

John C. Edwards, Ph.D.

Work: Process NMR Associates, LLC, 87A Sand Pit Rd, Danbury, CT 06810, USA
Tel: (203) 744-5905, Fax: (203) 743-9297, Cell: (203) 241-0143, e-mail: John@process-nmr.com
Web: <http://www.process-nmr.com> Blog: <http://www.nmrblog.com>

SUMMARY:

24 years of technical experience in the field of NMR and process NMR applied to petroleum, petrochemical, biochemical, food, and chemical R&D and manufacturing.

Principal of Process NMR Associates, LLC – established in 1997. The only process NMR applications consultancy operating in the world. Currently operating a commercial NMR analysis service with over 300 commercial customers in the petroleum, biotechnology, pharmaceutical, food processing, alternative energy, petrochemical, polymer, ceramics, catalyst and electronics industries. Developed new NMR technologies for process control and the laboratory, through relationships with other vendors. Consulted on application of new NMR technologies. Distributor for Spin Track TD-NMR systems in the Americas.

Principal of NMR Process Systems LLC – established in 2006. Distributor of Spectroscopic Process Analytical Technologies in the Americas. Joint venture company operating in conjunction with process analytical partner companies such as Modcon, ASPeCT Magnet Technologies, Qualion NMR, Petrometrix, Smith's Detection, Swagelok, Active Spectrum, Cosa Instruments, Xentaur Corporation.

Applied chemometric techniques to complex NMR analyses that yielded predictive models for many refinery applications using NMR as an on-line process analyzer/controller. Acknowledged as a world leader in the application of multivariate analysis to NMR spectroscopy.

Maintained and operated the only NMR facility within Texaco Inc. Provided **all** NMR spectroscopic services (liquid-state, solid-state, multidimensional, multinuclear), including all data interpretation, for **all** areas of Texaco's research efforts in both upstream and downstream areas.

At Texaco, coordinated compositional work related to business unit processing problems - MTBE plant, various refinery operations, product blending operations, used-oil recycling plant, paper recycling plant, plastics/coal gasification plant. Participated as team member on projects associated with competitive analysis, product quality monitoring, environmental liability, field problem sample analysis, engine test sample analysis.

Published and presented over 100 papers in various technical journals, symposia, and national meetings.

Inventor - 1 Patent for a process analytical NMR probe.

Performed detailed analytical NMR analysis in support of legal litigation and patent infringement cases.

Adjunct Professor – Marist College, Department of Chemistry, Poughkeepsie, NY - 2002-Present

Research Associate, State University of New York at New Paltz, Department of Chemistry, New Paltz, NY

EDUCATION:

Ph.D. Physical Chemistry, University of South Carolina, 1990.

Advisor: Professor Paul D. Ellis

Dissertation: "Solid-State Molybdenum-95 Nuclear Magnetic Resonance Spectroscopy of Molybdenum in Catalytic Environments"

B.Sc. (Dunelm) Honours in Chemistry, University of Durham, Durham UK, 1986

Secondary Education: Thornleigh Salesian College, Bolton, UK - 11 'O', 5 'A', 2 'S' Levels, 1983

PROFESSIONAL EXPERIENCE:

2003 to Present

Process NMR Associates, LLC

Manager - Process and Analytical NMR Services

- Enabled expansion of analytical NMR services to current customer level of over 300 companies.
- Developed Markets and Sales for Spin Track TD-NMR Spectrometers and Applications.
- Co-Founded NMR Process Systems LLC - providing process/at-line NMR analyzers and other process analytical technology solutions to industry.
- Consultant on NMR methodologies to several major petroleum companies including Sasol, SK Corporation, Petronas, Shell, Valero, Holly Refining, Schlumberger.
- Adjunct Professor - Marist College
- Research Associate – State University of New York at New Paltz

December 1997 to 2003

Process NMR Associates, LLC

Manager - Process and Analytical NMR

- Co-founder and operator of Process NMR Associates, LLC. Acted as a contract process NMR application development specialist. Served as application development company and NMR consultants to Invensys, FoxboroNMR, and APV. Operated a high field analytical NMR laboratory.
- Acted as Technical Product Manager for the FoxboroNMR Ltd Process NMR Product.
- Served as Technical Sales Support on all aspects of the Process NMR business.
- Managed over 30 validation projects for the Foxboro process NMR business.
- Directly involved in development of NMR incorporated into closed loop control by APC and optimization packages
- Served as applications support and service coordinator for Foxboro Process NMR.
- Provided contract solid and liquid-state NMR support to major petroleum and chemical companies.

