de 1 g/l Co^{2+} în electrolitul clorurat măreşte concentraţia particulelor din strat la 6,2…11,03% PTFE, iar în baia de fluoborat concentraţia particulelor în depunere atinge 18,9% procente în greutate.

S-a observat că apariţia punctelor de coroziune este inhibată prin adăugarea în electrolitul neutru de Sn-Zn-Co a unui compus pe bază de molibden (8…12 g/l Mo). Probele acoperite cu Sn-Zn-Co-PTFE (compus cu molibden ca inhibitor) supuse de asemenea tratamentelor de pasivare şi închidere a porilor au rezistat peste 1700 ore de ceaţă salină până la apariţia punctelor de coroziune.

În figura 1 sunt prezentate comparativ rezultatele testelor de corozine la ceaţă salină a acoperirilor compozite Sn-Zn-Co-PTFE şi Sn-Zn-Co-grafit cu a acoperirilor Zn-Fe obţinute dintr-un electrolit neutru — supus unui tratament de pasivare galben irizat (soluţie de pasivare pe bază de titan şi ceriu) şi închiderea porilor — şi a acoperirilor Zn-Ni (~10% Ni) obţinute dintr-un electrolit alcalin, pasivat galben irizat (soluţie de pasivare pe bază de crom hexavalent). [5, 6].

În figura 2 este prezentat ca exemplu aspectul şuruburilor acoperite cu aliaj Zn-Fe şi a celor cu aliaj Sn-Zn după aproximativ 1000 ore de testare în ceaţă salină. Se poate vedea că şuruburile care au fost protejate cu aliaj Zn-Fe după 1000 ore de testare sunt complet acoperite de rugină, în timp ce şuruburile acoperite cu aliaj Sn-Zn au numai câteva puncte de coroziune. Acoperirile au fost pasivate în soluţii de pasivare ecologice pe bază de titan şi ceriu şi introduse într-o soluţie comercială de închidere a porilor.

Rezultatele la coroziune în ceaţă salină pentru acoperirile nepasivate sunt prezentate în tabelul 2.

Acoperirile compozite, obţinute din electroliţi alcalini, cu matrice metalică Zn-Ni au o rezistenţă mai bună comparativ cu cele cu matrice de Zn-Fe, dar mai mică decât ce a depunerilor de Sn-Zn din electrolit neutru.

Particulele de PTFE măresc rezistenţa la coroziune, dar nu semnificativ, pentru toate tipurile de matrice metalică.

Acoperirile compozite Sn-Zn-PTFE pasivate au prezentat 864 ore, în atmosferă de ceaţă salină, până la apariţia coroziunii metalului de bază, iar acoperirile Zn-Ni-PTFE şi Zn-Fe-PTFE nepasivate 480 ore, respectiv 312 ore de testare în atmosferă de ceaţă salină, până la apariţia coroziunii metalului de bază.

Tabelul 3 prezintă densitatea curentului de coroziune I_{coor}, constantele Tafel β_a and β_c şi resistenţa de polarizare calculate din curbele anodice de polarizare pentru diferite tipuri de acoperiri compozite nepasivate.

a)

b)

***Figura 2**. Aspectul acoperirilor Zn-Fe pasivată şi Sn-Zn, după aproximativ 1000 ore de testare în ceaţă salină*
a)Zn-Fe pasivat galben irizat + tratament de închiderea porilor;
b)Sn-Zn pasivat galben irizat + tratament de închiderea porilor.

Tabelul 2. *Rezultatele testelor de coroziune în ceaţă salină*

Nr. ore	Zn-Ni	Zn-Ni-PTFE	Zn-Fe	Zn-Fe-PTFE
24	c.a.100 %	c.a.100%	c.a.100%	c.a.100%
48	c.a.100 %	c.a.100%	c.a.100%	c.a.100%

72	c.a.100 %	c.a.100%	c.a.100% c.b. pct.	c.a.100%
120	c.a.100 % c.b. pct.	c.a.100%	c. c.b. pct.a.100%	c.a.100%
168	c.a.100 % c.b. pct.	c.a.100%		c.a.100%
216		c.a.100%		c.a.100%
264		c.a.100%		c.a.100%
312		c.a.100%		c.b. 10%
360		c.a.100%		c.b. 25%
384		c.a.100%		c.b. 35%

Comparând acoperirile Sn-Zn-PTFE, Zn-Ni-PTFE şi Zn-Fe-PTFE s-a observat că depunerile compozite cu matrice Sn-Zn oferă o rezistenţă la coroziune mai bună. Rezistenţa la coroziune diferită este dată de matricea metalica – aliajul de zinc.

Particulele de PTFE cresc uşor densitatea curentului de coroziune.

3. CONCLUZII

Studiind comportarea la coroziune a acoperirilor compozite cu matrice metalică Zn-Fe (1-3%), Zn-Sn (20-25%) Zn-Ni (7-10%) şi particule de PTFE, obţinute din electroliţi neutri, acizi şi alcalini, s-a observat că particulele de PTFE nu măresc semnificativ rezistenţa la coroziune a acoperirilor compozite. Particulele de PTFE îmbunătăţesc proprietăţile tribologice ale acoperirii Sn-Zn, dar nu au un efect pozitiv asupra rezistenţei la coroziune.

Rezistenţa la coroziune este dată de matricea metalică. Cea mai mare rezistenţă la coroziune o are aliajul Sn-Zn. Staniul şi zincul au potenţiale standard electronegative şi există o mare diferenţă între potenţialele lor standard: $\varepsilon^0_{Sn^{2+}}$ = -0,136 V şi respectiv $\varepsilon^0_{Zn^{2+}}$ = -0,763 V.

Dacă depunerea acestora are loc pe un substrat de fier, atunci diferenţa relativă de potenţial pentru staniu este $E_{Sn}{}^{2+}$ = 0,3 V, iar pentru zinc este $E_{Zn}{}^{2+}$ = -0,3 V.

Astfel se pot explica proprietăţile anticorozive ale acestui aliaj. Aliajul Sn-Zn combină proprietăţile anticorozive ale celor două metale: staniul acţionează ca o barieră de protecţie a substratului împotriva coroziunii, iar zincul ca anod de sacrificiu pentru a oferi rezistenţă la coroziune a substratului.

Tabelul 3. *Rezultatele curbelor de polarizare*

Tipul acoperirii	β_a (panta anodică Tafel) mV	β_c (panta catodică Tafel) mV	R_p ohm x cm/	I_{coor} $\mu A/cm^2$
Zn-Fe	26,3	-58,9	1010	20,4
Zn-Ni	25,3	-139,8	977,08	13,7
ZnFe-PTFE	12,8	-100,2	659,63	9,67
Sn-Zn	20,12	-109,10	704,23	10,57
Sn-Zn-PTFE	23,4	-56,6	2970	5,83
ZnNiPTFE	16,4	-183,8	1130	6,92

BIBLIOGRAFIE

1. **J.P.Roos, J.P.Celis, J.Fransaer şi C.Bulens**; *J.Metals 42* (1990) 60.
2. **C.A.Boose**; *Tijdschrift voor oppervlaktetechnieken en corrosiebestrijding*, 34 (1990) 54.
3. **K.M.Yin şi H.J.Hong**; *Trans.IMF*., 75 (1997) 35.
4. **J.Foster şi A.M.H.Kariapper**; *Trans.IMF*., 51 (1973) 27.
5. **L.Roman, V.Filippi, C.Răducanu, C.Cristescu şi R.Stancu** "*Corrosion behaviour of phosphorus containing zinc alloys deposits from alkaline electrolytes*"; Materials and Corrosion, 51 (2000) 513.
6. **O.Radovici, L.Roman, V.Filippi, R.Stancu, C.Răducanu şi C.Cristescu** "*Consideration on low phosphorus containt zinc alloys deposits from alkaline electrolytes*" Ecologie industrială, 10-12 (2000) 17.

CERCETĂRI PRIVIND FUNCŢIONAREA PROTOTIPULUI INSTALAŢIEI DE GAZIFICARE DEŞEURI DE ANVELOPE CU COEFICIENŢI MICI DE EXCES DE AER/ RESEARCH ON THE FUNCTIONING OF GASIFICATION PROTOTYPE SYSTEM FOR WASTE TIRES WITH SMALL EXCESS AIR COEFFICIENTS

Laslu Mihail Gabriel[1], Mihailescu Alin[2], Sarbu Gheorghe[3]
[1] AIM, Bucharest, ROMANIA, e-mail: aim@aim-srl.ro.
[2] SAN SYSTEMS INDUSTRI Piteşti, ROMANIA, e-mail: sansystemsind@gmail.com
[3] ICTCM, Bucharest, ROMANIA, , e-mail: ictcm@ictcm.ro

REZUMAT
Lucrarea prezintă cercetări întreprinse în cadrul proiectului ENER-PLAST, ce şi-a propus realizarea unui nou reactor pentru gazificarea deşeurilor de cauciuc care rezolvă principalele bariere tehnice în dezvoltarea acestui tip de reactoare.
Dezvoltarea reactorului se bazează pe folosirea dispozitivelor puls jet de mare putere pentru alimentarea cu materie primă a reactorului, pentru transportul pneumatic al nisipului folosit pentru eliminarea cenuşei din reactor, pentru curăţarea suprafetelor de schimb termic şi de filtrare de gudroanele rezultate din procesul termochimic şi pentru intensificarea reacţiilor în zona activă.

ABSTRACT
The paper presents research done in ENER-PLAST project, which has proposed the achievement of a new reactor for gasification of waste tires which solves the main technical barriers in the development of reactors.
The reactor development is based on the use of pulse jet devices for high power reactor supply raw material, for pneumatic transport of sand used to remove ash from the reactor, heat exchange surfaces for cleaning and filtering the tars from thermochemical process for increasing reactions in active aria.

KEYWORDS: gasification , synthesis gas, reactor, co-generation, renewable energy.

CUVINTE CHEIE: gazificare, gaz de sinteză, reactor, co-generare, energie regenerabilă.

1. INTRODUCERE

Obiectivul cercetării este realizarea unui studiu privind funcţionarea instalaţiei cu coeficienţi mici de exces de aer ($\alpha<0,07$) pentru obţinerea unui gaz de sinteză cu putere calorică mare şi o cantitate cât mai mare de OIL, [1].

Cercetările întreprinse în cadrul proiectului ENER –PLAST au ca obiectiv final dezvoltarea unei tehnologii noi de gazificare a pneurilor uzate, iar gazul de sinteză (singaz-ul), combustibilul lichid, dar şi tar-ul şi negrul de fum rezultate din acest proces, să fie folosite ulterior la producerea de căldură, electricitate, combustibili sau produse chimice, [2].

Instalaţia utilizează ca materie primă anvelopele uzate, de la toate mijloacele de transport cu pneuri, indiferent de mărimea sau provenienţa lor.

De asemenea se pot utiliza şi alte deşeuri de cauciuc şi eventual biomasă, ce pot fi introduse în reactorul de gazificare după tocarea lor. Astfel se reintroduc în circuitul economic materiale deşeu, care altfel ocupau spaţiu inutil şi mai ales produceau poluarea mediului, obţinând din acestea: combustibili, energie electrică, energie termică, produse chimice sau o combinaţie a lor, [3].

2. PROIECTAREA PROTOTIPULUI

În cadrul proiectului s-a avut ca obiectiv imediat realizarea prototipului unei instalaţii de gazificare a anvelopelor uzate mărunţite.

Acesta este compus din:

- Reactorul de gazificare, prevăzut cu ventilatoarele de introducere a aerului de reacţie în grămada de bucăţi de cauciuc prin ţevi ce coboară din capacul superior al reactorului. De asemenea este prevăzut cu un dispozitiv puls jet pentru amestecarea cauciucului în reactor şi cu separatorul magnetic cu roată celulară pentru captarea bucăţilor metalice din stratul de pietriş ce iese din reactor. Totodată se realizează anihilarea undei de şoc din reactor, care ar fi produsă de dispozitivul puls jet de transport pneumatic al pietrişului, ce trimite pietrişul amestecat cu negru de fum, cenuşă şi puţin OIL la partea superioară a reactorului într-un ciclon, acesta separând pietrişul de aerul comprimat amestecat cu negru de fum şi OIL înainte de reintroducerea acestora în reactor, (Figura 1 a);

- Buncărul de alimentare cu două zăvoare tip ghilotină cu funcţionare automată, prevăzut cu un dispozitiv puls-jet pentru transportul pneumatic al bucăţilor de pneuri în reactor, (Figura 1 b);

- Un ciclon pentru separarea negrului de fum ce iese din reactor amestecat cu gazul de sinteză;

- Un filtru cu saci cu dispozitiv de curăţire puls jet, pentru condensarea OIL într-un rezervor şi separarea cenuşei şi negrului de fum din aerul ce iese din ciclonul de separare negru de fum, (Figura 1 c);

- Răcitoarele de gaz de sinteză pentru condensarea combustibilului lichid, (Figura 1 c);

- Un rezervor tampon pentru egalizarea presiunii gazului de sinteză,

- 4 arzătoare de gaz de sinteză, montate pe un focar asistate de un ventilator care furnizează aerul necesar arderii.

- Un pupitru de comandă şi supraveghere a funcţionării ansamblurilor instalaţiei.

a)

b)

c)

Figura 1. *Ansamblul instalaţiei*

3. CONCLUZII ŞI PROPUNERI

Cercetările întreprinse în cadrul proiectului s-au materializat în îmbunătăţiri ale funcţionării instalaţiei de gazificare şi rezultate enumerate în cele ce urmează şi prezentate succint în Tabelul 1 şi în Tabelul 2:

1. S-a realizat funcţionarea instalaţiei de gazificare în regim practic de piroliză cu un coeficient de exces de aer de numai 0,065, faţă de cel realizat de alte instalaţii cărora li se atribuie valori publicate pentru coeficientul de exces de aer de 0,15-0,25, [1];
2. Această valoare a făcut posibilă realizarea unui gaz de sinteză superior cu puterea calorică inferioară de 22,7 MJ/Nmc, net superioară celor publicate de 4-9 MJ/Nmc pentru alte instalaţii de gazificarea deşeurilor de cauciuc, [2];
3. S-a realizat curăţarea mulţumitoare a singazului, care a putut să ardă într-un focar fără alte măsuri speciale;
4. La probe s-a realizat condensarea unui procent de cca 20% din gazul de sinteză rezultat prin gazificare, obţinându-se un combustibil lichid cu caracteristici asemănătoare cu ale Combustibilului Lichid Uşor (CLU) comercializat. Faţă de alte realizări similare cu rezultate publicate în reviste de specialitate, acest combustibil se distinge prin lipsa apei şi a acidităţii, iar puterea calorică similară cu a altor produse este la fel de ridicată, fiind realizată la 39,78 MJ/kg (9501 kcal/kg), [2];
5. Din punct de vedere economic a rezultat că instalaţia de gazificare a deşeurilor de cauciuc prelucrează o cantitate de 330-370 kg/h, realizând o putere termică a gazelor de cca 2900 kWt şi o putere termică a OIL de cca. 770 kW. Se apreciază că la funcţionarea continuă a instalaţiei se va obţine un procent de cca. 30% OIL, realizând o putere termică de 1100 kW.

