ORNL/FTR--3081

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COVER SHEET FOR TRIP REPORT

SUBMITTED TO THE OFFICE OF ENERGY RESEARCH

Destinations and Dates for which Trip Report Is Being Submitted: Venice, Italy; 9/19-23/88
Toulouse, France; 9/26/88
Dijon, France; 9/28-29/88

Name of Traveler: Isidor Sauers

Joint Trip Report: No

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ORNL

FOREIGN TRIP REPORT

ORNL/FTR-3081

DATE: October 4, 1988

SUBJECT: Report of Foreign Travel of Isidor Sauers, Research Staff Member, Physics of Solids and Macromolecules Group, Health and Safety Research Division

TO: Alexander Zucker

FROM: Isidor Sauers

PURPOSE: To participate in the Ninth International Conference on Gas Discharges and Their Applications, Venice, Italy, September 19-23, 1988, and to visit laboratories at the University Paul Sabatier, Toulouse, France, and University of Dijon, Dijon, France

SITES VISITED:	9/19-23/88	Conference	Venice, Italy	
	9/26/88	Univ. Paul Sabatier	Toulouse, France	J. Casanovas
	9/28-29/88	Univ. Dijon	Dijon, France	J.-P. Goudonnet

ABSTRACT: The traveler attended the Ninth International Conference on Gas Discharges and Their Applications, which was held in Venice, Italy, on September 19-23, 1988; presented two papers, (1) "Ion Chemistry in SF_6 Corona" and (2) "Production of S_2F_{10} by SF_6 Spark Discharge"; and participated in numerous discussions with conference participants on gas discharges related to his work on SF_6. The traveler visited the Centre de Physique Atomique at the University Paul Sabatier in Toulouse, France, to discuss with Dr. J. Casanovas his work on SF_6 decomposition. Following that visit, the traveler visited the Laboratoire de Photoelectricite at the University of Dijon to discuss with Dr. J.-P. Goudonnet his work on surface studies and on the use of tunneling electron spectroscopy for the chemical analysis of surfaces.

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NINTH INTERNATIONAL CONFERENCE ON GAS DISCHARGES AND THEIR APPLICATIONS

The Ninth International Conference on Gas Discharges and Their Applications was held in Venice, Italy, on September 19-23, 1988, and was attended by 250 participants from over 25 countries. The 200 papers presented at the conference covered various topics including corona, arcs, compressed gas insulation, plasma chemistry/processing, and breakdown. The site of the conference, a former Benedictine monastery on the island of San Giorgio, provided an ideal setting for conference discussion owing to the striking absence of distracting commercial establishments.

The traveler presented two papers representative of current research efforts at Oak Ridge National Laboratory (ORNL)--(1) "Ion Chemistry in SF_6 Corona" and (2) "Production of S_2F_{10} by SF_6 Spark Discharge." Both papers were well received, inviting numerous questions and discussion following each presentation. In particular, the paper dealing with S_2F_{10} was the subject of numerous discussions with the traveler due to the fact that S_2F_{10} is highly toxic, having a threshold limit value for human exposure of 10 parts per billion. Because of its thermal instability at elevated temperatures, the conditions under which it may be formed in SF_6-filled, high-voltage equipment has been a highly controversial subject. Other researchers are now following suit in trying to detect and quantify S_2F_{10} production under various discharge conditions. The ORNL program is the only one that is doing both analytical and biological work on this important SF_6 by-product. There was also considerable interest in the first paper with regard to future diagnostic techniques for sensitively assessing the content of moisture and other components and breakdown products of compressed SF_6.

The traveler participated in various formal and informal discussions. A meeting was held with Dr. F. Y. Chu (Ontario Hydro, Canada) and Dr. R. J. Van Brunt [National Institute of Standards and Technology (NIST; formerly NBS), USA] on future collaborative studies on S_2F_{10} formation by electrical discharges in SF_6. The traveler met with Drs. A. Pigini and O. Celli [Centro Elettrotechnico Sperimentale Italiano (CESI), Italy] and G. Basile (Montefluos, an Italian producer of SF_6) on diagnostics that can be used on SF_6-filled equipment. Also, private discussions were held with Dr. Ivo Gallimberti (University of Padova, Italy), chairman and organizer of the conference, on SF_6 by-products, a subject which he currently is working on as well; Drs. M. and A. Goldman [Centre National de la Recherche Scientifique (CNRS), France] on the influence of electrode material on by-product formation and, conversely, the effect of by-products on surfaces; Prof. R. S. Sigmond (Trondheim, Norway) on the use of corona discharge mass spectrometry for diagnostics; Dr. L. Neimeyer (Brown-Boveri, Switzerland) on various aspects of SF_6 use in compressed gas-insulated substations; and with K. Nakanishi (Mitsubishi, Japan) on SF_6 by-products and on current ORNL work on surface studies and scanning-tunneling microscopy. Also, the traveler discussed a paper to be written jointly with Dr. R. J. Van Brunt (NIST) on S_2F_{10} detection in SF_6 corona.

The traveler also participated in a meeting concerning the future of the International Symposium on Gaseous Dielectrics which traditionally has been held in Knoxville, Tennessee. European, Japanese, and U.S. participants were in agreement that the sixth conference should be held in Knoxville again, and a lengthy discussion was held on the format, budget, and prospective sponsors of the symposium.