Research Chemist - Process Analytical and Organic Spectroscopy Group:

- Manager and sole-operator of all NMR services within Texaco Inc., providing solid and liquid-state NMR analyses for Texaco's business units and business partners. Lab comprised: Varian NMR Systems: UnityPlus-300, UnityPlus-200, Unity-300WB, VXR-300S ; Elbit-ATI 55 MHz Process NMR Systems: 1 lab and 2 in-line refinery systems.
- Member of Process Analytical Technology team charged with providing process instrumentation and sensing to the refining business units and the Texaco fuel marketing company. Involved in online NMR and NIR projects, as well as a mobile FT-IR facility that monitored gasoline quality at Texaco gas stations.
- Developed chemometric models for application of process NMR technology to control and optimize refinery operations such as: alkylation, fluid catalytic cracking, reforming, hydrotreating, tank-farm inventory reduction, crude assay, and gasoline blending. Aided in development of the first two commercial NMR based refinery analyzers for fuel gas analysis and alkylation control at a Texaco refinery.
- Coordinated analytical work provided to Huntsman Corporation, DSM Copolymer, Ethyl Corp., First Brands, and various universities.
- Fouling team member and analytical coordinator for a 3,500 bpd used oil recycling plant.
- Strong supporting roles in gasoline and diesel fuel additive development, lubricant additive development, compositional analysis, heavy oil upgrading, and methane-to-liquids upgrading.

Project Chemist - Organic Spectroscopy, Compositional and Thermal Analysis Group.

- Assumed partial responsibility for liquid-state NMR analysis as well as maintained full responsibility for solid-state NMR applications throughout Texaco. Areas of responsibility included all areas of Texaco's upstream and downstream research efforts (polymers, catalysts, fuel/lubricant additives, complex mixture analysis, membranes, gasification, heavy oil upgrading, methane-to-liquids upgrading, competitive analysis, base oil, gasoline, diesel, crude composition, process failure analysis, and compositional analysis). Services supplied involved all experimental design, data collection, processing, and interpretation.
- Received Texaco's Outstanding Contributor Award for advancing the understanding of the complex structure of combustion chamber and other engine deposits.
- Analytical representative on the Clean System-3 fuel additive development team.
- Justified the expansion of Texaco's NMR capabilities from two spectrometers to four, and networked the system to allow home-access and control of the spectrometers.
- Expanded NMR domain within Texaco to include the exploration departments, in particular geochemical and log analysis areas.
- NMR spectroscopist responsible for all solid-state NMR analyses (wideline, CRAMPS, CP-MAS, nutation, 2-dimensional).

- Developed a large program to correlate fuel and fuel-additive chemistries with engine performance and engine deposit quantity and chemistry.
- Developed structure-reactivity relationships in catalyst systems utilizing multinuclear (^1H , ^2H , ^{27}Al , ^{31}P , ^{23}Na , ^{133}Cs , ^{13}C , ^{29}Si , ^{11}B , ^{95}Mo , ^{15}N , ^{17}O , ^{33}S) solid-state NMR characterization. Catalyst systems included zeolites, clays, aluminophosphates, oxides, mixed oxides, oxide supported metals, modified buckminsterfullerenes, and carbons.

August 1986 - September 1990

University of South Carolina

1987-1990 Research Assistant - Chemistry Department, NMR Laboratory

1986-1987 Teaching Assistant - Chemistry Department, General Chemistry

PROFESSIONAL AFFILIATIONS:

Member-American Chemical Society, Petroleum Chemistry and Fuel Chemistry Divisions
Mid-Hudson NY ACS Section Secretary (2005 and 2008-2010), Chair-Elect (2006, 2011), Chair (2007)

Member- Materials Research Society
Society of Applied Spectroscopy
American Oil Chemists Society
American Herbal Products Association (Associate Member)

PEER REVIEWED PUBLICATIONS

1. "Measurement of Quadrupolar Coupling Constants, Shielding Tensor Elements, and the Relative Orientation of the Quadrupolar and Shielding Tensor Principal Axis Systems for ^{87}Rb and ^{85}Rb in Rubidium Salts by Solid-State Nuclear Magnetic Resonance". J.T. Cheng, J.C. Edwards, P.D. Ellis, **J. Phys. Chem.**, **94**, 553 (1990).
2. "Solid-State ^{95}Mo NMR Study of (Aryldiazenido)- and (Organohydrazido)-Polyoxomolybdates. Investigation of Model Compounds of Catalytic Molybdenum Environments". J.C. Edwards, J. Zubieta, S.N. Shaikh, Q. Chen, S. Bank, P.D. Ellis, **Inorg. Chem.**, **29**, 3381 (1990).
3. "A ^{95}Mo Solid-State NMR Study of Hydrodesulfurization Catalysts. 1. The Formation of Fresh HDS Catalyst Precursors by Adsorption of Polyoxomolybdates onto γ -Alumina". J.C. Edwards, R.D. Adams, P.D. Ellis, **J. Amer. Chem. Soc.**, **112**, 8349 (1990)
4. "Cross-Polarization for Quadrupolar Nuclei - Proton to Molybdenum-95". J.C. Edwards, P.D. Ellis, **Magn. Reson. Chem.**, **28**, S59 (1990).
5. "Solid-State ^{95}Mo NMR Study of Hydrodesulfurization Catalysts. 2. Investigation of Reduced/Sulfided Molybdena-Alumina Catalysts and the Effect of Promoter Ions on 'Fresh' and Reduced/Sulfided Molybdena-Alumina Catalysts". J.C. Edwards, P.D. Ellis, **Langmuir**, **7**, 2117 (1991).