Cercetările întreprinse pentru realizarea prototipului subliniază caracteristicile specifice acestei tehnologii:

- Aportul de aer în reactor se face cu un ventilator de presiune înaltă şi printr-un dispozitiv puls-jet, prin ţevi dispuse in mai multe zone in masa cauciucului. Acest fapt măreşte viteza de reacţie prin amestecarea şi omogenizarea materiei prime cu aerul necesar;
- Instalaţia are un filtru cu pietriş, circulant, pentru separarea fazei solide şi a gudroanelor din gazele de sinteză, ce conduc la următoarele efecte: prag de filtrare 6 -12 μm (faţă de min 50 μm la cicloanele industriale folosite curent de celelalte tehnologii), transportul impurităţilor şi cenuşei într-un ciclon exterior pentru separarea acestora de nisip şi mai departe în reactor sau într-un filtru cu saci pentru separarea lor din gazul necondensabil, fiind astfel o instalaţie compactă şi mai ieftină.
- Alimentarea cu cauciuc şi transportul nisipului, cu pulsuri scurte de presiune, de mare viteză are ca efect minimizarea consumului de gaz comprimat purtător;
- Se realizează încălzirea directă prin insuflare de aer în zona de oxidare în cantităţi strict controlate. Aerul introdus este aerul minim necesar pentru a produce energia de autoîntreţinere a reacţiilor de gazificare şi de piroliză, mărindu-se ponderea pirolizei, cu efect favorabil în ceea ce priveşte puterea calorifică a singazului;
- Injecţia materiei prime se face cu dispozitive puls-jet, permiţând funcţionarea în flux continuu, fără a fi necesară oprirea reactorului în fazele de alimentare;
- Roata celulară cu separatorul magnetic, de pe circuitul agentului filtrant este un utilaj de concepţie proprie, pe lângă etanşare asigurând şi recuperarea armăturii metalice a pneurilor,prin valorificarea ei mărindu-se eficacitatea economică a instalaţiei.

BIBLIOGRAFIE

[1] **Matti Nieminen** „*Fluidised Bed Gasification, Gas Cleaning, and Gas Utiliyation System*" May, 2004.

[2] **International Energy Agency** „*Hydrogen & Fuel Cells – Review of National R&D Programs*" OECD/IEA, 2004.

[3] **Ulrik Henriksen, Jesper Ahrenfeldt, Torben Kvist Jensen, Benny Gøbel, Jens Dall Bentzen, Claus Hindsgaul, Lasse Holst Sørensen** *"The Design, Construction and Operation of a 75 kW Two-Stage Gasifier*" Biomass Gasification Group, Department of Mechanical Engineering, Technical University of Denmark; ECOS 2003,Copenhagen, Denmark Jun 30-July 2, 2003.

Tabel 1. *Caracteristici şi performanţe*

	Parametrul/Caracteristica	Realizat
1.	Tipul reactorului realizat	Cu alimentare pulsatorie a deşeurilor din cauciuc şi încălzire directă
2.	Etapa de dezvoltare	Prototip
3.	Tipul de materie prima utilizata	Anvelope uzate de orice tip, tocată cu o granulaţie cuprinsă între 0 şi 50 mm.
4.	Debit de materie primă gazificată [kg/h]	Debit realizat: 330-370
5.	**Condiţii de reacţie:**	
	-presiune [mbar]	Suprapresiune în reactor: 16-40
	- Temperatura în zona de reacţie ^{0}C	300 - 900° C
	- Temperatura singazului la ieşire din reactor ^{0}C	Max 270^0 C
	- Reactanţi	Aer cu coeficient de exces de aer redus (piroliză)

.

Tabel 2. *Rezultatele cercetării*

Aer introdus de la atingerea temperaturii de 300^0 C	197	mc/h	250,35067	mc			
Timp funcţionare de la 300^0 C	74	minute					
consum specific de aer (raportat la masa de combustibil)			0,6124038	mc/kg			
Coeficient de exces de aer realizat α (EN)			0,0646678				
Debit orar cauciuc			331,4	kg/h			
Debit gaze de sinteză			501	mc/h			
Raport singaz/aer			2,5462151				
Compoziţie gaze de sinteză							
% N2			18,63				
%H2			12,42	Estimativ			
% ∑CH			49	Măsurate			
%CO			15,4				
%CO2			4,55				
TOTAL			100%				
Arderea singazului							
Putere gaze			10439,548	MJ/h	2900	kWt	
Putere calorică gaze			5412,66	Kcal/Nmc	22,7	MJ/Nmc	
Aer teoretic necesar ardere (L0)			5,3269772	Nmc/Nmc			

LABORATORY TESTS REGARDING DIFFERENT INDUSTRIAL AND MEDICAL APLICATIONS FOR THE TECHNOLOGICAL SPECIFIC PARAMETERS FOR THE HVOF PROCEDURE

V. Avramescu, R. Niţă, L. Păun, S. Roşulescu, D. Bobe

S.C. ICTCM S.A. Mechanical Engineering and Research Institute, Bucharest, ROMANIA,
e-mail: valeriuavramescu@yahoo.com

REZUMAT

Articolul are ca obiectiv principal determinarea parametrilor tehnologici necesari metalizării unor reperere, inclusiv prin efectuarea unor teste de laborator.Testele efectuate au fost utilizate pentru determinarea valorilor parametrilor tehnologici ce vor fi luate în calcul la proiectare.

ABSTRACT

The paper has as main objective the determination of the necessary technological parameters for metallization of some workpieces, including some laboratory tests. The performed tests were used to determine the values of technological parameters to be taken into account in the design of the prototype.

KEYWORDS: HVOF, technological parameters, thermal spraying, carbide, NI alloys

CUVINTE CHEIE: HVOF, parametri tehnologici, pulverizare termică, carburi, aliaje NI

1. INTRODUCTION

The project "Applied research, technology and process equipment on thermal spraying of high strength by HVOF procedure, process used in industrial and medical applications", proposes the design of a technological system and laboratory equipment, which allows the applied of metal coatings of high mechanical rezistance, termical and anticorrosive materials used in industrial or medical applications using the HVOF procedure (High Velocity Oxygen Fuel).

2. PROPUSED TEST, TYPE OF USED MATERIALS, SAMPLES.

2.1 DESCRIPTION OF THE TEST

Laboratory test for the determination of the technological parameters specific to the HVOF procedure assumed the following stages [1, 2]:

- coating of the samples by thermal spraying using HVOF technology
- realisation of the necessary test for the coating characterization, for every sample
- highlighting the achieved results.

The set of tests which have been carried out for each of the samples is described in the following table [3]:

Table 2.1. *The set of tests*

Item.	Testing category	Parameters	Workpiece/ sample (*table 2.2*)	Obs.
1. Characterization of microstructure				
1.1	Crystallographic analysis	- particle orientation/ texture; - condition present in the sample	1, 3, 4, 5	

1.2	Microstructure analysis	- defects: vacancies, unmelt particles, inclusions; - covering coat thermic/mechanic deformation	1, 3, 4, 5	
2. Mechanical properties of the coatings				
2.1	Determination of the adherence	-stretching tension at maximum adhesion of the coating (N\/mm2)	1, 3, 4, 5	- „push-up" / Adhere n-cy test at stretch
2.2	Hardness determination	- hardness /micro temper using Vickers tests (HV)	1, 3, 4	
2.3	Wear tests	- abrasive wear	1, 3, 4	- fixing on a disc
2.4	Corrosion testing	- aqueous corrosion in saline/marine environment	1, 5	
3. Physical properties of coatings				
3.1	Determination of thickness	- coating thickness (μm)	1, 3, 4, 5	
3.2	Determination of porosity	- porosity of the coating (%)	1, 3, 4, 5	
4. The electrical property of the coating				
4.1	Dielectric properties	- dielectric strength of the coating layer (kV/cm)	5	- voltage drop

2.2 SAMPLES DESCRIPTION

The samples, table 2.2, were executed by the beneficiary – Mechanical Engineering and research Institute SC ICTCM SA and were delivered to the F.H. Gelsenkirchen laboratory. The coating material was selected from H.C. Stark company's products, Amperit brand.

Table 2.2. *Coated samples/pieces*

Cr. Item.	Piece/ sample (1)	No. pc.	Piece/ Sample material(2)	The material used for spraying
1	Piston rod	15	OLC 45	WC-Co-Cr/ Amperit 554.071
2	The sample for stamping mould	2	OSC 10	WC-Ni / Amperit 547.074
3	Sample for glass casting mould	2	OLC 45 DIN 17210	NiCrBSi / Amperit 335.063 self luxing
4	Glass moulding die	1	Cast iron CF 350	NiCrBSi / Amperit 335.063 self fluxing

Figure 2.1 presents the samples that were sent for covering to the F.H. Gelsenkirchen laboratory.

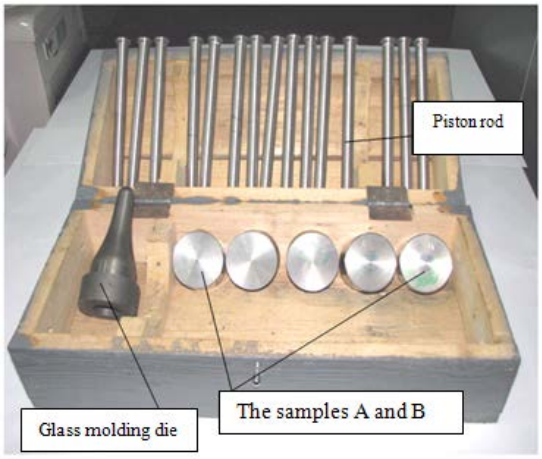


Figure 2.1. *The samples / pieces before coating by thermal spray by HVOF*

3. RESULTS FROM TESTS

3.1 USED TECHNOLOGICAL REGIMES

Laboratory tests were carried out on the HVOF deposition device whose characteristics are described below (Table 3.1) [4, 5, 6]:

Table 3.1. *The used HVOF equipment*

Cr. Item.	Characteristic	Variant 1	Variant 2
1.	The used HVOF spraying method	With liquid fuel	With gaseous fuel
2.	Equipment manufacturer	Thermic	Sulzer – Metco
3.	The equipment composition - the basics	Spray-gun, controller, powder dispenser	Spray-gun, controller, powder dispenser
4.	Type of the gun	CJS K5.2-N	DJ 2700

	for HVOF metal covering		
5.	The used fuel	Kerosene	Propene
6.	Combustion pressure (MPa)	0,83	0,55
7.	Method of powder injection	Radial	Axial
8.	Power / capacity (kW)	250	113
9.	The average flow of coated powder (g/min)	70	30 - 60

The technological regimes used for the samples shown in Table 2.2 are listed in Table 3.2 [4, 5, 6].

Table 3.2. *Used HVOF technological regimes*

Cr. Item.	**Covered Sample/piece**	**Technological operation for HVOF covering**	**Values of HVOF technological regime**
1	**2**	**3**	**4**
1	**Piston bar**	*Operations for surface preparation / Sandblasting*	
		Used abrasive particles	Corundum
		Particle size (µm)	500
		Air pressure (MPa)	6
		The used air flow rate (N m^3 / h)	4,33
		Sandblasting time (min)	5,5
		HVOF technological process - variant with gaseous fuel	
		The covered link material (if is necessary)	Is not necessary
		Powder covered	WC-Co-Cr 86/10/4
		Flow of covered powder (g/min)	60
		The used flow of fuel gas (propylene) (N l/min)	77
		Pressure of fuel gas - propylene (bar)	6,9
		Oxygen flow (N l/min)	253
		Oxygen pressure (bar)	10,3
		Air flow (N l/ min)	376
		Air pressure (bar)	6,9
		The distance between the spray gun and piece (mm)	230
		Relative speed between the spray gun and piece (m/min)	130
		Number of passes	18
		Deposited layer thickness (µm)	180
		Technological operations applied after covering	
		Adjustment	-
2	**Sample for stamping mould**	*Operations for surface preparation / Sandblasting*	
		Abrasive particles	Corundum
		Particle size (µm)	500
		Air pressure (MPa)	6
		Air flow rate (N m^3 / h)	4,33
		Sandblasting time (min)	2,5
		HVOF technological process – variant with liquid fuel	
		The covered link material (if is necessary)	Is not necessary
		Powder covered	WC-Ni 45/15
		Flow deposited powder (g/min)	100
		The used flow of fuel (l/h)	22,7
		The gas flow for powder transportation (Nl/min)	9
		The distance between the spray gun and piece (mm)	380
		Oxygen flow (N l/min)	792
		Oxygen pressure (bar)	7,2
		Relative speed between the spray gun and piece (mm/min)	130
		Number of covered layers	20
		The total thickness of covered layer (µm)	200
		Technological operations applied after covering	
		Polish	-
3	**ple for glass casti ng mou**	*Operations for surface preparation / Sandblasting*	
		Abrasive	Corundum

		particles	
		Particle size (µm)	300
		Air pressure (MPa)	6
		Air flow rate (Nm^3/h)	4,33
		Sandblasting time (min)	5
		HVOF technological process – variant with liquid fuel	
		The covered link material (if is necessary)	Is not necessary
		Powder deposited	NiCrBSi 75/45
		Flow of deposited powder (kg/h)	5,9
		The flow of used fuel - kerosene (l/h)	22,7
		The gas flow for powder transportation (l / min)	9,9
		The distance between the spray gun and piece (mm)	355
		Relative speed between the spray gun and piece (m/s)	0,2
		Oxygen flow (m^3/h)	52,4
		Oxygen pressure (bar)	21
		Number of deposited layers	16
		The total thickness of deposited layer (µm)	200
		Technological operations applied after covering	
		Induction remelting	
		Adjustment	-
		Polish	-
4.	**Glass casting mould stamping**	*Operations for surface preparation / Sandblasting*	
		Abrasive particles	Corundum
		Size of particles (µm)	300
		Air pressure (MPa)	6
		Air flow (Nm^3/h)	4,33
		Sandblasting time (min)	5
		HVOF technological process - variant with liquid fuel	
		The covered link material (if is necessary)	Is not necessary
		Powder covered	NiCrBSi 75/45 self fusible
		The flow of covered powder fuel (kg/h)	5,9
		The flow of used fuel - kerosene (l/h)	22,7
		The gas flow for powder transportation (l/min)	9,9
		The distance between the spray gun and piece (mm)	230
		Relative speed between the spray gun and piece (m/s)	0,2
		Number of covered layers	28
		The total thickness of covered layer (mm)	300
		Technological operations applied after covering	
		Induction remelting	-
		Polish	-

3.2 CHARASTERICS OF THE COATING

3.2.1 – The piston rod (poz. 1, table 2.2)

A. **The used powder** is sintered tungsten carbide with 10% and cobalt 4%, uniformly distributed in the matrix of cobalt-chromium with a particle size less than 2 µm.

Chemical composition: WC-Co-Cr 86/10/4, Carbon (C) 5,0…6,0%, Chrome (Cr) 3–5%, Oxygen (O) max 0,2%, Iron (Fe) max 0,8%, Cobalt (Co) 8,5%, Wolfram (W).

B. **Test results** The rods were coated with powder form WC-Co-Cr, by HVOF process; the phases of the technological process are described in Table 3.2.

The microstructure of the deposited layer, taken with an electron microscope on a slit prepared from a sample, Figure 3.1, shows an uniform and compact arrangement of particles, and an uniform melting. There are some porosities specific to the process, but there are not combined funnels that affect the strength of deposited layer. The layer does not have thermal or mechanical external surface, the exterior surface having a good roughness and geometric shape very close to final shape. Due to the specific operating conditions, the pieces were further processed to be used for subsequent functional testing facility water jet cutting.

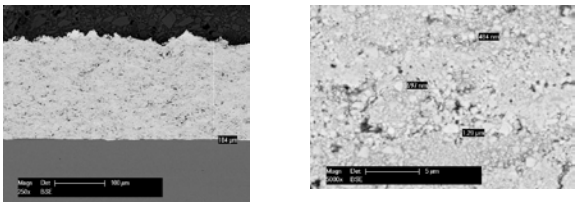


Figure 3.1. *The piston rod (SEM view of a layer of WC-Co-Cr HVOF deposited without further processing)*

In the table 3.3, the properties of the coating obtained are given from tests carried out with specific test methods [4, 5, 6].

