Ingineria automobilului

Registrul Auto Român

SIAR

Societatea Inginerilor de Automobile din România

SE DISTRIBUIE GRATUIT CA SUPLIMENT AL REVISTEI AUTOTEST

Nr. 37 / decembrie 2015

EAEC-ESFA 2015

European Automotive Congress

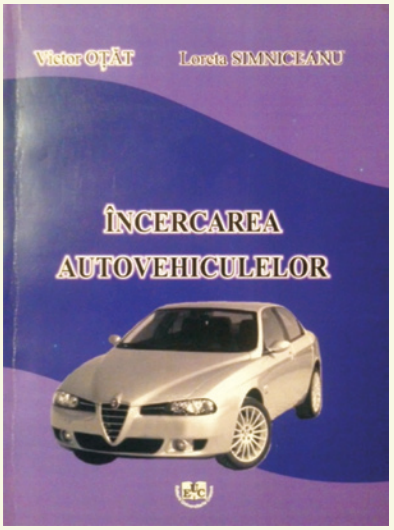
- Protecția activă a automobilelor conectate wireless
- Dinamica tribosistemului culisant în regim instabil
- Analiza procesului de frânare utilizând matlab/simulink
- Posibilități de optimizare a regimului de mers în gol
- Poluarea produsă la pornirea motorului autoturismului hibrid

SIAR ESTE MEMBRĂ

FISITA INTERNATIONAL FEDERATION OF AUTOMOTIVE ENGINEERING SOCIETIES

EAEC EUROPEAN AUTOMOBILE ENGINEERS COOPERATION

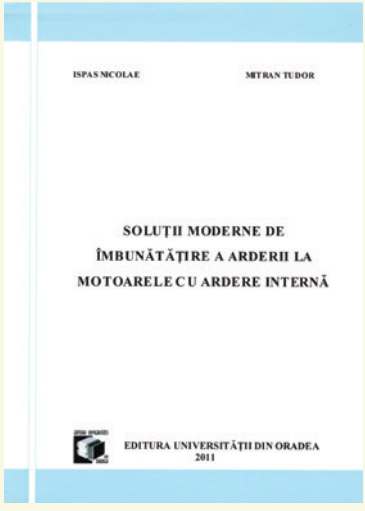
ÎNCERCAREA AUTOVEHICULELOR



Autori: Victor OȚĂT, Loreta SIMNICEANU

Anul apariției: 2010
Editura Universitaria Craiova
ISBN: 973-8043-62-X

Principalele direcții de dezvoltare a construcției de autovehicule în prezent sunt: realizarea unor autovehicule care să asigure un confort și o securitate sporită, reducerea poluării în vederea protejării mediului ambiant, creșterea calităților dinamice și economice ale acestora, simplificarea conducerii autovehiculului prin automatizarea diferitelor comenzi.
Dezvoltarea industriei de autovehicule nu poate fi concepută astăzi fără ca în activitatea de concepție să fie cuprinsă cu o pondere importantă, activitatea de cercetarea experimentală.
Având în vedere aceste considerente, lucrarea prezentată este structurată în nouă capitole care prezintă elementele de bază privind: criteriile de alegere a aparaturii; precizia și erorile de măsurare; evaluarea erorilor de măsurare; traductoarele; amplificatoarele de semnal și aparatele pentru înregistrarea semnalelor obișnuite din lanțul de măsurare; importanța, scopul și clasificarea încercărilor autovehiculelor; alegerea și pregătirea autovehiculelor pentru încercări; modul de întocmire a programului de încercări; metodologia de încercare a principalelor subansambluri ale autovehiculului (motor, transmisie etc.); modalități de determinare a performanțelor autovehiculelor (măsurarea vitezei, determinarea calităților de accelerare și frânare, măsurarea forței de tracțiune, determinarea consumului de combustibil); încercarea autovehiculelor la stabilitate și maniabilitate; determinarea parametrilor de confort; determinarea capacității de trecere; determinarea durabilității autovehiculelor.
Lucrarea se adresează în primul rând studenților din domeniul „Autovehicule Rutiere", precum și specialiștilor care lucrează în domeniul concepției, cercetării, fabricării și exploatării autovehiculelor, punându-le la dispoziție metode de încercare a acestora în condiții de drum și de laborator.
Lucrarea mai cuprinde un mic dicționar în domeniul poluării și o listă de abrevieri.



SOLUȚII MODERNE DE ÎMBUNĂTĂȚIRE A ARDERII LA MOTOARELE CU ARDERE INTERNĂ

Autori: Nicolae ISPAS, Tudor MITRAN

Editura Universității din Oradea
Anul apariției: 2011
ISBN: 978-606-10-0649-6

Motorul cu ardere internă are o lungă istorie. Provocările impuse de utilizarea pentru echiparea autovehiculelor au determinat perfecționarea continuă a acestuia. În prezent, performanțele motoarelor cu ardere internă trebuie să se încadreze în normele din ce în ce mai severe stipulate de legislația în domeniul protecției mediului. Una din căile principale pentru încadrarea emisiilor motoarelor cu ardere internă în normele de mediu este îmbunătățirea procesului de ardere.
Lucrarea prezentată este destinată studenților de la programele de master și specialiștilor din domeniul autovehiculelor rutiere și cuprinde unele metode de îmbunătățire a procesului de ardere din motoarele pentru autovehicule, pornind de la modul de formare a amestecului carburant, continuând cu concepte noi privind procesul de ardere și cu prezentarea influenței arhitecturii camerei de ardere.
În capitolul introductiv se prezintă necesitatea îmbunătățirii procesului de ardere la motoarele pentru autovehicule.
În următoarele două capitole sunt enumerate metode specifice de îmbunătățire a arderii la motoarele cu aprindere prin comprimare, respectiv la motoarele cu aprindere prin scânteie.
Capitolul 4 tratează conceptul arderii amestecurilor omogene (HCCI), cu analiza posibilităților de aplicare practică a acestuia.
Ultimul capitol prezintă aspecte privind autoaprinderea controlată (CAI).
Lucrarea oferă o bază solidă celor interesați în dezvoltarea unor noi generații de motoare cu ardere internă, cu performanțe superioare

SIAR@25TH ANNIVERSARY ACADEMIA, INDUSTRY AND GOVERNMENT: TOGETHER FOR AUTOMOTIVE ENGINEERING DEVELOPMENT

SIAR LA CEA DE-A 25-A ANIVERSARE EDUCAȚIA, INDUSTRIA, STATUL: ÎMPREUNĂ PENTRU DEZVOLTAREA INGINERIEI AUTOVEHICULELOR

Anul 2015 marchează împlinirea unui sfert de veac de la fondarea **S**ocietății **I**nginerilor de **A**utomobile din **R**omânia (SIAR). Existența SIAR este semnul distinctiv al faptului că filiera automobilistică din România este organizată pentru a crea condiții propice unui *dialog* ale cărui părți interesate sunt sistemul de învățământ, industria de automobile și structurile de profil ale statului. Pentru a servi acestui scop, printre altele, SIAR organizează anual, sub patronajul **F***édération* **I**nternationale des **S**ociétés d'**I**ngénieurs des **T**echniques de l'**A**utomobile (FISITA), un congres internațional.

Anul acesta, congresul SIAR este organizat de către Universitatea Politehnica din București, beneficiind, în premieră, de label-ul « European Automotive Congress / Congres European de Automobile ». Acest congres este, de fapt, rezultatul unui efort conjugat al European Automobile Engineers Cooperation (EAEC) și SIAR. Ca urmare, discutăm de congresul EAEC-ESFA2015 ce reprezintă, pe de-o parte, cea de-a 14-a ediție a Congresului EAEC, iar, pe de altă parte, cea de-a 9-a ediție a tradiționalei Conferințe ESFA a SIAR. Pe scurt, este vorba despre „European Automotive Congress" (www.eaec-esfa2015.com), guvernat, la această ediție, de motto-ul „Academia, Industry and Government: together for automotive engineering development"**.**

Așadar, în această relație tripartită se desfășoară activitatea SIAR. Desigur, trebuie să privim în viitor, motiv pentru care partea ce vizează mediul academic din motto-ul congresului nostru, se poate diviza pentru a pune în evidență, în mod distinct, studenții noștri. Aceasta cu atât mai mult cu cât SIAR are o puternică componentă academică.

Provocările sunt complexe și trebuie să vizeze asigurarea unei devoltări durabile/sustenabile a societății... Aș menționa, acum, numai necesitatea existenței unei resurse umane corespunzător pregătită. Pentru aceasta, cele trei părți interesate (profesorii și studenții din mediul academic, mediul industrial, respectiv, structurile statului) trebuie să fie într-un *dialog* continuu. Eficiența ar trebui să fie atributul primordial al acestui *dialog*. Așadar, această structură tripartită trebuie să se constituie într-un adevărat sistem integrat ce funcționează în buclă închisă. Cuvântul cheie ar trebui să fie *feedback*. Fără *feedback* nu se poate miza pe o ameliorare reală, al cărui obiectiv final nu poate fi decât crearea unei resurse umane de calitate pentru o societate mai bună. Generic vorbind, în interacțiunile din cadrul acestui sistem integrat, ar trebui urmărită *satisfacția clientului*, fiecare dintre cele trei părți având simultan atât calitate de client, cât și de furnizor. Este evident, cred, că această satisfacție nu poate fi atinsă fără *dialog*, deci, fără *feedback*...

Închei repetând ceea ce am mai spus, și anume: în tot acest sistem, SIAR trebuie să aibe un rol de interfață, dovedindu-și, în acest fel, utilitatea publică. Este (încă) nevoie de intensificarea dinamicii SIAR și este important ca vocea SIAR să fie auzită, astfel încât utilitatea organizației noastre să fie evidentă pentru părțile implicate.

La ceas aniversar, SIAR este recunoscător partenerilor săi și rostește tradiționala urare:

VIVAT, CRESCAT, FLOREAT !

Adrian CLENCI,

Președinte SIAR, Director al Departamentului Autovehicule și Transporturi
Universitatea din Pitești

SUMAR „INGINERIA AUTOMOBILULUI" NR. 37

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George-Adrian DINCĂ
Director Tehnic
Cristian Viorel BUCUR
Director Adjunct
Dorin Ilian LEȚEA
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Redactori
Radu BUHĂNIȚĂ
Emilia PETRE
George DRUGESCU
Gabriel MANOLE

Contact:
Calea Griviței 391 A,
sector 1, cod poștal 010719,
București, România
Tel/Fax: 021/202.70.17
E-mail: autotest@rarom.ro
www.rarom.ro
www.autotestmagazin.ro

SIAR

Contact
Facultatea de Transporturi
Universitatea Politehnica
București
Splaiul Independenței 313
Sala JC 005, Cod poștal 060042,
sector 6, București, România
Tel/Fax: 021/316.96.08
E-mail: siar@siar.ro
www.ingineria-automobilului.ro
www.siar.ro

TIPAR

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Str. Vulturilor 12-14, sector 3, București

Ingineria automobilului: an apariție ediția tipărită 2006 (ISSN 1842 – 4074) / ediția electronică 2007 (ISSN 2284 – 5690).
Serie nouă a Revistei Inginerilor de Automobile (RIA), tipărită în perioada 1990-2000 (ISSN 1222-5142)
SIAR publică online Romanian Journal of Automotive Engineering ISSN 2457 – 5275

INTERVIEW WITH MR. CHRIS MASON FISITA CHIEF EXECUTIVE OFFICER

INTERVIU CU DL. CHRIS MASON CHIEF EXECUTIVE OFFICER FISITA

FISITA brings together the professional associations of the automotive engineers all over the world, continuously acting in achieving and providing a proper frame to our common actions, for our common tasks. What would be the main lines of actions for FISITA in this period of time?

FISITA has been in existence as a membership organisation for nearly 70 years, our primary focus is on providing our members with beneficial services that add value and bringing the automotive technical community together to network, from a technical perspective.

We focus much of our time on organising and running technical events such as World Automotive Congress, World Automotive Summit and EuroBrake. Also also work with members in developing activities and initiatives through the FISITA Committee structure, primarily the Education, Technical and Internal Relations Committees.

We could easily notice an enhancement of FISITA's actions. Keeping that in mind, what would be the future tasks and objectives for FISITA?

Since joining the organisation as CEO in August 2014 I have been learning, listening and talking to members and stakeholders in order to work out how we ensure that FISITA continues to stay relevant to our members and the broader community.

The five year vision plan I presented to the Executive Board in July focuses on maintaining and developing what we have, while sensitively adding new focus on existing activities or bringing new initiatives in to continue to support and add value for our members. The Board agreed the following six objectives, which we now refer to as our 2020 RoadMap:

1. Improve FISITA engagement and recognition
2. Demonstrate purpose and value of FISITA membership
3. Develop meaningful membership proposal
4. Align academia within membership structure
5. Improve communications and brand awareness
6. Operational management

FISITA brings together automotive engineers from 37 countries. Each and every National Association has its own priorities. What are FISITA's instruments to harmonize them?

We are lucky to have such a large and committed membership from all around the world. We try to maintain an open dialogue with all our members, but the main contributor is the members themselves. They are very well organised within the Committee structure and of course our Executive Board and Council are made up of member volunteers, so they set the overall direction for the staff team to deliver. We all work very well together and that's the key.

To increase the efficiency of FISITA's activities, a main way is given by improving communication. What are the plans of FISITA to improve the intercommunication between the National Associations as well as the communication between FISITA and the National Associations?

The FISITA Internal Relations Committee already does a fantastic job and you'll have seen new initiatives from them such as the member survey and Regionsl Report already this year. The more we engage with our members, the more channels of communication can be discovered and opened up. As we develop our plans from the 2020 RoadMap members will continue to see us look to engage with them more often, on different subjects, we will continue to use the website as an area to use to hold discussions, debates and develop plans together. And of course, the new FISITA head office in Stansted, UK has been especially fitted out to accommodate more meetings with members and also for our members to use as a free of charge workspace whenever they are in the UK.

Globalization is a strong trend, making it self felt in the Automotive Industry as well. This trend assumes both a full professional communication and projects that imply counterparts scattered all over the world. How does FISITA support this kind of projects?

Again, we see globalisation as something that has been part of the

FISITA remit since 1948, as that's the role of an international membership organisation. With regard to our project work, we use the Internet and Webex/Skype meetings routinely as its not practice, or always necessary, to travel in order to progress projects. Although, there is no substitute for a face to face meeting, the Internet has changed working practices and made the world a significantly smaller place.

FISITA's cohesion is commonly assured by the central management's actions, but mostly by projects that involve members of different National Associations. How do you comment the present status of the FISITA? Do you consider some necessary improvements in these directions?

We always strive to improve what we do and how we do it, this is a fundamental business practice in my view.as the leader of any business if yo aren't looking to improve, then I believe you are not taking your responsibility to the organisation seriously.

What we are mindful of at FISITA is the rich history and relationships that are as vital to the organisation as business development strategy.

Do you think that a way to promote the activities developed by the national Associations would be provided by better displaying them on FISITA's website and publications?

Yes. We have been working on a brand new website for the last few months which will be much easier for us to add and edit content on than our current site. Once this is live, we will be able to provide more reference to our members activities and achievements than we are able to do right now. We also introduce the monthly Inside Track newsletter, which has been very well received over the last year.

