Science Advisory Board

Elmer Rauckman, Ph.D. was trained as a chemist but has been a practicing toxicologist for over 25 years. He received his Ph.D. in organic chemistry from Duke University where his thesis work concerned isolation and identification of alkaloids from plants. He also conducted and published research in immunology prior to being awarded his PhD. After post-doctoral work in pharmacology and toxicology, he joined the facility of Duke Medical Center with a joint appointment in the departments of Surgery and Pharmacology. He was involved in setting up the Toxicology training program at Duke and conducted an active research program in drug metabolism and free-radical toxicology. His research on Reactive Oxygen Species (ROS) provided major contributions for the determination and measurement of Hydroxyl radical and superoxide induced toxicity. Subsequently, he joined the National Toxicology Program (with the National Institute of Environmental Health Sciences of the National Institutes of Health) where he managed EPA and FDA sponsored research programs in general toxicity and carcinogenicity of drugs and chemicals.

After leaving government service, Elmer directed the toxicology programs for several divisions of Hoechst-Celanese and the Hoechst Corporation. His experience there included toxicology and global regulatory issues for chemicals, drugs, medical devices, plastics and both direct and indirect food additives. He has served on several trade-association scientific committees and taskforces as well as NIH grant and contract review committees. He is a Diplomat of the American Board of Toxicology and a full member of the Society of Toxicology.

Donald O. Johnson, Ph.D. was formerly the Associate Director of the Energy Systems Division and the Director of the Center for Industrial Technology Systems at Argonne National Laboratory (ANL). He has been responsible for managing and directing several multidisciplinary, multimillion-dollar, multiyear projects. As Center Director, he has been responsible for all scientific and engineering programs related to industrial processes, including environmental controls (air and water) and process improvements. These programs included all activities in sonication, advanced oxidation, photocatalysts, ultraviolet systems, and incineration. He has almost 40 years experience in the environmental and energy fields.

Dr. Johnson joined Argonne in 1974 following 10 years of fieldwork as a geologist for the Illinois State Geological Survey (1964-1972), and two years at the Ohio Geological Survey. From 1974 to 1979, DOE and EPA funding supported his research, which focused primarily on cleanup of lands contaminated by coal mining. He was Deputy Director of the Center for Land Reclamation Research before he left Argonne to join the newly formed Gas Research Institute (GRI). He established an internationally recognized program of environmental research to solve natural gas industry problems.

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In 1986, Don returned to Argonne where he gradually assumed greater management responsibilities including annual budgets of $30 to $50 million and staffs of up to 140 professionals. He left the Laboratory in August 2000 to establish TechSavants, Inc. During the past year, Dr. Johnson has been Principal Investigator on a USDA-SBIR grant (Closed Loop Recycling of Animal Wastewater), two USDOE-SIBR grants (Phase 1 and Phase 2 on stimulating oil wells using sonication), as well as being directly involved in projects with the industrial sector involving sonication to remediate underground natural gas storage wells and for air and water cleanup at a California foundry. He received his B.S. and M.S. degrees in geology from Northern Illinois University, and his Ph.D. in geology from the University of Illinois. Dr. Johnson has been a member of 11 national/international committees and has more than 50 publications in various areas of energy and environmental research.

Geoffrey E. Dolbear, Ph.D. earned a Bachelor of Science in Chemistry from the University of California, Berkeley, in 1962. He went on to earn a PhD in Chemistry at Stanford University in 1966, where his major professor was Henry Taube, who was awarded the Nobel Prize for Chemistry in 1983. Geoff is an active member of the

American Chemical Society, and was treasurer and later Chair of the Division of Petroleum Chemistry. He is also a member of the North American Catalysis Society and the Commercial Development and Marketing Association. He is listed in American Men and Women of Science.

Dr. Dolbear is founder and President of G.E. Dolbear & Associates, a consulting firm active since 1989, dedicated to improving clients' profits. His specialty is solving energy and environmental problems, marketing to help them find customers for their products and services, and in writing and editing technical reports. Dolbear's experience in these areas includes in-depth work in several areas:

Expertise in fuels and refining process chemistry, developed over 35 years of experience in developing and evaluating new and improved processes for petroleum refining. Specific areas of experience include manufacture of clean diesel by hydrotreating and oxidative desulfurization, fluid catalytic cracking catalysts and processes, and catalytic hydroprocessing of heavy liquids (residual oil, tar sand bitumen, and heavy oils). The work led to several dozen publications and more than ten issued US patents.

Dolbear led team of consultants that developed a novel oxidative desulfurization technology for diesel and jet fuel for a refining company client. This work built on chemistry identified by the client, and led to process defined and evaluated at the bench scale. US Department of Energy issued a contract with the client company to develop the process through the pilot stage. Several papers and patents also resulted from the work.

Dr. Dolbear's publications include the book ***Petroleum Catalysis in Non-Technical Language*** (Pennwell, 1998), co-authored by John S. Magee. He is called upon regularly to provide tutorial seminars on areas of petroleum refining including the manufacture of clean fuels and the chemistry of refining processes.

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Goeff was instrumental in developing processes to convert oil shale and coal to petrochemicals, and he led a team to provide technical and economic evaluation of these processes and development of process options to improve the economics of projects based on them. Two patents and more than ten publications resulted from various aspects of this work.

Dr. Dolbear's experience in solving environmental problems includes projects aimed at control of solid waste and reduction of air pollution. Several publications and three issued US patents resulted from this work.

Geoff's firm provides marketing services to technical firms seeking to expand their businesses. Current and past projects include developing and implementing marketing plans for clients who provide services and products. Successful completion of these projects relies on applying well-established techniques of market and business analysis, utilizing a broad network of personal and professional contacts in the oil and chemical industries.

