Journal of Technology Law & Policy

Volume XIV – Fall 2013

ISSN 2164-800X (online)

DOI 10.5195/tlp.2013.137

http://tlp.law.pitt.edu

GasFrac: A Cost-Benefit Analysis of Hydraulic Fracturing with Liquefied Petroleum Gas Gel

B. Tyler Wilson

GasFrac: A Cost-Benefit Analysis of Hydraulic Fracturing with Liquefied Petroleum Gas Gel

B. Tyler Wilson*

INTRODUCTION

What if the majority of the environmental and health concerns surrounding the hydraulic fracturing ("fracing") process could be solved with one technological advancement? The use of a liquefied petroleum gas ("LPG") gel as a substitute for water and other fluids during the fracing process could be such an advancement. The National Petroleum Council estimates that up to 95% of the wells drilled in the United States use hydraulic fracturing, accounting for more than 43% of total U.S. oil production and 67% of natural gas production.[1] The U.S. Energy Information Agency ("EIA") and the Environmental Protection Agency ("EPA") attribute the rapid increase of natural gas production to two key technologies, horizontal drilling and hydraulic fracturing.[2] Despite the prevalence of fracing in oil and natural gas production, many questions remain unanswered, mainly concerning the potentially harmful effects of traditional fracing fluids when found in water sources.[3] In 2010, Congress enlisted the EPA to study the impacts of hydraulic fracturing in shale formations on drinking water sources.[4] Unfortunately, the final draft report of this study will not be released until 2014.[5] While these questions remain unanswered,

* Tyler Wilson is a J.D. Candidate class of 2015 with the University of Pittsburgh School of Law.

[1] NAT'L PETROLEUM COUNCIL, PRUDENT DEVELOPMENT: REALIZING THE POTENTIAL OF NORTH AMERICA'S NATURAL GAS AND OIL RESOURCES 21 (2011), *available at* http://www.npc.org/NARD-ExecsummVol.pdf.

[2] *See, e.g.*, U.S. Energy Info. Agency, *Technology Drives Natural Gas Production Growth from Shale Gas Formations*, EIA (July 12, 2011), http://www.eia.gov/todayinenergy/detail.cfm?id=2170; U.S. ENVTL. PROT. AGENCY, EPA/601/R-12/011, STUDY OF THE POTENTIAL IMPACTS OF HYDRAULIC FRACTURING ON DRINKING WATER RESOURCES: PROGRESS REPORT 1 (Dec. 2012), *available at* http://www2.epa.gov/sites/production/files/documents/hf-report20121214.pdf#page=18 [hereinafter EPA 2010].

[3] *See* Hannah Wiseman, *Untested Waters: The Rise of Hydraulic Fracturing in Oil and Gas Production and the Need to Revisit Regulation*, 20 FORDHAM ENVTL. L. REV. 115, 118–19, 127–28 (2009) ("The fluids used in the [fracing] process vary from pure water to water mixed with solvents or gel (a drilling mud or a polymer, for example) to hydrochloric acid and even diesel fuel, although many operators have signed a non-enforceable memorandum of agreement not to use diesel fuel.").

[4] *See generally* EPA 2010, *supra* note 2.

[5] *Id.*

Volume XIV – Fall 2013 ● ISSN 2164-800X (online)
DOI 10.5195/tlp.2013.137 ● http://tlp.law.pitt.edu

the regulations that govern chemical additives used in and the methods of disposal for fracing fluids remain in constant flux.[6] Future regulations may increase the cost of traditional fracing methods.[7] Under the right circumstances, operators may benefit from a fracing method that resolves most environmental and health issues.[8]

GasFrac, a Canadian company, currently spearheads the development of a safe and effective LPG gel fracing method.[9] Through GasFrac's proprietary method, LPG gel enters the well as a gel under high pressure and then gradually vaporizes into a gas.[10] The company with rights to drill and frac a well (the "operator") extracts the vaporized LPG along with the natural gas and/or oil released through the fracing process.[11] This fracing method provides an attractive alternative to traditional fracing methods because it leaves no residue and eliminates the need for the disposal of used fracking fluids ("wastewater").[12]