6. "FT-IR and Solid-State NMR Investigation of Phosphorus Promoted Hydrotreating Catalyst Precursors". E.C. Decanio, J.C. Edwards, T.R. Scalzo, D.A. Storm, J.W. Bruno, **J. Catal.**, **132**, 498-511 (1991).
7. "Effects of B³⁺ Content of B-ZSM-11 and B-ZSM-5 on Acidity and Chemical and Thermal Stability". M.W. Simon, S.S. Nam, W.Q. Xu, S.L. Suib, J.C. Edwards, C.L. O'Young, **J. Phys. Chem.**, **96**, 6381 (1992).
8. "Deactivation of Hydrotreating Catalysts", J.G. Weissman, S. Lu, B.M. McElrath, J.C. Edwards, **Studies in Surface Science and Catalysis**, **73**, 377-384 (1992).
9. "²⁷Al NMR, FT-IR AND Ethanol-¹⁸O TPD Characterization of Fluorided Aluminas". E.C. Decanio, V.P. Nero, J.C. Edwards, J.W. Bruno, **J. Catal.**, **140**, 84 (1993).
10. "Average Molecular Structure of Gasoline Engine Combustion Chamber Deposits Obtained By Solid-State ¹³C, ³¹P, and ¹H Nuclear Magnetic Resonance Spectroscopy". J.C. Edwards, P.J. Choate, **SAE Paper 932811**, presented at the Fuels and Lubricants Meeting of the Society of Automotive Engineers, October 21, (1993).
11. "Relationship Between Combustion Chamber Deposits and SI Engine Performance". P.J. Choate, J.C. Edwards, **SAE Paper 932812**, presented at the Fuels and Lubricants Meeting of the Society of Automotive Engineers, October 21, (1993).
12. "Observation of [Al(OH)_n(H₂O)_{6-n}]_n(MoO₄) in Hydrotreating Catalyst Precursors by Solid-State ²⁷Al NMR". J.C. Edwards, E.C. Decanio, **Catal. Lett.**, **19**, 121 (1993).
13. "¹³C and ¹⁵N Cross-Polarization Magic Angle Spinning NMR Spectra of ¹⁵N-Enriched 2-Phenethylamine Adsorbed on an Activated Clay". S.Bank, B. Yan, J.C. Edwards, G. Ofori-Okai, **Langmuir**, **10**, 1528 (1994).
14. "Performance and Characterization of Zirconium Modified Hydroprocessing Catalysts". J.G. Weissman, E.C. Decanio, J.C. Edwards, **Catal. Lett.** **24**, 113 (1994).
15. "Molecular Representations of Ratawi and Alaska North Slope Asphaltenes Based on Liquid- and Solid-State NMR". D.A. Storm, J.C. Edwards, S.J. Decanio, E.Y. Sheu, **Energy & Fuels** **8**, 561 (1994).
16. "Solid-State MAS ¹H NMR Characterization of Gamma-Alumina and Modified Gamma-Aluminas". E.C. Decanio, J.C. Edwards, J.W. Bruno, **J. Catal.**, **148**, 76 (1994).
17. "Effect of Secondary Porosity on Gas Oil Cracking Activity". E.P. Dai, L.P. Neff, J.C. Edwards, published in the ACS Symposium Series : "Fluid Catalytic Cracking III : Materials and Processes" , M.L. Ocelli, P.O'Connor, Editors, Chapter 6, p63-80 (1994).
18. "A Spectroscopic and Catalytic Study on the Formation and Thermal Decomposition of Sodium Ionic Clusters in NaX Zeolite: A Mechanism for Defect Site Formation". M.W. Simon, J.C. Edwards, S.L. Suib, **J. Phys. Chem.**, **99**, 4698 (1995).
19. "N-Butene Skeletal Isomerization to Isobutylene on Shape-Selective Catalysts: Ferrierite/ZSM-35". W-Q. Xu, Y-G. Yin, C.L. O'Young, J.C. Edwards, S.L. Suib, **J. Phys. Chem.**, **99**, 9443 (1995).