In our opinion, the scientific events lately organized by FISITA have a dual feature. On one hand they restrict the participation of the interested persons due to the high participation fees. On the other hand, having the papers published in formats that are not internationally recognized, determine even the persons having money for fees to avoid them. Does FISITA have any intention to analyze and maybe to correct these aspects?

Yes. The recognition of a 'FISITA Paper' and then it's 'discoverability' seem to me to be two areas that haven't received the levels of investment that they should have over recent years. Our 2020 RoadMap plans to work towards addressing this issue, but it will take time.

We pay attention to the activities of the Educational Committee of FISITA and have great expectations for the future Academic Committee. The programs for the young automotive engineers are important, maybe the most important for FISITA, taking into account their potential in future development of the society. How do you evaluate the youth's implication in FISITA's activity?

Our ability to engage with young people in order to demonstrate to them how attractive automotive careers can be is fundamental and integral to the entire 2030 RoadMap plan. We need to build on the excellent work we already do in this area and reach out to more young people around the world and offer them more routes to experience what we already know, the international automotive sector is a fabulous place to work!

The EAEC-FISITA Congress 2016, organized by SIAR due to the impossibility to hold this Congress in Győr, Hungary, made possible the meeting of an important number of participants. It also provided the possibility to reveal important aspects of the research and development within the Automotive Engineering domain. How do you appreciate the place of this Congress among FISITA's events and the results of this Congress as well?

It is my first experience of EAEC and I am really pleased to be here in Bucharest today, while carrying out this interview, in order to experience the event. This year sees the 14th EAEC, and I think we need to ensure we are still celebrating its cause and relevance to the European Auto Engineering community in another 30 years. I'm looking forward to taking away what I learn from the experience as helping ensure it continues to thrive as a key FISITA event.

Thank you for the interview!

My pleasure! Any time!

INTERVIEW WITH DR.-ING. LUDWIG G.E. VOLLRATH FISITA VICE PRESIDENT AND EAEC PRESIDENT

INTERVIU CU DR. ING. LUDWIG G.E. VOLLRATH VICEPREŞEDINTE FISITA, PREŞEDINTE EAEC

Mister President of EAEC, organizing the EAEC Congress, for the first time by SIAR, was a last moment solution, given by the impossibility to hold this Congress in Győr, Hungary. How do you evaluate, now, in the end of this European level scientific event, the organizing and the results of the EAEC-FISITA Congress 2015?

First of all I should like to express my gratitude to SIAR and in particular to Prof. Adrian Clenci and Prof. Minu Mitrea. They had worked in close collaboration with Prof. Christian Andreescu and his team to get the joined conference EAEC-ESFA 2015 rolling. Only a very brief period for preparation had been available to them since the beginning of this year when we took the decision jointly. The results of our incessant work are most convincing.

With the occasion of the EAEC Congress (meetings), held in Bucharest, has been set that the future one should be organized in 2017 in Cracow, Poland. Scheduling and organizing an European Automotive Engineering Congress may be a difficult task since its outcome doesn't get an important acknowledgment outside the FISITA environment. How do you think the future steps should be taken like, to increasing the international visibility and acknowledgment of the papers presented to these scientific events?

We are talking about Europe relative to EAEC. Europe is characterized by a very specific collaboration for research and development represented by academia and industry in the automobile sector. This means a closely interlinked network in Europe.

I am convinced that an European Automotive Congress is an excellent platform to present to and to discuss among colleagues new ideas and concepts for the future. There are several thousands of engineers and scientists concerning the future of the automobile. Their bright ideas must be gathered and publicized to benefit all of Europe and to reach out to the world- also through the communication channels offered by FISITA.

EAEC is a virtual structure, its President being, de facto FISITA's Vice-President for Europe. So, do you think that a formalization of EAEC would be necessary in the future? What do you think about our proposition that the National Societies would successively, and by agreement, provide for a one-year term a Secretariat for EAEC that would facilitate a better relationship between the European Member Societies?

You are right, for the time being we have a personal union with FISITA VP Europe due to lack of manpower.

The original idea of EAEC the European Automobile Engineers Cooperation is to function as a platform for the European engineering community.

A better way to ensure effective working is to follow the procedure of presidency as laid down for the member states in the EU : they follow a fixed list of rotation making sure that the last presidency and the following presidency as consultance to the current presidency.

In this way we follow FISITAs approach of ensuring presidents for the different continents. EAEC would profit by this approach by setting up a presidency/coordinator to be elected by the European members.

The procedure of election should involved a kind of list of rotation of presidency and secretariat president and secretary are independently voted and may be held by different countries in Europe .

The national European Societies have their own features, generated by their specific social and

economical context. Some of them, like SIAR for example, have a powerful academic component, while others have the majority of their individual members as people coming from the industrial environment. These features could generate difficulties in finding common projects. How do you think we should act in the future to increasing the coherence of the actions of the National Member Societies and reaching objectives of common interest?

I am quite aware that the member societies have quite different national backgrounds. I think every member country should undertake a policy of inclusion of academia and industry. The benefit for both will be that they generate synergies and will gain greater attractiveness for national institutional and personal members as well as international investors as stakeholders.

The European Union tends towards a stronger integration. Other European Countries also join this trend, in different extents. How do you assess building up an European common environment for the Automotive Engineering? What would be the main paths or lines of action in this respect?

The automotive industry does not stop short at the EU borders. No do engineers. This spells "networking" on your national level reaching out to the neighboring countries and from there to the world

This networking is the fundamental idea of the European Automotive Engineer Congress EAEC.

Its success always stands on the many legs of the European members.

The European University education adopted a common model to train engineers, including the automotive engineers. We speak here about the Bologna model. Do you consider that EAEC could involve in defining the minimal competencies of the domain's graduates at different levels of the educational process?

EAEC is a platform to exchange experience and findings. It is not a rating agency, not an educational adviser. However as a pool of cooperating member societies we could provide the platform as a matchmaker between students and industry.

On long term, could EAEC become a partner of the European Commission in promoting the specific interests of the domain?

EAEC does not understand itself as a lobbyist but could be useful in contacting the EU commission when it comes to present specific projects for promotion.

How do you evaluate the role of the University scientific research in the field of the Automotive Engineering and its integration within the European scientific research as a whole?

University based scientific research in the field of automotive engineering is indispensable both on a national and European level it will benefit both people and research content best if it reaches out to the practical engineering by means of join projects.

A strong co-operation bond between the industry and the Universities allows an efficient use of the available resources and competencies within these institutions. How do you think this co-operation could be intensified? What do you think about the idea that EAEC should develop a mechanism within its structure, able to facilitate contacts between the Universities (especially from Eastern Europe) and automotive and part manufacturers? Should be mentioned that this mechanism aims both at cooperation of the Universities within the scientific and technological innovating domain and at providing scholarships for the students of this side of Europe to FISITA's training activities.

I strongly believe that successful cooperation between academia and industry should not be organized by central organizations. Partnership of this kind means that the interested parties should seek each other as is looking for marriage. Again matchmaking is the keyword by proving the platform e.g. congresses.

Things are different for education: students need promotion, scholarships, internships etc. to expand their professional horizon and to prepare them for their future jobs in the global automotive industry. Such programmes already exist within FISITA and are constantly developed.

It's notorious by now your involvement in sustaining programs for young automotive students, of their practical activities and especially of the "Formula Student" project. In Romania, our students also have this kind of concerns. In many Universities, the students, helped by their teachers, developed projects within the "Formula Student" project. But they also have been involved in smaller scale projects: small vehicles (go-karts) powered by various power units (compressed air, electrical or thermal engines). They take their vehicles to international contests, e.g. "Kart Low Cost" (with partners from France and Tunis) or "Pneumobil" (Hungary and Slovakia). How do you appreciate the contribution of these projects in developing the professional skills of the future automotive engineers, since they aim at developing a career in the Automotive Engineering? Moreover, how do you think the "Formula Student" project could be further developed in Eastern Europe?

Formula Students as an International Design Competition had been conceived for the first time in the USA almost 30 years ago and has developed into the focal competition for students and young engineers on a global scale. More than 600 student teams from 52 countries take up the challenge every year to design a competitive vehicle, to present it to an international jury and to match their engineering capabilities against those of their fellow student teams.

In Europe this competition enjoys a special role in two ways:

Five years ago FS Electric had been called into life in Germany to take up the challenges of future drive systems that will save the environment. 80 percent of the E-teams come from European universities and polytechs. This highlights the significance of sustainability that is addressed by this young generation.

Secondly, 250 student teams have been formed in Europe over the recent years, in Europe the most international competitions are organized, like in UK, Italy, Spain, Germany, Austria, Czech Republic, Hungary and quite recently in Russia. The later countries are an indication that Formula Student enjoys a most dynamic development in Eastern Europe.

I personally think that any kind of student based competition is an excellent platform to deal with novel technology concepts, to work out solutions in a team and to put their solutions to the test. The projects you mentioned are proof of this spirit to take up the spirit of technology, cost and environment.

Mister President, the SIAR members felt and appreciated your continuous support. We kindly ask you, since the EAEC-ESFA Congress has ended and the 2016 New Year is closing, to send them a message.

Dear friends from Romania, thank your for your excellent work as organizers and your heartwarming hospitality. I wish you and all your associates all the best and success for the future. I greatly enjoyed working with all of you and I think I have made very good friends.

Thank you very much for this interview and let us wish you A Merry Christmas and A Happy New Year!

THE EUROPEAN AUTOMOTIVE CONGRES EAEC-ESFA 2015

CONGRESUL EUROPEAN DE AUTOMOBILE EAEC-ESFA 2015 25-27 Noiembrie 2015 Bucureşti, România

MOTTO: Academia, Industry and Government: together for automotive engineering development

Prof. dr. ing.
Minu MITREA
General Secretary of SIAR
minumitrea@yahoo.com

SIAR, Spl. Independentei 313 060042 Bucharest
Romania

În perioada 25.11 – 27.11.2015 au avut loc lucrările Congresului European de Automobile EAEC-ESFA 2015, organizat de Conferința Europeană a Inginerilor de Automobile – EAEC și Societatea Inginerilor de Automobile din România – SIAR, în organizarea Facultății de Transporturi a Universității Politehnica din București prin Departamentul de Autovehicule Rutiere, sub patronajul FISITA (International Federation of Automotive Engineering Societies).

Conceput ca un eveniment științific major în comunitatea europeană a cercetătorilor, cadrelor didactice și a altor specialiști din domeniul ingineriei autovehiculelor, Congresul European de Automobile EAEC-ESFA 2015 a avut ca piloni de bază în structurarea sa două manifestări de tradiție: Congresul internațional al SIAR de inginerie a autovehiculelor ESFA „Economicitate, Securitate și Fiabilitate pentru Autovehicule" ce are o bogată tradiție și recunoaștere internațională, fiind organizat anterior în anii 1981, 1984, 1987, 1991, 1995, 1998, 2003 și 2009, precum și conferința europeană EAEC. Conferința europeană a inginerilor de automobile organizată de către EAEC – European Automotive Engineers Cooperation la fiecare doi ani între congresele mondiale ale FISITA a marcat până în prezent 13 ediții găzduite de Germania (1987, 1993), Marea Britanie (1989), Franța (1991, 1995, 2003), Italia (1997), Spania (1999, 2011), Slovacia (2001, 2009), Serbia (2005) și Ungaria (2007).

Congresul European de Automobile EAEC-ESFA 2015 a fost organizat de Departamentul de Autovehicule din cadrul Facultății de Transporturi a Universității Politehnica din București, unul dintre centrele de excelență în cercetarea aplicativă și fundamentală din domeniul ingineriei autovehiculelor și transporturilor rutiere, cu o largă recunoaștere națională și internațională.

Congresul a fost însoțit de un ansamblu de manifestări care au atras atenția specialiștilor români și străini din domeniul ingineriei autovehiculelor și transporturilor rutiere prezenți la București cu această ocazie. Aceste manifestări au făcut ca Bucureștiul să devină pentru câteva zile un centru internațional al ingineriei autovehiculelor, oferind astfel prilejul stabilirii unor contacte utile de colaborare și informare în domeniul problemelor actuale privind dezvoltarea autovehiculelor, siguranța transporturilor rutiere, protecția mediului.

Schimbul activ de idei, alături de mobilitatea cercetătorilor, caracterizează societatea actuală și constituie unul dintre motoarele de dezvoltare a domeniului ingineriei automobilelor. Participarea la lucrările congresului a unui număr important de specialiști din mediile academic, social și economic din țară și de peste hotare a permis crearea unui cadru prielnic abordării cu substanță a temelor importante care preocupă societatea contemporană și constituie provocări continue.

Direcțiile de interes propuse pentru Congresul European de Automobile EAEC-ESFA, au asigurat un cadru științific adecvat unor schimburi de idei și dezbateri intense și obiective, au reflectat aceste preocupări din domeniul ingineriei autovehiculelor, fiind orientate pe următoarele teme: sisteme avansate de propulsie; autovehicule rutiere și mediul; sisteme moderne de transport și trafic auto; vehicule grele și speciale; metode avansate de inginerie;materiale și tehnologii.

Cei peste 250 de participanți la congres au avut ocazia de a se implica activ la lucrările științifice prezentate în sesiunea plenară, cât și în cadrul secțiunilor, work-shop-uri, expoziții, vizite tematice, activități sociale.

În cadrul ceremoniei de deschidere a congresului au prezentat salutul lor dr. ing. Ludwig G.E. VOLLRATH - vicepreședinte al FISITA și președinte EAEC (European Automotive Engineers Cooperation), Chris MASON – CEO FISITA, Mihnea COSTOIU – rectorul UPB, PASCAL CANDAU – manager general la Renault Technologie Roumanie,, ing. George DINCĂ – manager general RAR, ing. Constantin STROE – președinte ACAROM, ing. Mihai BOLDIJAR – reprezentant Robert Bosch Romania și Bulgaria, Gerolf STROHMEIER – AVL Austria, conf. dr. ing. Adrian CLENCI – președintele SIAR și prof. dr. ing. Cristian ANDREESCU – vicepreședinte SIAR și președinte al comitetului de organizare a congresului EAEC-ESFA 2015.

După ceremonia de deschidere a congresului care a avut loc în Amfiteatrul AN010 al Universității Politehnica din București, s-a trecut la prezentarea lucrărilor în plen.

Prima lucrare, susținută în plen de Ovidiu TEODORESCU – Equipment Design Engineering Manager la Renault Technologie Roumanie, a abordat o temă de primă importanță în această perioadă pentru Renault și anume asigurarea unui management performant în concepția și producția de autovehicule pe 4 continente și în 14 uzine.

În continuare Gerald TEUSCHL – Product Line Manager Powertrain Electrification la AVL List Austria – a avut o intervenție urmărită cu mult interes de auditoriu cu titlul „Eficient Powertrain Solutions – Tension 12 V to 800 V".

Lucrarea susținută de Filip DEBLAUWE – Technical Manager la SIEMENS PLM Software Germany, a evidențiat preocupările și realizările companiei sale în domeniul economiei de combustibil prin lucrarea „Addressing performance balancing in fuel economy driven vehicle programs ".

Prof. dr. ing. Eden Mamut a prezentat stadiul cercetărilor în domeniul Fuel Cells.