Teh Fu (Dave) Yen, Ph.D. is Professor of Environmental Engineering at the University of Southern California. He has had a long and illustrious career and is highly respected in his field. His education and degrees include: B.S. Huachung (Central China) University, Chemistry, 1947; M.S. West Virginia University, Chemistry and Chemical Engineering, 1953; Ph.D. Virginia Polytechnic Institute, Organic Chemistry and Biochemistry, 1956; Postgraduate in Mathematics, Kent State University, 1955-58; University of Akron, 1958-59; University of Pittsburgh, 1959-61 (Ph.D. Candidate in Mathematics, dissertation not complete); Took courses in Microbiology, University of Southern California, 1970-71; Certificate of Bioengineering: Columbia University, 1972; D.Sc. (hon.) Energy Engineering: Pepperdine University, 1982; D.Sc. (hon.) Dubna International University, Russia, 1996; D.Sc. (hon.) VNIGRI (Environmental Sciences), St. Petersburg, Russia, 1999.

Positions held include: Senior Research Chemist, Goodyear Tire and Rubber Co. (1955-59) (Polymer sciences); Fellow (1959-64), Senior Fellow (1965-68), Mellon Institute, Carnegie-Mellon University (1959-68) (Geochemistry); Associate Professor of Chemistry, California State University, Los Angeles, (1968-69) (Organic Chemistry); Associate Professor of Biochemistry, Chemical and Environmental Engineering, University of Southern California (1969-80); Current: Professor of Environmental and Civil Engineering, University of Southern California (1980-present).

Concurrently he has held positions as Research Liaison and Advisor, Gulf Research and Development Co., Gulf Oil Corp (1960-68); Asian Foundation Lectureship by Academia Sinica to National Tsinghua University and Union Industry Research Institute (now Industry Technology Research Institute), Taiwan, (1965); Gulf Oil Lecture Tour at University of Guelph, Sherbrook University, Brock University and University of Windsor (1967); Visiting Professor of Chemistry and Chemical Engineering, National Taiwan University (Spring 1968); Toyo Rayon Lectureship, University of Tokyo (1968); US Representative, 8th World Petroleum Congress, Moscow, also lectured at Shell, Amsterdam, French Institute of Petroleum and B.P. Research Center (1971); Major Consultant to Chevron (1968-75); to UOP (1968-75); to TRW (1982-85); to Exxon (1981-82); to US Department of Commerce

(1982-85); to DuPont-CONOCO (1985-88); to Imperial Oil (1994-1998); US National Academy of Sciences Nominated Exchange Visitor to USSR Academy of Sciences, Moscow, Borok, Lvov (Ukraine), also to Katowice, Poland (1975); UNITAR lectureship to Gottingen University, Germany, University of Bristol, UK, and University of Cardiff, Wales (1976); Japan National Oil Corp. Lectureship, Chiyoda Chemical Engineering Co. and Akita University (1982); Chinese Academy of Sciences, UNDP-TOKEN Fellow (1987), Standing Committee Member, Colloid and Surface Chemistry (1990-present), Councilor, Organic Geochemistry (1993-present), Professor (hon.), Institute of Photochemistry (1996-present); East China University of Chemical Technology, Shanghai, Special Lecturer (1980, 1985), Professor (hon.) (1986-present); University of Petroleum, Beijing, Professor (hon.) (1987-present), Special Lecturer (1991), Training program (1992), Committee Member for heavy oil (1993-present); Specialist, Industrial Development Bureau, Taiwan (1999).

Among the honors and awards are: Distinguished Faculty Member Award, Alumni Association of University of Southern California (1975); Imperial Crown Gold Medal, Iran (1977)-for research and published books on oil shale; Achievement Award, Chinese Engineering and Scientific Association of Southern California (1977)-for his contribution of energy technology; Outstanding Service Award, National American Chemical Society (1982)-for founding of the Geochemistry Division at the American Chemical Society in 1980; International Community Service Award, Government of Honduras (1989)-for energy source exploration; American Chemical Society Awards in Petroleum Chemistry (sponsored by AMOCO Foundation) (1994)-in recognition of his pioneering efforts in the development of geochemistry including establishment of the structure and chemistry of asphaltenes; Chinese American Chemical Society Distinguished Achievement Award (1994)-in development of chemical processes for environmental engineering; Fellow, American Institute of Chemists (New York); Fellow, The Chemical Society, London; Fellow, Institute of Petroleum, London; Academician in earthscience (Foreign Member), Academy of Natural Sciences of Russian Federation (1994)-due to contribution of geochemistry of fossil remains; Academician (Foreign Member), National Academy of Engineering of Armenia (1995)-petroleum technology; Peter the Great Gold Medal, Russian Academy of National and Social Sciences, 1995 (for Geomicrobiology Applications); Lomonosov Medal, Former USSR Academy of Sciences, Moscow (1996)-fossil fuels; Editor and Editory Board Member of nine technical journals including founding editor for two journals (12 years of Biomaterials, Medical Devices and Artificial Organs, an international journal, since 1974, and 12 years of Energy Sources, an international journal, since 1973); Founder of Geochemistry Division, ACS (including the petition, having probationary status and being the first chairman in 1979); Listed in Who's Who in America (as well as in Technology, in the West, and in California), also in Marquis' World Who's Who in Science, from Antiquity to Present; Member, New York Academy of Science.

Dr. Yen's research centers on the science and technology leading to the development of alternative processes to achieve environmentally-benign fossil energy. In order to study the clean energy, microbiological processes applied to the recovery of natural resources and membrane-mimetic chemistry related to environmental engineering processes of wastewater and soil, such as decontamination and biotreatment including biorestoration,

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were demonstrated. Currently the uses of medium microwave-and ultrasound-assisted chemical processes have applied to the cracking and upgrading of heavy oil and degradation of disinfectant-byproducts and other contaminants in water.