Table 3.3. *The physico-mechanical properties of the layer of WC-Co-Cr*

No. item.	Tests	Parameter / units	Obtained value	Obs.
1. Mechanical properties of the layer				
1.1	Determina-tion of adhesion	-tensile stress at maximum adhesion of the layer (N/mm^2)	75	- „push-up" / strength tensile test
1.2	Hardness determina-tion	- hardness/ Vickers micro hardness/ (VH)	1350	
1.3	Tear tests	- abrasive wear (mg / number of cycles)	7 / 8000	- rod disk
1.4	Corrosion tests	- aequos corrosion in saline medium (mg)	no corrosion spots	- saline medium
2. Physical properties of the layer				
2.1	Thickness determinati on	- thickness of the covering /(μm)	180	- without processing (as sprayed)
2.2	Porosity determina-tion	- the covering porosity / (%)	2,6	- without processing (as sprayed)
2.3	Roughness determina-tion of the layer	- Ra / (μm)	3,5 – 5	- without processing (as sprayed)

3.2.2 - Sample for stamping mould (item 2, Table 2.2)

A. Used powder is a tungsten carbide obtained by agglomerating / compacting and sintering, very easy to use, where the WC particles are homogeneously distributed in the Ni matrix.

In figure 3.2 is observed the distribution of tungsten carbide particles, which have an approximately spherical shape, in the Ni matrix.

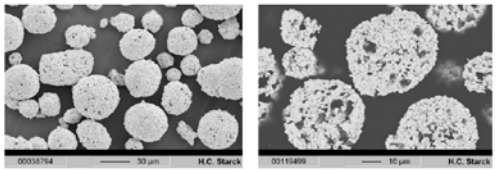


Figure 3.2. *The microscopic aspect of the WC-Ni powder 45/15 [4, 5, 6]*

Chemical composition: Formula WC-Ni 88/12, Carbon (C) 5.2 ... 5.6% Nickel (Ni) 11-13% Iron (Fe) 0.2% max, Tungsten (W).

B. **Test Results**: Samples A, made of OSC 10 as shown in Annex A were coated with WC-Ni powder by HVOF process; technological phases are described Table 3.2.

Microstructure of deposited layer

In Figure 3.2 there is a layer structure without voids or inclusions. A deformable layer does not have thermal or mechanical external surface, having a good surface roughness and geometric shape very close to final shape. This powder was selected because of its high resistance to abrasive wear or sliding abrasion. In Fig. 3.3 is presented the layer form as a result by coating (as sprayed).

Table 3.4 presents the properties of the layer obtained after testing by specific test methods [4, 5, 6].

Table 3.4*. The physico-mechanical properties of the layer of WC-Ni*

No. item.	Tests	Parameter / units	Value	Observations
1. Mechanical properties of the layer				
1.1	Determina-tion of adhesion	-tensile stress at maximum adhesion of the layer (N/mm^2)	80	- „push-up" / strength tensile test
1.2	Hardness determina-tion	- hardness/ Vickers micro hardness/ (VH)	1100	
1.3	Tear tests	- abrasive wear (mg / number of cycles)	7 / 8000	- rod disk
1.4	Corrosion tests	- aequos corrosion in saline medium (mg)	no corrosi on spots	- saline medium
2. Physical properties of the layer				
2.1	Thickness determina-tion	- thickness of the covering /(μm)	200	- without processing (as sprayed)
2.2	Porosity determina-tion	- the covering porosity / (%)	2	- without processing (as sprayed)
2.3	Roughness determina-tion of the layer	- Ra / (μm)	5 – 6	- without processing (as sprayed)

3.2.3 – Sample and die casting for moulding glass (item. 3 and 4 , table 2.2).

A. The used powder for HVOF covering was the same for the two samples, which is obtained by spraying a homogeneous mixture of the Ni and Cr in an almost

spherical morphology. The powder is self fusible. In figure 3.4 is observed the particle shape in the nickel matrix [4, 5, 6].

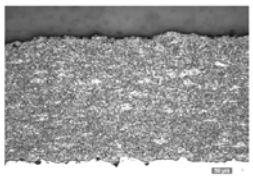


Figure 3.3. *Sample A – the form layer after coating*

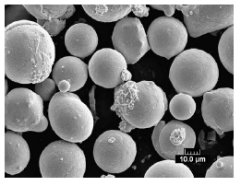


Figure 3.4. *Microscopic form of the NiCrBSi 75/45powder*

Chemical composition: Formula NiCrBSi 75/45, Crom (Cr) 13 – 17% , Carbon (C) 0,6 … 1,2%, Silicon (Si) 4,0 – 5,0%, Boron (B) 2,75 – 3,50 %, Iron (Fe) 3,0 - 6,0%, Nickel (Ni).

B. **Test Results**: The two samples used for coating, the sample B and the die of the mould glass are made from RS 45 and GCI 350. These were coated with the same powder-NiCrBSi by the HVOF process; the phases of the technological process are described in table 3.2. Later proceed covering the two samples were subjected to induction heating for remelting layer and obtaining a surface without porosity or porosity as low.

The microstructure of deposited layer

The microstructure will be studied in two cases, because is a powder that requires subsequent remelting deposit:

• the layer microstructure after deposition;

• the layer microstructure after remelting.

In figure 3.5 is shown the layer microstructural after deposition.

It is observed that the layer is made from partially molten powder because of the low flame temperature and the high velocity of the particles which are coated, specific to HVOF process. It also observed the existence of porosity on polished sample.

In figure 3.6 is shown the layer microstructure after remelting [4, 5, 6].

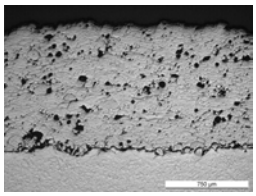


Figure 3.5.*NiCrBSi layer after coating*

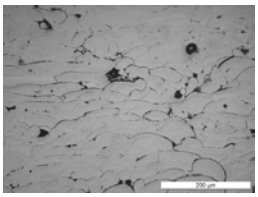


Figure 3.6. *NiCrBSi layer after remelting*

It is observed that after induction remelting, the sample has a very dense structure of the coated layer. It is observed that the porosities are gone and there is a diffusion layer at the interface between the coating and substrate.

The mechanical and physical properties of the coted layer

In table 3.5 are presented the properties of the layer obtained after testing by specific test methods [4, 5, 6].

Table 3.5. *The physico-mechanical properties of the NiCrBSi layer after remelting*

No. item.	Test	Parameter / units	Value	Observations
1. Mechanical properties of the layer				
1.1	Determi-nation of adhesion	-tensile stress at maximum adhesion of the layer (N/mm^2)	55/52	- „push-up" / strength tensile test
1.2	Hardness determi-nation	- hardness/ Vickers microhardness/(VH)	450 / 370	
1.3	Tear tests	- abrasive wear (mg / number of cycles)	12 / 8000	- rod disk
1.4	Corrosion-on tests	- aequos corrosion in saline medium (mg)	no corrosion spots	- saline medium
2. Physical properties of the layer				
2.1	Thickness determi-nation	- thickness of the covering /(μm)	200/ 300	- after remelting and without processing
2.2	Porosity determi-nation	- the covering porosity / (%)	<1	- after remelting and without processing
2.3	Roughness determi-nation of the layer	- Ra / (μm)	2 – 3	- after remelting and without processing

CONCLUSIONS

The tests allowed providing important information on process equipment, process parameters and results that can be obtained for these cases. Values were obtained on: the used technological equipment; technological regime parameters; the obtained layer structure; values for the mechanical and physical properties of the coating.

The technical data are necessary for choosing the best components specific to HVOF equipment that will be used to achieve the objectives of the project. The results test regarding the physical and mechanical properties of the coated layers are according to the scientific and technical tasks of the project, including to achieve a performant equipment witch to be able to approach industrial applications for metal covering or some research projects in the field. It is considered that the data obtained are revealing in terms of the HVOF process in industrial and medical applications, they will be discussed in subsequent activities of the project.

REFERENCES

[1]. **Erja Turunena, Tommi Varisa, Tom E. Gustafssona, Jari Keskinenb, Teppo Fa¨ltc, Simo-Pekka Hannulaa** *„Parameter optimization of HVOF sprayed nanostructured alumina and alumina–nickel composite coatings"*, Surface & Coatings Technology, (2005);

[2]. **Goetz M (Thermico)., Sturgeon M (TWI)** *Application of the HVOF Process in internal coatings of cylinders and hard and software for the internal coating technology of complex components, Advanced coating solutions*, THERMICO, 2006.

[3]. **R.C. Souza , H.J.C. Voorwald b, M.O.H. Cioffi** *„Fatigue strength of HVOF sprayed Cr3C2–25NiCr and WC-10Ni on AISI 4340 steel"*, Surface & Coatings Technology 203 (2008) 191–198

[4]. *** *Thermal spray materials guide*, SULZER – METCO

[5]. *** *Surface technology*, H.C.STARK

[6].*** *HVOF and thermal spray powders*, DELO.

APPLICATIONS OF THERMAL SPRAYING

V. Avramescu, L. Paun, R. Nita, S. Rosulescu, D. Bobe

Mechanical Engineering and Research Institute, Bucharest. ROMANIA, e-mail: valeriuavramescu@yahoo.com

REZUMAT

Articolul are ca obiectiv principal prezentarea principiului de lucru in procedeul HVOF, a unor domenii de utilizare a procedeului de acoperire termica, a tipurilor de instalatii utilizate, cat si a principalelor avantaje care se obtin prin rezolvarea unor probleme practice din industrie sau din producţia de echipamente medicale.

ABSTRACT

The article has as main objective the presentation of the working principle of the HVOF procedure, of some domains for using the thermal spraying procedure, of the types of installations used and also of the main advantages which can be obtain by solving of some practical problems from the industry and the production of medical equipments.

CUVINTE CHEIE: HVOF**,** pulverizare termica, energia de intrare, pulverizare cu flacara, pulverizare cu plasma, pulverizare cu arc, aplicatii ale pulverizarii termice

KEYWORDS: HVOF**,** thermal spraying, energy input, flame spraying, plasma spraying, arc spraying, thermal spraying applications

1. THERMAL SPRAYING WORKING PRINCIPLE, MAIN ADVANTAGES FOR INDUSTRIAL OR MEDICAL APPLICATIONS.

Coatings processes, known as thermal spraying techniques, can provide thick coatings of 20 micrometres approx. thickness, in which melted (or heated) materials are sprayed onto a surface.

The most known materials available for thermal spraying are metals, alloys, ceramics, plastics and composites.

Are known different variations of thermal spraying as: plasma spraying, detonation spraying, wire arc spraying, flame spraying, high velocity oxy-fuel coating sprays (HVOF), warm spraying, and cold spraying.

As known from the literature [2] the term thermal spraying is defined as follows: thermal spraying includes processes in which spray materials, inside or outside spray equipment, are propelled onto the surface of a work piece - melted or surface-melted depending on the type of material, as shown in fig. 1. The working principle [2] is: the coating material is fully or partially melted by an energy source, the melted particles are accelerated onto the specimen to build a lamellar coating, and different types of energy sources can be used.

Thermal spraying is used to deposit coatings for repairing of the components, for increasing the wear, oxidation and corrosion resistance, increase the catalytic properties, as thermal barrier and combinations of these.

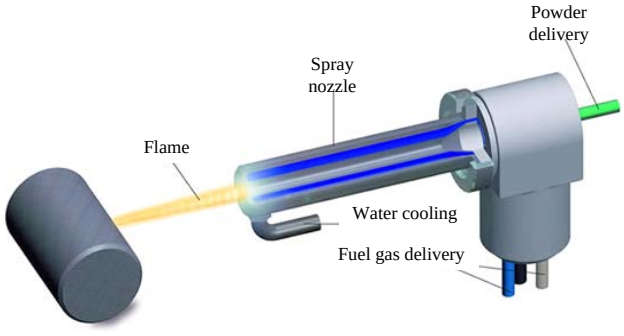


Figure 1. *Principle of the thermal spraying procedure, [2]*

From energy point [3] of view the thermal spraying processes fall into two categories: lower energy and higher energy, as shown in fig. 2.

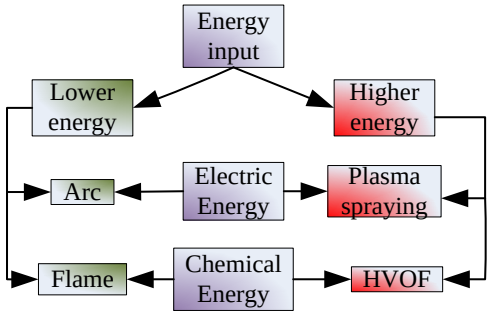


Figure 2. *Classification of the thermal spraying processes*

The processes that use lower energy [3] are widely used for reclamation of worn or damaged components, and for depositing coatings of metals such as aluminium and zinc alloys to protect steel structures from corrosion.
The higher energy processes [3] of plasma, high velocity oxyfuel and detonation spraying have been developed to produce coatings with much lower porosity and oxide levels, together with greater adhesion to the substrate.

2. FLAME SPRAYING

2.1 FLAME SPRAYING WITH WIRE OR ROD

As in figure 3, the material that is sprayed is continuously melted in the centre of an oxy-acetylene flame [4].

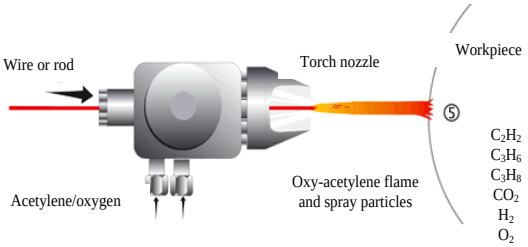


Fig. 4 Flame spraying with wire or rode [4]

The working principle is the following, [4]: the droplet-shaped spray particles are discharged from the melting zone and propelled onto the prepared workpiece surface with the aid of an atomizing gas such as compressed air or nitrogen.

2.2 FLAME SPRAYING WITH POWDER

The spray material in powder form, that can be self-fluxing, which require additional thermal post-treatment , or self-adhering, is melted or fused in an oxy-acetylene flame and propelled onto the workpiece surface with the aid of expanding combustion gases [4], as shown in figure 5.

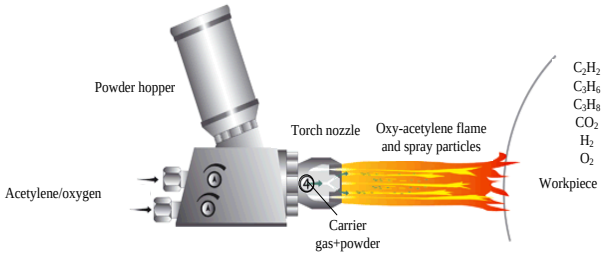


Figure 5. *Flame spraying with powder [4]*

3. HVOF

HVOF –high velocity oxygen fuel [4] involves gas combustion under high pressure in a combustion chamber of a powder form which is fed into the central axis of the chamber and the fuel gases can be used are propane, propylene, ethane, acetylene and hydrogen, as shown in figure 6.
Because of the high pressure of the oxyfuel gas mixture produced in the combustion chamber, the spray particles are accelerated to high velocities, leading to exceptionally dense spray coatings with excellent adhesion [4].