Și prezentarea dlui Bogdan CERNAT-GRUICI, H2020 NCP pentru Smart, Green and Integrated Transport – „Horizon 2020, oportunități de finanțare pentru domeniul ingineriei autovehiculelor. Programe curente și programe cu declanșare în perioada următoare" (2016-2017), s-a bucurat de toată atenția audienței.

Lucrările pe secțiuni au fost prezentate într-un cadru special, elegant și multifuncțional asigurat de noua bibliotecă a Universității Politehnica din București.

La lucrările Congresului au participat cadre didactice universitare, cercetători și specialiști din domeniul ingineriei autovehiculelor și transporturilor rutiere din Austria, Bulgaria, Belarus, Franța, Germania, Iran, Israel, India, Japonia, Macedonia, Marea Britanie, Republica Moldova, Pakistan, Polonia, Serbia, Slovacia, Spania, SUA, Turcia, Ungaria și din România.

Congresul a prilejuit atât prezentarea rezultatelor activităților de cercetare desfășurate, cât și schimburi de opinii pe diverse teme de interes. Pe durata congresului, s-a organizat o vizită la Palatul Parlamentului, iar 17 firme cu activități de profil și-au prezentat produsele în spațiul expozițional special destinat. În cadrul a două work-shop-uri, participanții au dezbătut probleme specifice ingineriei autovehiculelor, aplicații software și sisteme complexe de testare a autovehiculelor.

Desfășurarea în paralel cu lucrările Congresului European de Automobile a fazei pe țară a celei de a doua ediții a Concursului național studențesc de inginerie a autovehiculelor „Prof. univ. ing. Constantin GHIULAI" cu participarea studenților reprezentând nouă universități, câștigători ai fazelor locale, a contribuit din plin la construirea în rândul participanților a unei imagini optimiste, pline de încredere în viitorul ingineriei autovehiculelor în România.

ACTIVELY DEFENDING THE CONNECTED CAR FROM WIRELESS ATTACKS

APĂRAREA ACTIVĂ A AUTOMOBILELOR CONECTATE WIRELESS

REZUMAT

Securitatea cibernetică a automobilelor conectate wireless este o preocupare majoră pentru punerea în aplicare a conectivității integrale a automobilelor, cu atât mai mult pentru vehiculul autonom.

Cu excepția unui răspuns remarcabil care va convinge toate părțile implicate (tehnice și publice), probabil că niciodată nu va fi adoptată pe scară largă o conectare completă, autonomă, a autovehiculului la rețea.

Lucrarea prezentată are ca bază o simulare software online în timp real a unui algoritm de protecție pe mai multe niveluri, bazat pe criptarea asimetrică puternică a unei semnături și pe o criptare asimetrică de nivel redus a comunicării pe un singur canal. Mecanismul automat se bazează pe un algoritm de detecție și reacție special conceput pentru a îmbunătăți rezistența la atacul în rețea. Simularea constă într-un program software de modelare a unui autovehicul și a turnului cu care comunică într-o conexiune Infrastructură de conectare - Vehicul (V2I), prin transferarea pachetelor de date la intervale regulate. Sistemul funcționează pentru o varietate de moduri de comunicare și atacuri cibernetice.

Componenta logică ilustrează o securitate multi-level bazată pe criptarea RSA, în timp ce componnental fizică demonstrează o conexiune wireless multi-canal. Lucrarea prezintă matricea riscurilor automobilelor conectate wireless, asociate recunoașterii și descrierii atacurilor cibernetice.

Keywords: *connected car, RSA Asymmetric Cryptosystem, lightweight encryption, man in the middle, deny of service.*

Drd. ing.
Ron DAVIDESCU[1]
rondavidescu@gmail.com

Prof. dr. ing.
Eugen NEGRUȘ[2]

[1] SATEC LTD Jerusalem 91450, Israel
[2] Universitatea Politehnica din București, Spl. Independenței nr. 313, 060042 București, Romania

1. INTRODUCTION

One of the main obstacles in large scale implementation of the connected car is keeping the two way communication safe, secure and discrete. The landscape of Vehicle to Infrastructure is quite clear in the mode of operation and infrastructure as one mode or another of machine to machine communication through the latest GSM /Mobile networks, however the Vehicle to Vehicle part is a totally different story, due to the high number of vehicles communicating simultaneously in a real time operation through short range communication.

The contradicting demands of reliable ,strong encryption and description while keeping real time operation in a low computer resource environment on a moving vehicle with no wired connection to back up and databases requires tailored solution.

Encryption Key Management: Public-key cryptography or Asymmetric cryptography is cryptography in which a couple of keys is used to decrypt and encrypt communication so that it is transmitted securely. At first, a user of the network receives both a private and public key's from a permitted authority. All other network users who wants to read an encrypted message can get the intended recipient's public key from a public directory. They use this key to decrypt the messages from original user. When the recipient gets the message, they decrypt it with their public key. In cases of the RSA cryptography, where the same algorithm is used to decrypt and encrypt, a packet can be signed securely by the sender. If the sender encrypts the message using their private key, then the message can be decrypted only using the sender's public key, and therefore authenticating the sender.

Therefore due to the ease of use of key management and the authentication capabilities the RSA cryptography was selected as the simulator encryption demonstrator. It is not in the scope of this paper to explain the mathematics of the RSA public key cryptosystem which is described in details in public resources, this is a nut shell explanation of the RSA Key generating, encryption and description process.

"The RSA public-key cryptosystem, which was invented at MIT in 1977 by Ronald Rivest, Adi Shamir and Leonard Adleman. The public key in this cryptosystem consists of the value n, which is called the modulus, and the value e, which is called the public exponent. The private key consists of the modulus n and the value d, which is called the private exponent", Burt Kaliski.

Table 1. An RSA public-key / private-key pair can be generation: Burt Kaliski

1. Generate a pair of large, random primes p and q.
2. Compute the modulus n as n = pq.
3. Select an odd public exponent e between 3 and n-1 that is relatively prime to p-1 and q-1.
4. Compute the private exponent d from e, p and q. (See below.)
5. Output (n, e) as the public key and (n, d) as the private key.
The encryption operation in the RSA cryptosystem is exponentiation to the eth power modulo n:
C = ENCRYPT (m) = m^e mod n.
The decryption operation is exponentiation to the dth power modulo n: m = DECRYPT (C) = C^d mod n

Key size:

RSA key pair length is usually specified in bits. That determine the number of bits in the module.

As there are no free meals, the question is what length of RSA key should we choose?

The answer in short.

Key generating time:

Generating an RSA key, the longer the key the stronger the security. However a longer key takes longer to generate, as shown in table 3.

Table 2. Recommended RSA key length: Javamex.com

A RSA key length of 1024 bits is sufficient for many medium security purposes such as web site logins;
for high security applications or for data that needs to remain confidential for more than a few years, you should use at least a 2048 bit key, and consider having a contingency plan for migrating to larger key sizes.
to keep data confidential for more than the next two decades, RSA recommends a key size larger than 2048 bits.

It is clear that real time operation and low computer power on a connected vehicle, as well as high cost of special processors does not allow large key generating on the vehicle itself.

Normally as described above there is no interest in keys smaller than 512 bit, however for the special purpose of the connected car a simulation for small key generation on a regular PC was performed as shown on Table 4.

*Keys 8 to 256 bit where generated by special written simulator.

Keys 512 to 4096 bit where generated online by the: Online RSA Key Generator: http://travistidwell.com/jsencrypt/demo/

The short duration of smaller than regular key generating allows the

Table 3. RSA key generation time vs. Key size: Cisco IOS Security

Router	360 bits	512 bits	1024 bits	2048 bits (maximum)
Cisco 2500	11 seconds	20 seconds	4 minutes, 38 seconds	More than 1 hour
Cisco 4700	Less than 1 second	1 second	4 seconds	50 seconds

Table 5: RSA Performance [milliseconds]: Matthew Short and Geoffrey Waters

Measurement Point	33 MHz	50 MHz	66 MHz	83 MHz	100 MHz	133 MHz	166 MHz	333 MHz
512 bit modulus 512 bit exponent	8.09 [ms]	5.34 [ms]	4.05 [ms]	3.22 [ms]	2.67 [ms]	2.01 [ms]	1.61 [ms]	0.80 [ms]
512 bit modulus 3 bit exponent	0.43 [ms]	0.29 [ms]	0.22 [ms]	0.17 [ms]	0.14 [ms]	0.11 [ms]	0.09 [ms]	0.04 [ms]
1024 bit modulus 1024 bit exponent	54.71 [ms]	36.11 [ms]	27.35 [ms]	21.75 [ms]	18.05 [ms]	13.57 [ms]	10.88 [ms]	5.42 [ms]
1024 bit modulus 3 bit exponent	1.48 [ms]	0.97 [ms]	0.74 [ms]	0.59 [ms]	0.49 [ms]	0.37 [ms]	0.29 [ms]	0.15 [ms]
2048 bit modulus 2048 bit exponent	406.50 [ms]	268.29 [ms]	203.25 [ms]	161.62 [ms]	134.14 [ms]	100.86 [ms]	80.81 [ms]	40.28 [ms]
2048 bit modulus 3 bit exponent	5.40 [ms]	3.56 [ms]	2.70 [ms]	2.15 [ms]	1.78 [ms]	1.34 [ms]	1.07 [ms]	0.53 [ms]

vehicle to create lightweight encryption based on local generated RSA keys, private and public.

Encryption and description:

With normal utilization, multiplying the RSA key by two means that decryption will be eight time slower and encryption will be four times slower. The theory clarifies that for an n-bit key, computational resources for decryption in proportional to n^3 while encryption is to n^2, however in practice the overhead does not scale in the same way.

Table 4. RSA key generation time vs. Key size: Simulation* results

Key size bit	msec
8	8.9
16	9
32	9.3
64	24
128	50
256	105
512	241
1024	1566
2048	2500
4096	*25288*

Table 5 shows the performance of the public-key execution unit at various frequencies.

The encryption and decryption of normal packets with large RSA keys will result in communication interruption due to computer delays. On the other hand there is a clear advantage for dedicated public key processor for RSA acceleration.

A simulation was created for Encryption of a regular 100 number packet in different RSA key smaller than regular sizes, as shown in Figure 1.

On top of that with every doubling of RSA key length, decryption is 6-7 times slower.

Figure 2 shows how decryption time increases with modules length. The timing were made on a 2GHz Pentium. (RSA Key length), as shown on Figure 2.

There is a clear advantage of combining lightweight encryption/ decryption with strong signature, authentication, allowing fast, real time communication while keeping the connected car system safe and secure. Therefore the simulation of Actively Defending the Connected Car from Wireless Attacks consists a Vehicle and a tower (infrastructure) communicating on regular intervals packets of encrypted data through RSA in multiple levels of encryption strength.

The header an encrypted, the main packet through light encryption and the footer acts as authentication and signature on strong encryption.

As is demonstrated in Table 6.

When the basic assumption is the strong encryption cannot be broken in real time, therefore the authentication and signature is secure.

Figure 3 shows the data flow between Transmitter and Receiver.

The simulation reveals a network analyzer to detect the signal strength and frequency as well as a packet analyzer to detect the system status and react accordingly, as described in Table 7.

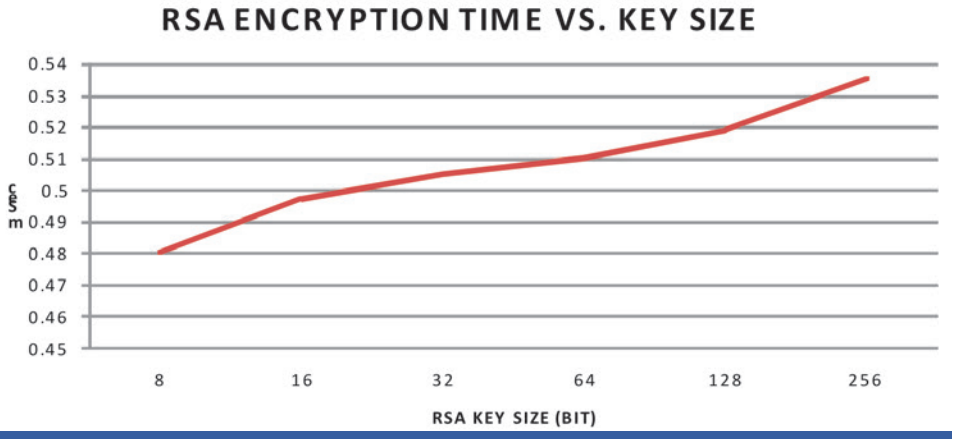

Fig. 1. RSA Encryption time vs. Key Size : Simulation results

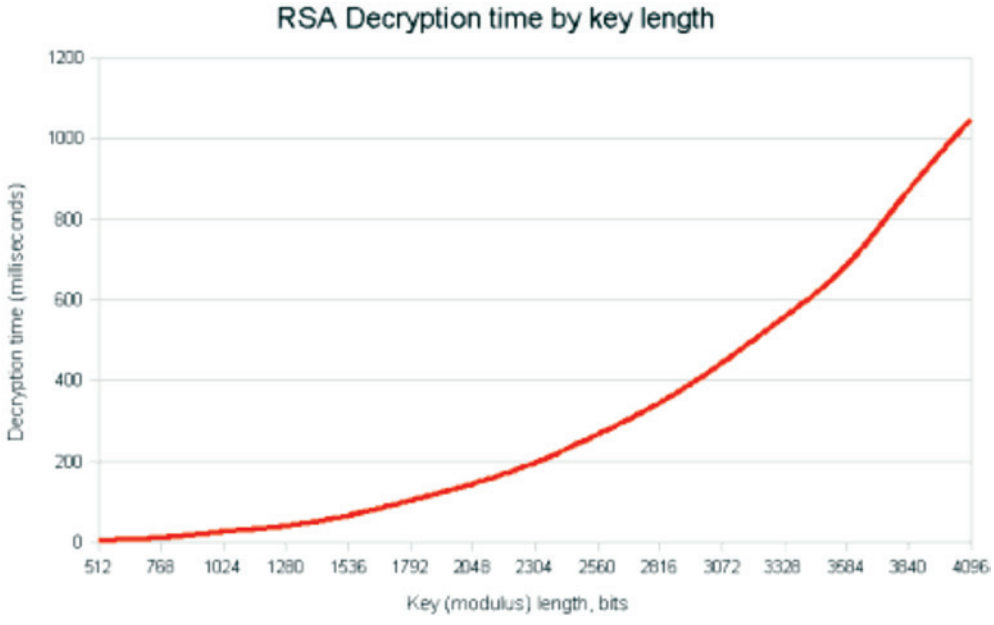

Fig. 2. RSA decryption time by key length: Javamex.com

2. CONCLUSIONS

Other transportation means ,for example, trains and planes are widely

Table 6. Packet structure

Header	None Encrypted Data	Client
Packet Data	Encrypted Data	Target
		Vehicles Parameters
		Road Parameters
Footer	Strong Encrypted Code	Access Code + Time

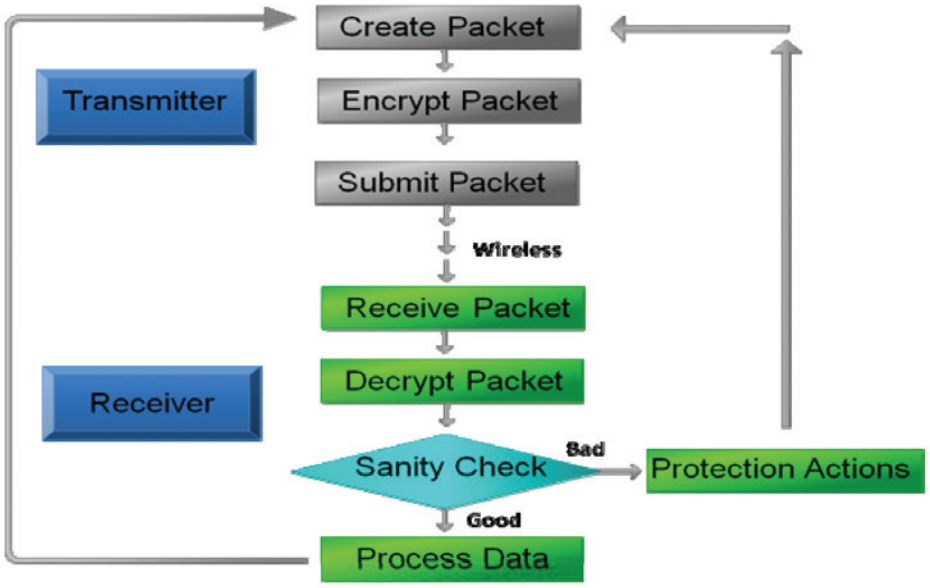

Fig. 3 Data flow between Transmitter and Receiver

connected and automated, however the connected vehicle brings a bigger challenge than that , as cars are much larger in number, mainly owned by the private sector, therefore more difficult to regulate and control.