Desulfurization of petroleum in ambient temperature and pressure has been accomplished through destructive adsorption by nanotechnology with intermetallics and oxidative conversion with ultrasound cavitation. He always employs multidisciplinary approaches to solve broad interdisciplinary problems. Detailed descriptions are as follows:

Sulfur Removal in Residual Oil by Filtration at Ambient Temperature and Pressure (Klinair Environmental),Either nanotechnology of destructive adsorption by intermetallics or attack by hydroxyl radicals under ultrasound can remove considerable amount of sulfur species in oil. Initially the interest is centered on the microbiological desulfurization technology, which involves enzymes in membrane mimetic system. Since the first announcement in ACS Div. Fuel Chem., 33(4), 573 (1988), with the subsequent publicity in Bioprocessing Tech., 10 (1988); AlChE Conf. (1989), many requests from foreign countries are at hand. After the appearance of Bioprocessing and Biotreatment, Coal, 725 (1990); J. Chem. Tech. Biotech., 48, 71 (1990); many requests for information have been received. For sulfur filters using nanotechnology or ultrasound, since USC Chronicle article, Smart Filter Promises Worldwide Applications: Nanotech Device Removes Sulfur, Refines Crude, was published, about 200 e-mails have been received. Also, papers appearing in New Scientist, April, 1998; Chemical Engineering, May, 1998; Chemical Progress Alert, June, 1998, Chemical Engineering Progress, December, 1998; and other news media. Preliminary publications include: PCT Int. App., A Fuel Filter and Production Process, April, 1997; Proc. 7th UNITAR International Conference, Beijing, 2, 2137 (1998); Proc. 3rd International Petroleum Conference Paper, New Delhi, 1999; J. Petrol. Sci. Tech. 18, 657 (2000). Membrane-Mimetic Chemistry based Utilization of Median Microwave or Ultrasound-Assisted Chemical Processes (Western Extraction, Enersource Inc., Remsol USA, INTEVEP, Texaco, Navy, AERA).

Earlier use of physicochemical treatment of heavily-laden industrial wastewater involves controlled electro-oxidation and reduction method. Retort water, aqueous liquid effluent from coal conversion, shipyard derusting water, geothermal brine, pink water, etc. U.S. Pat. 4,043,881 (1977); U.S. Pat. 4,114,501 (1978); Brit. Pat 1,535,106 (1978); 2nd Pacific ChE Congress, 1, (1977); EPA Report PB 82-208273 (1982); Wen's Ph.D. dissertation (1977); Env. Eng. ASCE, 460 (1984); U.S. Pat. 5,139,679 (1992). This combined pollution cleanup and processing concept is superior than the traditional pre- or post- pollution control measures, ranging from cracking and upgrading of fossil fuels to decontamination of disinfectant- byproducts from contaminated water by ultrasound method. 3rd and 4th UNITAR Conf. Papers; U.S. Patent 4,765,885, 1988 (22 claims); 4,891,131, 1990 (38 claims), 5,017,281, 1991 (6 claims), Canadian Patent 1,283,879 (47 claims). Review paper has been published in Russian, Geol. Nefti Gaza (Moscow) 8, 24 (1988); in Spanish, Ana. Quim (Madrid) 86, 175; and in English, Energy and Fuel, 4, 604 (1990); ibid. 7, 111 (1993); J. Pet. Sci. Eng., 8, 105 (1992); Chem. Eng. Comm., 117, 191 (1992); Energy Sources, 16, 439 (1994); In Situ and On-site Bioreclamation, 7, 31 (1995); 15th World Petroleum Congress, Forum 17, 2, 933, (1998); 7th UNITAR International Conference, 2, 2137

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(1998); ACS Div. Pet. Chem., 44(2), 213 (1999). Also resulted in two books, Membrane-Mimetic Chemistry (1994) and Asphaltene Particles (1994) and 4 Ph.D.'s dissertations. A number of trade journals publicized the ultrasound work: Hydrocarbon Processing, 5, 27 (1992); Hazmat World, 7, 69 (1992); Energy, 24(2), 41 (1999).

The Chemical Assisted Ultrasonic Process - Either Oxidative or Reductive Mode Oxidative desulfurization can remove sulfur from heavy oil and diesel efficiently. For diesel removal of sulfur from 2000 ppm to 50 ppm is feasible. (US Pat. 6,402,939, 2002; Lu's dissertation, 2000; Fuel (London), 81, 2002). MTBE and other oxygenaters can be completely destroyed in water by the oxidative ultrasound method. For the in situ elimination of MTBE in groundwater, transducers can be mounted in a driller or pumphead housing in a contaminated aquifer. The added advantage is also the destruction of TCE and PCE therein by this process. The added chemicals (hydrogen peroxide and ferrous ion) do not interfere with drinking water qualities. (ACS Div. Coll. Surf. Chem., 1999; Proc. 2nd International Conference of Remediation of Chlorinated and Recalcitrant Compounds, Monterey, 2000.) Using downhole upgrading and the reservoir as a reactor, the heavy crude can be lifted to pipeline with improved oil qualities (reduction of viscosity and heterocyclics) under the chemical assisted ultrasound at reducing conditions. The reducing agent, hydrogen, can be produced in situ by any bimetallic catalyst (ACS Div. Fuel Chem., 44(1), 76, 1999; Energy Fuel, 14, 1168, 2000). Pipeline Fouling and Blockage by Scales, Waxes, Corrosion Products and Asphaltenes for Production and Transportation (Chevron, Kaprielian Tech. Innovation Fund) Complexation dissolvers or inhibitors were studied by dissolution kinetics and solid surface modification of regrowth (even via magnetic flux) through AFM, SFM, SEM, Auger and other microscopic instruments. The investigation is centered on the environment, such as magnetic field, ultrasound radiation, and the presence of additives such as inhibitors. Mechanism and morthology of corrosion inhibitors will be examined by modeling. Morphological change at a given surface is investigated for any types of distortion or dislocation. ACS Div. Pet. Chem., 42(3), 691 (1997); Env. Sci. Tech., 33(16), 2821 (1999); J. Coll. Interf. Sci., 214, 427 (1999); ibid. 219, 212 (1999); Langmuir, 16, 649 (2000); Colloids and Surfaces, 160(2), (2000). In Situ and On-Site Biotechnology Adopted for Geotechnical Applications (NSF, NCEL, National Brookhaven Lab, Pacific Earthquake Center, DOE) Biopolymer barriers and covers, bioencapsulation, zonal bioremediation. Using Alcaligenes eutrophus together in soil matrices, the resulting intracellular polyesters (e.g., PHB) can decrease the relative fluid permeability and increase mechanical strength. Application of this concept is enormous, e.g., stabilization and minimization of soil erosion potential, mitigation of soil liquefaction susceptibility during earthquakes, etc. Other biopolymers, such as xanthum gum or polymers derived from slime-forming bacteria also can be used. Current work centers on the in-situ stabilization of subsurface contaminants through the use of three microbial polymers. Chitin/chitosan, PHB/PHV, and xanthan are used as a tripleset of interpenetrating polymer networks to vitrify the hazardous metals on site. 2 papers in MEOR-Recent Advances (1993); 3 Ph.D. dissertations; 2 papers in Applied Biotechnology for Site Remediation (1994); 7th Australia-New Zealand Conf. on geomechanics (1995); North Am. Water and Env. Congress (1996); 10th International Biotech. Symp. Sydney (1996); Tarim Petroleum Exploration Bureau, Xingjang, China (1996); J. Petroleum Sci. Eng., 21, 223 (1998); 5th International Symp. on In-Situ and On-Site Bioremediation, 5(6),