This Article evaluates the LPG gel fracing method from technological and economic standpoints. Part I notes the prevalence of traditional fracing methods and introduces the LPG gel fracing method. Part II examines the predominant environmental and health concerns associated with traditional fracing fluids when found in water sources. Part III outlines several current and pending regulations, on both federal and state levels, to address these environmental and health concerns. Part IV introduces GasFrac's LPG gel fracing method, analyzes the safety concerns associated with this fracing method, considers the need for safety regulations, and examines the costs involved in the implementation of this fracing method. Part V outlines a cost-benefit analysis of the LPG gel fracing method.

---

[6] *See, e.g.*, Angela C. Cupas, Note, *The Not-So-Safe Drinking Water Act: Why We Must Regulate Hydraulic Fracturing at the Federal Level*, 33 WM. & MARY ENVTL. L. & POL'Y REV. 605 (2009); Christopher S. Kulander, *Shale Oil and Gas State Regulatory Issues and Trends*, 63 CASE W. RES. L. REV. 1101 (2013).

[7] *See infra* Part III noting the de facto moratorium on fracing in New York, the regulations governing the disclosure of chemical additives used in fracing fluids, and the pending regulations under the Clean Water Act for the disposal of wastewater.

[8] *See infra* Part V outlining a cost-benefit analysis of the LPG gel fracing method.

[9] *See generally Numerous Patents/Numerous Pending*, GASFRAC, http://www.gasfrac.com/proven-proprietary-process.html (last visited Nov. 3, 2013) (providing information on the economic and environmental benefits of the LPG gel fracing method) [hereinafter GasFrac Proprietary].

[10] *Id.*

[11] *Id.*

[12] *See generally Operator Advantages*, GASFRAC, http://www.gasfrac.com/operator-advantages.html (last visited Nov. 13, 2013) [hereinafter GasFrac Operator Advantages].

Volume XIV – Fall 2013 ● ISSN 2164-800X (online)
DOI 10.5195/tlp.2013.137 ● http://tlp.law.pitt.edu

I. ENVIRONMENTAL CONCERNS[13]

There are several types of fracing methods, but all require some type of fluid.[14] The operator injects a mixture of fracing fluid and proppants into a pressurized well.[15] The injection increases the pressure of the well, creating cracks and opening gas pockets in the rock bed formations within the well.[16] The fluids aid in the fracturing of the rock bed formations and deliver the proppants into the fractures.[17] The proppants, in turn, keep the fractures open once the pressure of the well has been lowered.[18] Without the proppants, subsurface pressures would force the fractures shut once the pressure of the well has been lowered.[19] The operator lowers the pressure of the well by pumping out fracing fluid.[20] Eventually, natural gases are extracted along with any remaining fracing fluid.[21]

The potential environmental impacts of the fracing process range from contaminated drinking water to increased seismic activity.[22] The EPA briefly investigated the effects of fracing on underground sources of drinking water in a 2004 study,[23] focusing entirely on coalbed methane fracing operations as opposed to shale gas fracing operations.[24] The EPA concluded that the injection of

[13] This Article does not purport to address the validity of any concerns related to the fracing process. Rather, it briefly presents several predominant environmental and health concerns associated with traditional fracing fluids.

[14] Wiseman, *supra* note 3, at 118.

[15] U.S. ENVTL. PROT. AGENCY, EPA 816-F-04-017, EVALUATION OF IMPACTS TO UNDERGROUND SOURCES OF DRINKING WATER BY HYDRAULIC FRACTURING OF COALBED METHANE RESERVOIRS STUDY 4-1 (June 2004), *available at* http://water.epa.gov/type/groundwater/uic/class2/hydraulicfracturing/wells_coalbedmethanestudy.cfm ("Proppants are sand or other granular substances injected into the formation to hold or 'prop' open . . . fractures created by hydraulic fracturing.") [hereinafter EPA 2004].

[16] *Id.*

[17] *Id.*

[18] Coastal Oil & Gas Corp. v. Garza Energy Trust, 268 S.W.3d 1, 6–7 (Tex. 2008).