The connected car and particularly the autonomous car is different in the requirement for operation high availability, continuity and sturdy resilience to network assaults. Therefore a combination of strong asymmetric signature and authentication and light weight encryption, that does not require predefined keys, where adopted. To allow real time operation in a low computer resource area while keeping safe and discrete communication.

Based on earlier knowledge and information on probable attack effects on a wireless network, a unique rule base scenario was created that enabled automatic real time attack identification by the software nodule as well as automatic protection actions to ensure continues communication and operation under various cyber-attack scenarios.

It is vital to further investigate the combination of a dedicated processor/accelerator for RSA key generating, encryption and decryption that will allow stronger main body packet encryption on shorter time.

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Table 7. Rule based status classification

Registry	Signal			None Encrypted	Encrypted	Strong Encrypted
Network Status	Signal Level	Noise Level	Frequency	None Encrypted Data	Encrypted Data	Strong Encrypted Data
Full communication	Regular	Low	Regular	Valid	Valid	Valid
No/Low Signal	Low	Low	High	NO	NO	NO
Signal Jamming	High	High	High	NO	NO	NO
Denial of Service	Regular	Low	Regular	NO	NO	NO
Man-In-The-Middle	Regular	Low	Regular	Valid	No	NO
Intruder	Regular	Low	Regular	Valid	Valid	NO

THE DYNAMIC BEHAVIOUR OF THE SLIDING TRIBOSYSTEM IN CYCLICAL TRANSLATION MOTION IN UNSTEADY DUTY

COMPORTAREA DINAMICĂ A TRIBOSISTEMULUI CULISANT ÎN MIŞCAREA CICLICĂ DE TRANSLAȚIE ÎN REGIM INSTABIL

REZUMAT
Lucrarea de față tratează anumite aspecte metodologice ale cercetării comportamentul tribosistemului culisant în mișcare de translație ciclică din punctul de vedere al dinamicii proceselor de contact. Efectul dinamic se manifestă printr-un caracter fluctuant a variabilelor dinamice cu o evoluție de tip intermitent. Caracterul variabil al proceselor de contact impune condiții specifice în selectarea sistemelor de măsurare, achiziție și prelucrare a semnalelor dinamice ale sistemului. Prelucrarea semnalelor emise de către tribosistem se face pe baza metodologiei FNS (Flicker-Noise Spectroscopy).
Keywords *tribo-system, tribo-model, dynamic, temporal series, evolution*

Conf. dr. ing.
Gheorghe POȘTARU

Lector drd. ing.
Andrei POȘTARU

Conf. dr. ing.
Victor CEBAN

Universitatea Tehnică a Moldovei, Str. Studenților 9/8 MD-2012 Chișinău, Republica Moldova
dr_ceban@yahoo.com

1. INTRODUCTION

Modern theoretical and experimental methods of researching tribo-systems, with their new analysis methods, have outlined new structural aspects of contact layers at different hierarchic levels (mesoscopic, microscopic, nanoscopic) of temporal and spatial organization. The dynamic of these hierarchic structures, due to their capacity to modify and transform at mechanical energy dissipation, defines the instantaneous tribologic properties of tribo-element materials, and, as a consequence, the contact processes at a macrolevel.

Depending on the manner of reacting and the capacity to become adapted to the action of command parameters, the "coupled" materials may be conventionally grouped into two classes: tribostable and tribactive, with tribologic properties and distinct manifestations in the entire tribosystem behaviour.

The tribostability of the materials belonging to the first group is manifested by a relatively low intensity response of the tribosystem to variations within a wide range of command parameters. There are two adverse processes (destructurisation – wear of superficial layers and their restructuration-regeneration) in contact that are present on both sides of the instantaneous point of dynamic balance. The state of the contact (especially the mechanical and the thermodynamic) and the evolution trajectory direction depend on the predominance of one of these processes.

In the case of triboactive materials the response variants of the tribosystem are more diverse as compared with the variation of command parameters. The evolution in time takes place by intermittency of certain fluctuating (non-stationary) intervals with some periods of stability (standing). The fluctuating behaviour of the tribosystem is determined by the structural state of triboelement materials in the areas adjacent to contact surfaces and by the spatial and temporal dynamics of these structures. On the basis of this premise, the authors of this research [3] bring evidence concerning the fragmented structure of materials in the areas adjacent to contact surfaces. There were identified fragmented reliefs with scalar properties of self-similarity type at two correlative dimensional scales with dimensions 0,01-1μm and 40-100μm. These scales correspond to processes of deformation and fragmentation of superficial layers at the nano, micro and mesolevel, the latter being correlated to wear particles. It was established that the deformation and fragmentation net, and implicitly the fractal dimension, depends on the friction regimen. Thus, fractal analysis becomes an efficient source of researching material transfer kinetics, including wear. Similar structures were spotted at the use of C_{60} fullerene nanoparticles as additives [5]. In this context, accepting the Zhurkov kinetic model for the durability of atomic connections, the authors [4] admit as a fragmentation model the existence of certain clusters which are spatially limited by a border of deformation of interatomic connections on which the breaking at mechanic activation takes place.

According to Zhurkov theory, the moment of breaking the atomic connection

$$\tau = \tau_0 \exp(U_0 - \gamma\sigma)/RT \qquad (1)$$

where: U_0 – atomic connection energy (activation energy); $\gamma\sigma$ - the equivalent of atomic connection deformation energy; τ_0 - atom oscillation period; *R*- gas universal constant; *T*- absolute temperature.

The deformation of the cluster of atomic connections and their dynamic breaking is followed by the emission of energy accumulated in the mechanic activation period. Both the processes of deformation-breaking as well as the process of emission are accompanied by energy fluctuations (thermal) that differ in the direction of the thermal effect. At deformation-breaking an endothermal reaction is produced, at emission – an exothermal one. The fluctuation act represents an elementary irreversible "event-step" in the evolution of material structure.

The mechanic activation of triboelement materials in the presence of lubricants and chemically active additives (friction modifiers) leads to mechanic-chemical reactions in the surface layers. As a result of this, under the influence of energy of activating the reaction $(U_0 - \gamma\sigma)$, in real contact areas new compound structures with distinctive properties are formed. These complete and change the properties of interposition tribo-layer. According to the scalar properties of "self-similarity" type of the fragmented structures, the fluctuation phenomenon (thermal, energetic) may be, similarly, extended to various spatial and temporal scales, with reaction peculiarities specific for corresponding hierarchic levels. The step-by-step succession of the fluctuations (represented by the signals of dynamic variables $V(t)$), according to [6] determines the evolution of the structure in element materials and, consequently, of the behaviour of the system at

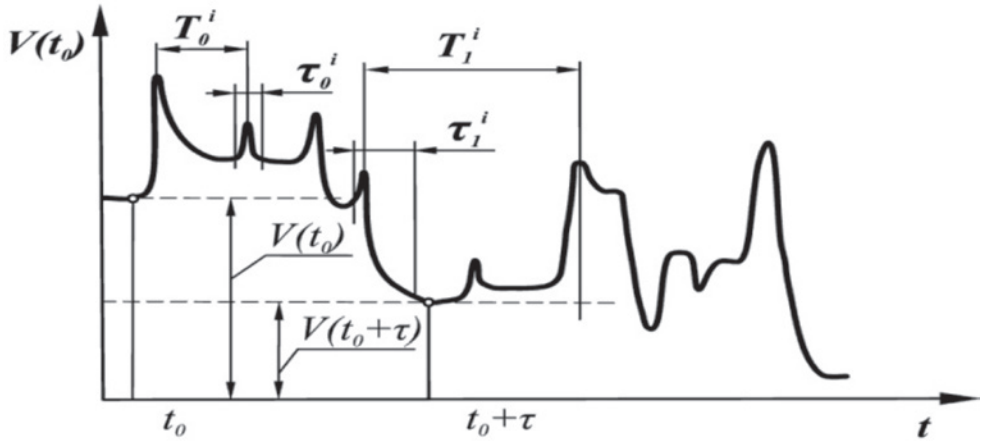

Fig. 1. Temporal series of the fluctuating evolution of open dissipative dynamic system

the macrolevel (fig.1).

2. METHODOLOGICAL ASPECTS AND EXPERIMENTAL RESULTS

The fluctuating character of contact processes imposes peculiar conditions on the methodology and of testing means (systems for the measurement, acquisition, and processing of the signals of dynamic variables $V(t)$ of the system). In this given situation the issue of revising, specifying and updating the tribomodels and research methods does arise. Adequate modelling of a tribosystem, in the case of fluctuating evolution, was possible to be carried out within the concept of *tribosystem-tribomodel* [1].

In the context of this concept, the main modelling conditions were formulated and the entire complex of instruments and measurements necessary for the conducting of the experiment were established. Among these were: 1 – the possibility of achieving the necessary energy level in the contact area, 2 – adequate sensitivity at various fluctuations of contact processes, 3 – step-by-step observing the evolution of contact state, 4 – automation of acquiring experimental data and processing dynamic variables signals, 5 – recognition of evolution regimen, 6 – selecting a method for processing signals of the variables of the system in correspondence with the established evolution regimen, 7 – presenting experimental data in a format that would be accessible for interpretation.

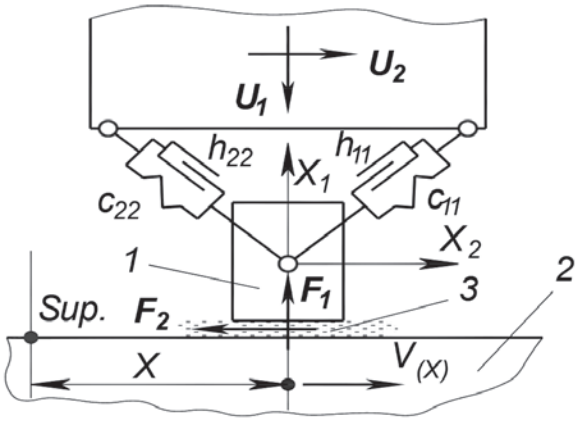

Fig. 2. The model of contact cyclical translation tribosystem

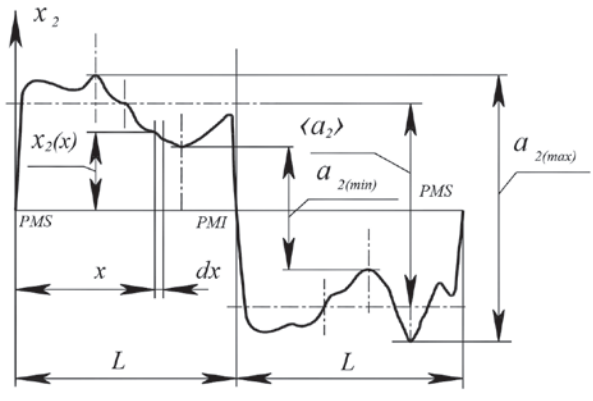

Fig. 3. Typical oscillogram of x2 coordinate cycle

One of the variants in which the above-mentioned requirements and conditions are carried out is the model of the cyclical translation tribosystem of piston segment-cylinder type (fig. 2) where: triboelement 1 performs cyclical motion on direction $\boldsymbol{x}$ of stroke $\boldsymbol{L}$ with a variable speed $\boldsymbol{V}_{(x)}$; triboelement 2 interacts with the conjugated surface of triboelement 1 through interposition tribolayer 3; contact interactions, on normal direction $\boldsymbol{F}_1$ and on tangential direction $\boldsymbol{F}_2$, appear as a result of the action of command parameters $\boldsymbol{U}_1$ and $\boldsymbol{U}_2$ on these directions. In order to record the signals of interaction forces an oscillator with an elastic element is used. Thus, the oscillator, being connected to the tribosystem, become a complex system with elastic and dissipative parameters on direction $\boldsymbol{x}_1$ ($\boldsymbol{c}_{11}$, $\boldsymbol{h}_{11}$) and $\boldsymbol{x}_2$ ($\boldsymbol{c}_{22}$, $\boldsymbol{h}_{22}$), forced by contact interactions $\boldsymbol{F}_1$ and $\boldsymbol{F}_2$ by means of the interposition tribolayer.

The state of the oscillator is described by the system:

$$m\frac{d^2X}{dt^2}+h\frac{dX}{dt}+cX=F(X,\frac{dX}{dt},V,p)+U \quad (2)$$

when: $X = \{X_1, X_2\}^T$ – is the vector of current coordinates of the mobile triboelement in the interposition layer area;

$F(X,\frac{dX}{dt},V,p)=\{F_1(X,\frac{dX}{dt},V,p),$

$F_2(X,\frac{dX}{dt},V,p)\}^T$ – is the vector of interaction functions in the tribologic connection on normal direction $\boldsymbol{x}_1$ and the tangential one - $\boldsymbol{x}_2$;

$p = \{p_1, p_2,...p_k\}$ – are the non-linear components of the parameters of the vector of interaction vector;

m, h, c- matrices of the mass, of dissipation factors (damping) and of rigidity of system elements;

U - the vector of external forces of loading the contact and external parameters;

$V = V_{(x)}$ – stroke sliding speed of the contact.

On normal direction $\boldsymbol{x}_1$ the oscillator reacts to the surface proximity force $\boldsymbol{F}_1$. The deviations of the oscillator on tangential direction $\boldsymbol{x}_2$, is a response which is directly proportional to the friction force and represents the analogue of this force ($x_{2(x)} \sim F_{2(x)} = F_{f(x)}$).