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175, (1999); Industry Partnership for Env. Sci. and Tech. Conf., DOE/NETL (2001).

Elucidation of the Chemical Structures of Various Native Petroleum Asphaltene from World-Wide Crude Oil (Gulf, PRF, DOE, GRI, AERA, Thygard) Development of various physical methods such as x-ray small angle scattering and wide angled diffraction, ESR, NMR, IR, electron microscopy, ultracontrifuge, and mass spectrometry suitable for analyzing the heavy fractions of petroleum. Anal. Chem., 33, 1587 (1961); Anal. Chem., 39, 1847 (1967); Nature, 233, 36 (1971); Energy Sources, 1, 47 (1974); The chemical structure of asphaltene has been illustrated in at least 15 books and journal review articles. The latest summary appeared in Encyclopedia of Polymer Sci. and Eng. (Wiley) as Asphaltic Material, 1990 by Yen, (10 pages of summary). One book was published by Plenum, two books by Elsevier, Asphaltenes and Asphalts (1994 and 2000). 1994 ACS Awards in Petroleum Chemistry sponsored by AMOCO foundation was given with a special symposium in honor of Yen. (ACS Petroleum Prep., 39(2), 196, 1994.) Keynote papers at Rome (1991) and Rio de Janeiro (1995) and Cancun (1997) conferences.

Featured chapter in Structures and Dynamics of Asphaltenes (1998). An issue of Petrol. Sci. Engineering was in honor of Yen (Vol. 22, Issue No. 1-3, pp. 1-216, 1999). Isolation, Separation, Concentration and Removal of the Polar Components in Petroleum and Other Synfuels. For applications, novel strategies of efficient recovery and control technology are demonstrated. Earlier the work was emphasized on the characterization of coal liquids and fractionations. Fuel, 58, 219 (1979); ibid. 57, 100 (1978); various papers in Anal. Chem. between 1978-1983. For applications, see U.S. Pat. 4,232,738 (1980), a monograph Oil-Field Chemistry, published in 1989, and a set of two volumes of Enhanced Oil Recovery (EOR), by Elsevier between 1985-1989. These include basic science of caustic alkaline water flooding and surfactant micellar recovery methods. Later, the emphasis was on the characterization of heavy oil components. Correlation of geochemical biomarkers to petroleum genesis and maturation including application to oil spill abatement and gas migration seepage mitigation. 1st and 2nd UNITAR/ UNDP Heavy Oil Proceedings papers; a monograph Geochemical Biomarkers, published in 1988, J. Planar Chromat. (Heidelberg), 3, 376 (1990); ibid. 5, 263 (1992). J. Pet. Sci. Eng., 6, 95 (1991); ibid. 8, 105 (1992). Asphaltene leads to novel methods for the selection of low-cost precursors of carbon fibers and graphites. Weinberg's Dissertation (1981); Fuel, 61, 383 (1982); Carbon, 21, 39 (1983); Fuel, 62, 1503 (1983); ACS Symp., 260, 263 (1984); Mol. Cryst. Liq. Cryst., 5, 141 (1988); U.S. Pat. 4,773,985 (1988); Energy Sources, 15, 391 (1993). A number of trade journals and newspapers have described the research conducted for cheaper ways to produce carbon fibers, e.g., "Its Lightweight, Yet Stronger Than Steel," Daily News, 1981; "Dentproof Cars," Science Digest, 1982; "USC Scientist Sees Revolutionary Future for Carbon Fiber," Engineer, 1982; "Growth of Composites is Bolstered by New Fibers," Chem. Engineering, 1984. In order to use abundant natural resources, development of in situ method for chemical reaction of coal and the chemical fracture of shale and other matrix modification of fossil fuel sources was made. Fuel, 59, 287 (1980); 1979 Intersociety Energy Conversion, Proc. paper, U.S. Pat. 4,522,265 (1985). Development of asphalt-based insulation foams, artificial wood and paneling, floor and outside tiles, and with carbon fiber as rigid foundation support. A prefabric house unit from asphalt has been built. The use of asphalt beyond transportation for pavement has