20. "Sludge Formation During Heavy-Oil Upgrading". D.A. Storm, S.J. Decanio, J.C. Edwards, E.Y. Sheu, published in the Proceedings of the 6th UNITAR International Conference on Heavy Crude and Tar Sands, Houston, Texas, February 12-17, (1995), p 365-372.
21. "The Synthesis and Structure of a Chiral Layered Aluminophosphate Containing the Template $Co(m)3+$ ". D.A. Bruce, A.P. Wilkinson, J.A. Bertrand, M.G. White, J. Edwards, **Chem Comm**, **1995**, 2059 (1995).
22. "Chemical Characterization of Coal Tar-Water Interfacial Films". E.C. Nelson, G. Marsh, J.C. Edwards, R.G. Luthy, A. Ramaswami, S. Ghosal, **Env. Sci. Tech.** **30**, 1014 (1996).
23. "Characterization and Aging of Hydrotreating Catalysts Exposed to Industrial Processing Conditions". J.G. Weissman, J.C. Edwards, **Applied Catal.**, **142(2)**, 289 (1996).
24. "Modification of Non-Template Synthesized Ferrierite/ZSM-35 for n-Butene Skeletal Isomerization to Isobutylene", Wen-Qing Xu, Yuan-Gen Yin, Steven L. Suib, John C Edwards, Chi-Lin O'Young, **J. Catal.** **163 (2)**, 232 (1996).
25. "Sediment Formation During Heavy Oil Upgrading". D.A. Storm, S.J. Decanio, J.C. Edwards, E.Y. Sheu, **Petroleum Science and Technology**, **15 (1&2)**, 77 (1997)
26. "Solid-State NMR and FT-IR Investigation of 12-Tungstophosphoric Acid Supported on TiO₂". J.C. Edwards, C.Y. Thiel, J.F. Knifton, and B. Benac, **Catal. Lett.**, **51**, 77 (1998).
27. "Molecular Composites: Design of Inclusion Complexes of Polyisobutylenes with Cyclodextrins". M.K. Mishra, J.C. Edwards, P. Subramanian, R.D. Pugliese, **Designed Monomers and Polymers**, **1(2)**, 225 (1998).
28. "Methyl tert-Butyl Ether Synthesis from tert-Butanol via Inorganic Solid Acid Catalysis", John F. Knifton, John C. Edwards, **Applied Catalysis A: General** **183(1)**, 1 (1999).
29. "Inverse Temperature Dependence of Chain Transfer Rate Constants for Chromium Metalloradicals in Polymerization of MMA". Lihao Tang, Jack R. Norton, and John C. Edwards, **Macromolecules**, **36**, 9716 (2003).
30. "Coal Asphaltene Molecular Size by Fluorescence Correlation Spectroscopy and ¹³C Nuclear Magnetic Resonance", A. Ballard Andrews, Wei-Chuan Shih, Koyo Norinaga, John C. Edwards, Oliver C. Mullins, submitted to **Energy & Fuels**
31. "Solid-State NMR and ESR Studies of Activated Carbons Produced from Pecan Shells", H. N. Cheng, Lynda H. Wartelle, K.Thomas Klasson, and John C. Edwards, **Carbon**, **48**, 2455 (2010).
32. "RCC Feedstream Analysis by ¹H and ¹³C NMR: Multivariate Prediction of Physical and Chemical Properties", John C. Edwards, Jincheol Kim, to be submitted to **Energy & Fuels**
33. "Solid-State ¹³C NMR Characterisation of Combustion Chamber Deposits Formed in Direct Injection Spark Ignition (DISI) Engines During an On-Road Vehicle Trial", Stefan de Goede, Tiaan Rabe, Andre Swarts, Riaan Bekker, Sibusiso Mtongana, and John C. Edwards, **SAE Paper 2010-01-2155**, to be presented at the Fuels and Lubricants Meeting of the Society of Automotive Engineer, San Diego, CA, October 25-27, 2010.

34. "Improved Approach to the Calculation of Average Molecular Descriptions of Heavy Petroleum Hydrocarbons by Combined Analysis by Quantitative ^{13}C and DEPT-45 NMR Experiments", John C. Edwards, A. Ballard Andrews, and Oliver C. Mullins, to be submitted to **Energy & Fuels**

PRESENTATIONS

1. "Solid-State ^{95}Mo Nuclear Magnetic Resonance Spectroscopy of Molybdenum in Catalytic Environments". J.C. Edwards, presented at the "Waugh Symposium" for High Resolution NMR in Solids, Massachusetts Institute of Technology, Boston MA, January 20, 1989.

2. "Solid-State Molybdenum-95 Nuclear Magnetic Resonance Spectroscopy of Hydrotreating Catalysts". J.C. Edwards, P.D. Ellis, presented at invited seminar, SUNY-Albany, Albany, NY, March 5, 1991.

3. "Structural Characterization of Alkyl Amine Intercalation Compounds of Hydrous Uranium Oxide". C.M. King, M.C. Thompson, R.B. King, J.C. Edwards, P.D. Ellis, presented at 201st Meeting of the American Chemical Society, Atlanta, Georgia, April 14-19, 1991.

4. "Solid-State ^{31}P , ^{27}Al , and ^1H MAS NMR of Phosphorus Promoted Hydrotreating Catalyst Precursors". J.C. Edwards, E.C. Decanio, D.A. Storm, presented at the American Chemical Society North East Regional Meeting, University of Massachusetts, Amherst, MA, June 1991.

5. "FT-IR, MAS NMR, and XRD Investigation of Phosphorus Promoted Ni-Mo/ Al_2O_3 Hydrotreating Catalyst Precursors". E.C. Decanio, J.C. Edwards, T.R. Scalzo, D.A. Storm, presented at the 202nd Meeting of the American Chemical Society, New York, New York, August 25-30, 1991

6. "Multinuclear Solid-State NMR Investigation of Boron-Zeolites and Borosilicates". J.C. Edwards, C.L. O'Young, P.J. Giammatteo, presented at the National ACS Meeting, New York, NY, August 25-30, 1991.