In tribosystems with cyclical movement, the main exponent of information about the state of the contact is the work cycle. In comparison with the period of cycle $\boldsymbol{T}_c$ the evolution of the system at the local level is appreciated (on stroke $\boldsymbol{L}$) and at a global level on long time periods $\boldsymbol{T}$. The typical oscillogram of the cycle of the oscillator on direction $\boldsymbol{x}_2$ is represented in figure 3. The local fluctuations of the

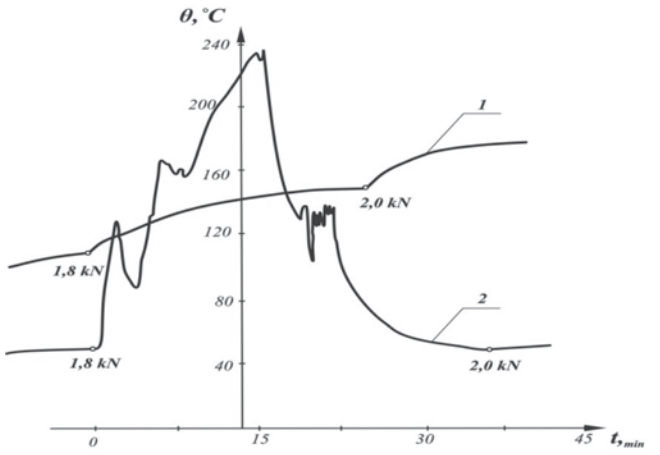

Fig. 4. Experimental temperatures evolution trajectories (θ oC) in the contact area for tribostable (1) and triboactive (2) materials

dynamic variables $V(t)$ that are present in the period of cycle T_c are significant for the appreciation of the dynamic evolution of the state of the interposition layer: elongation $x_{2(x)}$ at the motion of the contact on stroke L; the extreme throws of the fluctuations $a_{2(max)}$, $a_{2(min)}$. The value of the integrated average $\langle a_2 \rangle$ (the analogue of the energy dissipated on cycle) determined from relation (3) allows the appreciation of evolution of the contact on time intervals that exceed the period of the cycle ($T > T_c$).

$$\langle a_2 \rangle = \frac{1}{L}\int_0^{2L} |x_2(x)|dx \qquad (3)$$

At the global level, experimental temperature θ in the contact area is used as a dynamic variable. The signals of the dynamic variables of the tribosystem are recorded as temporal series. The temporal series of the state variations of stroke space and in time as well represent the dynamic behaviour of the tribosystem.

The comparative evolution of the temperature in the contact area at a load task F_n=1,8kN for representative combinations of tribostable materials (1) and triboactive (2) as well, lubricated with engine oil M-8V-2S is presented in (fig.4).

In the case of using tribostable materials, the temperature generated at friction evolves on the trajectory with slow fluctuations in the proximity of dynamic balance to the the stability domain. The methodology of testing sliding tribosystems that work in conditions of tribostability is described in a series of authors' works an updated in paper [2].

The tribosystem shows special behaviour when triboactive materials are used. The trajectory evolution is made manifesting essential fluctuations at various scalar levels. The behaviour of the tribosystem at the use a combination of composite materials lined on a steel surface and lubricated with engine oil M-8V-2S is representative of the group of triboactive materials.

The evolution of the tribosystem for various loads at cyclical frequency n_c=300 cycles/min is presented in fig.5. The experimental results confirm the fluctuating *intermittent* and non-stationary character of the tribosystem evolution – a characteristic evolution for non-linear complex dynamic and dissipative systems that go through chaotic work regimens.

Going through chaotic work regimens for these systems is a fundamental condition for the ordered reorganization of structures at different hierarchic levels and obtaining new properties [7] of triboelement materials. At the macrolevel, the fluctuating character is manifested in periods and amplitudes of various order.

In comparison with cycle period T_c, the fluctuations are conventionally divided into two categories: global (low frequency) with periods $T_g > T_c$; local on stroke (high frequency) with periods $T_l < T_c$.

Global level fluctuations are produced at the damping and intensification of certain mechanical-chemical reactions [4] on extended surfaces in the contact area that end in producing certain structural changes in the areas of friction surfaces. The throw and intensity of this kind of fluctuations is determined on the basis of temperature temporal evolution trajectory at the dissipation of the work of friction forces.

At the local level the fluctuations are identified on the basis of signals belonging to the elongations of the oscillator $x_{2(x)}$ within each work cycle.

In non-stationary functioning

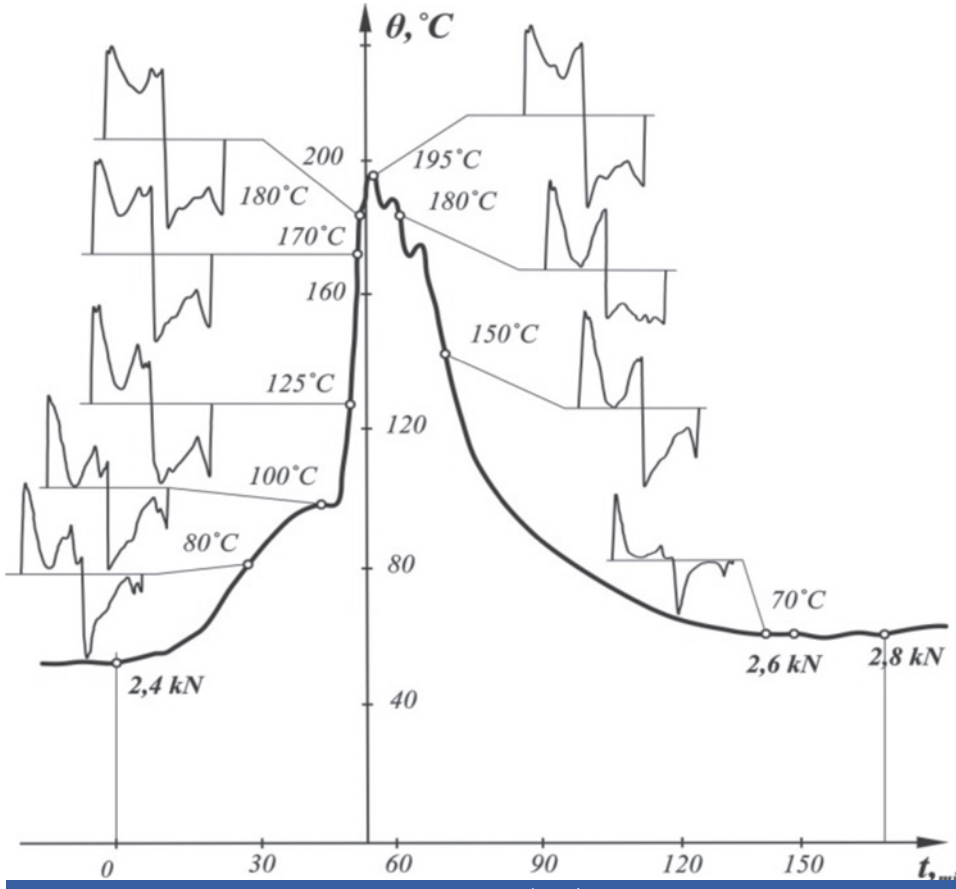

Fig. 5. Experimental temperatures evolution trajectories (θ oC) in the contact area and of local elongation $x_{2(x)}$ by cycle for triboactive material. Damping load, F_n=2,4 kN

regimen, at temperature increase in the contact area, on the activation phase slope and at the decrease, at relaxation slope, the local leaps and fluctuations are irreversibly modified, step by step, according to duration, amplitude, shape and position on stroke ***L*** (fig. 5).

Tribomodel tryouts were carried out for combinations of materials with triboactive properties, of various origins: alloy linings and metallic composites layered on steel surfaces achieved by various technologic procedures; polymer-based composite linings containing fluorine (epilam); metal-polymer composite linings; additives (friction modifiers) with a cladding effect. Engine oils of mineral and synthetic origin were used as lubricants. After having analysed the experimental results, conditions of damping and development of mechanical-chemical reactions on contact surfaces were finally established. Among these were: 1- the reactions are dampened only under certain combinations between command parameters and system variables; 2 – the reactions are carried out with fluctuations, with various amplitudes and periods (with a singular or multiple base period); 3 – at all hierarchic levels, each period is developed in two phases (activation and relaxation); 4 – at the macrolevel the process develops spontaneously (without modifying external parameters); 5 – at the end of relaxation phase on the base period, contact processes are stabilised and teh variables in the phase space take the domain of an attractor of limit cycle type; 6 – the state of stability is kept at a reduced level of friction loss for a wide variation range of command parameters.

A more detailed presentation of non-stationary and fluctuating behaviour of the tribosystem is possible only within the methodology of experimental research of non-linear systems and information technologies for processing dynamic variables signals. At the informational level, the structural elements of the signals are attributed various meanings: semantic, informative and quantitative. These meanings may also have various interpretations depending on the behaviour regimen of the system, on the purpose and objectives of the experiment. At the processing experimental data there are two main objectives: 1 – to establish the characteristic parameters and structural peculiarities of the tribosystem, by means of which dynamic evolutions are carried out; 2 – to establish the "precursors" of spontaneous state changes in the dynamic evolution of the tribosystem. The explanation of these objectives is made on the basis of spectral analysis, by extracting the information that is contained in the series of signals of dynamic variables.

The analysis of signals with a fluctuating character of *intermittency* type, is efficiently made in the framework of ***FNS*** (*Flicker-Noise Spectroscopy*) methodology [6]. The latter strives to enlarge and generalise the phenomenological base of researching dynamic systems by establishing a complex of informative phenomenological parameters of *certification data* of various physical significance.

The basis of the methodology are the following premises: 1 – open dissipative complex dynamic systems have an hierarchic structural organisation structured on various spatial and temporal levels; 2 – the dynamic behaviour of the system is determined by de „turbulent" chaotic fluctuating processes, that relax on borderline intervals with "laminar" phases at each hierarchic level; 3 – the transition from one hierarchic level to another is made spontaneously in leaps; 4 – intermittent consecutive change of the leaps and intervals of fluctuation with "laminar" intervals determines the evolution of the dynamic system; 5 - informative meaning (exponent of information) is attributed to successions of various types of irregularities (fluctuations, leaps, inflexion points of derivates of various order) of dynamic variables that are contained in the chaotic signals emitted by open complex systems.

According to FNS methodology, the correlative functions of temporal series irregularities play the role of exponents of information about the modifications of the structural organization of the dynamic system at each hierarchic spatial and temporal level. As a formal base to extract the information the autocorrelation function of series of dynamic variables $V(t)$ is used

$$\Psi(\tau) = \langle V(t)V(t+\tau)\rangle \qquad (4)$$

where: τ – is the parameter of temporal delay.

In order to interpret the informative content, the singling out the information from autocorrelation, according to the type of signal component, is made with *Fourier* $S(f)$ image of the signal strength range and of differential moments of level 2, $\Phi^{(2)}(\tau)$ [6]

$$S(f) = 2\left|\int_{T_2}^{T_2}\left[\langle V(t)V(t+t_1)\rangle - \langle V(t)^2\rangle\right]\exp(2i\pi ft_1)dt_1\right| \qquad (5)$$

$$\Phi^{(2)} = \left\langle [V(t) - V(t+\tau)]^2 \right\rangle \qquad (6)$$

The angle brackets

$$\langle(\ldots)\rangle = \frac{1}{T}\int_{-T/2}^{T/2}(\ldots)dt$$

show the average on calculation period ***T.***

The range and essence of *certification data* depend in particular on the structure of the noise that is emitted and on the character of system evolution.

The development and specification of the principles of FNS methodology and narrowing on the tribology sphere opens new possibilities and perspectives in experimental tribosystem research.

3. CONCLUSION

1. The experimental data outlined a fluctuating behaviour in the evolution of the tribosystem, accompanied by essential changes of triboelement material properties.

2. The information about the dynamics of the contact processes is comprised in the temporal series of the signals of dynamic variables.

3. In order to extract the information *FNS (Flicker-Noise Spectroscopy)* is suggested, developed and specified for the field of tribology.

4. Due to the use of FNS methodology possibilities for a deeper research of damping conditions and unfolding of structural transformations in superficial contact layer zones, including conditions of catastrophic transformation – gripping.

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ANALYSIS OF A BRAKING PROCESS USING MATLAB/SIMULINK

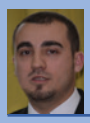
ANALIZA PROCESULUI DE FRÂNARE UTILIZÂND MATLAB/SIMULINK

REZUMAT

În acest articol se prezintă o aplicație computerizată dezvoltată în MATLAB / Simulink (fișier tip .slx), prin care se analizează distanța de frânare pentru două autovehicule care se deplasează în aceeași direcție, unul în spatele celuilalt. În această aplicație sunt introduse, ca parametrii de intrare, greutățile, vitezele și alte caracteristici dinamice ale autovehiculelor. În final, sunt obținute distanțele de frânare, mărimile forțelor normale și graficele caracteristice. Folosind aceiași parametri de intrare pentru ambele vehicule, sunt studiate influența greutății asupra distanței de frânare precum și riscul producerii unui impact.

Keywords: *Braking distance, Matlab-Simulink model, Simulation, Dynamic.*

Mihail RĂDOI
radoimihail@gmail.com



S.l.dr.ing.
Dan Alexandru MICU
dan.micu@upb.ro

Universitatea Politehnica București,
Spl. Independenței nr. 313, 060042 București,
România

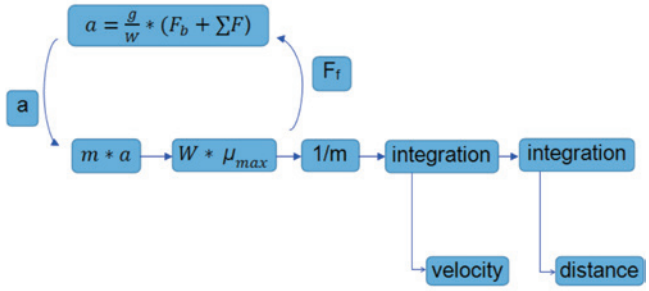


Fig. 1. The Flowchart for braking parameters estimation

1. INTRODUCTION

Braking performance of a motor vehicle is one of the most important characteristic that affects vehicle and passengers safety. Knowing the braking behavior of vehicles will allow engineers to design systems for reducing the accidents by keeping the wheel slip at the point of maximum tire traction and reducing braking distance to a minimum (Semmler, 2003).

Automotive engineers have found simulation to be a vital tool in the timely and cost-effective development of control systems (The MathWorks, 1998). Matcad-Simulink is a math modeling, designing and simulation tool that proceed from physical equations to block diagrams. It is used for both dynamic and control systems. The main results obtained by (S. Kim, 2015) are that the vehicle braking dynamics calculated by MATLAB/Simulink simulation were in reasonable agreement with reference values.