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been demonstrated. For carbon fiber alone, Du Pont, Oak Ridge, Mobil, ARCO (Harvey Center), Owens Corning, etc. all requested for seminars given by Yen between 1982-1985. Geological Biomarkers in Fossil Fuels: Elucidation of the Nature of Vanadium Bonding and Speciations in Heavy Oil Including the Geochemical Genesis of Vanadium and Nickel in Petroleum (Gulf, AGA, ERDA, NOAA, NSF, PRF, DOE) Yen's monographs of Electron Spin Resonance of Metal Complex, published in 1972 and The Role of Trace Metal in Petroleum, published in 1975. Review paper by John Reynold presented in Yen's 1994 petroleum award symposium (and subsequently published in Asphaltenes and Asphalts Vol. 2, 2000). Also later, the isolation, separation of fossil porphyrins in rocks and sediments were investigated. Studies of the geo-transformation of the porphyrin ligand structures by a number of physical and chemical methods. J. Am. Chem. Soc., 89, 3631 (1967), Inorg. Chem, 7, 731 (1968); ibid. 7, 2665 (1968); ibid. 8, 689 (1969); Fuel, 43, 191 (1969); J. Inst. Petroleum (London), 55, 87 (1969); Sci., 167, 754 (1970); Terrestrial and Extraterrestrial Stable Organic Molecules, in Chemistry in Space Research, (1972); Naturwiss. (Berlin), 58, 267 (1971); Space Life Sci., 4, 69 (1973); ACS Div. Pet. Chem., 44(2), 209 (1999); Bulk of materials translated and appeared in Chinese book version, entitled Collective Work in Organic Geochemistry of T.F. Yen, which was selected by Academia Sinica, Beijing, China and published by Xin Hua Publishers in 1986 with 22 articles. Lecturing on four trips to the USSR and Russia. Cited by Academy of Natural Sciences of Russian Federation as major contribution to science, and entitled to Yen to become an academician in 1994. Energy Sources issued a tribute to Prof. Yen on this occasion for being received the Vernadskey medal in Russia.

(Energy Sources, 12(6), iii-iv, 1995.) Induction or enhancement the self-containing minor component for catalyst and reagents for processing. Using original native V and S in residual oil to form VS4 as catalyst (Aurabon) UOP inc. right. Use of native Mo and Ti in coal for conversion catalyst. Also, use of surfactant present in petroleum to recover petroleum. U.S. Pat. 4,232,738 (1982); U.S. Pat. 4,325,433 (1982); Can. J. Chem. Eng., 60, 325 (1982); ACS Symp. Ser., 396, 376 (1889); 15th World Pet. Congress (1997). Using Fe2+, Cu2+ in groundwater and in oil for Fenton's reaction. Use of vast organic carbon containing kerogens and asphaltenes fermented as food supplements. First stage is the elucidation of kerogen structure by both chemical and physical methods. Geochim. Cosmochim. Acta., 41, 1411 (1977); ibid., 1007 (1977); Ten papers between 1975 and 1990 on the subject of Green River, Appalachian, Chattanooga and Monterey shale kerogen structure, including one book on kerogen to be published by Springer Verlag in 2002.

Wang's dissertation (1990). Using extreme thermophylics, Clostridium thermohydrosulfuricum 39E, with nitrogen enriched modified kerogen as sole substrate; the kerogen network can be biodecomposed to smaller molecules. (MEOR, Recent Advances, Elsevier, 1991).

Transport of Bacteria in Porous Media (DOE, NSF, United Tech.) Modification of cell and rock surfaces and the use of spores and phages to facilitate transport. Specially directly applicable to microbial enhanced oil recovery (MEOR). Basic investigation on zeta potentials involving interfacial phenomena and electrokinetic model of oxides. A series of

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6 publications in J. Coll. Interf. Sci. and Coll. and Surf. between 1983 and 1988. Bacterial transport became a major project. Four Ph.D. dissertations (Jang, Y. Chang, P. Chang, and M. Sharma), and 25 papers on this project. A number of trade journals recorded, e.g., "Microbes: The Oilman's Friend," The Energy Daily, 1981; "Research Brightens Future of Enhanced Oil Recovery," Chem. Eng., 1985. This work resulted in two books on MEOR; one was published by Elsevier in 1989, the other by CRC Press in 1990. New well-head biosurfactant sources are investigated, J. Petroleum Sci. Eng., 21, 223 (1998). Development of "Bio-Huff n Puff" for shallow formation of heavy oil. MEOR is successful whereas other recovery methods fail. Yen's first MEOR test was in an abandoned well in Kansas using Clostridium sp. with syrup in 1985. Subsequently, Pseudomonas sp. and Bacillus sp. were used in Daqing Oilfield in 1988 and again the two bacteria species were used in Qinghai Oilfield in 1996, both in China. This essentially lead to the concept of ultimate oil recovery (UOR). MEOR-Recent Advances, 297 (1991); Proc. 6th UNITAR Conf., Houston, 2, 231 (1995). Case study in Qinghai Oilfield is summarized in Oil and Gas J., 98(4), 46, (2000). The biochemical conversion of oil shale to a more efficient production. As an earlier example, use of sulfur-oxidizing bacteria for production of sulfuric acid to increase permeability of shale matrix, including other means of matrix modification. U.S. Pat. 3,982,995 (1976) and 15 associated publications in various journals, e.g., Appl. Env. Microbiol., 32, 610 (1976), including 3 books, one by Lewis Publishers, one by ACS and one by Elsevier, all in 1976. At least 12 newspapers (including Denver Post) published the news between 1972 and 1973. The research was featured in L.A. Channel 5 Morning Show in 1973 and Town Hall of California in 1974.

Congress Hearing, 93rd Congress, 1st Session and 2nd Session (1973-1974), Washington, D.C.; Oil and Gas J. (1972); 9th World Petroleum Congress, Tokyo (1975). Latest review is in the Encyclopedia of Earth System Science (Academic Press), 1991. Technologies lead to mild microbiological treatment of composites by multi-stage process consisting of physiochemical steps. Much earlier work was concentrated on coal, Process Biochem., 22(1), 24 (1987); Bioprocessing and Biotreatment of Coal; 179 (1990); ibid., 725 (1990); Resources, Conservation, Recycling, 2, 249 (1988); J. Chem. Techn. Biotech., 48, 71 (1990). Later, the studies were concentrated on obsolete propellants and munition wastes. This method was also suitable for the recovery of wasted tires. 3 papers at ACSE, North Am. Water and Env. Congress (1996); ACS Symposium, 139 (1995); J. Env. Sci. Health, A32, 2669 (1997); Energy Sources, 19, 833 (1997). The topics, "Rocket-Fuel Disposal System" and "Cold Water Clean Up," were displayed at Epcot of Walt Disney World Resort, Orlando in May, 1996 and won the finalists for the Discovery Magazine Award. Also, "Environmentally Correct Fungus" was published in the LA Times, October 24, 1995. KCA-TV, Channel 9, also displayed a two-minute news segment on September 6, 1995.

