

COST Action P6

"Magnetofluidynamics"

Final Report

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1. Short Summary

The COST Action P6 "Magnetofluidynamics" (MFD) has started its work in March 2000 and completed the work in July 2004. Since then, five working groups have been established which have successfully accomplished the goals set out in the working programme of the action. The results involve the initiation of numerous bi- and multilateral scientific collaborations, working group meetings, short term missions, the organization and co-organization of four major conferences, seven workshops and the preparation of the book "Magnetohydrodynamics: Historical Evolution and Trends" edited by S. Molokov, R. Moreau, and H.K. Moffatt which summarizes the work of the COST action and represents an important step to enhance the visibility of the subject. Thanks to the effective role of COST P6 in establishing a powerful research network in MFD, COST has decided in early 2005 to support the new action "Electromagnetic Processing of Materials" which includes additional topics and serves to further improve the competitiveness of European MFD research.

2. Scientific background

Magneto Fluid Dynamics (MFD), characterises the study of interaction between hydrodynamics and electrodynamics. It deals with contactless control and influence of electrically conducting fluids through electromagnetic fields and is of great interest for basic research as well as for a variety of technical applications like material processing and material science. MFD methods can be applied everywhere, where an electrically conducting fluid is to be manipulated without a mechanical contact. A classical but not yet exhausted area of application is magnetic or inductive stirring and mixing. This successful technology enables contactless stirring and mixing of arbitrary hot and aggressive melts. It is recognised that for the huge electrolytic cells used to produce aluminium the unwanted wave instability is controlled by the MFD effects. A further application is the technology of magnetic braking, which is used to calm turbulence during continuous casting through a homogeneous magnetic field. Furthermore, space conditions can be simulated by way of magnetic fields (quasi-weightlessness), fluids flows can be suppressed (steady magnetic fields) or directly generated (alternating magnetic fields). These applications are valid, above all, for fluids with a high electrical conductivity like liquid metals but also for electrolytes (electrochemistry), molten glass, and seawater. The application of MFD methods is extremely versatile and reaches from metallurgy and crystal growth to electron beam technologies or welding processes. Perspectives of MFD are the use of the results for process engineering and the improvement of products in material technologies, the transfer of results from space research into earth technologies by using electromagnetic fields as well as to prove a fundamental phenomenon of physics the dynamo-effect. Generally, the basic phenomena of MFD are investigated, then these results are transferred into a variety of industrial applications in co-operation with suitable partners.

3. Structure of COST P6

During ist kick-off meeting on 1 March 2000 in Brussels a management committee was formed consisting of the following members:

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The scientific work of the COST action takes place in frame of the following five working groups (WG):

WG1	Fundamentals	(coordinator J. Leorat, Paris)
WG2	Crystal growth	(coordinator A. Muznieks, Riga)
WG3	Poorly conducting fluids	(coordinator G. Gerbeth, Rossendorf)
WG4	Metallurgy	(coordinator B. Nacke, Hannover)
WG5	High magnetic fields	(coordinator S. Molokov, Coventry)

4. Main accomplishments

The work of COST P6 was conducted according to the work programme set out in the text of the proposal. Below we provide a brief summary of the main accomplishments.

4.1 Management committee and working group meetings

COST P6 has conducted eight management committee (MC) meetings, namely

- First MC meeting on 1 March 2000 in Brussels (Belgium)
- Second MC meeting on 7 June 2000 in Ilmenau (Germany)
- Third MC meeting on 20 September 2000 in Giens (France)
- Fourth MC meeting on 19 September 2001 in Brussels (Belgium)
- Fifth MC meeting on 17 September 2002 in Ramatuelle (France)
- Sixth MC meeting on 16 October 2003 in Lyon (France)
- Seventh MC meeting on 27 May 2004 in Coventry (UK)
- Final MC meeting on 21 September 2004 in Ilmenau (Germany)

In addition each of the five working groups has conducted two meetings per year on average. The results of these meetings are detailed in the minutes which can be found at the COST P6 website

http://www.maschinenbau.tu-ilmenau.de/mb/wwwtd/COST/COST_Page01.html

4.2 Organization of conferences

The members of COST P6 have actively contributed to the organization of the following major conferences:

- 18-22 September 2000: PAMIR Conference on Magnetohydrodynamics, Presqu'île de Giens, France

- 15-19 September 2002: PAMIR Conference on Magnetohydrodynamics, Ramatuelle, France
- 14-18 October 2003: International Congress on Electromagnetic Processing of Materials, Lyon, France
- 26-28 May 2004, International Conference on the History of MHD, Coventry, UK

The conferences were combined with meetings of different working groups of COST P6 and were considered a major contribution to the international visibility of the field.

4.3 Organization of workshops

In addition to the conferences mentioned above the following workshops and topical meetings were organized or co-organized by members of the COST P6 action:

- 4-6 June 2000: International Workshop on Electromagnetic Control of Free Surface Flows in Materials Processing, Ilmenau, Germany
- 20-23 May 2001: International Workshop on Magnetism and Electrochemistry, Renvyle House, Connamara, Ireland
- 27-29 June 2001: International Seminar on Electromagnetic Processing of Materials, Coventry, UK
- 13-14 June 2002: International Workshop on the Use of Magnetic Fields in Crystal Growth, Riga, Latvia
- 17-19 June 2002: International Workshop on High Magnetic Fields, Grenoble, France
- 22-23 January 2004: Topical Meeting on Dynamo Theory, Paris, France

4.4 Short term scientific missions

There have been approximately 15 short-term scientific missions (STSM) in frame of COST P6. To give a specific example of the usefulness of these missions it should be mentioned that one STSM enabled two researchers of the Institute of Materials Science in Dresden to travel to the High Magnetic Field Laboratory in Grenoble and to conduct experiments that would have been otherwise impossible. The results of

the experiments were published in conference proceedings and in journal articles with proper acknowledgment of COST funding.

4.5 Joint book publication

Perhaps the most important impact of the COST action is the preparation and joint publication of a book entitled "Magnetohydrodynamics: Historical Evolution and Trends" edited by S. Molokov, R. Moreau, H.K. Moffatt, to be published in 2005 in the Springer series "Fluid Mechanics and Its Applications". This book is an extended collection of review papers prepared by members of COST P6 and other researchers in response to Dr. Sergej Molokov's initiative during the International Conference on the History of MHD (26-28 May 2004, Coventry, UK). The book does not only provide an excellent survey of past and present research in magnetofluidynamics for people working in MFD but will certainly also be of great interest for those outside the field who wish to become familiar with the fundamentals and challenges of this exciting field. We attach as an appendix an outline of the book and the preliminary versions of the papers. A final version will be supplied in April 2007.

Attachment

**Preliminary version of the book
"Magnetohydrodynamics:
Historical Evolution and Trends"**

edited by

S. Molokov, R. Moreau, H.K. Moffatt,

to be published in April 2007

in the Springer series

"Fluid Mechanics and Its Applications".