7. "Deactivation of Hydrotreating Catalysts" J.G. Weissman, S. Lu, J.C. Edwards. Presented at the 12th Canadian Symposium on Catalysts, Alberta, Canada, May 25-28, 1992.

8. "FT-IR, NMR and XRD Investigation of Phosphorus Promoted Ni-Mo- Al_2O_3 Hydrotreating Catalyst Precursors". E.C. Decanio, J.C. Edwards, T.R. Scalzo, D.A. Storm, presented at Spring Symposium of the Catalysis Society of New England, Yale University, March 18, 1992.

9. "FT-IR, NMR and XRD Investigation of Phosphorus Promoted Ni-Mo- Al_2O_3 Hydrotreating Catalyst Precursors". E.C. Decanio, J.C. Edwards, T.R. Scalzo, D.A. Storm, presented at Spring Symposium of the Catalysis Society of Metropolitan New York, Lehigh University, March 11, 1992.

10. "Investigation of Calcined, Reduced, and Sulfided Phosphorus Promoted Ni-Mo/ Al_2O_3 Hydrotreating Catalyst Precursors". E.C. Decanio, J.C. Edwards, D.A. Storm, presented at 22nd North East regional Meeting of the ACS, Syracuse, NY, June 21-24, 1992.

11. "FT-IR, Solid-State MAS NMR and Ethanol- ^{18}O TPD Analysis of Fluorided Aluminas". E.C. Decanio, V.P. Nero, J.C. Edwards, J.W. Bruno, presented at 204th ACS National Meeting, Washington D.C., August 25-28, 1992.

12. "Acidity, Chemical and Thermal Stability of [B]-ZSM-5 and [B]-ZSM-11". M.W. Simon, S.S. Nam, W. Xu, S.L. Suib, J.C. Edwards, C.L. O'Young, presented at ACS Symposium on Recent Advances in Molecular Sieve Materials, Denver, Colorado, March 1993.

13. "Comparison of Molecular Representation of Ratawi and Alaska North Slope Asphaltenes Based on Liquid and Solid-State NMR". D.A. Storm, J.C. Edwards, S.J. Decanio, E.Y. Sheu, presented at ACS Symposium on Resid Upgrading, Denver, Colorado, March 28-April 2, 1993.
14. "Effect of Secondary Porosity on Gas Oil Cracking Activity". E.P. Dai, L.P. Neff, J.C. Edwards, presented at the Symposium on Advances in Fluid Catalytic Cracking, 206th ACS Meeting, Chicago, IL, August 22-27, 1993.
15. "Elucidation of the Inorganic Chemistry of Hydrotreating Catalyst Additives". E.C. Decanio, J.C. Edwards, D.A. Storm, presented at the National ACS Meeting, Denver, Colorado, March 28-April 2, 1993.
16. "Investigation of Phosphate and Sulfate Promoted Ni-Mo/Al₂O₃ Hydrotreating catalyst Precursors". E.C. Decanio, J.C. Edwards, D.A. Storm, J.W. Bruno, presented at 13th North American Meeting of the Catalysis Society, Pittsburgh, Pennsylvania, May 2-7, 1993.
17. "Molecular Modeling Studies of Phosphate Chains on Gamma-Alumina". J.R. Ugolini, E.C. Decanio, J.C. Edwards, P.S. Subramanian, K.J. Chou, presented at the Fall National ACS Meeting, Chicago, Illinois, August 22-27, 1993.
18. "Mechanisms of Formation of Combustion Chamber Deposits". W.P. Acker, R.T. Hahn, F.J. Deblase, J.C. Edwards, R.L. Sung, presented at CRC Combustion Chamber Deposit Meeting, Orlando, Florida, November 1993.
19. "Applications of Solid- and Liquid-State ¹³C and ¹H Nuclear Magnetic Resonance to the Analysis of Ethylene-Propylene Copolymers". G.Marsh, J.C. Edwards, M.Mishra, presented at the Spring National ACS Meeting, San Diego, California, March 13-18, 1994.
20. "Process Applications of NMR on Flowing Gaseous Streams". P.J. Giammatteo, G.Marsh, J.C. Edwards, presented at the 35th Experimental NMR Conference, Asilomar, California, April 10-15, 1994.
21. "The Role of Chemists in the Petroleum Industry". J.C. Edwards, presented under the auspices of the Industrial Research Institute, at Vassar College, Poughkeepsie, New York, March 9, 1994.
22. "Characterization of Gasoline Engine Combustion Chamber, Intake Valve and Crankcase Deposits by Solid-State ¹³C CP/MAS NMR Spectroscopy". J.C. Edwards, presented at the 36th Rocky Mountain Conference on Analytical Spectroscopy, Denver, Colorado, July 31-August 5, 1994.
23. "Sludge Formation During Heavy-Oil Upgrading". D.A. Storm, S.J. Decanio, J.C. Edwards, E.Y. Sheu, presented at the 6th UNITAR International Conference on Heavy Crude and Tar Sands, Houston, Texas, February 12-17, 1995.
24. "Process Applications of NMR on Flowing Gaseous Streams. Part II". P.J. Giammatteo, J.C. Edwards, presented at the 36th Experimental NMR Conference, Boston MA, March 26-30, 1995.
25. "Monitoring the Chemistry of Phosphorus Compounds in Lubricants". J.R. Sieber, J.C. Edwards, presented at the 44th Annual Denver X-Ray Conference, Colorado Springs, Colorado, July 31 - August 4, 1995.

