



REFERENCES

- Abdallah, W., Buckley, J.S., Carnegie, A., Edwards, J., Herold, B., Fordham, E., Grau, A., Habashy, T., Seleznev, N., Signer, C., Hussain, H., Montaron, B., Ziauddin, M., 2007, Fundamentals of Wettability: Oilfield Review, p. 17.
- Abu-Khamsin, S.A., 2004, Basic properties of reservoir rocks, Manual handbook, Department of Petroleum Engineering, King Fahd University of Petroleum and Minerals, Dhahran.
- Agarwal, A., Ng, W.J., and Liu, Y., 2011, Principle and Applications of Micro Bubble and nano Bubble Technology for Water Treatment, Chemosphere 84.
- Ahmed, T., and McKinney, P.D., 2005, 2 - Water Influx, in Advanced Reservoir Engineering: Burlington, Gulf Professional Publishing, p. 149–185.
- Akai, T., Xue, Z., Yashamita, Y., and Yoshizawa, M., 2015, Application of CO₂ Micro Bubble for The Innovative CO₂-EOR, Abu Dhabi International Exhibition and Conference, Society of Petroleum Engineers.
- Alvarado, V., and E. Manrique, 2010, Enhanced Oil Recovery: An Update Review: Energies, v. 3, no. 9, p. 1529–1575.
- Anderson, W. G., 1986, Wettability Literature Survey-Part 3: The Effects of Wettability on the Electrical Properties of Porous Media: Journal of Petroleum Technology, v. 38, no. 12, p. 1,371-1,378.
- Anderson, W. G., 1987, Wettability Literature Survey- Part 4: Effects of Wettability on Capillary Pressure: Journal of Petroleum Technology, v. 39, no. 10, p. 1,283-1,300,
- Baviere, M., 1991, Basic Concepts in Enhanced Oil Recovery Processes, Critical Reports on Applied Chemistry, v. 33, Springer, p. 432.
- Bjorndalen, N. and Kuru E., 2008, Stability of Microbubble-Based Drilling Fluids Under Downhole Conditions, Journal of Canadian Petroleum Technology, v. 47, no. 6, p. 40-47.
- Bjorndalen, N., Alvarez, J.M., Jossy, W.E., and Kuru, E., 2011, A Study of The Effects of Colloidal Gas Aphron Composition on Pore Blocking, SPE Drilling & Completion.
- Blatt, H., Jones, R. L., and Charles, R.G., 1982, Separation of quartz and feldspars from mudrocks: J. Sediment. Petrol., v. 52, p. 660–662.



- Blunt, M., Fayers, F. J., and Orr F. M. Jr., 1993, Carbon dioxide in enhanced oil recovery: Energy Conversion and Management, v. 34, no. 9–11, p. 1197–1204.
- Boggs, S. Jr., 2009, Petrology of Sedimentary Rocks, Cambridge University Press, 2nd Edition, Cambridge, p. 21-62 and p. 111-164.
- Bredwell, M.D., Telgenhoff, M.D., and Worden, R.M., 1995, Formation and coalescence of microbubbles – scientific note, Journal of Applied Biochemistry and Biotechnology 51-52, p 501-509.
- Breit, V.S., 1992, Enhanced Oil Recovery: Part 10. Reservoir Engineering Methods, Development Geology Reference Manual, AAPG Special Publications, p 527-530.
- Brooke, T., 1998, Microbubbles: New aphrons drill-in fluid technique reduces formation damage in horizontal wells. In: SPE 39589 presented at the SPE International symposium on formation damage control, Lafayette, Louisiana, 18-19 February.
- Cardoso, J. J. F., Spinelli, L. S., Monteiro, V., Lomba, R., and Lucas, E. F., 2010, Influence of polymer and surfactant on the aphrons characteristics: Evaluation of fluid invasion controlling, eXPRESS Polymer Letters, Vol. 4, no. 8, p. 474-479.
- Castle, J. W., 2001, Appalachian basin stratigraphic response to convergent-margin structural evolution, Basin Research, 13 (4), p. 397–418.
- Castor, T. P., Somerton, W. H., and Kelly, J. F., 1981, Recovery Mechanisms of Alkaline Flooding: p. 249–291.
- Christensen, J. R., Stenby, E. H., and Skauge, A., 2001, Review of WAG Field Experience. Society of Petroleum Engineers, 4(02), 97-106.
- Czernichowski-Lauriol, I., Rochelle, C., Gaus, I., Azaroual, M., Pearce, J., and Durst, P., 2006, Geochemical Interactions between CO₂, Pore water and Reservoir Rocks: Lessons Learned from Laboratory Experiments, Field Studies and Computer Simulations, Advanced in The Geological Storage of Carbon Dioxide, NATO Science Series IV.
- Churcher, P.L., French, P.R., Shaw, J.C., and Schramm, L.L., 1991, Rock properties of Berea sandstone, Baker dolomite, and Indiana limestone, paper SPE 21044. Proceedings of the 1991 SPE International Symposium on Oilfield Chemistry, Anaheim, Feb.20 – 22.