[19] *Id.*

[20] *Id.*

[21] EPA 2004, *supra* note 15, at 4-2.

[22] Inessa Abayev, Note, *Hydraulic Fracturing Wastewater: Making the Case for Treating the Environmentally Condemned*, 24 FORDHAM ENVTL. L. REV. 275, 285–89 (2012–2013).

[23] *See generally* EPA 2004, *supra* note 15.

[24] U.K. Envtl. Agency, *Unconventional Gas—Shale Gas and Coalbed Methane*, ENVTL. AGENCY, http://www.environment-agency.gov.uk/business/topics/126689.aspx (last updated Sept. 19, 2013) ("Shale gas is a natural gas extracted directly from shale. . . . [Coal bed methane] is extracted by

Volume XIV – Fall 2013 ● ISSN 2164-800X (online)
DOI 10.5195/tlp.2013.137 ● http://tlp.law.pitt.edu

traditional fracing fluids into coalbed methane wells posed little or no threat to underground sources of drinking water and therefore more detailed study was unnecessary.[25] While the EPA expressed concern over the use of several constituents, including bactericides, acids, diesel fuel, solvents, and alcohols, it reconciled these concerns with the constituents' high potential for dilution, dispersal, absorption, and/or biodegradation.[26] Traditional fracing fluids generally consist of about 95% non-toxic constituents by volume.[27] The EPA essentially determined that the high potential for dilution, dispersal, absorption, and/or biodegradation suffices as the sole method of dealing with the other 5% of toxic constituents,[28] which could amount to thousands of gallons of chemical additives.[29] This conclusion seems tentative at best.

The EPA's study investigated both direct and indirect injection of traditional fracing fluids into underground water sources.[30] In coalbed methane fracing operations, direct injection is a common practice whereby fracing fluid is injected directly into underground water sources as a consequence of the fracing process.[31] The underground water sources run through the coalbed that the well is fracing.[32] By contrast, indirect injection designates the injection of fracing fluid into a coalbed well that is adjacent to an underground water source.[33] In cases of indirect injection, fractures in the coalbed can extend, and serve as a conduit for fracing fluid, into the adjacent underground water source.[34] Many concerns related to the contamination of drinking water with traditional fracing fluids remain unchecked and unanswered despite the EPA's 2004 study.[35]

---

releasing pressure in coal seams, usually by natural gas production or by pumping water from the coalbed.").

[25] Wiseman, *supra* note 3, at 128, 133–36.

[26] *Id.* at 133–34.

[27] *Id.*

[28] *Id.*

[29] Abayev, *supra* note 22, at 280–81.

[30] Wiseman, *supra* note 3, at 129.

[31] *Id.*

[32] *Id.*

[33] *Id.*

[34] *Id.*

[35] *See id.* at 129–36 (describing citizens' concerns in several regions of the U.S. and the EPA's conclusions).

Volume XIV – Fall 2013 ● ISSN 2164-800X (online)
DOI 10.5195/tlp.2013.137 ● http://tlp.law.pitt.edu

The EPA commenced another more comprehensive study in 2010 at the request of Congress.[36] This study picks up where the 2004 study left off and focuses on fracing in shale formations.[37] Unfortunately, the final draft report of this study will not be released until 2014.[38] The EPA has, however, released draft findings from a ground water investigation that examined the effects of fracing on the drinking water of Pavillion, Wyoming,[39] a town with a long history of oil and gas extraction from a shale rock formation.[40] This investigation determined that synthetic chemicals commonly linked to gas production and traditional fracing fluids were present in an aquifer that served as the best source of water for domestic use in the region.[41] Critics deem this investigation inconclusive and scientifically questionable, but these critics, mainly the owner of the Pavillion field, Encana Oil & Gas (USA) ("Encana"), and the governor of Wyoming, Matt Mead, stand to suffer from negative publicity directed toward the oil and gas industry.[42] Encana could lose business from worried landowners, and Matt Mead may want to ensure the oil and gas industry remains a viable economic resource for Wyoming.[43] The ground water investigation in Pavillion is a good example of the type of case studies that form the basis of the EPA's 2010 study.[44]

Looking past the injection of traditional fracing fluids into a well, the disposal of traditional fracing fluids removed from a well also poses serious environmental and health concerns.[45] Wastewater contains not only the chemical additives added

---

[36] U.S. Envtl. Prot. Agency, *EPA's Study of Hydraulic Fracturing and Its Potential Impact on Drinking Water Resources*, EPA, http://www2.epa.gov/hfstudy (last updated Dec. 19, 2013).