26. "Modification of Non-Template Synthesized Ferrierite/ZSM-35 for N-Butene Skeletal Isomerization to Isobutylene". W.Q Xu, Y.G. Yin, S.L. Suib, J.C. Edwards, C.-L. O'Young, presented at the Fall National ACS Meeting, Chicago IL, August 1995.
27. "Design of 'Beaded Molecular Strings' ". M.K. Mishra, J.C. Edwards, P.M. Subramanian, R.D. Pugliese, presented at International Ionic Polymerization Conference, Istanbul, Turkey, September 2-9, 1995.
28. "Development of a Process NMR Gasoline Analysis System". J.C. Edwards, P.J. Giammatteo, G.P. Firmstone, P.D. Cusatis, presented at the 37th Experimental NMR Conference, Pacific Grove, CA, March 17-22, 1996.
29. "Process Applications of NMR on Flowing Gaseous Streams. Part III. The Installation and Operation of an On-Line NMR in a Refinery". P.J. Giammatteo, J.C. Edwards, T. Cohen, M.W. Blakley, presented at the 37th Experimental NMR Conference, Pacific Grove, CA, March 17-22, 1996.
30. "²H NMR of Low Temperature Crystallization Processes in Base Oils Utilizing a Perdeuterated Probe Molecule". J.C. Edwards, P.J. Giammatteo, A.J. Stipanovic, M.P. Smith, presented at the 37th Experimental NMR Conference, Pacific Grove, CA, March 17-22, 1996.
31. "Multinuclear and Multidimensional Solid-State NMR Investigations of Combustion Chamber Deposits". J.C. Edwards, presented at the National ACS Meeting, Petroleum Division, New Orleans, LA, March 24-29, 1996.
32. "NMR Based Refinery Process Control Systems: New Technology for Process Optimization". P.J. Giammatteo, J.C. Edwards, G.P. Firmstone, presented at the Texaco Technology Conference, Houston TX, July 15-17, 1996.
33. "NMR Based Process Analysis and Control: New Technology for Process Optimization". P.J. Giammatteo, J.C. Edwards, presented at the Instrument Society of America Meeting, Chicago IL, October 7-11, 1996.
34. "The Nature of 12-Tungstophosphoric Acid-on-Titania Catalysts". J.C. Edwards, C.Y. Thiel, B.L. Benac, J.F. Knifton, presented at the ACS Southwest Regional Meeting, Houston, Texas, October 17-19, 1996.
35. "High Resolution NMR Based Process Control for Petroleum Refining - Part I". P.J. Giammatteo, J.C. Edwards, presented at the Eastern Analytical Conference, Somerset, New Jersey, November 18, 1996.
36. "High Resolution NMR Based Process Control for Petroleum Refining - Part II". J.C. Edwards, P.J. Giammatteo, presented at the Eastern Analytical Conference, Somerset, New Jersey, November 18, 1996.
37. "High Resolution NMR Based Process Control for Petroleum Refining". P.J. Giammatteo, J.C. Edwards, presented at the Annual New Jersey ISA Chapter Meeting, Princeton, New Jersey, November 20, 1996.
38. "Investigation of Low Temperature Crystallization Processes in Base Oils Utilizing a Perdeuterated Probe Molecule and ²H NMR". J.C. Edwards, A.J. Stipanovic, P. J. Giammatteo, M.P. Smith, Invited presentation at the American Chemical Society National Meeting, San Francisco, CA, April 13-17, 1997.