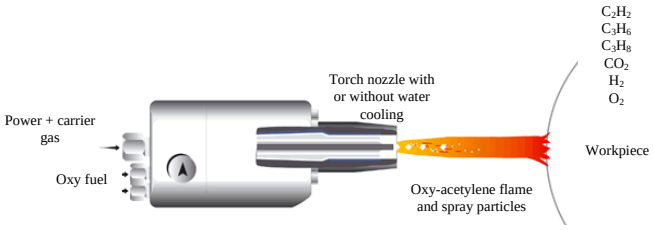
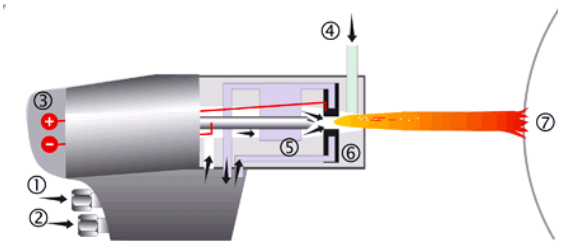


Figure 6. *HVOF spraying [4]*

4. PLASMA SPRAYING

In plasma spraying [4], the spray material, in powder form, is melted by a plasma jet in or outside the spray gun and propelled onto the workpiece surface. The plasma is produced by an arc which is constricted and burns in argon, helium, nitrogen, hydrogen or their mixtures as shown in fig. 7 [4], causing the gases to dissociate and ionize, and attaining high discharge velocities and, on recombination, transferring their thermal energy to the spray particles.

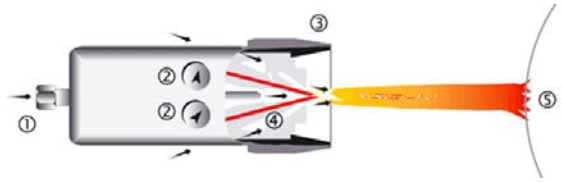


1. rare gas, 2. cooling water, 3. direct current, 4. powdered spray materials, 5. cathode, 6. anode, 7. workpiece

Figure 7. *Plasma spraying [4]*

5. ARC SPRAYING

Arc-spraying, high-performance wire spraying process, suppose using of two similar or different types of spray material in wire form [4], as shown in fig. 8. These materials are melted off in an arc and propelled onto the prepared workpiece surface by means compressed air [4]. In these type of spraying can be used only which only electrically conductive coats materials.



1. atomizing gas, 2. wire-feed control, 3. torch head,
4. electrically conductive wire, 5. workpiece

Figure 8. *Arc spraying [4]*

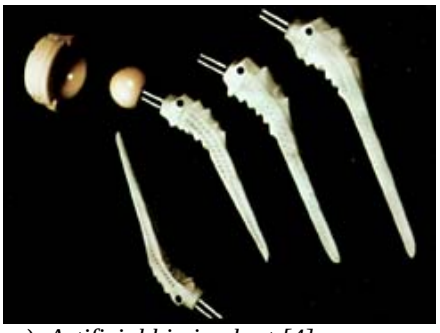
In order to prevent oxidation of the materials is important to use nitrogen, argon or nitrogen / oxygen mixtures as the atomizing gas. Using these gases and preventing oxidation of the materials can be achieved specific coating properties.

6. COATING PROCESS THERMAL APPLICATIONS

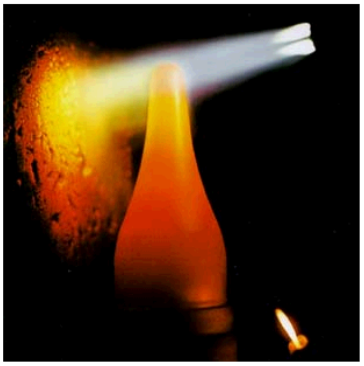
Branches of Industry [4]: medical instruments, power plant construction, chemical plant construction, plastics processing industry, pump industry, ferrous and non-ferrous metal production, electronics industry, apparatus construction, smelters, foundries, steel production, steel drawing works, aerospace industry, automotive industry, cars, shipbuilding, agricultural machinery, petroleum refining, mining, energy and water supply, mechanical engineering, paper industry, printing trades (presses), glass industry, household and kitchen appliances, medical technology.

Applications [4]

- Anti-wear coatings
- Anti-corrosion coatings
- Thermal barriers
- Anti-friction coatings
- Particle erosion
- Granular abrasion
- Electrical conductivity
- Electrical resistance
- High-temperature protection
- Salvaging of scrapped parts - Bearing coatings
- Chemical exposure
- Oxidizing atmospheres
- Resistance to galling



a) Artificial hip implant [4]



b) Gauge for the manufacture of hollow glass [4]

c) Axle flange of a truck [4]

d) Flame spraying of the legendary Mercedes 300 SL to protect against corrosion [4]

e) Pump housing [4]

f) Plasma-sprayed frying pan [4]

g) Flame spraying of a Kaplan turbine [4]

h) Fusing of a roll-table roller [4]

i)

Figure 9. *Applications examples*

Advantages of Thermal Spraying [4]

- Any material can be coated
- Any material can be applied as a coating
- The material to be coated is not thermally altered
- Parts of any size and geometry can be coated
- Thermal spraying lends itself to automation
- Flexible operation
- Very high reproducibility
- High dimensional accuracy
- High quality standard
- Several elements can be included and combined in the spray coating (e.g. Cr, Ni, carbides, etc.)

7. HVOF – SC ICTCM SA

The project ***Research of applications of High Velocity Oxygen Fuel (HVOF) thermal spraying technology and equipment used in industrial and medical applications – TEHVOF*** is a scientific applicative research project in metal spraying domain. The main project objective represent build/create in ICTCM a competence and scientific research team for HVOF spraying technology and equipment with high mechanical resistance, thermic, anticorrosion for the materials used in industrial or medical applications.
Technological process used is thermal spraying with very high velocity by accelerating the powder/particle by using forced oxygen combustion –HVOF procedure (High Velocity Oxygen Fuel).

The HVOF Thermal spray equipment has in composition:

1. HVOF thermal spraying gun pistol for exterior and interior plane and cylindrical surfaces, tool kit and spray gun accessories, complete sets of spare parts: nozzles, tubes, seals, HVOF spraying pistol grip

support on the mechanical interface of FANUC Robot;
2. spray HVOF system controller, control console operator (HMI) VIP type 6000, GTV cabin for gas (O_2/air/N_2), GTV interface for robot drive GTV pumping kerosene;

The controller for the spraying regime has the role to ensure:

- the command and control in real time: the flow of liquid fuel, oxygen pressure and flaw rate, water pressure and flow rate for the gun cooling system;
- safety /on-off type system;
- operator interface touch screen type;
- interface with components: powder feeding/dosing system, spray gun cooling system, HVOF thermal spraying gun;
- interface with other devices: robot or equivalent;
- control parameter λ

3. powered feeding/dosing system which can be actuated by local command or from the controller, assuring protection against oxidation of the carried powder.

The most important characteristics of the powder feeding/dosage system are as follows:

- no. storing powder containers: 2 pieces,
- powder flow: according to the necessities of the spraying gun,
- powder dosing accuracy: ± 5%,
- range of transported powder dimension: 5-100 µm
- cooling system for the spraying gun, with a cooling power of 95 kW and which is operating at a temperature of the environment between 5-38 ºC.

Other important requirements of HVOF system developed in SC ICTCM are as follows: electrical wiring connection for spraying controller: 10 m electric connection cables, flexible pipes for gas and liquid fuel: 7m, electrical cables and flexible pipes between the thermal spraying gun and others components: 7m.
Used materials: cermet: WC-Co; WC-Co-Cr; WC-Ni; Cr_3C_2-NiCr; alloys: MCrAlY (ex.: NiCoCrAlY); pure metals, alloys and compounds: NiCr; NiAl; NiCrBSi; stelite (ex.: Ni-Cr-C-Co); TRIBALOY (ex.: Cr-Mo-Co).
Parameters of the obtained surfaces by the thermal spraying processes are the following:
Roughness: Ra = max. 3,2µm (exception NiCrBSi was Ra = max. 6,5µm); porosity: max. 2%; minimum adherence: min 75 N/mm^2;
Micro hardness: $HV_{0,3}$ = min. 1000 (exception NiCrBSi were $HV_{0,3}$ = min. 800); Powder particle size: 5-100 µm; Minimal caloric power given by the system: 250 kW; the minimum speed of the combustion gas: 2000 m/s.

CONCLUSIONS

Achieving of the technological system-prototype allows carrying out applied research on coatings for high mechanical and thermal strength, corrosion on materials used for industrial or medical applications using the HVOF procedure, the promotion on the internal market of the new technologic system in order to implement the technology in the industry, to the direct beneficiaries.

REFERENCES

[1].DIN EN 657
[2].http://www.stellite.com/ProductsServices/HardfacingAlloys/WeldingProcesses/HVOFSprayDeposition/tabid/328/Default.aspx
[3].http://www.twi-global.com/technical-knowledge/faqs/process-faqs/faq-what-are-the-different-thermal-spraying-processes/
[4]. http://www.gts-ev.de/html_e/ts-info.htm#v_FLD

Quick Info

The Environmental Technology Network Danube Region (ETNDR)—development and operation

As part of priority area 8, Umwelttechnik BW is charge of the development and operation of an Environmental Technology Network. The initiative focuses on supporting small and medium-sized companies, which entails networking with research organisations operating in the state.

Goals of the Environmental Technology Network

- Carry out sustainable improvements to the environment in the Danube Region
- Increase market_opportunities for environmental technologies and resource efficiency from Baden-Württemberg in the Danube Region

Network development focussing on two areas

- Baden-Württemberg: Integrating stakeholders and existing networks from business, science and the public sector and expanding networks
- Danube Region: Build up parallel networks with points of contact and stakeholders in the countries and regions

Who is it aimed at?

Companies (providers of environmental technologies, components and elements for environmental technology facilities, complete installations, planners and engineering offices), networks, chambers, associations, funding institutes, local councils and scientific and public institutions.

Work priorities for Umwelttechnik BW in the Danube Region

- Improving communication between potential clients and partners in the Danube Region
- Supporting networking between companies and planners to enable joint project acquisition and project management in the Danube Region
- Supporting businesses and potential clients in activities in the Danube Region and in the related application and processing of funding
- Identifying potential projects in the Danube Region with the view to using business to turn these into reality.

What added value does the Environmental Technology Network offer?

- Identify and update stakeholders and partners
- Brings cooperation partners together
- Identify and support projects and initiatives ET (especially waste and water) in the Danube Region
- Ensures media transparency of the cooperation partners, e.g. internet, flyer, brochures, publications
- Organises cooperation meetings and events, such as, for example, trade fair presence, workshops
- Apply for INTERREG and other funded projects with consortiums.

Representatives and partners

In order to set up the Environmental Technology Network effectively and operate it on a country-specific basis, we are looking for local representatives and partners. We support their development into parallel ETNDRs of the individual conutries in the Danube Region.

Representative in Bulgaria: Katya Goranova, Executive Director of the Business Support Centre for Small and Medium Enterprises (BSC SME) in Ruse.

Representative in Romania: Doru Dragomir, President Bilateral Chamber of Commerce Bulgaria-Romania.

Representative in Croatia: Dr. Marin Miletic, Senior Researcher, Energy Institute Hrvoje Pozar in Zagreb.

Representative in Hungary: Agnes Czibok, International Relations Manager, Association of Environmental Enterprises (KSZGYSZ) in Budapest.

Contacts

Rumjana Hilpert
Project Manager EU Strategy for the Danube Region & ETNDR
Telephone +49 7031 20398-31
rumjana.hilpert@umwelttechnik-bw.de

Stefanie Dörre
Project Manager Network Environmental Technology Danube Region (ETNDR)
Telephone +49 7031 20398-25
stefanie.doerre@umwelttechnik-bw.de

MODELE STRATEGICE PRIVIND SISTEMELE DE ENERGIE CARE VOR ASIGURA ENERGIE CURATĂ PENTRU CONSUMATORI/ STRATEGIC MODELS OF ENERGY SYSTEMS THAT WILL PROVIDE CLEAN ENERGY TO CONSUMERS

Oana Diana Radu (Cristea)[1], Laurentiu Vladutoiu[2]
[1] National Institute of Research - Development for Machines and Installations designed to Agriculture and Food Industry - INMA, Bucharest, Romania, diana10.cristea@gmail.com
[2] National Institute of Research - Development for Machines and Installations designed to Agriculture and Food Industry - INMA, Bucharest, Romania, e-mail laurentiuvladutoiu82@gmail.com

REZUMAT
Principalele subiecte abordate conceptual în prezenta comunicare sunt următoarele:
- Modele strategice de proiectare şi dezvoltarea viitoarelor structuri sigure energotehnologice capabile să satisfacă cerinţe (A.A.A.A. – Accessibility, Availability, Acceptability, Acountability) la nivelul managementului tuturor resurselor curate;
- conceperea reţelelor inteligente (SMART-GRIDS) care vor asigura regimuri de lucru fără riscuri , începând cu proiectarea noilor structuri energetice de viitor şi finalizând cu eficientizarea pieţei de energie, creionarea managementului arhemo-sistemic în cercetări operaţionale destinat optimizării întregului arsenal de resurse materiale, umane, informaţionale, astfel ca în sistemele energetice de viitor să se apeleze la procese performante virtuale, agile şi fractale care permit reducerea preţurilor energiei curate livrate consumatorilor eligibili.

ABSTRACT
The main topics approached conceptually in the present communication are the following:
- strategic models of designing and developing the future safe energy technological structures able to meet the requirements (A.A.A.A. – Accessibility, Availability, Acceptability, Accountability) at the level of the management of all clean resources;
- the concept of intelligent networks (SMART-GRIDS) that will ensure working states without risks starting with designing the new future energy structures and ending with rendering efficient the energy market, the designing of the archemo-systemic management in the operational researches meant for optimizing the entire stock of material, human, informational resources so that in the future energy systems one should call for virtual, agile and fractal efficient processes allowing the cut of the prices of clean energy delivered to eligible consumers.

CUVINTE CHEIE: cercetări operaţionale, energie curată şi sigură, reţele inteligente

KEYWORDS:: operational researches, safe clean energy, SMART-GRIDS.

1. INTRODUCTION

1. Models for implementing the strategy of providing consumers in the future with highly efficient clean energy

The models for renewing and operating systems that can provide consumers with clean energy in the future currently starts from the following significant actions:

- Building and developing processes dictated by industrial reengineering (agile processes and fractal processes) based on the following characteristics:

a) Agile processes aim at directing all the resources of productive units towards a quick delivery of solutions able to meet the requirements of the competitive market;

b) Fractal processes propagate the ideas of renewing corporations resorting to integrating all the resources based on the neurogenetically assisted

archemo-systemic concept. On this basis one can anticipate changes using SMART GRIDS networks that appeal to operational research.

As agile systems constitute the renewal platform of the future production, and fractal systems allow the designing of this solution, we will tackle the research models regarding the innovative design of strategic objectives that can provide in the future (2050÷2100) the clean energy required by neuronally assisted eligible consumers.

To attain this goal one should begin by developing the design workshops of fractal units that will aim at eliminating the uncertainty of correlating the costs at the level of the risk – quality relation. Within the creation fractal workshops one appeals building up neurobotic systems that by appealing to neuroinformatics provide specialists with knowledge on solving the new problems in real time.

The fractal theory applicable to developing the new structure generating clean energy allows the detection of archemic irregularities and ensures the finding of the best solution for developing the requirements and electric networks as fractal units that allow turning damage into total resource savings.

The structure of a fractal company and the functional relations of the modules including the structure of the algorithm program for evaluating and correlating the risk – quality costs can be seen in Figure 1.

