

ALFRED ROY JENNINGS, JR., P.E.

Enhanced Well Stimulation, Inc.

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PROFESSIONAL SUMMARY

An accomplished and recognized world-class expert in well stimulation – Experience involves *all* aspects of well stimulation applications:

- Selection, design, and application of successful hydraulic fracturing and acidizing treatments in all types of sandstone and carbonate formations.
- Field studies involving review of well histories and well performance for the selection of well stimulation candidates, recommendations for improvement, and post-treatment evaluation.
- Selection, design, and on-site application of hydraulic fracturing treatments on critical, high deliverability oil and gas wells, onshore and offshore.
- On-site assistance in treatment preparation and in monitoring real-time fracturing treatment pressures; working with service companies to facilitate modification and improvement of treatment procedures.
- Assistance with design and implementation of re-fracturing treatments.
- Application of various remedial treatments (removal of water blocks and residual spent stimulation fluids, cleanup of paraffin and asphaltene deposition, and scale and salt deposit removal).
- Development of modified techniques and procedures for effective well stimulation (with propped fracturing, acid fracturing, and matrix acidizing) in horizontal wellbores.
- Expert Witness testimony in cases related to well stimulation.

Stays current in technology through active participation in technical meetings, seminars, and forums and through frequent communications with service company research and operating company well stimulation experts.

AREAS OF STRENGTH

- Well stimulation techniques and procedures
- Practical aspects of applications
- Candidate well selection and evaluation of treatments
- Interpersonal skills with various cultures
- Successful stimulation experience with “good” wells
- Experienced trainer of young professionals

PROFESSIONAL WORK EXPERIENCE

Enhanced Well Stimulation, Inc. – Athens, Texas (Sept. 1995–Present)

Well Stimulation Consultant / President

- Established business in September 1995 to provide both domestic and international well stimulation consultation.
- Providing consultation and on-site assistance involving various successful fracture stimulation treatments in sandstone and carbonate formations throughout the world.
- Conducting field studies to assess well stimulation candidacy and prior treatment results and then providing on-site consultation and assistance during proppant fracturing, acid fracturing and matrix stimulation treatments for “enhanced” post-stimulation well performance.
- Teaching several Courses offered by OGCI/PetroSkills as primary instructor: *Hydraulic Fracturing Applications, Advanced Hydraulic Fracturing, Acidizing Applications in Sandstones and Carbonates, and Overview of Well Production*. Serving as back-up instructor for OGCI/PetroSkills Courses: *Production Operations 1, Formation Damage Control, and Well Stimulation*.
- Involvement with selection of candidates and development of strategic applications of re-fracturing in low permeability gas wells.
- Development of Acidizing Guidelines and Sand Control Guidelines.
- Development and presentation of well stimulation schools in Canada, Russia, U.K., Indonesia, Africa, Malaysia, Mexico, Saudi Arabia, Venezuela, and in various locations in the U.S.
- Successful introduction and implementation of hydraulic fracturing and acid fracturing design techniques and procedures for Saudi Aramco in Saudi Arabia for stimulation of deep, sour gas wells for the Hawiyah Gas Plant Development Project (during a rotational contractual assignment, 1997–2001).
- Extensive well stimulation consultation for PEMEX (Mexico) involving several asset areas involved in oil production and gas production from both carbonate and sandstone reservoirs.
- Extensive recent experience with hydraulic fracturing treatments using slickwater and crosslinked gel in the Cotton Valley Sand in East Texas.
- Expert witness testimony in the United States and Canada as a well stimulation expert.
- Assessment of service company products and services related to well stimulation techniques and practices.

Mobil E&P Technical Center (MEPTEC) – Dallas, Texas (1992–1995)

Associate Engineering Advisor

- Responsible for transfer of well stimulation technology to Mobil operating affiliates worldwide.
- Provided on-site assistance for strategic Mobil well stimulation applications of hydraulic fracturing (with proppant), acid fracturing, and matrix acidizing.
- Presented sandstone and carbonate acidizing schools to Mobil affiliates on-site and at the Technical Training facilities in Dallas, TX.
- Taught hydraulic fracturing schools for Mobil affiliates.
- Participated as joint industry project representative for proppant studies and fracturing fluid rheological studies (STIM-Lab, Inc), acidizing research studies (University of Texas), Completions Engineering Association activities, and member of Production Advisory Group (Gas Research Institute).
- Provided consultation concerning well stimulation techniques and procedures for several horizontal wells for Mobil affiliates.
- Pursued acidizing and hydraulic fracturing research objectives for a Mobil Well Production Well Stimulation Project.