39. "XPS and Solid-State NMR of Soot Produced in a Heavy-Duty Diesel Engine: Impact of Lubricant Additive Chemistry on Wear Performance". J.K. Mowlem, J.C. Edwards, presented at the 215th National ACS Meeting, Dallas, TX, March 29 – April 3, 1998.
40. "On-line Acid Strength Measurement and Sulfuric Acid Alkylation Process Control Using Process NMR". J.C. Edwards and Paul J. Giammatteo, presented at the ISA Analytical Division Meeting, Research Triangle Park, April 26-29, 1998.
41. "Lubricant Additive Chemistry Effects of Diesel Engine Soot on Wear Performance as Studied by XPS and Solid-State NMR", J.K. Mowlem, and J.C. Edwards, presented at the 72nd Colloid and Surface Science Symposium, Pennsylvania State University, June 21-24, 1998.
42. "Utilization of Process NMR for On-Line Acid Strength Determination and Sulfuric Acid Alkylation Process Control" J.C. Edwards, P.J. Giammatteo, E. Ross, presented at ISA Expo98, Houston, Texas, October 19-22, 1998.
43. "Process NMR Applications in the Refinery: Utilization, Closed Loop Control, and Value-Added Statements" J.C. Edwards, Presented at the Delaware ACS-SAS Process Analytical Topical Group Meeting, June 2002.
44. "Detailed Hydrocarbon Analysis of Naphtha by On-Line NMR : Integration of Real-Time NMR Feed Analysis With Advanced Process Control and Optimization" J.C. Edwards, P.J. Giammatteo , Presented at Eastern Analytical Symposium, Somerset, New Jersey, November 18-21, 2002.
45. "On-Line Analysis of Crude Feeds and Distillation Products: Utilization of On-Line NMR on a Refinery's Crude Distillation Unit", P.J. Giammatteo, J.C. Edwards, Presented at Eastern Analytical Symposium, Somerset, New Jersey, November 18-21, 2002.
46. "Process MRA Lube Plant Application", Silvia Guanziroli, Roberto Giardino (EniTecnologie), Antonio Farina (ENI Refining & Marketing), Victor Lough (Invensys), John C. Edwards. Presented at the ERTC Computing Conference, Milan, Italy, June 23-25 2003.
47. "Process NMR Applications: Utilization, Closed Loop Control, and Value Added Statements", John C. Edwards and Paul J. Giammatteo, Presented at CPAC Fall 2003 Sponsor Meeting, Seattle, WA, November 3-6, 2003.
48. " High resolution NMR for On-Line Process Analysis and Control: Application and Utilization in Petroleum Refining and Petrochemical Industries. ", Paul J. Giammatteo and John C. Edwards, Presented at Eighteenth International Forum Process Analytical Chemistry - IFPAC, Arlington, VA, January 12-15, 2004
49. "Crude Oil Blending." Paul J. Giammatteo and John C. Edwards, Presented at the International School of Hydrocarbon Measurement, Oklahoma City, OK, May 18-20, 2004
50. "The Overlooked Spectroscopy - NMR and Process Analytical Technology" John C. Edwards, Presented at the Society of Applied Spectroscopy New York Section Meeting, December 1, 2004
51. "Pulse, Acquire, Control : Ten Years of Online High Resolution NMR in Refining, Petrochemical, and Food manufacturing", John C. Edwards and Paul Giammatteo, Presented at the 46th Experimental NMR Conference, Providence, RI, April 10-15, 2005.

52. "The Overlooked Spectroscopy - NMR and Process Analytical Technology" John C. Edwards, Presented at the Mid-Hudson Section ACS Meeting, Vassar College, Poughkeepsie, NY, May 12, 2005
53. "The Overlooked Spectroscopy - NMR and Process Analytical Technology" John C. Edwards, Presented at Scientific Update Conference on PAT in Organic Process R&D, Cambridge, MA, June 29, 2005
54. "Pulse, Acquire, Control : Ten Years of Online High Resolution NMR in Refining, Petrochemical, and Food manufacturing", John C. Edwards and Paul Giammatteo, Presented at NERM 2005, Fairfield, CT, July 14-17, 2005
55. "The Wonderful World of Non-Traditional NMR", John C. Edwards, Invited Presentation at the ACS student Section Meeting, Marist College, Poughkeepsie, NY December 6, 2006
56. "Pulse, Acquire, Control : Ten Years of Online High Resolution NMR in Refining, Petrochemical, and Food manufacturing", John C. Edwards, Invited Presentation at Elms College, Chicopee MA, April 17, 2007
57. "Pulse, Acquire, Control : Ten Years of Online High Resolution NMR in Refining, Petrochemical, and Food manufacturing", John C. Edwards, Invited Presentation at Cooper Union, New York, NY, September 18, 2007
58. "New Developments in Non-Traditional NMR Applications", John C. Edwards, Invited Presentation at 9th Upstate New York NMR Symposium, SUNY-ESF, Syracuse, NY, October 12, 2007
59. "Introduction to High Resolution NMR in Process Control", John C. Edwards, Presented at Eastern Analytical Symposium, Somerset, NJ, November 14, 2007
60. "How to Derive Considerable Returns from 1970's Style NMR - Quantitative $\pi/4$ ^1H Pulses at 60 MHz", John C. Edwards, Invited Presentation at the North Jersey ACS - NMR Spectroscopy Group Meeting, Iselin, NJ, December 12, 2007
61. "Solid-State ^{13}C NMR Applied to Petroleum Related Materials - Combustion Deposits, Asphaltenes, Residues, Kerogen, Shale, Bitumen, Coal, the Works", John C. Edwards, Invited Presentation at the SACI/RSC Solid-State NMR Spectroscopy Workshop, University of Stellenbosch, Stellenbosch, South Africa, February 4-7, 2008
62. "Aspects of Liquid and Solid-State NMR Applied to Materials Science", John C. Edwards, Invited Presentation at the SACI/RSC Solid-State NMR Spectroscopy Workshop, University of Stellenbosch, Stellenbosch, South Africa, February 4-7, 2008
63. "Pore Surface of Cellulose as Studied by Low-Resolution NMR", E. Nikolskaya, Y. Grunin, John C. Edwards, L. Grunin, Presented at the 9th International Bologna Conference Magnetic Resonance in Porous Media, Cambridge, MA, July 13-17, 2008
64. "RCC Feedstream Analysis by ^1H and ^{13}C NMR: Multivariate Prediction of Physical and Chemical Properties", John C. Edwards, Jincheol Kim, Presented at ACS 236th National Meeting, Philadelphia, PA, August 17-21, 2008
65. "Counting Carbons for Tighter Control: Combining GC and NMR to Improve Distillate Manufacturing" Paul J. Giammatteo, John C. Edwards, George Winter, Presented at 104th Gulf Coast Conference, Galveston, TX, January 20-21, 2009.