Template Synthesis of Large Molecules and Various Bonding Methods (NASA, JPL, Gulf, Goodyear) First report of macro-size crystals of high molecular weight polyisoprene analog via canal complex polymerization by 60Co radiation was accomplished. J. Polymer Sci., 35, 533 (1959); ibid. 38, 272 (1959). Using 3-d tessellation of rigid silicate or intermetallo nanotube as host, and the intended reactive molecule as guest for condensation reaction, large molecules with fixed geometry can be in the free cavities within the stable network.

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Bonding by crosslinking or grafing to an etched surface either by enzymatic or by short-wave energy beam. For example, successful grafing of heparin to a number of polymeric surfaces for anti- and non-clotting usages of extracorporal circulation of blood was demonstrated. J. Macromol. Sci. Chem. A4(33), 694 (1970); Biochim, Biophy. Acta, 184, 646 (1969), (over 150 worldwide requests for the latter paper); Biomat. Med. Div. Art. Org., 14, 195 (1986). Coating of bacteria through chemical derivatization and also the coating of porous media were made. Coll. Surf., 16, 193 (1985).

Dr. Yen has over 450 publications. Out of these, he has authored or edited/co-edited 26 books, including three books in which his name appeared as assistant editor. Four of these books have been translated into Chinese, and one was translated into Russian. The book entitled Oil Shales was reviewed in Nature and it was stated that "the book provides an important comprehensive corpus of up-to-date information on geology, chemistry and extractive technology of oil shale." "It is time to say that USC is the intellectual front of books . . ." Comments on "Environmental Chemistry" in two volumes are overwhelming. There are many positive reviewers and the books have been adopted as textbooks in many universities. "...Yen has excelled in environmental sciences long before frantic environmental awareness has caught on. It is comfortable to know that this pioneer has come out with a book that is indispensable for all engineers...." "...The topics dictate that numerous disciplines be covered with equal rigor - a task often considered too difficult to be undertaken by a single author, and the author did a marvelous job in completing it...."

In peer-reviewed journals, there are 156 papers to Yen's name. He has composed 118 entries for book chapters. There are a total of 114 entries under the title of conference proceedings, which includes some preprints and technical reports. However, no items are listed except those appearing in Chemical Abstract and/ or Energy Research Abstract (Advanced Fossil Energy Technologies), published by National Technical Information Service. In addition, there are 17 U.S. patents listed, not including those issued by foreign nations on the same topics. Out of the 450 plus publications, roughly 77% have been published with graduate students, research associates and colleagues, while 18% bear the sole authorship of T.F. Yen, and 5% are from undergraduate and/ or work-study students. There are 62 different colleagues and collaborators who have been published along with Yen, and a total of 67 different graduate students, research associates, and visiting scholars have contributed. Eleven work-study and three high school students (i.e., NSF Summer Trainers) have also participated.

Ten of the selected publications of the last three years are as follows: Metabolism of 2, 4, 6-Trinitrotoluene by Mixed Microbial Populations in Digested Sewage Sludge, Under Strict Anaerobic Conditions, S. H. Kwon and T. F. Yen, J. Environ. Sci. Health, A32 (9, 10), 2669-2682 (1997). Staged Process for Composite Propellants: Recovery of Energetic and Metallic Fuel, F. J. Y. Shiu, E. C. Y. Yang and T. F. Yen, Energy Sources, 19, 833-843 (1997). Asphaltenes: Types and Sources, T. F. Yen, Structure and Dynamics of Asphaltene (O. C. Mullins, E. Y. Sheu, eds), Plenum, New York, pp. 1-20, 1998. Denitrogenation of Shale Oil by Oxime Formation from Pyrroles, R. S. Y. Hsu-Chou, S. Mobashery and T. F. Yen, Energy Souces, 20(9), 857-866 (1998). Correlation between Heavy Crude Sources and Types and Their Refining and Upgrading Methods, T. F. Yen,

Proc. of the 7th UNITAR International Conference on Heavy Crude and Tar Sands, Vol. 2, pp. 2137-2144, Petroleum Industry Press, Beijing, China, 1998. Interfacial Activity of n-Alkylamines from Microbially Produced Spiculisporic Acid, T. Ban, T. Sato and T. F. Yen, J. Petroleum Science Eng., 21, 223-238 (1998). Potential Use of Biopolymer Grouts for Liquefaction Mitigation, D. Momemi, R. Kamel, R. Martin and T. F. Yen, Phytoremediation and Innovation Strategies for Specialized Remedial Applications (A. Leeson and B. C. Alleman, eds), 5(6), Batelle Press, Columbus, OH, pp. 175-180, 1999. Mechanisms of Surface Precipitation and Dissolution of Barite: a Morphology Approach, K. Dunn, E. Daniel, P. J. Shuler, H. J. Chen, Y. Tang and T. F. Yen, J. Coll. Interface Sci., 214, 427-437 (1999). Dissolution of Barite Sulfate Scale Deposits by Chelating Agents, K. Dunn and T.F. Yen, Env. Sci. Tech., 33(16),2821-2824 (1999). Environmental Chemistry: Essentials of Chemistry for Engineering Practice, Vol. 4A, 762 pp., Environmental Chemistry: Chemical Principles of Environmental Process, Vol. 4B, 848 pp., Prentice Hall Inc., Upper Saddle River, NJ, 1999. Ten significant publications are listed as follows: J.P. Dickie and T.F. Yen, "Macrostructures of the Asphaltic Fractions by Various Instrumental Methods," Anal. Chem., 39, 1847-1852 (1967).This is the first time that a chemical structure model appeared. This model has been verified by a number of physical methods, such as x-ray, NMR, IR, n-d-M, ESR, SEM, MS, etc. This paper forms the structure studies by different investigators (even T.F. Yen has over 60 entries). The last is summarized in "Asphaltic Materials" by T.F. Yen in Encyclopedia of Polymer Science and Engineering, Supplementary Volume, 2nd edition (H.S. Mark, N.M. Bikales, C.G. Overberger and G. Menges, eds.), John Wiley & Sons, New York, 1989, pp. 1-10; also a condensed version appeared in Concise Encyclopedia of Polymers Science and Engineering, (J.I. Kroschwitz, ed.) John Wiley and Sons, 1990, pp. 61-62. Over the years, many authors have used this model in various books, including textbooks of geochemistry in many countries. This model and the associated research was recognized by the American Chemical Society for the Petroleum Chemistry Award through the AMOCO foundation.