Mobil E&P Services, Inc. (MEPSI) – Dallas, Texas (1987–1992)

Associate Operations Engineering Advisor

- Responsible for maintaining knowledge of “leading edge” well stimulation technology and transferring it to Mobil affiliates.
- Performed background study and then led development of a successful acid fracturing treatment campaign for high deliverability, high temperature gas wells in Mobil's Arun Field, Sumatra, Indonesia (assisted with 17 treatments that provided productivity uplift [Δq] of +350 MMSCFD and +18,000 BCPD production for the Field).
- Maintained Production Engineering Technology Needs List for Mobil affiliates.
- Obtained several Mobil patents concerning well stimulation and well completions technology.
- Began work concerning downhole disposal of drilling wastes into dispensable zones using hydraulic fracturing.

Mobil R&P Corp., Dallas Research Lab – Dallas, Texas (1982–1987)

Research Associate

- Responsible for special well stimulation applications for Mobil worldwide.
- Helped develop successful fracture designs and provided on-site assistance for several fracturing treatments (Offshore Netherlands) using well stimulation vessels and high strength proppant.
- Performed laboratory research involving formation damage removal techniques and gravel size selection criteria for gravel packing.

- Participated in various Mobil schools teaching well stimulation in Production Engineering, Reservoir Engineering, and Drilling Engineering.

Halliburton Services Research Center – Duncan, Oklahoma

Fracturing Section Supervisor (1979–1982)

- Supervised work of 25 professionals and 15 technicians involving hydraulic fracturing research, development and field services activities for Halliburton Services.
- While Supervisor, several new products (variations still in use today) were introduced by the Fracturing Section including thermally stable fracturing fluid systems, bactericides, fluid leak-off control agents, gel breakers, liquid gel concentrates, and high strength proppant systems.
- Other responsibilities included ongoing contact with major operating companies' research labs and chemical vendors.

Field Services Group Leader (1977–1979)

- Guided work of 6 professionals and 6 technicians involving laboratory testing of formation core samples to provide data for hydraulic fracturing considerations.
- Assisted in the design and application of several Massive Hydraulic Fracturing Treatments (Texas, Louisiana, and Rocky Mountain areas) using crosslinked fracturing gel systems.
- Served on several API Sub-Committees related to development of recommended practices and guidelines for testing fracturing sand, synthetic proppants, and hydraulic fracturing fluids.

Development Engineer / Sr. Chemist, Field Services Group (1967–1977)

- Used laboratory data and preliminary vertical fracture modeling software to design hydraulic fracturing treatments throughout the U.S., Canada, Mexico, and South America.
- Provided active on-site assistance to Halliburton field personnel involving the introduction of early crosslinked gel systems.
- Designed and assisted in the application of several successful high pressure fracturing treatments (20-hour duration) using large volumes and low injection rates in North Louisiana using a special “two-stage” thermally stable fluid system.
- Developed method for calculating average fracturing fluid temperatures (in the fracture) and used this data to design accelerated gel breaker schedules.

PROFESSIONAL AFFILIATIONS

Society of Petroleum Engineers of AIME

- Editorial Review Committee (1983–1987; 2006–2007)
- Distinguished Author Committee (1989–1992)
- SPE Fracturing Forum Committee (1983 and 1993)
- SPE Conduct Committee (1995 ATCE, Dallas)
- Program Committee, SPE Intl. Form. Damage Symposium (1996, 2004, 2006, 2008, 2010, and 2012)
- SPE Well Completions Committee for ATCE (1997–2001)
- Chairman, Well Completions Committee (1998 ATCE, New Orleans)
- Chairman, Continuing Education – SPE East Texas Section [Tyler, TX] (2005–Present)

Completions Engineering Association (1988–Present)

Gas Research Institute, Nat. Gas Supply Project Advisory Group (1992–1995)

CERTIFICATION

Registered Professional Engineer, State of Texas, No. 64684

EDUCATION

B.S. in Chemistry, 1967, University of Oklahoma

M.S. in Petroleum Engineering, 1972, University of Oklahoma

PATENTS

Author and co-author of **90** U.S. Patents and over **40** International Patents. (List of Titles and Patent Numbers can be provided upon request). The patents, assigned to Mobil Corporation, deal with various aspects of well stimulation and well completion techniques and procedures for both vertical and horizontal wells.

