

Heating by Electromagnetic Sources (HES-16) Int'l Conference

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The international conference on heating by electromagnetic sources (HES) is dedicated to electromagnetic processing of materials by induction, conduction, microwaves, and dielectric mechanisms. The recent HES-16 meeting was held in Padua in May 24-26, 2016.

At the HES-16 edition, 140 participants were registered, and 85 papers were presented by authors coming from 18 different countries. A number of selected papers will be published in the Int'l Journal of Applied Electromagnetics and Mechanics (IJAEM) and in the COMPEL Journal.

HES in Padua

Since 1998, every three years the Laboratory for Electroheat of the Department of Industrial Engineering at the University of Padua (Italy) organizes the int'l HES conference in Padua. This year it was already the 7th edition of this scientific event.

The Laboratory for Electroheat of Padua University (LEP) researches about electroheat and electromagnetic processing. LEP was founded about 40 years ago by Prof. Di Pieri, it was led for many years by Prof. Lupi, and now it is directed by Prof. Dughiero. The emphasis of this laboratory initially was on conduction and induction heating. The scope has been gradually enlarged, and currently the laboratory is running research projects in the full area of electromagnetic processing. In this enlarged context, also dielectric and microwave heating has a substantial part in the research portfolio of the laboratory.

The evolution of the laboratory from conduction and induction heating to the much wider horizon of electromagnetic processing is also reflected in the parallel evolution of the successive HES conferences. This HES-16 conference devoted special sessions not only to induction heating, but also to

microwave heating and biomedical applications (Fig. 1).



Figure 1. An oral session at HES-16.

Academics, attracted by the high scientific level of the conference, together with people from industry (engineers as well as entrepreneurs) belong to the regular audience coming back to Padua, edition after edition. This mixed audience has proven to be very inspirational for industry as well as for academe. People from industry get aware of the newest state of the art of advanced technologies, and people from academe get more sensitive to the vital importance of an openness of mind that keeps them broadly oriented towards interdisciplinary knowledge (Fig. 2).



Figure 2. Social gathering of the HES-16 attendants.

The sponsorship of research projects is hardly interested in induction or microwave heating as such. The genuine research question is more often than not oriented to the creation of industrial added value or full problem-solving. To reach this target an

interdisciplinary and multi-physics approach is necessary.

For this mixed industry-academe audience, high scientific level papers were presented at the HES-16 conference, showing how the final research targets can only be reached by a multi-disciplinary approach including electro-magnetism, heat transfer, thermodynamics, magneto-fluid dynamics, phase transitions, residual stresses, power electronics, control algorithms, etc.

Consequent to the prestigious Electro-magnetic Processing of Materials Conference in Cannes (October 2015), the HES-16 conference gave a great deal of prominence to this field of research. Induction as well as dielectric heating (to mention just those two electroheat techniques) are part of a much broader field of study which can more adequately be defined as “Electromagnetic Processing of Materials” (EPM). In EPM the interaction is investigated between an electromagnetic field (of all frequencies) on one side, and materials (of all kind) on the other side. This EPM field of study is becoming more and more important, and it can be expected that the EU Research and Innovation programme Horizon 2020 will pay big attention to this field of research as well. At the HES-16 conference, various stakeholders were given another opportunity to follow the rapid evolutions in this field.

Concerning the session on induction heating, it was interesting to notice how a multi-physics knowledge and simulation of a hardening process (to give just one illustration) is helpful to fine-tune the parameters in a hardening process, so that it leads to far more advantages (quality of the final product, process time, energy and pollution savings, etc.) than the more conventional carburizing treatment.

A full session was devoted to special applications covering biomedical applications, household applications, special devices and processes, and chemical reactors. By spreading knowledge to these fields, quite other than usual areas of applications can be reached as there are: medicine, biology, food industry, and semiconductor industry.

In the session on microwaves, a low reflection reactor for chemical synthesis was presented. Some developments on metal-ceramic composite castings by microwave energy were discussed. Also a model for microwave heating of thin laminate composite parts was proposed. The safety issue by using microwave technology was also addressed by an investigation of the influence on the human body when using a 2.45 GHz choke.

The HES course for research students

A particular event at the occasion of the HES-16 conference was the intensive PhD course preliminary to the conference (Fig. 3). There were 15 PhD students coming from all over Europe who participated in this meeting.



Figure 3. HES course for research students.

The recurrent (biennial to annual) organization of such an intensive PhD course is an initiative of UIE, the International Union for Electricity applications. It is a tradition to organize such a course just before a conference dealing with proper topics, like HES (Heating by Electromagnetic Sources - University of Padua), MMP (Modelling for Material Processing - University of Latvia), MEP (Modelling for Electromagnetic Processing - University of Hanover) and the four-yearly UIE conference.

The aim of this PhD course is to establish a scientific cooperation among PhD students and researchers from different institutions operating in the fields of electroheat, electromagnetic processing of materials, microwave and biomedical applications of electromagnetism. The students participate in lectures and they discuss their own scientific topics and existing problems under the

guidance of well-experienced supervisors in order to take profit for their research studies. As a result of this process, they have to carry out in separate working groups small projects and to present the received results finally.

The course has a typical duration of 5 days. In the course, specific topics are presented in the form of full immersion lectures with the help of some laboratory tutorials. For the HES-16 edition of the UIE-PhD intensive course three main specific subjects have been chosen:

- (a) Numerical modelling of induction heating (Prof. Francois Bay, Mines Paristech, France).
- (b) Models for food processing (Prof. Ashim K. Datta, Cornell University, USA).
- (c) Medical and biological applications of electroheat (Prof. Robert Ivkov, John Hopkins Medical University, USA).

At the end of the course, the participating PhD students have presented a summary of the laboratory activities and discussed the results of the short projects.

The high level event of an intensive PhD course fully complies with the educational mission of AMPERE. Therefore, some members of the AMPERE Management Committee are thinking of contributing to the organization of a next PhD course in a joint UIE-AMPERE support. The students that participate in a PhD intensive course get free access to the subsequent conference.

Social and cultural activities

On the last evening the conference boat was moored at the isle of Torcello, near to Venice. After a guided visit of the ancient cathedral, an exquisite gala dinner was offered in open air to the HES-16 participants. On a glamorous boat trip, returning to the Terraferma, the reflecting moonlight on the waters of the lagoon raised scientific and other thoughts to higher levels of beauty and inspiration...

About the Author



Koen Van Reusel received the degree of Master of Electrical Engineering from the KU Leuven (Belgium) in 1985, and the degree of Doctor of Engineering from the KU Leuven in 2010. Since 1992 he is at LABORELEC (Belgium), a technical competence center in energy processes and energy use. As senior expert he is member of the Power Quality and Electromagnetic Compatibility (EMC) Department. He is currently involved in industrial projects on the mitigation of wind turbine interaction with radar systems, EMC in power stations, the aggregation of harmonics produced by wind turbines and photovoltaics, health effects of the exposure to electromagnetic fields, and the mitigation of lightning incidents on wind turbines. He is visiting professor at the KU Leuven, where he teaches "Electromagnetic Processing of Materials" and "Power Quality".

Koen Van Reusel is Member of the Management Committee of AMPERE, the Association for Microwave Power in Europe for Research and Education; General Secretary to UIE, the International Union for Electricity applications; Member of the Board of Directors of FISUEL, the Int'l Federation for the Safety of the Electricity Users; and member of the Int'l Electro-technical Commission (IEC) Electro-technical Committee n° 27 "Industrial Electroheating and Electromagnetic Processing of Materials".