Doghaish, N. M., 2009, Analysis of Enhanced Oil Recovery Processes: A Literature Review: Dalhousie University, Canada, p. 102.

Donaldson, E., Chilingarian, G., and T.F, Yen., 1989, Enhanced oil recovery II, processes and operations, Amsterdam: Elsevier science publishers B. V., v. 17B.

Ehrenberg, S. N., and Nadeau, P. H., 2005, Sandstone vs. carbonate petroleum reservoirs: A global perspective on porosity-depth and porosity-permeability relationships: AAPG Bulletin, v. 89, no. 4, p. 435–445.

Fatt, I., 1958, Pore Volume Compressibilities of Sandstone Reservoir Rocks, J. Pet. Tech 10, v. 3, p. 64-66.

Filer, J. K., 2003, Stratigraphic evidence for a Late Devonian possible back-bulge basin in the Appalachian basin, United States, Basin Research, v. 15, no. 3, p. 417-429.

Fischer, S., 2013, Mineralogical-Geochemical Effects during Geological Storage of CO₂ Experimental Investigations and Geochemical Modeling, Scientific Technical Report STR13/13, GFZ German Research Centre for Geosciences.

Folk, R. L., Andrews, P. B., and Lewis, D. W., 1970, Detrital sedimentary rock classification and nomenclature for use in New Zealand: New Zealand J. Geol. Geophys., v. 13, p. 955-959.

Friedman, G. M. and Sanders, J. E., 1978, Principles of Sedimentology: John Wiley and Sons, New York, p. 792.

Gao, D., Shumaker, R. C., and Wilson, T. H., 2000, Along-Axis Segmentation and Growth History of the Rome Trough in the Central Appalachian Basin: AAPG Bulletin, v. 84, p. 75-99.

Gaonkar, A. G., 1992, Effects of salt, temperature, and surfactants on the interfacial tension behavior of a vegetable oil/water system: Journal of Colloid and Interface Science, v. 149, no. 1, p. 256–260.

Ghedan, S., 2009, Global Laboratory Experience of CO₂-EOR Flooding. SPE/EAGE Reservoir Characterization & Simulation Conference.

Ghosh, M., 2013, Laboratory study on the generation and characterization of CO₂ colloidal gas aphrons, Master Thesis, University of Alberta.

Glover, P. W., 2011, Chapter 7: Wettability. Formation Evaluation MSc Course Notes.



Graton, L. C., and Fraser, H. J., 1935, Systematic packing of spheres with particular reference to porosity and permeability: Journal of Geology, v. 43, p. 785–909

Green, D. W., and Willhite, G. P., 1998, Enhanced Oil Recovery. SPE textbook series.: Richardson, Texas, Society of Petroleum Engineers, p. 545.

Grigg, R.B., and Schechter, D.S., 1997, State of The Industry in CO₂ Floods, SPE 38849, Society of Petroleum Engineers, Annual Technical Conference and Exhibition, San Antonio, Texas, October 5-8.

Growcock, F.B., 2005, Enhanced wellbore stabilization and reservoir productivity with aphrons drilling fluid technology. GTI-05/0226. GasTIPS 11, p. 12-16

Gupta S and Cawiezel KE (2013) Method of fracturing with aphrons containing fluids. Patent 0126163 A1, US.

Hadlow, R.E., 1992, Update of Industry experience with CO₂ injection, SPE-24928, SPE Annual Technical Conference and Exhibition, Washington, 4-7 October.

Haynes, H.J., Thrasher, L.W., Katz, M.L., and Eck, T.R., 1976, An Analysis of The Potential for Enhanced Oil Recovery from Known Fields in the United States, National Petroleum Council, U.S. Department of The Interior.