2. MATLAB/SIMULINK MODEL

2.1. The math behind

As always behind a computer simulation there is a mathematical background composed by equations or algorithms. In the paper it is assumed that the braking maneuver is performed along a straight line. The starting equation is represented by the second Newton's law.

$$F = m*a \quad (1)$$

For obtaining longitudinal equation of motion of a vehicle we have to consider the retarding forces of a vehicle and using equation (1)

Using equation (1) and considering all the retarding forces that are acting to a vehicle it is obtained the longitudinal equation of motion for a vehicle.

$$m*a = F_b + \Sigma F \quad (2)$$

where:

$$\Sigma F = f_r*W\cos\theta + R_a \pm W\sin\theta + R_t \quad (3)$$

where:

f_r is the rolling resistance coefficient;

W is the vehicle weight;

θ is the angle of the slope;

R_a is the aerodynamic resistance;

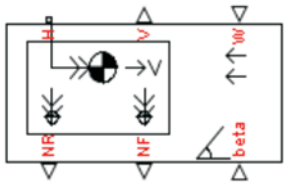
R_t is the transmission resistance.

$$Fb = \mu*W \quad (4)$$

The braking force of a vehicle is determined by the coefficient of road adhesion, μ, and the normal load W equation (4) [1][2]. Depending on the CG position the normal load on each axle is different. According to the equilibrium of moments about the front axle and tire-ground contact point, the normal loads are obtained. It should be noted that the braking is at the point of impeding skid. Any variation would cause the tires to lock up [3][4].

2.2. The model

For this kind of simulation it was used pre-defined Simulink blocks as shown in figure 1. Normal reaction on wheel and vehicle deceleration were calculated using Vehicle Body and Tire (Magic Formula) Blocks.



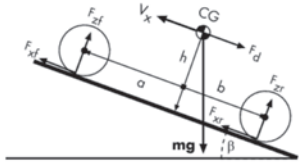


Fig. 2. Simulink model of the vehicle

Fig. 3. Simulink model of the tire

The first block (Figure 2) represents a two-axle vehicle body in longitudinal motion; it neglects side forces and do not concern side stability. It computes the vehicle velocity V and the dynamic front and rear normal forces NF, NR. The H connection is the mechanical input for the dynamic longitudinal forces received from Tire block. The block has also inputs for road inclination and wind velocity. There are intrinsic parameters: mass[kg]; numbers of wheels per axle; horizontal CG distance; CG height; front area [m²]; drag coefficient [5][6].

The Tire block (Figure 2) represents the longitudinal behavior of a tire using the tire Magic Formula (Hans B. Pacejka). The block computes longitudinal forces. The N connection is a physical signal input for normal forces, the dynamic front and rear normal forces NF, NR from Vehicle Body are applied. The intrinsic parameters for this block are: Rolling radius

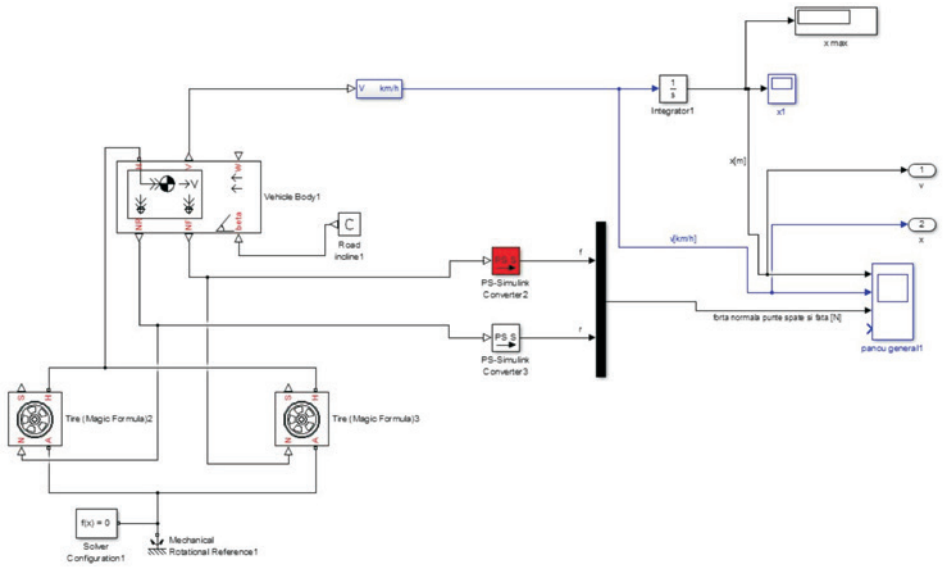


Fig. 4. Simulink model for velocity and distance estimation

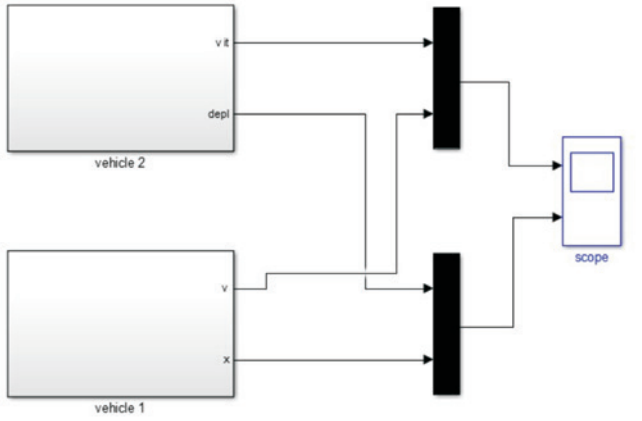


Fig. 5. Serial arrangement of two vehicles

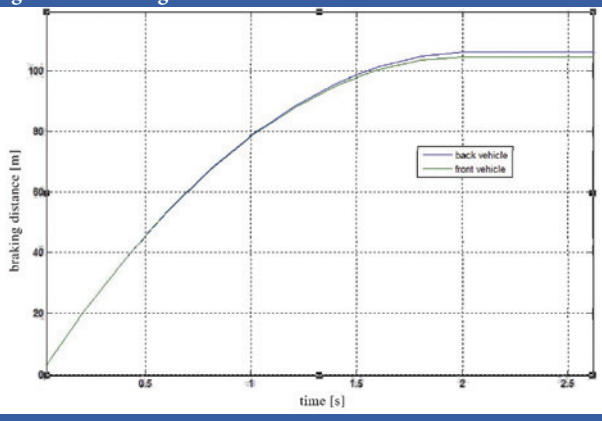


Fig. 6. The braking distance obtained with Simulink simulation (green – back vehicle, blue – front vehicle)

and rolling resistance coefficient.

For obtaining vehicle breaking distance, the output signal of vehicle velocity V [km/h] is integrated once. For normal forces is used a PS-S (physical signal to Simulink signal) converter and then insert to a scope.

2.3. Model validation

Every computer simulation should have a real life comparison. For this paper the data obtained from Simulink were compared with data from NHTSA experiments. (Garrott, 2011)

3 BREAKING SIMULATION FOR THE TWO VEHICLES

For this simulation two vehicles are chosen. Both vehicles move in the same direction one behind the other. The frontal car weight is W_1=1400 kg while the back car weight is W_2=1600 kg.

The velocities of the cars are equal V_1=V_2=130 km/h and the rolling resistance coefficients are 0.8 and 0.85. The Simulink block of the vehicles is the one presented in Figure 2.

A simplification was considered according to the subjectivity of the driver's reaction time. The back car braking process starts in the same moment with the frontal one, as the time for reducing the play of the braking system is zero. Those simplifications are made in Simulink by serial arrangement for Vehicle blocks.

The influence of the weight is analyzed. The first vehicle stops in 104 m, while the back one in just 106m. The braking distance is greater for the second vehicle, even its rolling resistance coefficient is higher. An accident would happen in case the initial distance between the two cars is less than 2m, as it can be noticed in the plot of the simulation in Figure 6.

4. CONCLUSIONS

The power of computer has been increasing in the last decades. Now it is possible to simulate and to analyze complex physical processes (Momose, 1992). The Simulink model presented in this paper describes the braking distance in time for two vehicles.

Table 1 NHTSRA and Model comparison

		NHTSRA	SIMULINK
v[mph]	v[kmh]	d[m]	d[m]
20	28,8	6,688	7,5
55	86,4	68,096	67
65	104,4	96,064	102

The back vehicle had a greater brake distance, even its rolling resistance coefficient is higher than the one of the front vehicle. The other difference between their parameters consist in a different weight: the back vehicle has a greater weight than the front one. If the initial distance between the vehicles is less than 2 m, and reaction times of the both drivers are the same, the back vehicle impacts the frontal one.

The input parameters can be changed, and other influences, like road surfaces or type of the tires, can be studied.

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CONSIDERATIONS OVER THE IDLE REGIME OPTIMIZATION POSSIBILITIES

CONSIDERAȚII ASUPRA POSIBILITĂȚILOR DE OPTIMIZARE A REGIMULUI DE MERS ÎN GOL A M.A.I.

REZUMAT

Această lucrare prezintă o analiză asupra posibilităților de optimizare a regimului de mers în gol a motorului cu ardere internă în vederea minimizării emisiilor poluante în timpul testului de omologare. Se fac scurte referiri la tendințele actuale de evoluție a normelor privind poluarea și ponderea regimului de mers în gol în structura ciclului european. Se prezintă o analiză a metodelor actuale de depoluare a motorului cu aprindere prin scânteie și a posibilităților oferite de tehnologia actuală în acest sens. Sunt incluse, de asemenea, rezultate ale cercetărilor privind optimizarea regimului de mers în gol prin schimbarea pozițiilor VVT.

Keywords: *european cycle, depollution, idle regime.*


Prof. dr. ing.
Florian IVAN


Dr. ing.
Andrei BUȘOI
andrey1401@yahoo.com


Dr. ing.
Daniel LIȚĂ


Drd. ing.
George TRICĂ

Universitatea din Pitești Str. Târgu din Vale Nr. 1
110040 Pitești România

1. THE LEGISLATIVE NORMS EVOLUTION

The road vehicles contribute to the environement global pollution with a series of primary pollutants like: carbon monoxide (CO), nitrogen oxide (Nox), hydrocarbons (HC), particles (PM).

They also contribute with precursors in forming secondary pollutants (tropospheric ozone, photochemical smog, particles and acid rain). The carbon dioxid emissions contribute at the greenhouse effect with it's well known atmosphere global warming effect. In 1996 the International Energy Agency established that the road traffic contribute with 11% from the gases emissions with a greenhouse effect. Due to the risks represented by these pollutants over the ecological balance, one adopted national and international regulations that specify the border values of the atmospheric pollutants concentrations. In table 1 one presents the european norms evolution imposed for maximum pollutant emissions concentrations.

For the Euro 6 norm the constructors must guarantee the depollution system efficiency for 160 000 km. That's why one has in view the deterioration factor, FD that determine the maximum imposed limits.

For determining the pollutant emissions concentrations of the all the new vehicles at european level one uses the european driving cycle (NEDC – New European Driving Cycle).

The cycle analyze leads to the conclusion that the idle regime totals 267 seconds, which means a percentage of 23% from the entire engine functioning during the homologation test.

From this it results that the duration of this regime can affect in an unwanted way the quantity and the concentration of the chemical pollutants in the exhaust gases. The authors have in view the fact that in this regime the burning process is negatively influenced by the low flow speeds of the mixture in the intake valve gate and the low temperatures of the burned gases significantly alters the three way converter (TWC).

As we know, a determinant role in ensuring the EURO norms is represented by the engine distribution phases. That's why the current engines are equipped with devices that varies the opening and closing moments of the valves (VVT), depending the engine working regime.

Because of the valves superpositioning the exhaust gases backflow phenomenon can appear, to the admission sewer and their return in the cylinder, a phenomenon called internal EGR. Usually this phenomenon is made on approximately 45° CRK as it is presented in figures 1 and 2 (situation exemplified for VVT at the admission valves level).

In figure 1 it is presented the engine's functioning in which the

Table 1. The european norms evolution imposed for maximum pollutant emissions concentrations

The european norms evolution imposed for maximum pollutant emissions concentrations										
Pollutants	Euro1 July 1992	Euro2 January 1996	Euro3 January 2000	Euro4 January 2005	Euro5 Septembre 2009		Euro6b Septembre 2014		Euro6c Septembre 2016	
					with FD	without FD	with FD	without FD	with FD	without FD
CO	2.72	2.2	2.3	1	1	0.666 (1.5)	1	0.666 (1.5)	1	0.666 (1.5)
NOx	-	-	0.15	0.08	0.06	0.038 (1.6)	0.06	0.038 (1.6)	0.06	0.038 (1.6)
THC	-	-	0.2	0.1	0.1	0.077 (1.3)	0.1	0.077 (1.3)	0.1	0.077 (1.3)
NMHC	-	-	-	-	0.068	0.052 (1.3)	0.068	0.052 (1.3)	0.068	0.052 (1.3)
HC+NOx	0.97	0.5	-	-	-	-	-	-	-	-
PM*mas	-	-	-	-	0.0045	0.0045 (1)	0.0045	0.0045 (1)	0.0045	0.0045 (1)
PM*nr	-	-	-	-	-		6x1012	6x1012 (1)	6x1011	6x1011 (1)

* only direct injection
FD - deterioration factor

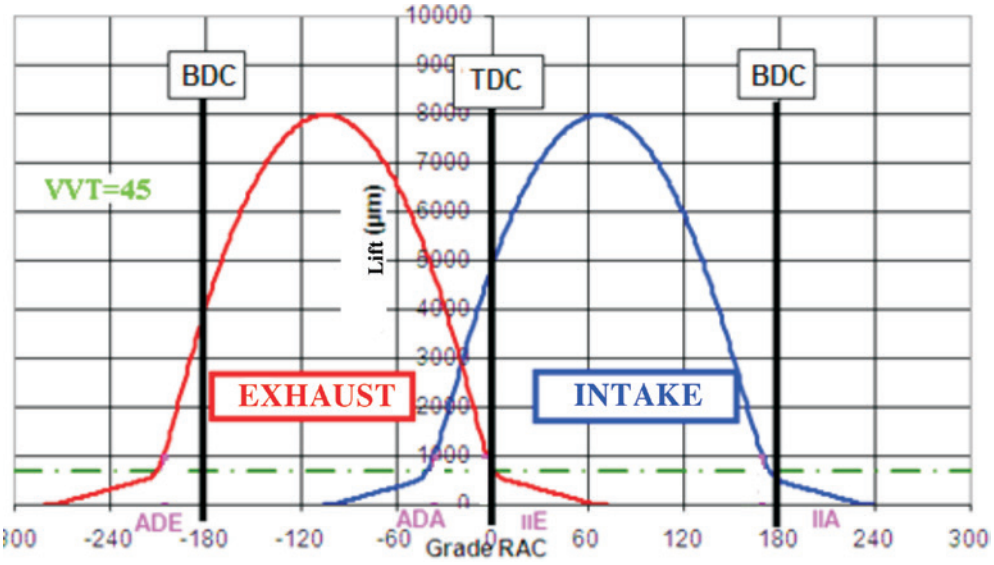

Fig. 1. The distribution laws profilewith VVT=45

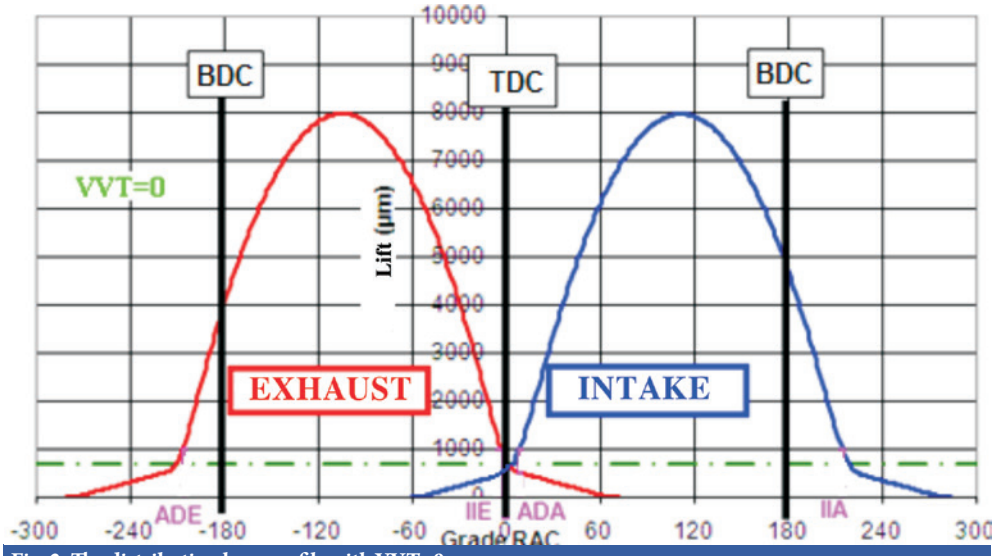

Fig. 2. The distribution laws profile with VVT=0

Table 2. Engine characteristics

Engine capacity	Stroke	Bore	Distribution phases				Performances	
			ADA	IIA	ADE	IIE	Mmax	Pmax
[cm^3]	[mm]	[mm]	[°RAC]	[°RAC]	[°RAC]	[°RAC]	[Nm]	[kW]
999	81.3	72.2	-18	46	55	-12	91 (2850 rot\min)	51.5 (6000 rot\min)

recirculated burned gases rate is high for decreasing the harmful chemical emissions, especially decreasing the nitrogen oxide and unburned hydrocarbons. On the other side, figure 2 shows the engine's functioning with a minimum recirculated burned gases rate for obtaining high dynamic performance due to inertial filling by a high delay at the admission valve closing (for high rotations).