CENTRE DE PHYSIQUE ATOMIQUE, UNIVERSITY PAUL SABATIER

After attending the Gas Discharge Conference in Venice, the traveler visited the gas discharges laboratory at the University Paul Sabatier in Toulouse, France. There, Dr. J. Casanovas is leading the French program on SF_6 by-products analysis, funded by Electricite de France. The traveler had the opportunity to compare notes on SF_6 by-product formation in sparks and corona discharges and to discuss experimental techniques employed by the French group. The French are also moving ahead on a study of SF_6 by-product formation in power arc discharges, an area that ORNL is interested in pursuing in the near future in order to address practical aspects of SF_6 use. The French group has recently published a paper on corona and gamma-irradiated SF_6 and has two manuscripts on sparked SF_6 and AC corona out for review. The traveler's appraisal of the French program is that a considerable amount of data has been taken under a variety of conditions (moisture, pressure, electrode gap, etc.), but insufficient care has been taken to analyze the data properly. As a result, some of the interpretations of the results are questionable. They admit, however, that their objective was not to deduce mechanisms or to provide kinetic information on reactions induced by SF_6 discharges. The traveler found that the experimental techniques employed by Dr. Casanovas' group have been modeled after the traveler's ORNL program and that the ORNL work has been cited extensively in their published work. The traveler pointed out to the French group certain concerns about their analytical method. For example, they do not detect SOF_4, an important and abundant by-product of both spark and corona discharges, and they do not use a reference standard, a serious deficiency in their method. Also, they observe peculiar saturation effects not observed by NBS in their corona studies. The reason appears to be due to the lack of proper moisture monitoring during the course of their experiments. On the other hand, the traveler was pleased to see that Dr. Casanovas was using a fast transient recorder/digitizer to capture both voltage and current wave-forms to measure the energy deposited into the gas. The traveler has already initiated plans to use a similar technique to gain a more accurate measure of the spark energy. Overall, the traveler was impressed with the level of activity in France on SF_6 decomposition studies and that the level of support for those activities is increasing. This reflects the concern by the French electrical utilities that there is currently an incomplete understanding of the physics and chemistry of SF_6 discharges.

LABORATOIRE DE PHOTOELECTRICITE, UNIVERSITY OF DIJON

The traveler ended the trip with a visit to the laboratory of Dr. J.-P. Goudonnet at the University of Dijon in France. The traveler has been interested for some time in the work of Dr. Goudonnet on surface studies. In particular, the traveler has been interested in the influence of SF_6 by-products on insulator surfaces, electrode erosion in SF_6 discharges, new diagnostics for gaseous by-product detection and insulator damage, and on new surface desorption techniques. The traveler was interested in the French group's work on scanning-tunneling microscopy and discussed with Dr. Goudonnet the possibility of employing tunneling electron spectroscopy as a means of chemical analysis of the surface for detection of high-molecular-weight SF_6 by-products condensing or adsorbing to surfaces. The traveler was also interested in the French work on surface enhanced Raman spectroscopy, another technique that could be applied toward the detection of chemicals adsorbed on surfaces. The SF_6 by-product S_2F_{10} might be detected in low concentrations in an SF_6 background using this technique, since it has a Raman shift distinguishable from the Raman shift in SF_6. The traveler was impressed with the facilities at Dijon and believes that future collaboration may be possible in these areas.

CONCLUSION

The traveler met with a number of leading scientists in the field of gas discharges and, in particular, with Italian and French scientists working on breakdown products of electrically discharged SF_6. The traveler's own work was well received. Many of the conference attendees expressed high regard for the ORNL work in understanding the physics and chemistry of SF_6 discharges. A great deal of interest was expressed in the traveler's report of detecting the highly toxic S_2F_{10} in spark-decomposed SF_6. These results, the traveler believes, will stimulate new research efforts in understanding the processes that determine the formation of this and other species in SF_6. Discussions held with various European, Canadian, and U.S. scientists will, in the traveler's opinion, stimulate future cooperation and research in this area.

APPENDIX

ITINERARY

9/16/88	Travel from Knoxville to Washington Dulles Airport by car
9/16-17/88	Travel from Washington to Munich, West Germany, via plane
9/17-18/88	Travel from Munich to Venice, Italy (overnight in Innsbruk), by car
9/18-23/88	Participation at the conference
9/24-25/88	Travel from Venice to Toulouse, France, by car
9/26/88	Visit at University Paul Sabatier
9/27/88	Travel from Toulouse to Dijon by car
9/28/88	Visit at University of Dijon
9/29/88	Travel from Dijon to Paris by car
10/1/88	Travel from Paris to Washington Dulles Airport via plane
10/2/88	Travel from Washington to Knoxville by car

PERSONS CONTACTED

Venice -- F. Y. Chu, R. J. Van Brunt, A. Pigini, O. Celli, G. Basile, I. Gallimberti, M. Goldman, A. Goldman, R. S. Sigmond, L. Neimeyer, K. Nakanishi, and other delegates at the Ninth International Conference on Gas Discharges and Their Applications

Toulouse -- J. Casanovas, R. Derdouri

Dijon -- J.-P. Goudonnet

LITERATURE

Conference proceedings were brought back plus reprints and preprints. Other reprints will be mailed.

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