Harper, J.A., 1999, Devonian, in Shultz, C.H., ed., The geology of Pennsylvania: Pennsylvania Bureau of Topographic & Geologic Survey and Pittsburgh Geological Society, p. 108-127.

Hill, B., Hovorka, S., and Melzer, S., 2013, Geology Carbon Storage through Enhanced Oil Recovery, Energy Procedia, 37, 6808-6830.

Hiramoto, H., Kukuu, K., Kurihara, M., Akai, T., Takakuwa, Y., Sato, K., Tsuchiya, Y., Araki, N., and Shirai, S., 2016, Experiments of Micro Bubble CO₂ EOR using Berea Sandstone Core Samples, The 22nd Formation Evaluation Symposium of Japan.

Hoeksema, R.N., 2014, Defining Permeability, Oilfield Review, Schlumberger.

Holm, L.W. and Josendal, V.A., 1974, Mechanisms of oil displacement by carbon dioxide, SPE-4736-PA, Journal of Petroleum Technology, v. 26, no. 12, p 1427-1438.

Holm, L.W., 1982, CO₂ Flooding: Its Time has Come, Journal of Petroleum Technology, v. 34, no. 12, p 2739-2745.

Holm, L., 1986, Miscibility and Miscible Displacement. SPE-15794-PA. Journal of Petroleum Technology, p. 817 - 818.



Husain, A.M., Arezki, R., Breur, P., Haksar, V., Helbling, T., Medas, P., Sommer, M., and IMF Staff Team, 2015, Global Implication of Lower Oil Price, IMF Staff Discussion Note, International Monetary Fund, Washington, no. 15/15.

Islam, M.R. and Chakma, A., 1990, Mechanics of Bubble Flow in Heavy Oil Reservoirs. SPE 20070, 60th California Regional Meeting, Venture, California, April 4-6.

Johnson, E.F., Bossler, D.P., and Naumann, V.O., 1959, Calculation of Relative Permeability from Displacement Experiments, Trans. AIME, v. 216, p. 370-372.

Kareem, R., Cubillas, P., Gluyas, J., Bowen, L., Hillier, S. and Greenwell, H.C., 2017, Multi-technique approach to the petrophysical characterization of Berea sandstone core plugs (Cleveland Quarries, USA). Journal of Petroleum Science and Engineering 149, p. 436-455.

Keelan, D. K., 1982, Core analysis for aid in reservoir description: Journal of Petroleum Technology, v. 34, p. 2483–2491

Kukizaki, M. and Goto, M., 2006, Size control of nanobubbles generated from Shirasu-porous-glass (SPG) membranes. Journal of Membrane Science, 281(1-2).

Lake, L.W., 1989, Enhanced Oil Recovery, Prentice-Hall Inc. Englewood Cliffs: 550.

Lapedes, D.N., 1978, Encyclopedia of the Geological Science, University of Michigan, McGraw-Hill Book Co., New York, p. 616.

Moore, J., Adams, M., Allis, R., Lutz, S., and Rauzi, S., 2005, Mineralogical and geochemical consequences of the long-term presence of CO₂ in natural reservoirs: an example from the Springerville-St. Johns field, Arizona and New Mexico, USA. Chem. Geol. 217, p. 183–186.

Mohanty, K. K. and Shalter, S. J., 1982, Multiphase flow in porous media: ii pore-level modeling, SPE-11018-MS, Proceedings of the 57th Annual Fall Technical Conference and Exhibition of the Society of Petroleum Engineers of AIME, New Orleans, LA, September 26-29.

Milici, R.C. and Swezey, C.S., 2014, Assessment of Appalachian basin oil and gas resources: Devonian gas shales of the Devonian Shale-Middle and Upper Paleozoic Total Petroleum System: Chapter G.9 in Coal and petroleum resources in the Appalachian basin: distribution, geologic framework, and geochemical character, US. Geological Survey, Professional Paper 1708- G.9.



Muggeridge, A., A. Cockin, K. Webb, H. Frampton, I. Collins, T. Moulds, and P. Salino, 2014, Recovery rates, enhanced oil recovery and technological limits: Phil. Trans. R. Soc. A, v. 372.

Muller, N., Qi, R., Mackie, E., Pruess, K. and Blunt, M., 2009, CO₂ injection impairment due to halite precipitation. Energy 112, p. 3507–3514.

Nemes, I., 2016, Revisiting the applications of drainage capillary pressure curves in water-wet hydrocarbon systems, Open Geosciences 8, v. 1, p. 22-38.