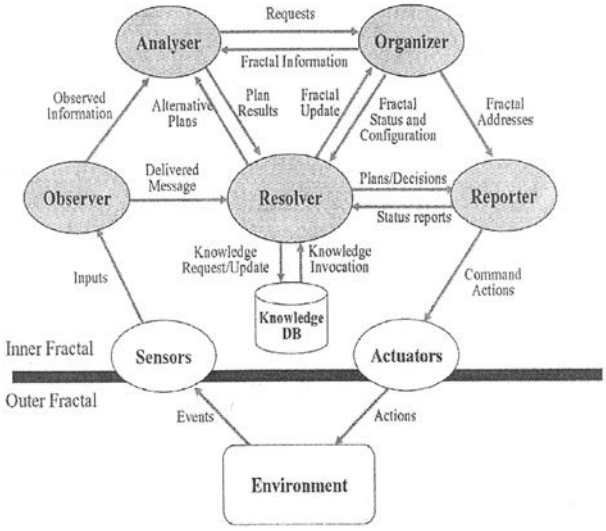


Figure 1. *Functional relations between the fractal unit modules [2]*

Upon approaching these issues of fractal concept optimum one should take into account the modeling of all the clean energy production, transmission and distribution units to consumers by means of the computer assisted operational research by underlining the directions of building up the quality of the human factor so that the new specialists should turn to the unit led to professional excellence steps. In this new orientation the archemic formation of managers and performers can be best carried out if one appeals to the theory of cardinals and to quantum decisions regarding the choice of the competent personnel.

The model of optimizing the new structure of power systems that will produce clean energy has the following mathematical structure modeled in the archemic design of operational research:

$$C_{tac} = \sum_{i=1}^{dv} (1+r_a)^{-i} \ (C_{DD} + C_{CC} + C_{PR} + C_{RU} + C_{EF} + C_{DC} + c_p R_{tan})_i = \min \quad (1)$$

$$p_{ei} = \left[C_{tac}/g_i \cdot E_{pi} \cdot dv\right] + \left[tax + profit\right] \text{lei/kWh}$$

Where are named:
the sustainable development costs (CDD),
the commercial cost(CCC),
the production cost (CPR),
the human resources (CRU),
the economic-financial (CEF),
the decision and communication (CDC),
restrictions (Rtan),

r_a = cost updating rate = $r_{rate}^{interest} + r_{rate}^{inflation} + r_{rate}^{risk}$;
g_i = (0.8÷0.9);
E_{pi} = produced energy;
dv = lifetime.

The restrictions (Rtan) are approached on the six directions starting from the following operational model:

$$Rtan = (RDD+RCC+RPR+RRU+REF+RDC) \quad (2)$$

If we resolve optimally the restrictions at each level then the total updated costs are minimal. When ignoring the restrictions of the total cost of the activities at the level of an operating year of the fractal company doubles.

In order to increase the competitivity of fractal companies the employees have to appeal to the competence of creating electronic values (e.values) and to the increased customization of the product. To create electronic values one has to correlate the main competencies with the essential ones in view of optimizing the entire value chain and besides networking has to develop at the level of business (delivery – sales markets, cooperation partners, SMART-GRIDS networks extension, etc).

2. The role of SMART-GRIDS strategy in providing clean energy proposed in energy fractal systems

SMART GRIDS provide clean energy along the entire production – transport – distribution chain and supplies to consumers if the archemo-systemic

conditions are met for supervising and carrying out all the activities of research, design, mounting of agile equipment, the optimal operation of installations including the preventive maintenance of the entire renewed system in order to reach the European and world objectives on the horizon (2050÷2100) without neglecting costs, energy quality and operating reliability.

The application of the SMART-GRIDS strategy at the level of national and international power systems is meant to modernize the entire technological – managerial structure and economic – financial structure of all equipment by appealing to vulnerability anticipation monitors by carrying out a decentralized production resorting to renewable fuels, by implementing in the new power systems intelligent equipment (meters, substations and power plants equipped with virtual and agile transformers and separators), by activating at the level of the market the intelligent agents that allow consumers to take part in optimizing the operation of the whole system submitted to sustainable development, and by developing neuroinformatics that allows the valorization of current power informatics and makes the passage to neurofractal design workshops of the new high archemic resolution power structures (Figure 1).

The practical objectives of the SMART-GRIDS strategy that allow the delivery to safe clean power consumer mainly refers to the following endeavors: designing a power transmission capacity produced so that to render flexible the production – consumption relation, minimizing losses based on resorting to the management of reactive power and voltage control equipment, online optimization of network monitoring starting from load management and control devices (SMART, Metering, Demand Side Management, predictive maintenance application and congestion management, etc), promoting SMART-GRIDS solution based on FACTS devices that might ensure the observing of the limits regarding power flow between the interconnection lines and 110 kV national networks, including the meeting of conditions regarding reactive power circulation imposed on interconnection lines, integrating the technology based on synchrophasors in the national power systems, the increase in the number of applications that should appeal to the correlated actions of the synchrophasors and factors applicable to the anticipatory monitoring of the entire system on the clean energy production – consumption chain, the reduction in power losses based on carrying out the SMART-GRIDS networks that require: developing lines with several phase conductors (3 x 300 mm2 and 4 x 240 mm2), correlated production control with clean power transport and distribution based on software engineering and reengineering suggested by the real facts research model that is based on the intelligent electronic control and resorts to the following program products (P.P.): sustainable development, commercial activity computerization, the production, human resources reconfiguring, decision elaboration in view of building up the entreprenorial concept of managing the new systems endowed with SMART-GRIDS equipment.

The preoccupations, capabilities and relevant interests of the specialists of Romanian energy sector focus on the following actions: extensive use of EMS/SCADA information systems; DMS/SCADA; HPMS/SCADA; PPM/SCADA implemented at the level of the National Power System management, respectively at the level of power plants, the metering system applied to the bulk energy market, electric power quality monitoring system, MIS (Management Information Systems), intelligent power consumption telemetering system, commissioning in the near future of new virtual and agile power production – transport – distribution equipment (optic transformers, FACTS information structures and phase shifters, etc). Besides, the Institute for Studies and Power Engineering works at a Pilot-project SMART-Grids that covers the simulation of the NPS operation with advanced software tools and may assume the role of a strategic partner in a consortium with an external consultant in order to elaborate and apply a new SMART-GRIDS strategy at a national level. [1], [3].

3. CONCLUSIONS

- The paper presents a new concept for ensuring integrated clean energies to the competitive energy market based on the archemo-systemic concept modelled in the operational research structure.
- The new models are built on operators of real facts as new trends of increasing the efficiency of power systems: sustainable development, commercial activities modelling, building production operators, reconfiguring human resources, presenting economic-financial actions and the decision-communication operator in the entreprenorial concept.
- The possible applications likely to be carried out at the level of the National Power System are represented like operational directions of increasing the technico-economic efficiency that open up the way to rendering profitable the energy companies integrated in the neuronally assisted competitive energy market.

4. REFERENCES

1. **Ioan Dan Gheorghiu,** *Managementul de proiect, Probleme şi studii de caz*, Editura Perfect Bucureşti, 2011, I.S.B.N. 978-973-7984-83-8.
2. **D. Henning**, *Die Fractale Fabrik*,Springer Verlag, 2010.
3. **I.Coteanu**, *Necesitatea introducerii şi extinderii reţelelor inteligente la eficientizarera Sistemului Energetic Naţional*, Editura ISPE, 2010¸ I.S.B.N 978-973-741-203-4.

Quick Info

Bucharest International Technical Fair is an emblematic trade fair for Romexpo and an event of high importance for the Romanian national economy. Therefore, TIB is a "must-visit" event in the agenda of any professional in the field. The 40th edition will be held between the 15th and the 18th of October 2014 at Romexpo Exhibition Centre within the Pavilions A, C2, C4, C5, C6 and platforms 1,2,3 and 4.

TIB was first organized in 1970 and starting with 1993 it has been internationally certified by the Global Association of the Exhibitions Industry – UFI, being included among the most important technical fairs at international level.

The 2014 edition will take place in the same period with ExpoEnergiE – International trade fair for renewable energy, conventional energy, equipment and technologies for the oil and natural gas industry and INVENTIKA – Invention and innovation show.

The main exhibition categories included in the TIB thematic are:

• Mechanical engineering;
• Metal-working machines;
• Industrial robots;
• Pumps, compressors, and hydraulic equipment;
• Metallurgy and welding;
• Electrical engineering;
• Electronics and automations;
• Measuring, control and testing equipment;
• IT and industrial software;
• Communications;
• Machines, equipment and raw materials for plastic processing;
• Auto engineering;
• Transport and storage.

In order to view the full thematic, you may access the following link: http://www.tib.ro/files/Forms_en/2014/F2-Tematica-2014-TIB-EN.pdf

REVIEW 2013:
The previous edition of TIB took place in the same period with ExpoEnergiE - International trade fair for renewable energy, conventional energy, equipment and technologies for the oil and natural gas industry. At these events, 250 exhibiting companies from 17 countries exhibited on an area of 11,000 square meters in four pavilions. The 10,000 specialized visitors who attended the TIB and ExpoEnergiE 2013 had the opportunity to have an overview of the technical industry and to be informed on the development projects of the Romanian and foreign companies.

RECYCLING AND RECOVERY OF WASTE ELECTRICAL AND ELECTRONIC EQUIPMENT (WEEE)

Mihai Cornea, Alexandru Rădulescu, Irina Radulescu

University POLITEHNICA Bucharest, ROMANIA, email: varrav2000@yahoo.com

ABSTRACT
Waste Electric and Electronic Equipment (WEEE) represent waste flows with the fastest growth both nationally and internationally. The uncontrolled disposal of waste is a public health problem of our planet. Treating WEEE must be made only in specialized and authorized centers. The inadequate recycling procedures waste precious metals and recyclable plastic matters, generating energy consumption and damage of the environment as a result of the production of pure matters.

KEY WORDS: WEEE, Recycling, Ecology, Recovery

1. INTRODUCTION

Electronic waste is becoming a pressing problem of the environment for the whole mankind. Cellphones, computers, printers, video cameras, game consoles are disposed after only a few months after buying them. Producers and sellers with smart promoting companies try by all means to raise the demand for their products, encouraging clients to give up their old gadgets in favor of the new ones.

The only solution to these problems are the informing of the population programs regarding recycling, which will have the following effects: improvement of the health problems and the generation of new, decent, working places , the reduction of a large variety of precious metals such as silver, gold, platinum, palladium, copper and indium.

When WEEE are treated without the adequate procedures, damage over the environment is made, especially by releasing heavy metals such as mercury from the compact fluorescent lamps and flat screens, and lead from TVs. Cooling and freezing equipment will release each year, over 6 720 tons of greenhouse effect gas, that effects the ozone layer of the earth.

The first step towards ecological logistics of the WEEE is selective collecting. This can be done by disposing the old equipment at the store where the client is going to by the new one. Some companies offer a discount to encourage this methods and as a promoting method of the sales.

2. WEEE DEFINITION AND CLASSIFICATION

According to the Romanian legislation GD 448/2005, the electric and electronic equipment (EEE) is defined as the equipment that function based on electrical power or on electromagnetic fields and generating, transportation and measurement equipment of these fields or flows, destined to be used at a voltage smaller or equal to 1000V (alternating current) or to 1500V (direct current), [1].

Table 1 presents some examples of these categories (these are only examples; if a product isn't listed below, it can still be WEEE), [1].

Table 1. *Clasification of WEEE, [1]*

Category	**Example**
1. Large Electronics	Refrigerators, coolers, deep freezer, other large electronics used for freezing, preserving and keeping food supplies, laundry machines, washing machines, clothes driers, cooking machines, electric furnaces, microwaves, other large equipment used for cooking and preparing food supplies, electric heaters, other

Category	Example
	large equipment used for heating the rooms, beds and furniture; electric fans, air conditioning units, other ventilation equipment used for air evacuation and climate maintainer
2. Small Electronics	Vacuum cleaners, carpet cleaners, other cleaning equipment, irons, other ironing equipment, rolling press, other clothes maintaining equipment; toast fryers, fryers, coffee grinders, coffee filters, opening or sealing equipment, electric knives, hair cutters, hair dryers, electric tooth brushes, electric razors, electric clocks, electric watches, other measuring equipment, electric weighting scales, massage equipment, other personal care equipment
3.Communication and IT equipment	Electronic data processing (servers, mini-computers, printers), personal IT (personal computer, laptop, printer, photocopier, electronic typewriter, pocket and office calculator, other IT equipment), terminals and users systems : faxes, telephones, public telephones, wireless telephones, mobile telephones, answering machines, card readers, lasers, currency convertors, other video or audio transmitters
4.Common equipment	Radio, TV, photo and video camera, VCR, high definition equipment, CD player, DVD player, audio amplifier, microphone, electronic musical instruments, recording equipment, including signals and other spread technologies of sound or images than telecommunications
5.Illuminating equipment	Economic lamps, fluorescent lamps, ceiling lamps, straight fluorescent lamps, compact fluorescent lamps, high intensity gas discharge lamps, high pressure sodium lamps, metallic halogen lamps, low pressure sodium lamps, other illuminating equipment or diffusing and controlling equipment excluding bulbs
6.Electric and Electronic Tools (excepting large fixed industrial tools)	Drilling equipment, electric saw, sewing machine, recessing tool, miller, grinder, polisher, shearing machines, shearing machines, nibbling machines, bedding press, bending or similar processing wood machines, metal or other materials riveters, nailing or screwing or removing rivets, nails, screws or similar uses, tools for welding, soldering or similar uses, equipment for spraying, spreading, dispersing or other treatment of liquid or gases substances by other means, tools for mowing or other gardening activities, irrigation pumps for greenhouses systems, electric gates
7.Toys, sports and leisure equipment	Electric trains or car racing sets, portable video game consoles, Computers for biking, diving, running, rowing, etc.., Sports equipment with electric or electronic components, coin slots, electric bikes
8.Medical devices (excepting all implanted and infected products)	Radiotherapy equipment, cardiology, dialysis, diagnostics and testing, lung ventilators, Nuclear medicine, Laboratory for in-vitro diagnostics, analyzers, Freezers, Fertilization tests, hearing devices, rehabilitation equipment,

Category	Example
	medical equipment created video expressly for this purpose, Other appliances for detecting, preventing, monitoring, treating, alleviating illness, injury or disability
9.Monitoring and control instruments	Smoke detectors, heating regulators, thermostats, electric and electronic safety equipment, Measuring, weighing or adjusting appliances for household or as laboratory equipment Other monitoring and control instruments used in industrial installations (example in panels control)
10.Automatic dispensers	Automatic dispensers for money - ATMs, currency exchange machines, food vending machines: food vending and cigarette vending machines for hot drinks: coffee / tea / soup and dispensing bottles, dispensers: parking, public transport, condom dispensers, All appliances which deliver automatically a wide range of products

3. ASSESSMENT OF THE QUANTITIES OF WASTE ELECTRICAL AND ELECTRONIC EQUIPMENT

In the EU accession, Romania has pledged that by the end of 2008 to annually collect 4 kg of WEEE per capita, representing a population of 21698181 inhabitants a quantity of 84000 t annually. Since 2012, the target is 3 kg/year per capita of WEEE. For Romania this figure means a lot, and costs are estimated at € 17 million at the end of 2013, or about € 175 per ton of waste recycled and processed. Every citizen of the European Union now produces generally 17-20 kg of WEEE per year, according to data centralized by the Ministery of Environment and Water Management (Figure 1), [2].
The amount of EEE placed on the domestic market, although in a continuous growth is evident, for various reasons, primarily on the economic considerations of a large part of the population, small compared to the countries of the European Community.