T.F. Yen, M. Davar A. and Rembaum, "The Structure of Heparin: Interaction of Heparin with Basic Dyes by Visible Spectrometry," Biochim. Biophy. Acta, 184, 646-648 (1969); Erratum, ibid., 192, 574 (1969). This paper deals with heparin as a non-clotting agent useful in grafting to a polymeric surface. There are more than 150 worldwide requests for the reprints and letters for further explanation of these for extracoporal circulation of blood in any contacting surfaces.

T.F. Yen, "Resonance Topology of Polynuclear Aromatic Hydrocarbons," Theoret. Chim. Acta (Berlin), 20, 399-404 (1971). This forms the basis for many studies dealing with polynuclear aromatic hydrocarbons. This has been adopted in some classical books, such as Nenad Trinajstic's Chemical Graph Theory, Vol. I & II, CRC Press (1990). This is essential to the basic knowledge of elucidating the structure of condensed benzenoid systems.

T.F. Yen, L.J. Boucher, J.P. Dickie, E.C. Tynan and G.B. Vaughan, "Vanadium Complexes and Porphyrins in Asphaltenes," J. Inst. Petrol. (London), 55, 87-99 (1969). This is a pioneer study of the fossilized pigments in petroleum and coal. The change of porphyrin ring structure as a function of geological ages has become an essential part of organic

geochemistry. Many successive investigations, particularly in Russia and China, are based on this concept. A recent survey of this portion appears in Asphaltene and Asphalts, Vol. II, by J. Reynold of Berkeley-Lawrence Laboratory in 1999. This formed the basis for the election of T.F. Yen as a foreign member of the Russian Academy of Natural Sciences and being awarded with the Vernadskiy Medal in 1995.

J.H. Rho, A.J. Bauman, T.F. Yen, and J. Bonner, "Fluorometric Examination of Lunar Sample," Science, 167, 754-755 (1970). This is the result from Apollo Lunar return samples team of Cal. Tech., USC and JPL. A definite conclusion was made that there is no life on the moon. This has settled the controversy that there is life on the moon.

C.S. Wen and T.F. Yen, "Optimization of Oil Shale Pyrolysis," Chem. Eng. Sci., 32(3), 346-349 (1977). Although the model was started with Green River oil shale, the optimization applies well with pyrolysis of any type of refuse, including plastic waste. Some textbooks have adopted this study as a model for pyrolysis in general.

K.I. Lee and T.F. Yen, "Sulfur Removal from Coal through Multiphase Media Containing Biocatalysts," J. Chem. Tech. Biotech., 48, 71-79 (1990). This is a good example of how well selective biodegradation or biodecomposition can be worked with fossil fuels or other composites.

T.F. Yen. Microbial Enhanced Oil Recovery: Principle and Practice, (ed.) CRC Press, Boca Raton, FL, 1990, 257 pp.; [Portions of draft version of the book translated into Chinese by Jin Gin-Ji, Chinese Petroleum Incorporation Research Bureau, Beijing, 1989.] This book is comprehensive in all aspects related to MEOR. The completed projects have resulted in some 40 papers at USC by Yen's students. DOE has used this book as an essential reference for anyone who wants to write a proposal on this topic to the agency. One of the officers in DOE has remarked that this is the Bible in the field.

J.F. Kuo, M.M. Sharma and T.F. Yen, "Electrokinetic Behavior of a Porous Composite Oxide Matrix," J. Colloid Interface Science, 126, 537-546 (1988). This study, which was proceeded by a number of papers, presents a working model for the interfacial phenomena of metal oxides. This is fundamental information for aquatic chemistry, environmental chemistry, enhanced oil recovery and geological science.

J.R. Lin and T.F. Yen, "An Upgrading Process through Cavitation and Surfactant," Energy and Fuels, 7, 111-118 (1993). This is a summary of a new environmental-benign refining process. The process is based on the cavitation phenomena caused by the application of ultrasound energy to an emulsion system of oil-water. Three U.S. Patents and one Canadian Patent have been issued on this process. More than 20 papers have been published subsequently by Yen and his students, including Russian and Spanish versions.

His teaching includes General Chemistry, Teaching Assistant, West Virginia University, 1952-53, resulted in a publication in Journal of Chemical Education, A Scheme for Memorizing Thermodynamic Functions, 31, 610 (1954); Theoretical Organic Chemistry; Physical Methods for the Analysis of Molecular Structures, Visiting Professor, National Taiwan University and National Tsinhua University, 1965, 1967, resulted in a book entitled Electron Spin Resonance of Metal Complexes, Plenum Publication, Corp., New York

(1969), 204 pp. Also, Adam Hilger Ltd., London (1970), 204 pp. (reprint); Organic Chemistry I, II and III; Biochemistry, Associate Professor, Cal State University, Los Angeles, 1968-69; Biochemistry, Biomedical Materials, Dialysis in Nephrology, Associate Professor of Medicine (Biochemistry), USC Medical Campus, 1969-72, resulted in being the editor of a new journal, Biomaterials, Artificial Organs and Medical Devices, Marcel Dekker, New York (1973). Also resulted in being an editorial board member of Clinical Nephrology, Dustri-Verlag, Munchen-Deisenhofen, Germany, 1973-75; New Energy Sources, Associate Professor of Chemical Engineering, USC, simultaneously as TV courses for ChE, PE and EE, 1973-75, resulted in twice testifying before 93rd Congress Hearing for Energy Crisis at Washington, D.C. Also resulted in the call for a New Energy Sources Conference at USC, which attracted speakers from the White House, UN and other industries nationwide.