Pashin, J.C., 1990, Reevaluation of the Bedford-Berea sequence in Ohio and adjacent states: New perspectives on sedimentation and tectonics in foreland basins: Unpublished Dissertation, University of Kentucky, p. 824.

Pashin, J.C. and Ettensohn, F.R., 1995, Reevaluation of the Bedford-Berea Sequence in Ohio and adjacent states: forced regression in a foreland basin: Geological Society of America, Special Paper No. 298, p. 68.

Pepper, J.F., Witt, D.W.J., and Demarest, D. F., 1954, Geology of the Bedford Shale and Berea Sandstone in the Appalachian Basin: U.S. Geological Survey Professional Paper 259, p. 111.

Ohnari, H., 2007, Swing Type Fine Air Bubble Generation Device, US Patent 7261283.

Pettijohn, F. J., 1975, Sedimentary rocks, 3rd ed.: New York, Harper and Row, p. 628.

Pettijohn, F. J., Potter, P. E., and Siever, R., 1987, Sand and Sandstone, 2nd edition.: Springer-Verlag, Berlin, 618 p.

Quinlan, G.M., Beaumont, C., 1984, Appalachian thrusting, lithospheric flexure, and the Paleozoic stratigraphy of the Eastern Interior of North America. Canadian Journal of Earth Sciences, 21 (9), p. 973-996.

Rathnaweera, T.D., Ranjith, P.G., Perera, M.S.A., 2016, Experimental Investigation of Geochemical and Mineralogical Effects of CO₂ Sequestration on Flow Characteristics of Reservoir Rock in Deep Saline Aquifer, Scientific Reports 6/19362.

Rittenhouse, G., 1946, Map showing distribution of several types of Berea sand in West Virginia, eastern Ohio, and western Pennsylvania: U. S. Geol. Survey Oil and Gas Inv., Preliminary Map 58.

Ross, G. D., Todd, A. C., and Tweedie, J. A., 1981, The effect of CO₂, flooding on the permeability of reservoir rocks. Dev. Petrol. Sci. 13, p. 351–366.



Samuel, S., 2012, A Laboratory Study of Aqueous Colloidal Gas Aphrons for Enhanced Oil Recovery Applications, MSc Thesis, University of Alberta.

Sebba F., 1971, Microfoams An Unexploited Colloid System, Journal Colloid Interface Science, v. 35, no. 4, p. 643-646.

Sebba, F., 1987, Foams and biliquid foams-aphrons, John Wiley & Sons, New York, p. 236.

Selley, R.C., 1998, Elements of Petroleum Geology, Second Edition, Academic Press, San Diego, California, 470 p.

Serizawa, A., Inui, T., Yhiro, T., and Kawara, Z., 2003, Laminarization of Micro Bubble Containing Milky Bubbly Flow in A Pipe, Proceedings of The 3rd European-Japanese Two-Phases Flow Group Meeting, Certosa di Pontignano, Italy, September 21-27.

Shams, M.M., 2014, A Study of The Flow Behavior of Micro Bubbles in Capillary Tubes, Master Thesis, Department of Chemical and Petroleum Engineering, Calgary University, Alberta, Canada.

Shiraki, R. and Dunn, T. L., 2000, Experimental study on water-rock interactions during CO₂ flooding in the Tensleep Formation, Wyoming, USA. Appl. Geochem. 15, p. 265–279.

Shi, S., Wang, Y., Li, Z., Chen, Q., and Zhenghao, Z., 2016, Laboratory investigation of the factors impact on bubble size, pore blocking and enhanced oil recovery with aqueous colloidal gas aphrons. Journal of Petroleum Exploration and Production Technology 6, p. 409-417

Sloss, L.L., 1963, Sequence in the cratonic interior of North America, Geological Society of America Bulletin, v.74, no.2, p. 93-114.

Smithson, T., 2016, The Defining Series: Reservoir Drive Mechanism, Oilfield Review, Schlumberger.

Stalkup, Jr.F.I., 1978, Carbon dioxide miscible flooding: Past, present, and outlook for the future, SPE 7042, Presented at the 5th Symposium on improved methods for oil recovery, Tulsa, Oklahoma, 1978.

Swazey, C.S., 2002, Regional stratigraphy and petroleum system of the Appalachian basin, North America, US Geological Survey Geologic Investigations Seres Map I-2768.