SELECTED PUBLICATIONS

1. Jennings, A.R. Jr.: *The Effects of Surfactant-Bearing Fluids on Permeability Behavior in Oil Producing Formations*, SPE 5635, presented at the 50th Annual Fall Meeting of the SPE, Dallas, TX, Sept. 28–Oct. 5, 1975.
2. Jennings, A.R. Jr.: *Fracture Flow Capacity – A Key to Sustained Production After Hydraulic Fracturing*, SPE 6127, presented at the 51st Annual Fall Meeting of the SPE, New Orleans, LA, Oct. 3–6, 1976.
3. Jennings, A.R. Jr., and Sprawls, B.T.: *Successful Stimulation in the Cotton Valley Sandstone – A Low Permeability Reservoir*, JPT (October, 1977), 1267–1276.

4. Jennings, A.R. Jr., Darden, W.G., Wenzel, R.W., Shrut, R.S., and Foster, J.: *Massive Hydraulic Fracturing in the Eastern United States*, SPE 6866, presented at the 52nd Annual Fall Meeting of the SPE, Denver, CO, Oct. 9–12, 1977.
5. Crowell, R.F., and Jennings, A.R. Jr.: *A Diagnostic Technique for Re-Stimulation Candidate Selection*, SPE 7556, presented at the 53rd Annual Fall Meeting of the SPE, Houston, TX, Oct. 1–3, 1978.
6. Jennings, A.R. Jr., and Darden, W.G.: *Gas Well Stimulation in the Eastern United States*, SPE 7914, presented at the 1979 SPE Symposium on Low Permeability Gas Reservoirs, Denver, CO, May 20–22, 1979.
7. Jennings, A.R. Jr.: *Use of Field Data in the Analysis of the Influence of Proppants on Apparent Fracturing Fluid Viscosity*, SPE 20641, presented at the 65th Annual Fall Meeting of the SPE, New Orleans, LA, Sept. 23–26, 1990.
8. Jennings, A.R. Jr.: *Good Wells Make the Best Candidates for Well Stimulation*, *SPE Prod. Eng.* (November, 1991), 371–376.
9. Cannan, W.L., Jennings, A.R. Jr., Huseini, S., Bordelon, T.P., and Sardjono, S.: *Increasing Arun Deliverability Through Effective Acid Fracturing*, SPE 22397, presented at the SPE International Meeting on Petroleum Engineering, Beijing, China, Mar. 24–27, 1992.
10. Van Domelen, M.S., and Jennings, A.R. Jr.: *Alternate Acid Blends for HPHT Applications*, SPE 30419, presented at the Offshore Europe Conference, Aberdeen, Scotland, Sept. 5–8, 1995.
11. Jennings, A.R. Jr.: *Hydraulic Fracturing Fluids – Then and Now*, Technology Today Series Article, *JPT* (July, 1996), 604–609.
12. Coulter, G.R., and Jennings, A.R. Jr.: *A Contemporary Approach to Matrix Acidizing*, SPE 38594, presented at the SPE ATCE, San Antonio, Oct. 5–7, 1997.
13. Jennings, A.R. Jr.: *Laboratory Studies of Fines Movement in Gravel Packs*, *SPE Drilling and Completions* (December, 1997), 275–280.
14. Mauth, K.D., Ginest, N.H., and Jennings, A.R. Jr.: *Analysis of Extreme Fracture Pressure Gradients in a Deep Gas Reservoir*, SPE presentation at the 1998 SPE Technical Symposium, Dhahran, Saudi Arabia, Oct. 25–27, 1998.
15. Jennings, A.R. Jr.: *Strategic Well Stimulation: A Key to Reservoir Management*, E&P Technology Exchange Article, *JPT* (March, 2000), p. 62.
16. Jennings, A.R. Jr.: *When Fracturing Doesn't Work*, SPE 71657 presented at the ATCE Meeting in New Orleans, Sept. 30–Oct. 3, 2001.
17. Jennings, A.R. Jr.; Westerman, C.A.; Tadlock, D.W.; Westerman, R.; and Anderson, M.: *A Systematic Approach to Improved Success With Hydraulic Fracturing Applications*, SPE 101837 presented at the ATCE Meeting in San Antonio, Sept. 24–27, 2006.