Formed the basis of completing three books on oil shale: Science and Technology of Oil Shale (Ann Arbor Science Publishers), Shale Oil, Tar Sands and Related Fuel Sources (American Chemical Society), and Oil Shale (Elsevier) all in 1976. The latter was translated to Russian by the Soviet's Academy of Science Press in 1978. One book in tar sand: Bitumens, Asphalts and Tar Sands (Elsevier) in 1978 and two books in marine sediments: The Chemistry of Marine Sediments, 1977 (Ann Arbor Science Publishers) and Energy and Resources Development of Continental Margins, 1980 (Permagon Press, Oxford). Also resulted in becoming the editor of a new international journal, Energy Sources, by Crane, Russack and Co., New York (now changed to Taylor and Francis, London), beginning in 1973; Solid Wastes, Associate Professor of Environmental Engineering, USC, ENE, 1974-76, resulted in a book: Recycling and Disposal of Solid Wastes, Industrial, Agricultural and Domestic, Ann Arbor Science Publishers (1974); Coal Liquefaction Processes, Associate Professor of Chemical Engineering, USC, ChE, 1977-79, a TV Course, the description of the course outline and the experience is summarized in a paper entitled, A Course in Coal Liquefaction Processes, Chemical Engineering Education, 13(4), 180-82, 215-217 (1979). There were seven requests from other universities in the US, since they were considered to offer the same course. Resulted in two books: Analysis of Hazardous Organics Present in Liquid Waste from Coal Conversion Processes, (EPA, 1982) and Chemical and Geochemical Aspects of Fossil Energy Extraction, (Butterworth Publishers, Wohurn, MA, 1982); Energy and the Environment, Professor of Environmental and Civil Engineering, USC, ENE, 1979-85, the materials form the basis of the following two books, which are being completed, one on Resource Engineering and the other on Chemical Ecology; Environmental Chemistry; Chemical and Biological Processes for Environmental Engineering, Professor of Environmental and Civil Engineering, USC, ENE and CE, 1980-present, these two courses formed the basis of the completion of the textbook sets of Environmental Chemistry 4A, Essentials of Chemistry for Engineering Practice and Environmental Chemistry 4B, Chemical Principles for Environmental Processes, Prentice Hall, Upper Saddle River, NJ, 1610 pp., 1998 and 1999. A number of universities have adopted the two books as the course textbooks. Consequently, an Instruction Manual of Volume 4A by T.F. Yen, K. Dunn, S.-P. Tu and D. Momeni, has been printed by Prentice Hall. The last three authors are teaching assistants for USC courses at USC; A Review on Basic Chemistry for Engineers and Chemistry of Major Environmental Cycles will be published by Imperial College Press, London, 2002;

Environmental Engineering Seminar, Professor of Environmental Engineering, USC, ENE, 1978-present, a wide range of diversified topics related to environments are presented by the invited speakers from university professors, industrial leaders, and consultants and local, state, and federal government's spokespersons. So far, there were about 400 different speakers that have been involved in this program. Students taking one credit are benefited from a broad coverage of subjects. As a result, Yen was rewarded by participating students in Spring of 1997 for a service award (Trojan Award).

Other recognition includes: Honors from the following organizations: Phi Lambda Upsilon, Sigma Xi, Phi Kappa Phi, Skull & Degger, Tau Beta Phi, Omega Chi Epsilon, Pi Epsilon Tau and Phi Tau Phi (Energy Speaker Program, Oak Ridge Associate University (1979-1981) (Invited as a Dissertation Committee Member to evaluate the Ph.D. thesis of two graduate students, India School of Mines, Dhanbad, India (1989, 1997) (Mark of Distinction, Thailand's King's Own Body Guard and Regiment (1982) (Honorary Member, Southern California Academy of Sciences (1992-) Lecturing and Consulting in major universities, research institutes and oilfield laboratories in various parts of China for 14 trips between the years 1978 and 2000. Expenses are compensated by China Ministry of Petroleum, China National Corp. and United Nations (Chairperson/ co-chairperson or organizer of over 60 international and domestic symposia or conferences since 1968. Some examples are: 1st Pan-Pacific Synfuel Conference, Tokyo, 1982; 18th Intersociety Energy Conversion Engineering Conference, Orlando, 1983; 3rd Chemical Congress of North America, Toronto, 1988; International Conference on Bitumen Chemistry, Rome, 1991; International Symposium on Colloid Chemistry, Rio de Janeiro, 1995; 5th Chemical Congress of North America, Cancun, 1997; and 7th UNITAR International Conference on Heavy Crude, Beijing, 1998. Featured Speaker to the 50th Anniversary Celebration of Petroleum Chemistry, ACS, New York, 1972; Plenary Speaker, API Advisory Board's Rock Mountain Regional Meeting, University of Wyoming, Laramie, 1976; Review Speaker in Biotechnology Session, 28th IUPAC Congress, Vancouver, 1981; Plenum Paper, 3rd All Union Geochemistry on Oil Shale, Tallinn, Estonia, 1982; Distinguished Lecture Speaker on Bacteria Transport, Lehigh University, 1987; Plenum Speaker, 20th Anniversary of Central Regional ACS, West Virginia University, Morgantown, 1988; Invited Speaker, Esso Resource Canada, Ltd., Calgary, 1994; Invited Speaker, Taiwan EPA, Taipei, 1995; Keynote Speaker, 3rd International Conference, New Delhi, 1999 (Editor and Editory Board Member of nine technical journals, e.g., Geomicrobiology J. Applied Physics Communications, AOSTRA J. of Research, etc. (Professional Membership of 10 different organizations, including American Institute of Physics, American Institute of Mining, Metallurgical and Mechanical Engineers, International Union of Pure and Applied Chemistry, etc. (Principle Investigator of over 50 research projects for governments and industries, e.g., DOE, NSF, EPA, Air Force, Navy, etc.

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