Taber, J. J., 1969, Dynamic and Static Forces Required to Remove a Discontinuous Oil Phase from Porous Media Containing Both Oil and Water: Society of Petroleum Engineers Journal, v. 9, no. 1, p. 3–12.

Telmadarrie, A., Doda, A., Trivedi, J.J., Kuru, E., and Choi, P., 2016, CO₂ Microbubbles – A Potential Fluid for Enhanced Oil Recovery: Bulk and Porous Media Studies, Journal of Petroleum Science and Engineering.

Tiab, D., and Donaldson, E. C., 2012, Petrophysics: Theory and Practice of Measuring Reservoir Rock and Fluid Transport Properties: Gulf Professional Publishing, 971p.

Waldmann, S., Hofstee, C., Koenan, M., Loeve, D., Liebscher, A., Neele, F., 2016, Physicochemical effects of discrete CO₂-SO₂ mixtures on injection and storage in a sandstone aquifer, International Journal of Greenhouse Gas Control, v54, p 640-651.

Wallace, D. W. Jr., 1993, Principal oil and gas plays in the Appalachian Basin (Province 131), US Geological Survey, Bulletin 1839- I.

Wei, Q.F., Mather, R.R., Fotheringham, A.F. and Yang, R.D., 2002, Observation of Wetting Behavior of Polypropylene Microfibers by Environmental Scanning Electron Microscope, Journal of Aerosol Science, v. 33, no. 11, p. 1589-1593.

Wentworth, C. K., 1922, A scale of grade and class terms for clastic sediments, Journal Geology, 30, p. 377–392.

Willhite, G.P., 1986, Waterflooding, Society of Petroleum Engineers Textbook Series.

Williams, H., Turner, F. J., and Gilbert, C. M., 1982, Petrography: An Introduction to the Study of Rocks in Thin Sections, 2nd edition.: W. H. Freeman, San Francisco, California.

Xiao, M., Yuan, X., Cheng, D., Wu, S., Cao, Z., Tang, Y., Xie, Z., 2018, Feldspar Dissolution and Its Influence on Reservoirs: A Case Study of the Lower Triassic Baikouquan Formation in the Northwest Margin of the Junggar Basin, China, Geofluids, 4, p 1-19.

Xing, D., Wei, B., Trickett, K., Mohamed, A., Eastoe, J., Soong, Y., and Enick R., 2010, CO₂-Soluble Surfactants for Improved Mobility Control, Society of Petroleum Engineers, SPE 129907, presented at the 2010 SPE Improved Oil Recovery Symposium in Tulsa, Oklahoma, USA, April 24-28.



UNIVERSITAS
GADJAH MADA

**CO₂ Microbubble Colloidal Gas Aaphrons for EOR Application: Diameter Size and Gas Blocking Ability
Impact to Sweep Efficiency and Petrophysical Analysis**
M ANDY NATAWIJAYA, Dr. Ferian Anggara, S.T., M.Eng.
Universitas Gadjah Mada, 2019 | Diunduh dari <http://etd.repository.ugm.ac.id/>

Xue, Z., Yamada, T., Matsuoka, T., Kameyama, H., and Nishio, S., 2011, Carbon Dioxide Microbubble Injection – Enhanced Dissolution in Geological Sequestration, Energy Procedia 4, p. 4703-4313.

Xue, Z., Nishio, S., Hagiwara, N., and Matsuoka, T., 2014, Microbubble Carbon Dioxide Injection for Enhanced Dissolution in Geological Sequestration and Improved Oil Recovery, Energy Procedia 63, p. 7939-7946.

Yongmao, H., Zenggui, W., Yueming, J.B.C., Xiangjie, L., and Petro, X., 2004, Laboratory Investigation of CO₂ Flooding, SPE 88883, Society of Petroleum Engineers, 28th Annual SPE International Technical Conference and Exhibition, Abuja, Nigeria, August 2-4.

Zhang, Y., and Morrow, N. R., 2006, Comparison of Secondary and Tertiary Recovery with Change in Injection Brine Composition for Crude-Oil/Sandstone Combinations, SPE 99757, Society of Petroleum Engineers, SPE/DOE Symposium on Improved Oil Recovery, Tulsa, Oklahoma, April 22-26.

Zimmerman, W.B., Tesar, V., Butler, S.L., and Bandulasena, H.C.H., 2008, Microbubble Generation, Recent Patents on Engineering, Bentham Science, v.2, p 1-8.