66. "Analytical Data For Engineering Support: Improving the Lab/Process Interface" Paul J. Giammatteo, John C. Edwards, Presented at 104th Gulf Coast Conference, Galveston, TX, January 20-21, 2009
67. "Integrated Analysis and Control to Enhance Clean Fuels Production" Tal Cohen, Paul J. Giammatteo, John C. Edwards, Presented at 54th Annual Symposium of the ISA Analysis Division, Houston, TX, April 19-23, 2009.
68. "A Self-Employed Application Chemists Odyssey in the World of Analytical Instrument Development The Viability of a \$50K High Resolution NMR and \$15K ESR Spectrometers", John C. Edwards, Invited Presentation to the Mid-Hudson ACS Section, Marist College, Poughkeepsie, NY, September 23, 2009.
69. "Digital Concepts in Building of NMR Relaxometers and Their Advantages in the Study of Natural Polysaccharides", L.Grunin, D. Karasev, E. Nikol'skaya, J.C.Edwards, I.Kalashnikov, I.Nikolaev, Y.Grunin, N.Celishva, presented at the 51st Experimental NMR Conference, Daytona beach, Florida, April 18-23, 2010.
70. "Improved Approach to the Calculation of Average Molecular Descriptions of Heavy Petroleum Hydrocarbons by Combined Analysis by Quantitative ¹³C and DEPT-45 NMR Experiments", John C. Edwards, Petrophase 2010, Newark, NJ, June 13-17, 2010.
71. "A Self-Employed Application Chemists Odyssey in the World of Analytical Instrument Development The Viability of a \$50K High Resolution NMR and \$15K ESR Spectrometers", John C. Edwards, Invited Presentation at University of South Dakota, Vermillion, SD, July 21 2010.
72. "Simple and Continuous Flow Reaction Monitoring by High Resolution Bench-top Permanent Magnet ¹H NMR at 60 MHz", John C. Edwards, Paul J. Giammatteo, to be presented at SMASH 2010, in Portland Oregon, September 26-29, 2010.
73. "Bench-top and On-line High Resolution Permanent Magnet 60 MHz NMR for Reaction Monitoring and Process Control" , John C. Edwards, Paul J. Giammatteo, to be presented at FACSS 2010, in Raleigh, NC, October 17-21, 2010.

BOOK CHAPTERS

1. "Sulfuric Acid Alkylation Process Control" John Edwards, in **Process/Industrial Instruments and Controls, 5th Ed.**, Eds. Gregory K. McMillan, Douglas M. Considine, McGraw-Hill, 1999.
2. "Laboratory Analysis" Paul Giammatteo and John Edwards, in **Environmental Instrumentation and Analysis Handbook** , Eds. Randy D. Down and Jay H. Lehr, Wiley, 2004.
3. "Process NMR Spectroscopy: Technology and On-line Applications" John C. Edwards, and Paul J. Giammatteo, in **Process Analytical Technology: Spectroscopic Tools and Implementation Strategies for the Chemical and Pharmaceutical Industries, 2nd Ed.**, Editor Katherine Bakeev, Blackwell-Wiley, 2010
4. "A Review of Applications of NMR Spectroscopy in Petroleum Chemistry" John C. Edwards, in **Monograph 9 on Spectroscopic Analysis of Petroleum Products and Lubricants**, Editor: Kishore Nadkarni, ASTM Books, to be Published in 2011.

PATENTS

1. "*NMR Probe with Flow Restriction Element*", Tal Cohen, John C. Edwards, Paul J. Giammatteo, Uri Rapoport, Naim Levi Assignee: Foxboro NMR Ltd, United States and International Patents Pending

MAGAZINE ARTICLES

1. "*Reliable Refinery Control Using Process NMR*", **Control Magazine**, Paul Giammatteo and John Edwards, June 1999.

2. "*Steam Cracker Performance Optimized by Process MRA*", **Control Magazine**, John Edwards, July 2003.

References Available Upon Request