[37] *Id.*

[38] *Id.*

[39] Larry Jackson & Richard Mylott, *EPA Releases Draft Findings of Pavillion, Wyoming Ground Water Investigation for Public Comment and Independent Scientific Review*, EPA (Dec. 8, 2011), http://yosemite.epa.gov/opa/admpress.nsf/0/EF35BD26A80D6CE3852579600065C94E.

[40] U.S. ENVTL. PROT. AGENCY, EP-W-05-050, PAVILLION AREA GROUNDWATER INVESTIGATION 4 (Aug. 30, 2010), *available at* http://www2.epa.gov/sites/production/files/documents/Pavillion AnalyticalResultsReport.pdf ("Generally the Wind River formation consists of poorly consolidated sandstone, siltstone, and shale.") [hereinafter EPA Pavillion Report].

[41] *Id.* at 6, 37–38; Jason T. Gerken, Comment, *What the Frack Shale We Do? A Proposed Environmental Regulatory Scheme for Hydraulic Fracturing*, 41 CAP. U. L. REV. 81, 91–93 (2013).

[42] *See* Kirk Johnson, *E.P.A. Links Tainted Water in Wyoming to Hydraulic Fracturing for Natural Gas*, N.Y. TIMES (Dec. 9, 2011), *available at* http://www.nytimes.com/2011/12/09/us/epa-says-hydraulic-fracturing-likely-marred-wyoming-water.html?_r=0.

[43] *Id.*

[44] *See generally* EPA Pavillion Report, *supra* note 40; EPA 2010, *supra* note 2, at 3 (describing the case studies used in the EPA's 2010 study).

[45] Abayev, *supra* note 22, at 283–84.

Volume XIV – Fall 2013 ● ISSN 2164-800X (online)
DOI 10.5195/tlp.2013.137 ● http://tlp.law.pitt.edu

prior to injection but also brines, which may include naturally occurring radioactive materials ("NORMs"), picked up during extraction.[46] The toxicity or radioactivity of these chemical additives and brines could pose health risks if consumed through drinking water.[47] In addition, wastewater almost always contains higher levels of total dissolved solids ("TDS"), as a result of the chemical additives and brines dissolved within it.[48] Even if the wastewater is not toxic or radioactive, it could contain enough TDS to make it five times saltier than seawater.[49] Wastewater with this amount of TDS could pose additional risks to the environment and human health.[50] The validity of the environmental and health risks posed by wastewater when added to water sources remains a hotly contested topic.[51] Nonetheless, growing concerns over the toxicity and radioactivity of chemical additives and brines and the amount of TDS contained in wastewater could lead to more stringent disposal regulations, at least until further studies can disprove these concerns.[52] Operators generally dispose of wastewater by treatment and discharge into surface water sources or by injection into deep injection wells.[53] The toxicity and radioactivity of chemical additives and brines and the amount of TDS contained in wastewater makes processing it at water treatment facilities very difficult.[54] For example, in 2011, Pennsylvania Governor Tom Corbett and the Department of Environmental Protection requested that public water treatment facilities discontinue processing wastewater due to concerns over elevated bromide levels in

[46] *Id.* at 284–85 (citing Daniel J. Soeder & William M. Kappel, U.S. GEOLOGICAL SURVEY, WATER RESOURCES AND NATURAL GAS PRODUCTION FROM THE MARCELLUS SHALE 4 (May 2009), *available at* http://pubs.usgs.gov/fs/2009/3032/pdf/FS2009-3032.pdf) ("The brines themselves often contain 'relatively high concentrations of sodium, chloride, bromide, and other inorganic constituents, such as arsenic, barium and other heavy metals, and radionuclides that significantly exceed drinking-water standards.'").