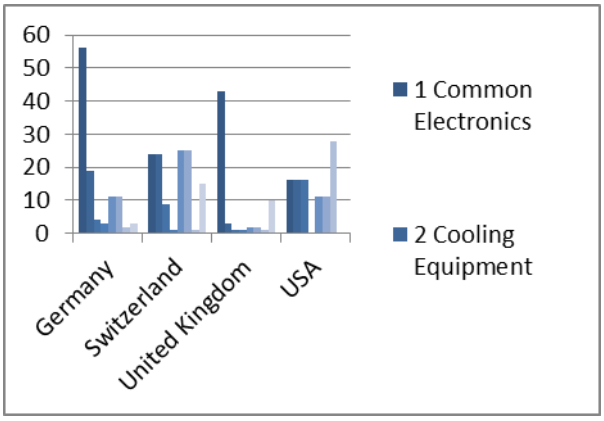


Figure 1. *Precentage of WEEE in some european countries and USA, [2]*

Thus, in 2005 the total amount of EEE placed on the market was about 6.5 kg/capita in 2006 to about 7.0 kg/capita, and in 2007 of 7.5 kg/capita (estimation made based on National Institute of Statistics), [3]. The same economic considerations past and present, the total amount of EEE existing households in 2005 was a 25 - 30 kg EEE/capita (according to INS), far less than the endowment of the population in EU countries, [3].
Regarding the situation of Romanian consumers the following features give indication about annual quantities of TV and refrigerateurs (Figures 2, 3, 4), [4].

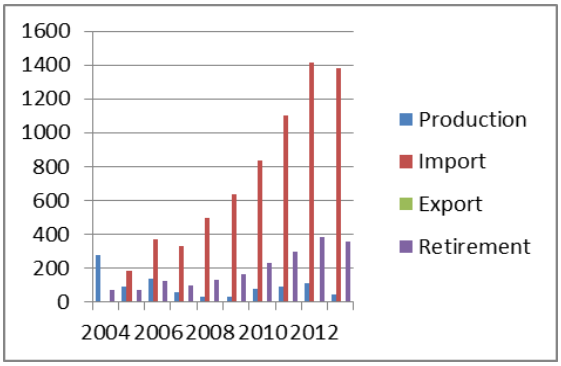


Figure 2. *Annual quantities of TV and similar, [4]*

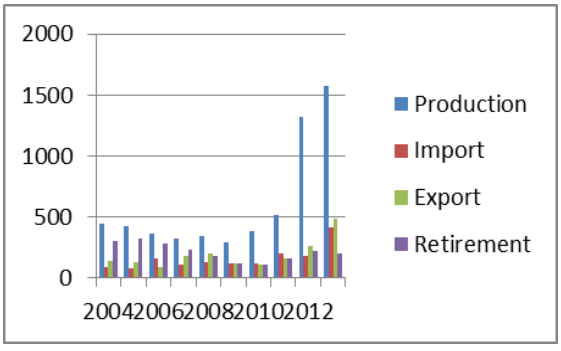


Figure 3. *Annual quantities of refriger and similar, [4]*

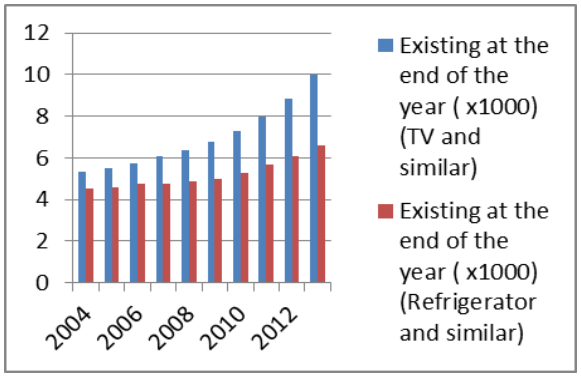


Figure 4. *Existing quantities at the end of the year, [4]*

4. TECHNIQUES FOR TREATMENT, RECOVERY AND RECYCLING OF WEEE

According to Article 6.1 of the WEEE Directive available for treating WEEE systems must use the best available treatment of recovery and recycling. There are reference documents for best available techniques for the treatment, recovery and recycling of WEEE, [5].

Dismantling, treatment, recovery and recycling most relevant are, [5]:

- Rather than make lists of best available techniques better determine a set of parameters to be obtained and they can be listed in the permit;
- Waste from 'waste' or ICT are very diverse. There can be something that represents best practice and cover all areas of the Directive.

For example, the treatment of small and large appliances suppose the following stages:

1. **Preparing devices for treatment:** consists in removing external electrical cables and components containing dangerous.
2. **Primary shredding:** Primary grinder performs a fractionation apparatus for an easy manual sorting of materials and components results.
3. **Manual sorting** sorted certain components to be treated on other lines (capacitors, coils and transformers, printed circuit boards), etc.
4. **Secondary shredding** is to bring the smaller fractions.
5. **Separation of fractions**
   a) Magnetic separation: separate ferrous fractions of fractions obtained;
   b) Inductive separation: the remaining fractions, fractions separate non-ferrous metal (e.g. copper and aluminum) metal fractions (e.g., plastic, wood, rubber, etc.).
6. **Input:**
   a) Household appliances small (coffee filters, toasters, vacuum cleaners, irons, hair dryers, alarm clocks, etc.);
   b) Large household appliances (washing machines, cars cooking, microwave ovens, electric heaters etc.).
7. **Output:** fractions of plastic, ferrous and nonferrous metals, glass, cables, circuit board.

5. LEGISLATION FOR WEEE MANAGEMENT

Some of most important decisions of WEEE management legislation are the following, [6]:

• Government Decision 448/2005 on waste electrical and electronic equipment;

• Government Decision 856/2005 on waste management records and to approve the list of waste, including hazardous waste

• Order 1223/2005 on the procedure for registration of producers, how to report and record data on electrical and electronic equipment and waste electrical and electronic equipment

• Order 986/2006 on the approval of the regulation and control of shipments of waste in Romania

• National Strategy for Waste Management

• Ordinance No.78/2000 on waste

• Law on the regime Nr.426/2001 components, subassemblies and consumables, equipment part

• 67/548/EEC/1997 EC Directive on classification, labeling and packaging of substances and dangerous goods

• European Directive 2002/96/EC regarding the financing of WEEE management process

A provision of the new law refers mainly to the following:

Product design

It establishes the obligation of manufacturers to introduce those in manufacturing electrical and electronic equipment (EEE) whose projects take into account the following aspects: to facilitate dismantling and recovery operations components; to provide opportunities for reuse and recycling of WEEE, their components and materials.

Selective collection

In order to collect WEEE from private households, the executive authorities of the administrative units have a number of obligations, of which: to organize, manage and coordinate the separate collection of waste electrical and electronic equipment private households and transport to collection points through public sanitation, or by entrusting WEEE collection by a collector operator authorized by the agency environmental Protection Agency; collection frequency should be at least once per quarter; to provide evidence of the inlet and outlet points WEEE collection and annual reporting agencies for environmental data.

Treatment

Operators WEEE treatment operator only if they have environmental permit, according to the legislation in force, permit to be obtained by them separately on each category of WEEE.

Recovery

Manufacturers or collective organizations acting on their behalf must ensure acquisition and recovery of WEEE collected selective. Those categories are required to meet certain targets for WEEE treated on the rate of recovery expressed in a minimum percentage of the average weight of the device.

Other Provisions

The decision also contains provisions on the financing of WEEE from private households and other users, the information that manufacturers are required to provide users of EEE, and information on reuse and treatment.

Ministry of Environment and Forests keeps a register of manufacturers, in which information is gathered annually, including estimates on the quantities and categories of EEE placed on the national market, the quantities and categories of EEE were collected by all means and reused, recycled and recovered or collected waste exported, by weight.

To eliminate improper treatment methods of waste electrical and electronic equipment, both nationally and internationally, have developed a number of laws governing the management of this waste stream. Thus, in 2005 was published in Official Gazette no. Government Decision No 491/10.06.2005. 448/2005 on waste electrical and electronic equipment.

Order no. 901/2005 regarding the approval of specific measures for the collection of waste electrical and electronic equipment presenting a risk of contamination

Order no. 1225/721/2005 the approval procedure and criteria for evaluation and authorization of collective organizations to take over responsibility for the annual objectives of collection, reuse, recycling and recovery of waste electrical and electronic equipment Order no. 66/20 January 2006 on setting up the evaluation and authorization of collective organizations to take over responsibility for the annual objectives of collection, reuse, recycling and recovery of waste electrical and electronic equipment, as amended and supplemented by MO. 262/2009

Order no. 1223/715/2005 the procedure for registration of producers, how to record and report data on electrical and electronic equipment and waste electrical and electronic equipment

Oeder 556/435/191 5 June 2006 on the specific marking of electrical and electronic equipment placed on the market after 31 December 2006.

6. CONCLUSIONS

Following the regulation of WEEE management have established a number of collective organizations, companies acquiring WEEE producer responsibility on achieving annual collection, reuse, recycling and recovery of WEEE.

The importance of recycling and recovery of WEEE equipment is present in the obligation of manufacturers to introduce in product design these specifications.

Also, the WEEE selective collection and transport from private households, that is initiated by the executive authorities of the administrative units, give the measure of a good WEEE management.

All measures initiated by manufacturers, ministries and civil society show increasing importance for the achievement of a good WEEE management.

REFERENCES

[1] *** Distance Sale of Electrical and Electronic Equipment to Consumers, EU-WEEE Workshop, Copenhagen, 9-10 November 2006

[2] *** Inland Waterways & Environmental Protection, European Conference of Ministers of Transport ECMT, Netherlands, 2006

[3] *** Evolution of (Bio-) Waste Generation/Prevention and (Bio-) Waste Prevention Indicators, Final Report Project ENV.G.4/FRA/2008/0112, September 16th, 2011

[4] *** Study to determine the costs of WEEE and the required number of collection points in Romania, ICPE contract no. 362/2006

[5] *** Guidance on Best Available Treatment Recovery and Recycling Techniques (BATRRT) and treatment of Waste Electrical and Electronic Equipment (WEEE), Department for Environment, Food and Rural Affairs, Nobel House, 2006

[6] http://www.deseurielectrice.ro/legislatie.htm (accessed on 15.04.14)

Quick Info

"START - Danube Region Project Fund": First call for proposals open!

About us
Priority Area 10 **"Stepping up institutional capacity and cooperation"** of the EU Strategy for the Danube Regionis coordinated by the City of Vienna (Austria) and the Centre of Excellence in Finance (Slovenia), with the involvement of a wide network of key players and stakeholders.

The website
Here you can find out about main activities, projects and actions in the field of institutional capacity and cooperation in the Danube region, latest news and upcoming events on the topic.
The first call for project proposals of the new initiative *START – Danube Region Project Fund* is officially launched. The call will be opened from **18th of July until17th of September 2014**.
All relevant documents for the application can be found in the START section of the website.

Save-the-date! Strategic meeting "Fostering Cooperation and Institutional Capacity for Roma Integration in the Danube Region", Vienna, 9-10 October Vienna,
9-10 October 2014

Venue:
Federal Ministry of Labour, Social Affairs and Consumer Protection | Stubenring 1,
A-1010 Vienna
This event is a joint event of Priority Area 10 "Institutional Capacity and Cooperation" of the EUSDR (City of Vienna), Priority Area 9 "People and Skills" (Federal Ministry of Labour, Social Affairs and Consumer Protection, Austria) and the Austrian National Contact Point for Roma Integration (Federal Chancellery, Austria).

Participation in the event is free of charge and upon invitation only.

Basic principles to be eligible for *START* funding:
Projects located in the entire Danube Region:

- EU Member States: *Germany (Baden-Württemberg and Bavaria), Austria, Hungary, Czech Republic, Slovak Republic, Slovenia, Bulgaria, Romania and Croatia;*
- EU Accession Countries: *Serbia, Bosnia and Herzegovina and Montenegro* and
- Non-EU Countries: *Moldova and Ukraine (part of the country located in the Danube Region).*

In principle, projects must involve **at least two partners from two EUSDR countries**.

- Eligible applicants are **public** or **private** organisations with **legal personality** (no individuals). START is especially designed for **small institutions, non-governmental and civil society organisations**.
- Projects which address topic(s) from at least one of the **Priority Areas (PA) of the EUSDR**:
- Projects must be of **public interest** and have a **macro-regional impact**.
- Project duration: **up to one year.**

START is designed to support two different **types of projects:**
A) A specific part of a larger project
The budget of the overall project is larger than available START funding (but below € 25M):
START can finance e.g. the preparation phase and/or the implementation of specific work packages of the overall project.
Result: specific work packages are completed.
B) A small project
The total budget of the project fits within the limits of START:
START can finance the entire project implementation (incl. preparation activities, if any).
Result: the project is completed.

The amount of the START EU grants can range **between € 10.000 and € 40.000 per project.** In addition, project partners must co-finance min**. 10%** of the total project costs, from their own resources or other (non-EU) sources.

As *START* is a Seed Money, **50% pre-financing** is paid after project selection, to provide sufficient cash-flow. A**second pre-financing (up to 25%)** can be paid after validation of the interim report, halfway through the project duration. The payment of the balance is done after validation of the final report and expenses declared.

For more information, please contact info@pa10-danube.eu

(source :http://www.danube-capacitycooperation.eu/pages/start)

MODELE ALE SISTEMELOR STRATEGICE DE RECONFIGURARE A STRUCTURILOR CIBERNETICE ÎN CONCEPŢIE ROBOTICĂ/ STRATEGIC SYSTEMS MODELS FOR CYBERNETICS STRUCTURES RECONFIGURATION IN ROBOTIC DESIGN

Oana Diana Radu (Cristea)[1], Laurentiu Vladutoiu[2]
[1] National Institute of Research - Development for Machines and Installations designed to Agriculture and Food Industry - INMA, Bucharest, Romania, diana10.cristea@gmail.com
[2] National Institute of Research - Development for Machines and Installations designed to Agriculture and Food Industry - INMA, Bucharest, Romania, e-mail laurentiuvladutoiu82@gmail.com

REZUMAT

Ideea principala de la care porneşte lucrarea este: cercetarea ca proces creativ ce presupune aplicarea în practică a unor metode şi tehnici specifice energetiei globale şi nepoluante, o încercare de a aduce soluţii pentru rezolvarea situaţiei dificile în care se află industria energetică românească.

Unul din principalele obiective ale politicilor energetice mondiale este reprezentat de dezvoltarea surselor regenerabile de energie ca resursă energetică globală şi nepoluantă care are ca scop în contextual dezvoltării durabile, reducerea consumurilor energetice, creşterea siguranţei în alimentare cu energie, protejarea mediului înconjurător şi dezvoltarea tehnologiilor energetice viabile.

ABSTRACT

The main idea of starting work is: researching the creative process involves the practical application of methods and techniques energetiei global clean an attempt to bring solutions to the difficult situation in which the Romanian energy industry.

One of the main objectives of global energy policy is the development of renewable energy as global energy and clean resource that aims in the context of sustainable development, reducing energy consumption, increasing energy security of supply, environmental protection and the development of sustainable energy technologies .

KEYWORDS: energy viable, SMART GRIDS agencies, energy efficiency

CUVINTE CHEIE: energie viabila, agenţii SMART-GRIDS, eficienta energetica

1. INTRODUCTION

1. STRUCTURE OF NEW SYSTEMS THAT CAN ENSURE THE NON-POLLUTANT PRODUCTION OF ENERGY AND ALLOWS THE SUPPLY OF CLEAN ENERGY TO ELIGIBLE CONSUMERS

The main endeavors that will ensure a future safe clean energy refer to the development of the following original endeavors.