In the figures above one used the next notations: BDC – Buttom Dead Center; TDC – Top Dead Center; ADE – exhaust valve opening before BDC; ADA – inlet valve opening before TDC; IIE – exhaust valve closing after TDC; IIA – inlet valve closing after BDC. The VVT system must cooperate with the depollution system by treating the burned gases. Unfortunately, the current VVT systems doesn't approach the extension of this cooperation for the idle regime. That's why the authors investigated the effect that a VVT device has over the pollutant concentrations and over the economicity in this regime. The purpose was to highlight the reserves and opportunities for expanding the action range of the VVT devices for this regime.

2. METODOLOGY AND EXPERIMENTAL RESULTS

For the experimental researches one used a gasoline engine with the characteristics presented in table 2, with the reference at the notations in figure 1.

One considered: gap position ADA=0 and ADE=0 as using the distribution phases presented in the table above. The experimental determinations were applied to the idle regime, respectively 800 rot/min, characterized by an excess air coefficient, $\lambda \approx 1$. One analyzed the next distribution phases combinations, presented in table 3.

In the graphics below one presented the experimental results for different distribution laws and their effect over the consumption parameters, performances and pollutant emissions:

Analyzing the results of the experimental determinations one can establish that changing the admission and exhaust valves opening moments has important effects over the pollutants concentrations and over the effective specific consumption (CSE).

For example, CSE decreases with 58 g/kWh, respectively 10%, by increasing AD from -18 °RAC to -58 °RAC. Also, one established an important reduction of the nitrogen oxides concentrations, a reduction of over 10 times.

On the other side one found that increasing the exhaust valve opening advance can lead to an important HC emission concentration from the exhaust gases and also of the CSE. As a result, the optimization of the distribution phases for the idle regime is imposed, constituting

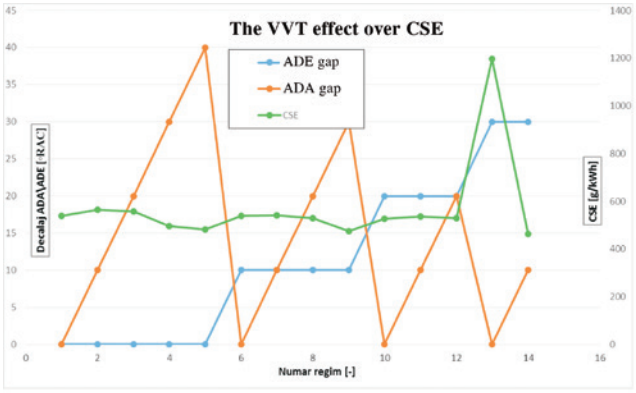

Fig. 3. The effect over the specific fuel consumption

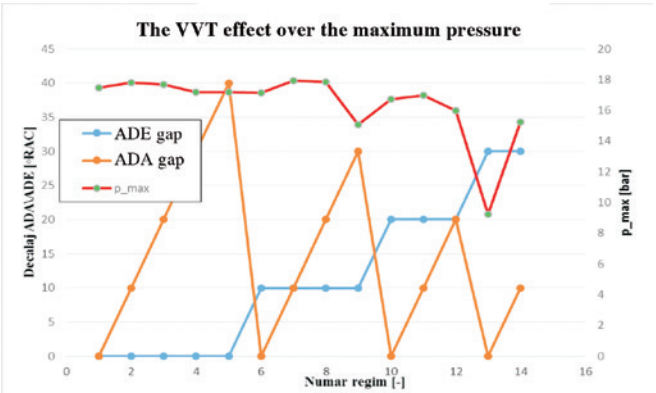

Fig. 4. The effect over the maximum pressure in the cylinder

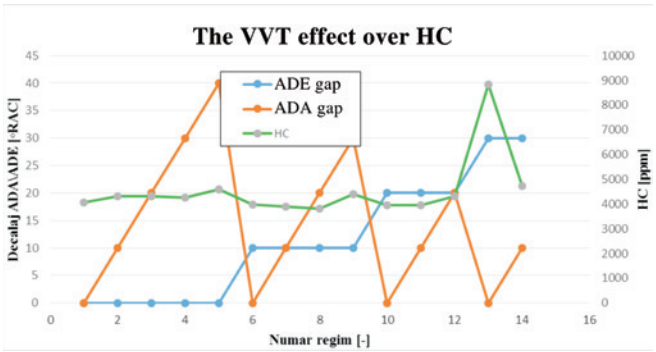

Fig. 5. The effect over HC

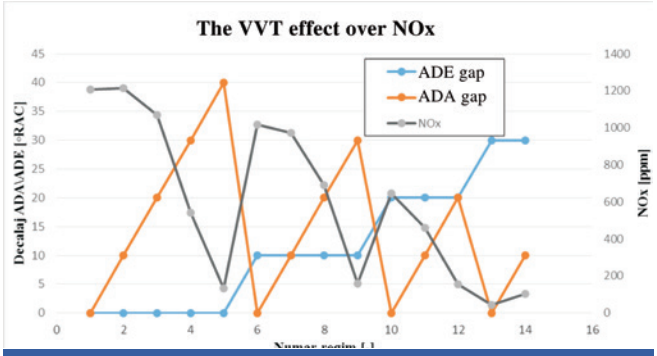

Fig. 6. The effect over NOx

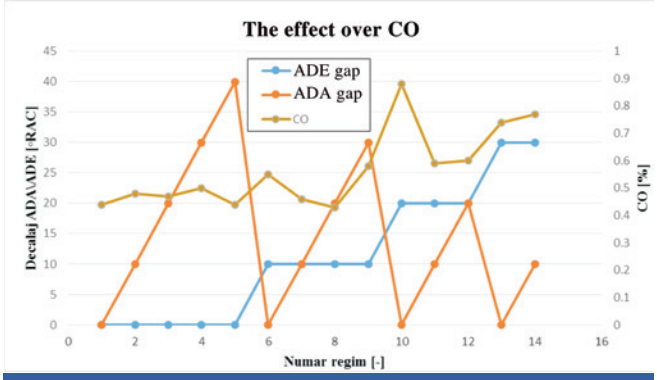

Fig. 7. The effect over CO

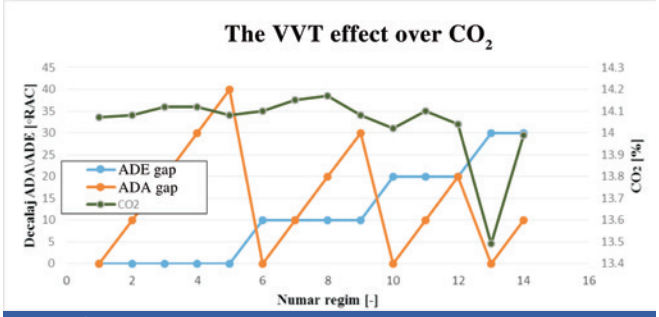

Fig. 8. The effect over CO_2

Table 3. The studied regimes

Regime Nr.	Engine rotation [rot/min]	ADA Gap	[°CRK]	ADE Gap	[°CRK]
1	800	0	-18	0	55
2	800	10	-28	0	55
3	800	20	-38	0	55
4	800	30	-48	0	55
5	800	40	-58	0	55
6	800	0	-18	10	65
7	800	10	-28	10	65
8	800	20	-38	10	65
9	800	30	-48	10	65
10	800	0	-18	20	75
11	800	10	-28	20	75
12	800	20	-38	20	75
13	800	0	-18	30	85
14	800	10	-28	30	85

a reserve that must be valued for economic and ecological improvement of a spark ignition engine.

Obviously, choosing an optimal version is imposed, a compromise one. This kind of version assumes extending the investigations that will highlight the effect of the valves closing moments correlation with the particularities that the termodynamic processes must take place in this regime. For this purpose, the researches are in progress.

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POLLUTION LEVEL PRODUCED AT ENGINE START FOR A HYBRID VEHICLE

NIVELUL DE POLUARE PRODUS LA PORNIREA UNUI MOTOR CE ECHIPEAZĂ UN AUTOTURISM HIBRID

REZUMAT

Această lucrare prezintă un studiu privind emisiile produse de un motor care ar putea echipa un vehicul hibrid. Scopul principal al acestei lucrări este de a descrie emisiile suplimentare la pornirea la rece a motorului, în funcție de temperatura gazelor de evacuare. Cercetarea experimentală a fost făcută pentru un vehicul ușor, Toyota Prius, echipat cu un motor de 1503 cm3, 57 kW, motor cu aprindere prin scânteie, alimentat cu benzină sau GPL. Au fost comparate emisiile de gaze de eșapament pentru un vehicul hibrid cu motor pe benzină, alimentat cu benzină și GPL. Pentru toți parametrii înregistrați, valorile au fost mai mici pentru GPL, decât pentru benzină.

Keywords: *Hybrid, Vehicle, Engine, Cold, Pollution.*

S. l. dr. ing.
Stelian ȚÂRULESCU
s.tarulescu@unitbv.ro

Asist. dr. ing.
Radu ȚÂRULESCU

Prof. dr. ing.
Adrian ȘOICA

Universitatea Transilvania Brașov, Str. Politehnicii nr. 1, 500024 Brașov, România

1. INTRODUCTION

Pollutant emissions produced by vehicles represents approximately 60 % of urban air pollution (Bhandarkar, 2013). One of the strategies used for reduction of vehicle air pollution is the use of alternative fuels. The European Union adopted a directive that requires the use of biofuels for vehicles. Directive 2003/30/EC (Brussels, 2003) requires that EU member countries must reach a certain target for use of alternative fuels in the transport sector to reduce pollution and CO_2 content from the exhaust gases, in order to meet Euro 6 standards. Dual fuel (or flexible-fuel) cars have engines designed to run on more than one kind of fuel. Usually, the engine burns a combination of ethanol or methanol and gasoline. Both fuels can be stored in the same fuel tank on the vehicle and sensors in the engine automatically adjust to different concentrations. So whatever the proportion of its constituents, the engine can always use the blended fuel. There are also bi-fuel cars. These store fuel in separate tanks with the engine running on one separate fuel at a time. These engines can burn petrol from one tank, then Liquefied Petroleum Gas (LPG) or Compressed Natural Gas (CNG) from the other. The advantages of flexible-fuel and bi-fuel cars are that when market forces cause say, petrol to become more expensive, motorists can adjust what they buy to make driving as economical as possible. And if they should need fuel in an area where LPG is scarce, they always have the option to fuel up with gasoline. In the long term, vehicles with a multi-fuel capacity could prove to be a valuable enabling factor as societies adapt to cleaner new fuels (www.toyota.com).

However, since catalysts are effective only at high temperature, emissions are more significant during the initial part (cold phase) of a trip when engine and catalyst are cold. Nowadays, due to catalyst improvements the most significant part of the total emission during a trip, especially for short trips (<10 km), takes place during the cold phase. Therefore, the analysis of additional emissions during the cold phase, referred to as the cold start extra emissions, has gradually gained significance in improving emission models and thus emission inventories. It is very important to determine the level of pollution for cold engine running for analyzed vehicle, for gasoline and for Liquefied Petroleum Gas (Mareș, 2015). The experimental researches has been done for a hybrid auto vehicle, fueled with two different fuels: gasoline and LPG. The registered data was:

Fig.1. The measurement procedure for Toyota Prius equipped with a 1503 cm3, 57 kW, spark ignition engine fueled with gasoline or LPG (right) and the portable analyzer, GA-21 plus (left)

Table 1 Values registered for engine fueled with gasoline

No.	T_{gas} - Gasoline	T_{gas} - Gasoline	O_2 - Gasoline	CO_2 - Gasoline	CO - Gasoline	NO - Gasoline	NO_2 - Gasoline	NO_x - Gasoline
	°F	°C	[%]	[%]	[ppm]	ppm	ppm	[ppm]
1	116.2	46.8	0.87	13.19	2901	406	2	408
2	111.5	44.2	0.75	13.19	3075	455	2	457
3	108.7	42.6	15.07	6.3	2643	237	1	238
4	107.4	41.9	19.25	0.8	791	0	0	0
5	110.7	43.7	20.03	0.3	291	0	0	0
6	121	49.4	7.93	3.3	988	102	3	105
7	125.2	51.8	1.27	12	4879	187	5	192
8	128.5	53.6	0.67	13.6	2197	288	3	291
9	120	48.9	1.05	12.2	1079	250	2	252
10	119.1	48.4	18.18	2.1	442	0	0	0
11	117.9	47.7	19.85	0.4	175	0	0	0
12	126.3	52.4	19.84	0.7	153	0	1	1
13	129.6	54.2	2.78	7.2	956	71	4	75
14	132.5	55.8	0.73	13.6	899	112	3	115
15	125.1	51.7	0.41	12.3	258	0	2	2
16	123.1	50.6	18.29	3.3	131	0	0	0
17	122.2	50.1	19.78	0.4	120	0	0	0
18	123.9	51.1	11.3	8.3	414	87	1	88
19	123.4	50.8	19.24	1.2	127	0	0	0
20	120.9	49.4	20.39	0.2	85	0	1	1
21	119.5	48.6	20.56	0.1	87	0	1	1
22	125.8	52.1	20.95	0.2	82	0	1	1
23	130.1	54.5	4.61	5.2	519	8	4	12
24	126	52.2	1.07	13.1	962	293	4	297
25	123.6	50.9	11.84	6.2	226	93	1	94
26	122.4	50.2	19.5	0.7	59	0	0	0
27	120.9	49.4	20.17	0.3	61	0	0	0
28	120.4	49.1	20.4	0.2	66	0	1	1
29	119.3	48.5	20.54	0.1	62	0	1	1
30	118.7	48.2	20.95	0.1	59	0	1	1
31	118.4	48.0	20.95	0.1	60	0	1	1
32	116.8	47.1	20.95	0.1	58	0	1	1
33	125.1	51.7	20.01	0.6	52	0	1	1
34	129.7	54.3	3.17	7.2	795	104	4	108
35	123.6	50.9	1.01	12.9	720	383	4	387
36	121.5	49.7	17.56	4.5	91	79	0	79
37	120.2	49.0	19.73	0.5	30	0	0	0
38	119.7	48.7	20.25	0.3	33	0	1	1
39	119	48.3	20.48	0.2	41	0	1	1
40	118.2	47.9	20.95	0.1	39	0	1	1
41	117.2	47.3	20.95	0.1	42	0	1	1
42	115.9	46.6	20.95	0.1	42	0	1	1
43	115.3	46.3	20.95	0.1	43	0	1	1
44	114.2	45.7	20.95	0.1	42	0	1	1
45	113.7	45.4	20.95	0.1	41	0	1	1
46	113.2	45.1	20.95	0.1	41	0	1	1
47	112.8	44.9	20.95	0.1	36	0	1	1
48	111.9	44.4	20.95	0.1	35	0	1	1
49	111.4	44.1	20.95	0.1	34	0	1	1
50	110	43.3	20.95	0	35	0	1	1
51	109.5	43.1	20.95	0	32	0	1	1
52	109.4	43.0	20.95	0	31	0	1	1
53	108.5	42.5	20.95	0	28	0	1	1
54	108	42.2	20.95	0	27	0	1	1
55	107.6	42.0	20.95	0	26	0	1	1
56	107.3	41.8	20.95	0	21	0	1	1
57	114.7	45.9	20.95	0.2	22	0	1	1
58	115.1	46.2	20.95	0	21	0	1	1
59	115.8	46.6	20.95	0.2	23	0	1	1

exhaust gas temperature (at pipe end), oxygen O_2, carbon dioxide CO_2, carbon monoxide CO, nitrogen monoxide NO, nitrogen dioxide NO_2 and nitrogen oxides NO_x ($NO_x = NO + NO_2$).