[47] Abayev, *supra* note 22, at 299.

[48] *Id.* at 281.

[49] *Id.*

[50] *Id.* at 281–82 (citing PA. DEP'T OF ENVTL. PROT., PENNSYLVANIA ENVIRONMENTAL QUALITY BOARD FINAL AMENDMENT OF REGULATIONS ON WASTEWATER TREATMENT REQUIREMENTS 1 (Nov. 2011), *available at* http://files.dep.state.pa.us/Water/Wastewater%20Management/WastewaterPortalFiles/TDS/TDSPlainLanguageSummary11-3-11.pdf) ("[T]oo much TDS can cause adverse effects on 'aquatic life, human health and drinking water supplies. High concentrations of TDS can make waters saltier, harder, and potentially toxic to fish and other wildlife.'").

[51] *See* Abayev, *supra* note 22, at 318–21.

[52] *Id.* at 299.

[53] *See id.* at 300–03.

[54] *Id.* at 303.

Volume XIV – Fall 2013 ● ISSN 2164-800X (online)
DOI 10.5195/tlp.2013.137 ● http://tlp.law.pitt.edu

western Pennsylvania's rivers.[55] The water treatment facilities in the area had been treating and discharging wastewater into these rivers.[56] The elevated bromide levels in the rivers indicate the ineffectiveness of the treatment methods used at these facilities.[57] As another example, a recent Duke University study measured dangerous levels of radium, a highly radioactive alkaline earth metal, in a creek located near a water treatment facility that had treated wastewater prior to the 2011 halt.[58] Many water treatment facilities, including this facility, were not designed to remove radioactive materials.[59] Consequently, these treatment facilities inevitably discharge most radioactive materials contained in wastewater into local water sources.[60]

The EPA regulates deep injection wells through the Underground Injection Control Program.[61] Deep injection wells store large amounts of wastewater and other substances deep underground.[62] Pennsylvania has been allowed relatively few deep injection wells.[63] Following the 2011 halt on the treatment of wastewater in public water treatment facilities, Pennsylvania sends most of its wastewater to Ohio for disposal.[64] Although Ohio has banned the disposal of wastewater through water treatment facilities, it has enough deep injection wells to dispose of Pennsylvania's and its own wastewater.[65] This disposal method may seem harmless in comparison

---

[55] Steve Ferris, *DEP Asks Marcellus Drillers to Stop Taking Waste Water to Treatment Plants*, HERALD-STANDARD (Apr. 22, 2011), http://www.heraldstandard.com/gcm/news/local_news/dep-asks-marcellus-drillers-to-stop-taking-waste-water-to/article_d810dd58-fc71-5464-9483-2f3777d8af22.html?mode=jqm (linking the increase in bromide to wastewater disposal).

[56] Marc Levy, *Fracking Wastewater Disposal Process to be Altered in Pennsylvania*, THE HUFFINGTON POST (Apr. 19, 2011), http://www.huffingtonpost.com/2011/04/20/fracking-wastewater-disposal-pennsylvania_n_851441.html.

[57] *Id.* ("Bromide is a salt that reacts with the chlorine disinfectants used by drinking water systems and creates trihalomethanes, which have been linked to cancer when given in high doses to laboratory animals.").

[58] Gayathri Vaidyanathan, *Radioactive Materials Found in Hazardous Levels Near Pa. Waste Treatment Plant*, E.E. NEWS (Oct. 3, 2013), http://www.eenews.net/stories/1059988264.

[59] Kathleen Hoke, NETWORK FOR PUB. HEALTH LAW, SELECT STATE LAWS GOVERNING HYDRAULIC FRACTURING IN THE MARCELLUS SHALE 1 (Dec. 31, 2012), *available at* http://www.networkforphl.org/_asset/5q3qvm/.

[60] *Id.*

[61] State Impact, *Deep Injection Wells: How Drilling Waste Is Disposed Underground*, NAT'L PUB. RADIO, http://stateimpact.npr.org/pennsylvania/tag/deep-injection-well/ (last visited Nov. 3, 2013).