▪The primary conventional resources have to be entirely replaced with renewable resources (renewable fuels with calorific powers three times higher than lignite, genetically transformed maize allowing the cut in the power cost by 50% simultaneously with dramatically diminishing pollution from 100% in the case of conventional resources to 12% in case of using renewable resources, etc.).
In this field one can renew extractions with much smaller damage if one passes to coal gasification according to the German model.

▪The transformed resources (electric and thermal power) have to be carried out only in optimal states of aggregate charging that at economic powers (0.8÷0.9) Pi (in the installed power) carry

out minimum operation costs of power plants in the evolving structure of power systems.

▪ Information resources can be used best if one appeals to neuroexpert structures (combinations of expert systems with neuronal networks and with the evolving calculus based on genetic algorithms).

These structures based on artificial intelligence are the primary elements of system neuroinformatics.

The functionality of neuroinformatics has to be extended to the entire chain of primary resources – power production and competitive market assisted by the intelligent agents of the energy market.

▪The human resources have to be trained in the field of knowledge on the factors that do not contribute to carrying out a clean energy that is delivered to eligible consumers.

▪The training of the human resource able to best correlate the concepts of quality – uncertainty – risk – catastrophe has to focus on the reengineering of professional education in view of changing the mentality towards work based on the development of creativity.

These actions can be carried out if one appeals to the application of the neurogenetical concept of increasing the quality of the human factor.

▪Rendering efficient the renewal of the structure and flows within the generating systems of the future clean energy that is prepared today has to be approached on the industrial business reengineering models requiring in all the sectors the application of the new designing models of the power plant, networks, safe power clean supply, and at competitive prices accepted by neuronally assisted eligible consumers.

2. RECONFIGURING SYSTEMS OF CYBERNETIC STRUCTURES IN THE ROBOTIC CONCEPT AND CARRYING OUT A PROGRAM PRODUCT OF INTERFACING THE HUMAN OPERATORS WITH SMART-GRIDS AGENTS OF THE COMPETITIVE MARKET

Using the new trends of the fractal concept within the companies submitted to the dynamic evolution allows to appeal to the cybernetic configurations like those presented in Figures 1, 2, 3, that appeal to the intelligent networks known in the international literature under the name of SMART-GRIDS.

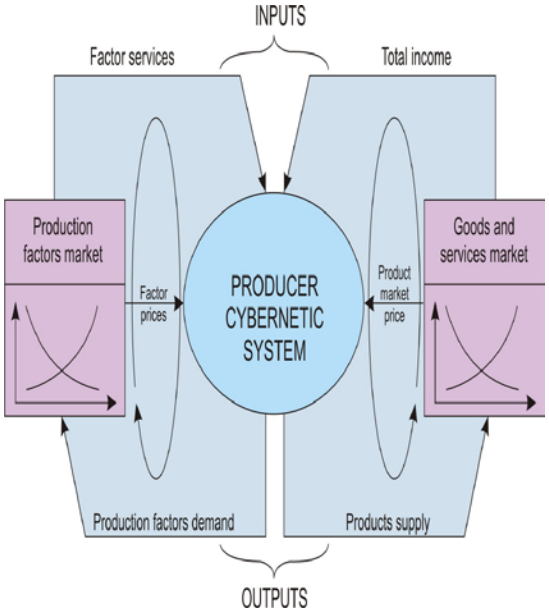


Figure 1. *Low chart of the cybernetic system of the neurobotic company, [1]*

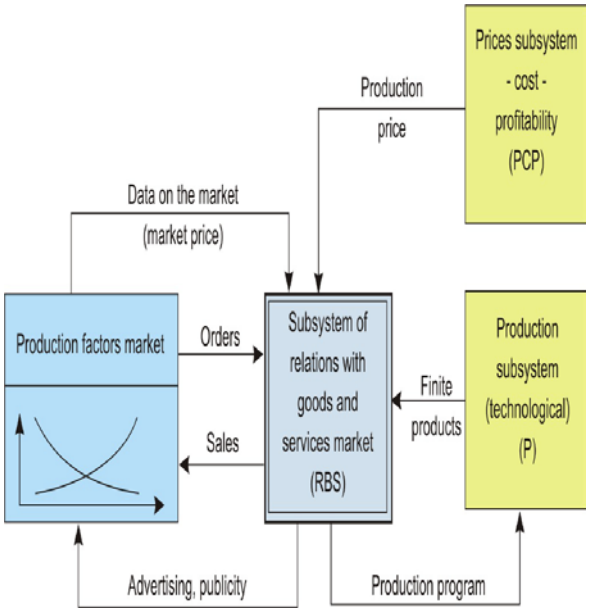


Figure 2. *Subsystem of market relations, [1]*

Using intelligent agents at the level of the energy market allows the optimal correlation of the production with the consumer demand.

Intelligent agents constitute assistants of human factors at the level of the competitive market.

Their collaboration leads to an increase in the efficiency as they learn their mutual preferences.

To understand these collaborations we will define in short the concepts of and intelligent agent.

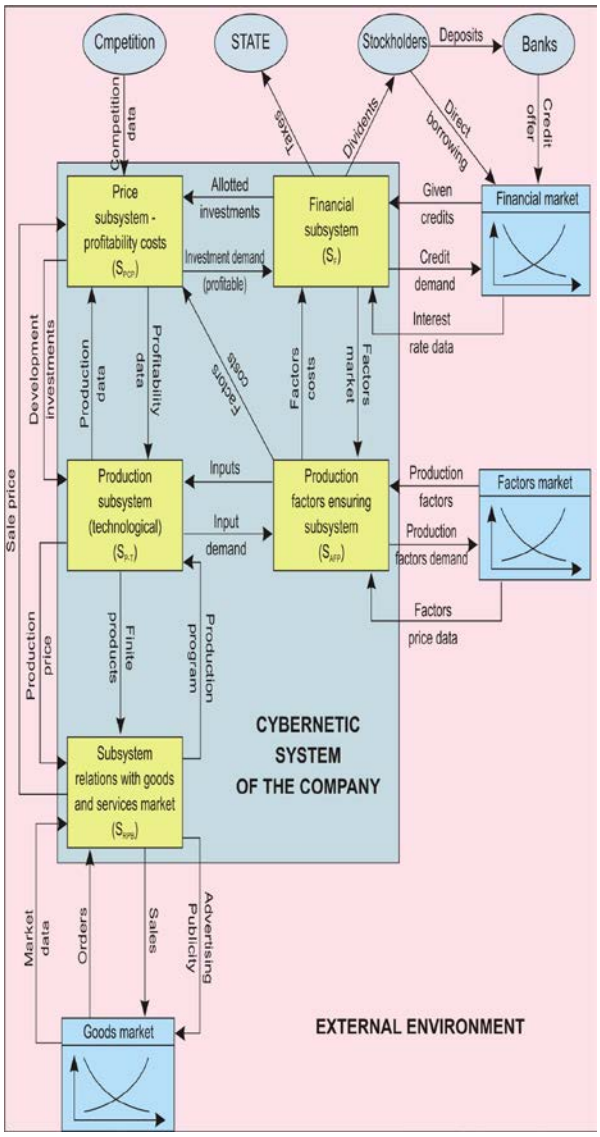


Figure 3. *Cybernetic system of the renewed cybernetic company [1]*

Thus, the agent defined by Russel-Norvig deals with things that might perceive the environment through sensors and can act upon that environment through effectors. Another definition shows that autonomous intelligent agents are computational systems that perceive a certain dynamic environment and act quickly according to the goal reached at designing.

The multitude of actions possible to be carried out by an intelligent agent defines the effective capacity of changing the performing environment. Based on these qualities of the intelligent agents it performs the following functions: the perception of the dynamic environmental conditions, acts to change them so that the results should lead to an increase in the efficiency of energy use at the level of free and captive consumers.

Thus we retain from these specifications that the intelligent agent is a program products that resolve the problems by taking into account the requirements of power consumers in the structure of the competitive energy market by appealing to cooperation.

An intelligent agent has the following properties: autonomy based on an independent process, reactivity that shows that after perceiving the environment it reacts to diminish disturbances; pro-activity based on its own initiative to intervene in case of failure, social abilities able to develop cooperation with other agents.

$$C_{tac} = \sum_{i=1}^{dv} (1+r_a)^{-i} \ (C_{DD} + C_{CC} + C_{PR} + C_{RU} + C_{EF} + C_{DC} + c_p R_{tan})_i = \min \quad (1)$$

$$p_{ei} = \left[C_{tac}/g_i \cdot E_{pi} \cdot dv\right] + \left[\text{tax} + \text{profit}\right] \text{lei/kWh}$$

Where are named:
the sustainable development costs (CDD),
the commercial cost(CCC),
the production cost (CPR),
the human resources (CRU),
the economic-financial (CEF),
the decision and communication (CDC),
restrictions (Rtan),
r_a = cost updating rate = $r_{rate}^{interest} + r_{rate}^{inflation} + r_{rate}^{risk}$;
$g_i = (0.8 \div 0.9)$;
E_{pi} = produced energy;
dv = lifetime.

The properties of intelligent agents of the SMART-GRIDS type are the following: infallibility that ensures the correct execution of tasks, the utility is given by the increase in the useful effect of power to consumer, the cost calculated by the relations 1, the automatic generation of goals, the engagement has to be fulfilled entirely, the conviction that a useful goal has been fulfilled that pays off in the end, the safety and profitability of the conducted actions, the aggregation of objectives, the fluency at the level of the interconnected agents, etc.

From the combination of these properties one can outline four types of agents, namely: collaborating agents, trainable agents, interface agents and complex intelligent agents of the SMART-GRIDS type.

In the energy field one appeals to the economic agents Buyer-Seller that attempt to find the most advantageous price for buying, respectively selling, energy products and installations.

The logical diagram of the agent function of the SMART-GRIDS type can be viewed in Figure 4.

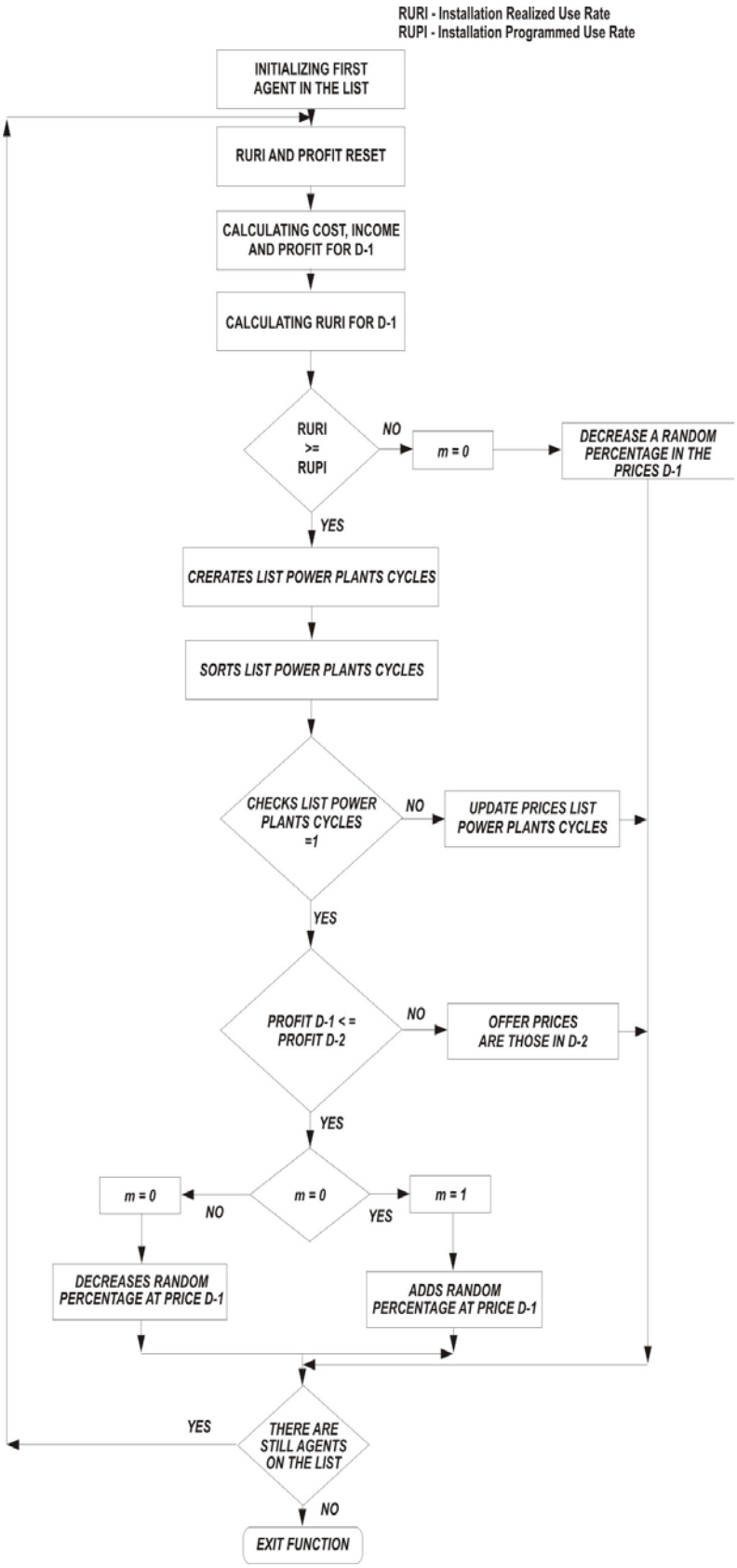


Figure 4. *Logical diagram of the intelligent agent function that contributes to carrying out clean energyat acceptable prices for consumers[3]*

3. CONCLUSIONS

- This way of approaching efficiency emphasizes the collaboration of all the operators of an energy company on the power production – transport and distribution chain at the level of the competitive market in the cybernetic concept as resulted from the operational structure of the elements presented in Figures 1, 2, 3 completed by the reference trends found in Figure 4.
- A new essential aspect is the presentation of a higher power efficiency of power systems equipped with intelligent systems of the SMART-GRIDS type whose significant configuration focuses on Figure 4.

4. REFERENCES

1. **Constantin Bălăşoiu**, *Proiectarea şi conducerea holdingurilor energetice în concepţia reinginerie industriale*, Teza de doctorat 2010.
2. **Ioan Dan Gheorghiu**, *Managementul de proiect, Probleme şi studii de caz,* Editura Perfect Bucureşti, 2011, I.S.B.N.-978-973-7984-83-8.
3. **Anatol Carabulea**, *Reingineria industrială a riscului energetic modelată în concepţia cercetărilor operaţionale,* Editura Politehnica Bucureşti, 2006, I.S.B.N.-978-973-7838-01-8.

ETUDES THEORIQUES POUR LE COMPORTEMENT DES CAPTEURS DE PRESSION

Marilena Violeta Giuglea[*], Sebastiano Brida[**], Alexandru Rădulescu[*]

* Université POLITEHNICA Bucarest, ROUMANIE, email: varrav2000@yahoo.com
** Esterline Advanced Sensors, Bourges, FRANCE

RESUME
De nos jours, grâce à l'évolution de l'informatique, nous pouvons réaliser des expériences théoriques (simulations) à la place des expériences pratiques pour réduire les couts financières et le temps. Cet article représente une synthèse du travail de recherche concernant les simulations pour l'encapsulation des capteurs de pression. Les systèmes micro-électro-mécaniques sont présentés, en commençant par leur définition, leur importance dans la vie actuelle et en finissant par le processus de fabrication d'un MEMS. A la fin, l'article présente les simulations numériques réalisées à l'aide du logiciel Comsol Multiphysiques et les conclusions dues aux résultats numériques obtenues.