2. METHODOLOGY

The experimental researches has been done for a single vehicle, fueled with two different fuels: gasoline and LPG, at idle engine speed. The measurements ware made in the could season, using a portable analyzer, GA-21 plus (produced by Madur Austria) as it shown in the Figure 1 (GA-21 plus, 2013).

There were been made two tests, for each type of fuel, from starting the engine operated at idle speed, for a duration of 10 minutes, from starting the engine until this runs in optimal conditions. Measurements ware made in warm season, in 19 June, 2015, when ambiental temperature was 25 [°C]. The software component of the pollution measurement system was set to register the values at 10 seconds. The collected values corresponds to 59 measurement points and are presented in the Table 1 and Table 2.

The values recorded by the analyzer and saved correspond to the following parameters: T_{gas} – exhaust gas temperature measured at tailpipe expressed in [°C] and [°F]; O_2 – the concentration of oxygen from exhaust gases expressed in [%]; CO_2 – the concentration of carbon dioxide expressed in [parts per million]; CO, NO, NO_2 and NO_x – the emission of carbon monoxide, nitrogen monoxide, nitrogen dioxide and nitrogen oxides, all expressed in [ppm].

3. RESULTS

At spark ignition engines, the properties of the exhaust gases depend directly on the rotary speed, on the weight/load of the engine and on the value of the dosage of the mixture air-fuel in its cylinders. The chemical composition of burnt gases is influenced by the operating

conditions of the engine, by the quality of the mixture air-fuel and by the ambient temperature (Tarulescu et al., 2014). The main engine emissions variations (carbon dioxide – CO_2, carbon monoxide – CO and nitrogen oxides – NO_x) depending on exhaust gas temperature (T_{gas}), for all 59 measurement points are presented in Figures 2, 3 and 4.

For the internal combustion engine of the hybrid vehicle, running at low temperatures will cause oscillating levels of exhaust emissions. From the start the engine up to optimum operating temperature is reached, there will be recorded high levels of CO_2, CO and NO_x. In this conditions, when engine is running cold, the level of CO_2 oscillate between 0 and 13.4 [%] for gasoline and between 0 and 14.5 [%] for LPG.

When the engine reaches optimal operating temperature, CO_2 level stabilizes at 0.1 – 0.2 [%] for gasoline and 0.3 [%] for LPG. Also, when engine is running cold, the level of CO oscillate between 0 and 4879 [ppm] for gasoline and between 0 and 1883 [ppm] for LPG.

When the engine reaches optimal operating temperature, CO level stabilizes at 21 – 23 [ppm] for gasoline and 35 – 37 [ppm] for LPG. For nitrogen oxides, when engine is running cold, the level of NO_x oscillate between 0 and 457 [ppm] for gasoline and between 0 and 5 [ppm] for LPG. When the engine reaches optimal operating temperature, NO_x level stabilizes at 1 [ppm] for gasoline and also for LPG.

4. CONCLUSIONS

A hybrid vehicle it was tested in order to determine the behavior of engine when running in cold conditions until achieve the optimal operating temperature. Measurements of pollution levels at exhaust pipe were made, when engine was fueled with gasoline and LPG.

After analyzing the recorded data,

Table 2 Values registered for engine fueled with LPG

No.	T_{gas} - LPG	T_{gas} - LPG	O_2 - LPG	CO_2 - LPG	CO - LPG	NO - LPG	NO_2 - LPG	NO_x - LPG
	°F	°C	[%]	[%]	[ppm]	ppm	ppm	[ppm]
1	107.6	42.0	20.95	0	0	0	1	1
2	120.8	49.3	20.95	0	0	0	1	1
3	132.8	56.0	20.95	0	0	0	1	1
4	142.2	61.2	20.95	0	0	0	1	1
5	151.5	66.4	20.95	0	0	0	1	1
6	159.1	70.6	20.95	0	0	0	1	1
7	165.2	74.0	20.95	0	0	0	1	1
8	169	76.1	20.95	0	0	0	1	1
9	169.9	76.6	20.95	0.1	0	0	1	1
10	172.2	77.9	9.13	3.4	0	0	3	3
11	175.1	79.5	1.67	12.5	11	0	4	4
12	165.5	74.2	0.89	13.3	609	0	3	3
13	168.4	75.8	17.43	4.6	715	0	0	0
14	174.6	79.2	8.43	3.9	142	0	2	2
15	177.5	80.8	1.26	13	504	0	4	4
16	166.1	74.5	8.94	9.6	1278	0	2	2
17	167.6	75.3	18.43	2	380	0	0	0
18	168.4	75.8	19.52	0.8	62	0	0	0
19	173.5	78.6	8.13	4	241	0	2	2
20	171.1	77.3	1.19	13.1	925	0	4	4
21	163.8	73.2	0.66	13.4	818	0	3	3
22	163.8	73.2	17.6	4.4	446	0	0	0
23	162.3	72.4	19.19	0.9	124	0	0	0
24	170.6	77.0	17.67	1.8	90	0	1	1
25	173.6	78.7	1.93	9.7	721	0	4	4
26	161.2	71.8	0.62	14.5	1216	0	3	3
27	158.1	70.1	14.11	7.6	1439	0	1	1
28	157.1	69.5	19.1	1.1	424	0	0	0
29	157.9	69.9	19.86	0.6	151	0	0	0
30	148.8	64.9	13.21	2.6	458	0	2	2
31	146.1	63.4	20.29	0.3	126	0	1	1
32	144	62.2	20.41	0.2	101	0	1	1
33	142.3	61.3	20.52	0.2	90	0	1	1
34	143.6	62.0	20.95	0.1	81	0	1	1
35	157.5	69.7	13.52	2	122	0	2	2
36	161.8	72.1	1.67	11.5	608	0	5	5
37	142.3	61.3	1.05	12.9	1883	0	3	3
38	139.5	59.7	17.98	3.9	1418	0	0	0
39	136.4	58.0	19.87	0.4	240	0	0	0
40	136.3	57.9	20.28	0.3	111	0	1	1
41	146.7	63.7	20.32	0.2	94	0	1	1
No.	**T_{gas} - LPG**	**T_{gas} - LPG**	**O_2 - LPG**	**CO_2 - LPG**	**CO - LPG**	**NO - LPG**	**NO_2 - LPG**	**NO_x - LPG**
	°F	°C	[%]	[%]	[ppm]	ppm	ppm	[ppm]
42	157.3	69.6	20.29	0.3	98	0	1	1
43	155.5	68.6	20.3	0.3	95	0	1	1
44	148.8	64.9	20.31	0.3	92	0	1	1
45	145.8	63.2	20.31	0.3	87	0	1	1
46	158	70.0	20.33	0.3	66	0	1	1
47	147.7	64.3	20.33	0.3	63	0	1	1
48	144.9	62.7	20.31	0.3	57	0	1	1
49	142.9	61.6	20.29	0.3	53	0	1	1
50	140	60.0	20.28	0.3	51	0	1	1
51	138.5	59.2	20.27	0.3	49	0	1	1
52	141.1	60.6	20.26	0.3	47	0	1	1
53	152.6	67.0	20.25	0.3	44	0	1	1
54	142.5	61.4	20.24	0.3	43	0	1	1
55	140.5	60.3	20.29	0.3	40	0	1	1
56	138.3	59.1	20.29	0.3	40	0	1	1
57	135.3	57.4	20.3	0.3	38	0	1	1
58	150	65.6	20.3	0.3	37	0	1	1
59	154.6	68.1	20.32	0.3	35	0	1	1

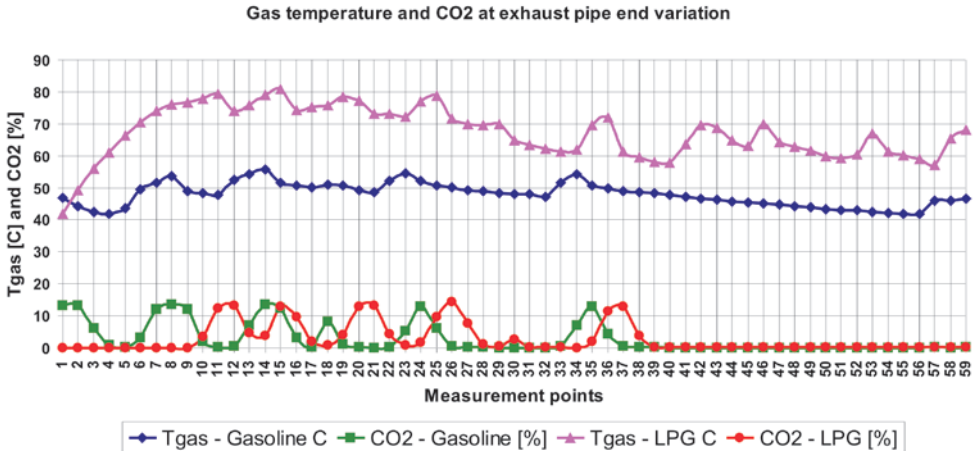

Fig.2. Exhaust gas temperature and CO_2 level at pipe end variation from engine start to optimal running conditions (engine fueled with gasoline or LPG)

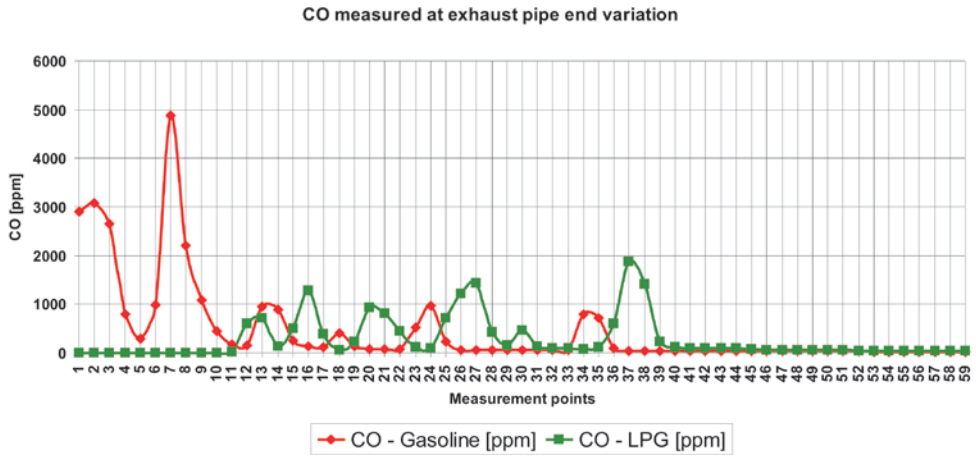

Fig.3. CO level at exhaust pipe end variation from engine start to optimal running conditions (engine fueled with gasoline or LPG)

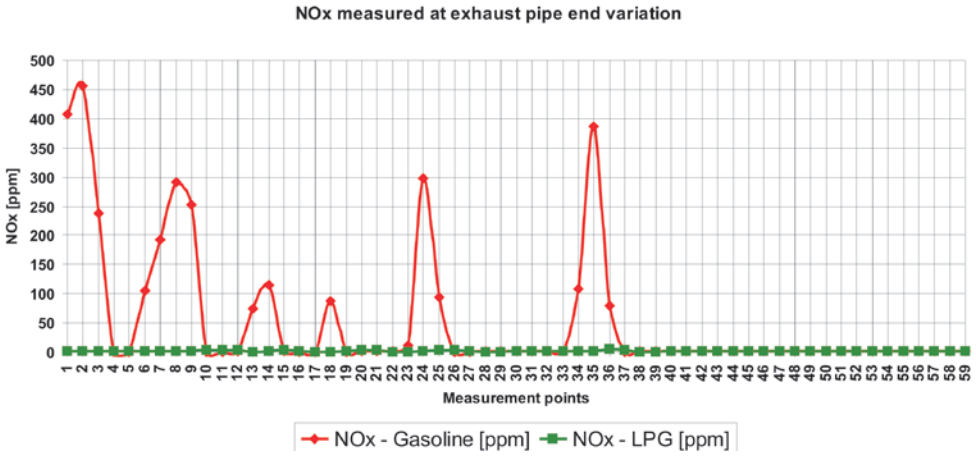

Fig.4. NOx level at exhaust pipe end variation from engine start to optimal running conditions (engine fueled with gasoline or LPG)

the following conclusions results:

- For cold running engine, the level of carbon dioxide vary, reaching peaks of around 13.4 [%] for gasoline and 14.5 [%] for LPG.
- For cold running engine, the level of carbon monoxide vary widely, reaching peaks of around 4900 [ppm] for gasoline and 1900 [ppm] for LPG.
- For cold running engine, the level of nitrogen oxides also vary, reaching peaks of around 450 [ppm] for gasoline and 5 [ppm] for LPG.
- The difference between emission levels for gasoline or LPG to fuel the engine is evident in favor of LPG for CO and NO_x.
- LPG is the most appropriate solution for exhaust pollution level diminish for older spark ignition engine vehicles.
- To reduce air pollution in urban areas we must: avoid using your car for short or unnecessary journeys; walking or cycling short journeys; using public transportation; plan our journeys; try to combining trips (such as shopping and the school run) to avoid taking the car out several times; try to use less congested routes and avoid rush hours if possible (Tarulescu, Soica, 2014).

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