MOTS CLES: Capteur de pression, Simulation, Liaison céramo-métallique.

ABSTRACT
Today, thanks to the evolution of computers, we can achieve theoretical experiments (simulations) in place of practical experience to reduce financial costs and time. This article represents a synthesis of the research on simulations for the encapsulation pressure sensors. Micro-electro-mechanical systems are presented, starting with their definition, their importance in the present life and ending with the process of manufacturing a MEMS. In the end, the paper presents the numerical simulations performed using Comsol Multiphysics software and the conclusions due to the numerical results obtained.

KEY WORDS: Pressure sensor, Simulation, Metal-ceramic liaison.

1. INTRODUCTION

Le besoin de capteurs de pression pouvant fonctionner à des températures extrêmement élevées et dans des environnements difficiles tels que les oxydants corrosifs, radiations et interférences électromagnétiques, températures élevées et sous grandes vibrations est en augmentation dans de nombreuses industries [1], [4]. Ce scénario a stimulé le développement de technologies pour la fabrication de MEMS (Micro Electro Mechanical Systems) qui peuvent fonctionner dans des conditions extrêmement dures garantissant la fiabilité de ses résultats.
Le travail est fondé sur une recherche des caractéristiques géométriques et aussi des matériaux pour l'amélioration des propriétés mécaniques des micro-capteurs. Ce pour cela qu'on a étudié le conditionnement qui permet à ce que le capteur soit un composant de travail facile à utiliser et fiable. Pour réaliser cette amélioration on a effectué des simulations en utilisant le logiciel COMSOL Multiphysics.

2. MODELE THEORIQUE

Systèmes micro-électro-mécaniques, ou MEMS [1], [3], [4], est une technologie qui, dans sa forme la plus générale peut être définie comme des éléments mécaniques et électromécaniques miniaturisés (à savoir: dispositifs et structures) qui sont fabriqués en utilisant les techniques de micro fabrication.
Les dimensions physiques critiques de dispositifs MEMS peuvent varier de moins d'un micron jusqu'à plusieurs millimètres [4]. De même, les types de dispositifs MEMS peuvent varier de structures relativement simples n'ayant aucun élément en mouvement, aux systèmes électromécaniques extrêmement complexes avec plusieurs éléments en mouvement sous le contrôle de la microélectronique intégrée.
les capteurs ont un rôle important à jouer dans notre vie de tous les jours dans lesquels nous avons besoin de recueillir des informations, de les traiter et d'effectuer certaines tâches.

Alors l'application réussie d'un capteur est déterminée par sa performance, son coût et sa fiabilité.
Le coût d'un capteur est souvent le facteur le plus important. Clairement, moins de matériaux sont nécessaires pour fabriquer un petit capteur mais le coût de traitement des matériaux est souvent un facteur plus important. L'évolution du silicium nous a permis de produire des petits transformateurs, fiables sous la forme de circuits intégrés utilisant la technologie microélectronique.
Le faible coût [1], [4] des capteurs à semi-conducteurs plus leur grande fiabilité et la petite taille a créé des nombreuses applications en biotechnologie, médicine, aéronautique, communications, inertie (accéléromètres, gyromètres) etc.
Du point de vue de principe de fonctionnement d'un MEMS, ils ont généralement une membrane souple en silicium qui se déforme en présence d'une différence de pression (Fig. 1). La déformation est convertie en un signal électrique qui apparait à la sortie du capteur. Ce capteur consiste de quatre éléments pièzorésistif qui forment un pont de Wheatstone [4].

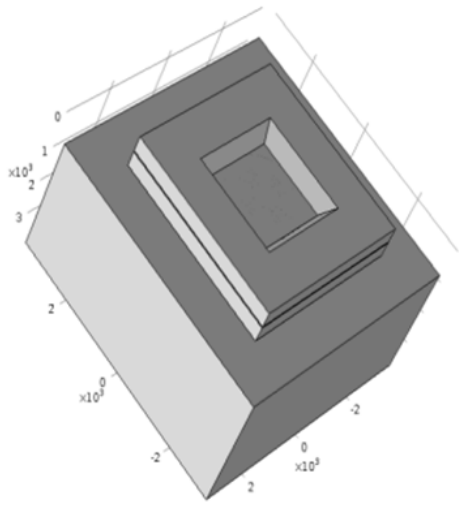


Figure 1. *Modèle générale du capteur*

En ce qui concerne la technologie de fabrication pour un capteur de pression, on recourt à plusieurs étapes [2], [5] :

- La photolithographie : l'ensemble des opérations permettant de transférer une image (généralement présente sur un masque) vers un substrat;
- La métallisation;
- La gravure;
- L'oxydation;
- L'implantation ionique;
- L'encapsulation niveau 0;
- L'encapsulation niveau 1;
- Caractérisation du processus (profilomètrie, microscopes, tests électriques).

3. SIMULATIONS NUMERIQUES

La simulation est un outil pour étudier les résultats d'une action sur un élément sans réaliser l'expérience sur l'élément réel.
La simulation numérique comprend la compréhension, l'analyse et la simulation du phénomène.
Les étapes de travail avec le logiciel COMSOL Multiphysics sont:
- on détermine la géométrie
- on choisit les matériaux
- on fait le maillage
- on choisit la physique
- on impose les conditions limites
- on lance la simulation
- on interprète les résultats

Les dimensions de la puce restent fixes pour toutes les simulations:
- largeur x longueur 4700 x 4700 μm.

Pour la membrane:
- largeur x longueur x épaisseur 2000 x 2000 x 25 μm;
- épaisseur des jauges: 10 μm;
- épaisseur du vide crée par la membrane: 20 μm;
- épaisseur d'élément piézoéléctrique: 25 μm.

Pour l'anneau en or:
- largeur x épaisseur: 300 x 3 μm.

Au cours de simulation on va changer le substrat et la liaison de scellement.
Parmi les résultats de la simulation on va regarder l'influence des différents paramètres:
- l'effet du coefficient d'expansion thermique;
- la géométrie de la surface de contact;
- l'épaisseur du contact;
- le type du matériau de contact;
- la forme du substrat en céramique;
- l'épaisseur du substrat en céramique;
- l'influence de la jupe en Kovar.

4. RESULTATS

4.1 Comparaison entre Al_2O_3 et AlN (effet du coefficient d'expansion thermique)

Pour le substrat on a utilisé deux types de céramiques, Al_2O_3 et AlN, dont les valeurs du coefficient de dilatation thermique sont:
- pour Al_2O_3: $\alpha = 8 \cdot 10^{-6}\ {}^0C^{-1}$;
- pour AlN: $\alpha = 4 \cdot 10^{-6}\ {}^0C^{-1}$.

Les résultats concernant les valeurs des contraintes dans les deux matériaux sont présentées dans la Figure 2. On peut observer que l'alumine engendre des contraintes 3-4 fois plus grandes que le nitrure d'aluminium.

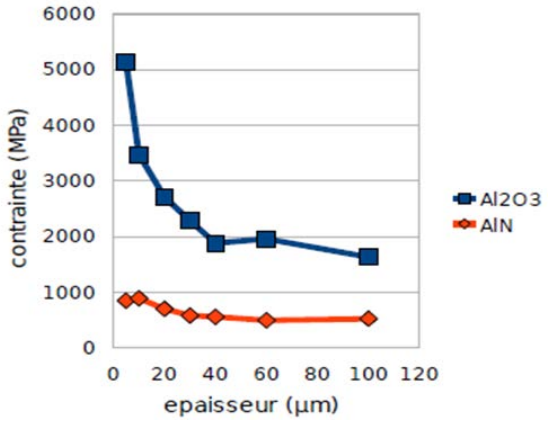


Figure 2. *Contraintes pour le modèle pad carré pour les deux céramiques en fonction d'épaisseur*

4.2 Géométrie de la surface de contact

Le modèle de base de simulation est constitué d'un substrat en céramique de forme parallélépipédique de longueur, largeur et épaisseur 7000 x 6920 x 3000 µm, simulé à une température de 200°C et une pression de 1200 mbar (Fig. 3). Les modèles envisagés sont: deux et quatre bumps, pad carre, ring arrondi et pad carre, ring arrondi et pad en L, ring arrondi et pad en L arrondi, ring arrondi et cylindres au centre de la puce).
Un exemple typique pour le gradient de pression obtenue pour le modèle ring arrondi et pad en L est présenté dans la Figure 3.

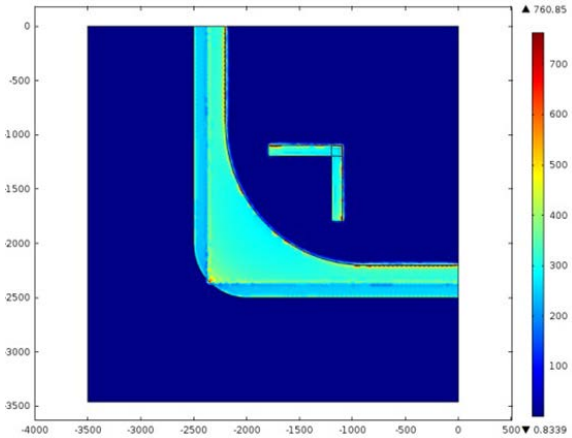


Figure 3. *Gradient de pression pour le modèle ring arrondi et pad en L*

4.3 Epaisseur du contact

En ce qui concerne l'épaisseur du contact d'or, elle influence la valeur de la contrainte maximale ainsi que sa répartition dans la surface et volume. La contrainte maximale a tendance de diminuer quand on augmente l'épaisseur, selon la Figure 2.

4.4 Matériau du contact

On a fait simuler cette condition juste sur deux des modèles pour les deux céramiques utilisées pour le substrat. Ainsi, la contrainte maximale reste plus baisse au cas de l'or.
Lors d'un changement de température, la différence de coefficients de dilatation thermique crée un champ de contraintes (Fig. 4). Son intensité et sa forme dépendent des caractéristiques des matériaux. II induit une zone de tension dans la céramique proche de l'interface et sur les bords de l'éprouvette. Les autres parties de la céramique sont en compression.

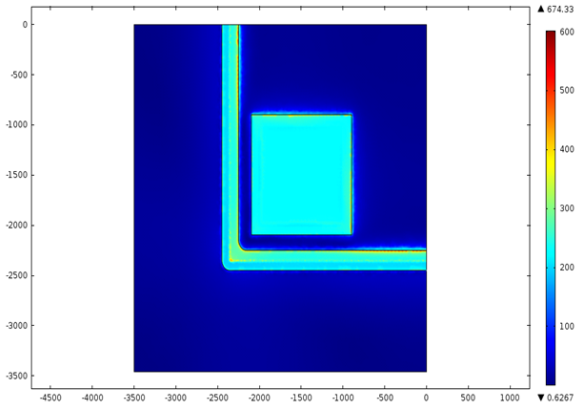


Figure 4. *Gradient de pression modèle ring arrondi et pad carre pour AlN-Au*

4.5 Forme du substrat en céramique

On a testé deux modèles de géométrie pour le substrat en céramique, l'un parallélépipède avec largeur et longueur épaisseur 6920 x 7000 x 3000 µm et un cylindre avec le rayon et épaisseur de 3400 x 3000 µm.
La géométrie a un rôle important en ce qui concerne les contraintes et ses répartitions dans la céramique mais aussi à l'interface métal-céramique du a l'effet des contraintes résiduelles affectées au cours de processus de fabrication.
On observe que la contrainte induite par le cylindre est 13% plus grande que celle induite par le parallélépipède.

4.6 Epaisseur du substrat en céramique

Le modèle analysé c'est un ring arrondi de largeur 200 µm et rayon de courbure 100 µm épaisseur 60 µm avec substrat cylindre 3000 et 6000 µm pour les deux céramiques.
Pour le cylindre si on augmente l'épaisseur la contrainte diminue mais pour le parallélépipède l'effet n'est pas élucidé. Le gradient de pression correspondant est présenté dans la Figure 5.

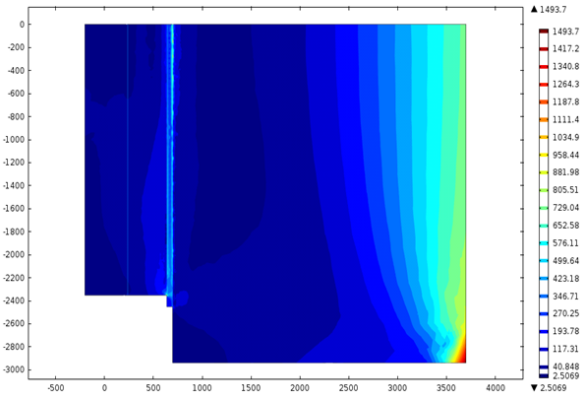


Figure 5. *Gradient de pression pour le modèle ring arrondi AlN cylindre 3000 µm*

4.7 Influence de la jupe en Kovar

Le Kovar est un alliage FeNiCo à faible coéfficient de dilatation thermique: $\alpha = 5 \cdot 10^{-6}$ $^{0}C^{-1}$. Il diminue la contrainte maximale, selon la Figure 6.

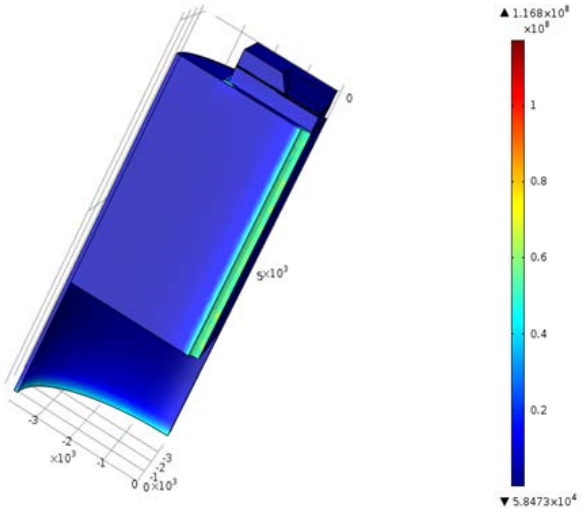


Figure 6. *Gradient de pression en volume cylindre 6000 µm et jupe 12000 µm AlN*

5. CONCLUSIONS

Actuellement, il existe de nombreux capteurs de pression pour l'aéronautique, dont la fonction est de mesurer la pression, influencés par les différents facteurs dans lesquels on peut les trouver comme par exemple : températures et vibrations.
L'objectif principal est d'améliorer la précision du capteur. Plus il sera fiable, plus il sera compétitif sur le marché par rapport à ses concurrents directs. Malgré tout, le design du capteur évoluera avec le temps, afin d'optimiser les résultats, lorsque l'on parle de design, on inclut le packaging de niveaux 0 et 1. Les dimensions varient et ils ont une influence importante sur l'efficacité du capteur.
Dans l'avenir il faut trouver un compromis pour le packaging niveau 1 entre la géométrie de surface, épaisseur et matériau de scellement et géométrie, épaisseur et matériau de la céramique mais aussi la métallisation autour de la céramique afin qu'on puisse avoir une contrainte plus faible tant au niveau du contact mais aussi dans la céramique en ne négligeant pas la plage de température de fonctionnement.

BIBLIOGRAPHIE

[1] Maluf, N. An Introduction to Microelectromechanical Systems Engineering, 2000
[2] Bonnassieux, Y. Fabrication des Transistors CMOS, 2006
[3] *** Handbook of semiconductor silicon Technology, 1990
[4] Gardner, J. M. Micro sensors - Principles and Applications, 1994
[5] Thau, C. Fabrication and characterization of wafer level gold thermo compression bonding, Thèse de doctorat, 2004