[62] *Id.*

[63] Abayev, *supra* note 22, at 287.

[64] *Id.*

[65] *Id.*

Volume XIV – Fall 2013 ● ISSN 2164-800X (online)
DOI 10.5195/tlp.2013.137 ● http://tlp.law.pitt.edu

to the treatment of wastewater at ineffective water treatment facilities, but it poses underground water source contamination risks and has been linked to increased seismic activity.[66] In sum, traditional fracing fluids generally contain harmful substances before and after use as part of the fracing process, and these harmful substances often find their way into water sources.

II. CURRENT FRACING REGULATIONS IN RESPONSE TO ENVIRONMENTAL AND HEALTH CONCERNS

Although hydraulic fracturing dates back to 1947,[67] the regulations that govern chemical additives used in and the methods of disposal for fracing fluids remain in constant flux.[68] With the Energy Policy Act of 2005, Congress exempted fracing from federal regulation by the EPA under the Safe Drinking Water Act.[69] As a result, most fracing regulation has occurred at the state level. In New York, a de facto moratorium currently prohibits fracing until further studies can conclusively determine its impacts.[70] Many states, including Pennsylvania, Texas, West Virginia, Oklahoma and Wyoming require that operators disclose the chemicals used in their fracing fluids for each well.[71] Many operators consider their fracing fluid formula a trade secret.[72] As a result, almost all regulations governing fracing fluid disclosure allow for an exemption through which operators may conceal the use of certain potentially harmful chemicals as trade secrets.[73] Although some states have enacted regulations to prevent abuse of trade secret

[66] *Id.* at 288–89.

[67] *Id.* at 294.

[68] *See, e.g.*, Cupas, *supra* note 6; Kulander, *supra* note 6.

[69] Wiseman, *supra* note 3, at 116.

[70] Bryan Walsh, *As Obama Visits Upstate New York, the Fracking Debate Takes Center Stage*, TIME (Aug. 22, 2013), *available at* http://science.time.com/2013/08/22/as-obama-visits-upstate-new-york-the-fracking-debate-takes-center-stage/.

[71] *See, e.g.*, 58 PA. CONS. STAT. ANN. § 3222.1 (2012); TEX. NAT. RES. CODE ANN. § 91.851 (2011); W. VA. CODE § 64-3-1 (2013); OKLA. ADMIN. CODE 165:10-3-10 (2013); WYO. ADMIN. CODE ch. 3, § 45 (2013).

[72] Brian J. Smith, Comment, *Fracing the Environment: An Examination of the Effects and Regulation of Hydraulic Fracturing*, 18 TEX. WESLEYAN L. REV. 129, 131 (2011); *see also* Patrick McGreevy, *California Officials Wrestle with Handling Trade Secrets on Fracing*, L.A. TIMES (July 17, 2013), *available at* http://articles.latimes.com/2013/jul/17/local/la-me-pc-fracing-rules-developing-20130717 (raising concerns about the use of trade secrets to inhibit full disclosure of the chemicals used in fracking fluids).

[73] *See, e.g.*, 58 PA. CONS. STAT. ANN. § 3222.1 (2012); TEX. NAT. RES. CODE ANN. § 91.851 (2011); W. VA. CODE § 64-3-1 (2013); OKLA. ADMIN. CODE 165:10-3-10 (2013); WYO. ADMIN. CODE ch. 3, § 45 (2013).

Volume XIV – Fall 2013 ● ISSN 2164-800X (online)
DOI 10.5195/tlp.2013.137 ● http://tlp.law.pitt.edu

exemptions,[74] these exemptions make it inherently more difficult to know exactly what chemicals operators are putting into the ground.[75] Federal and/or state regulations may ultimately require full disclosure of chemical additives.[76] Operators using traditional fracing methods may be held liable or face negative publicity if these chemical additives are later found in local water supplies.[77]

Currently, no national standard exists for the disposal of wastewater,[78] but most state governments have enacted a variety of regulations.[79] On the federal level, the Clean Water Act ("CWA") regulates any type of discharge into navigable waterways in the United States.[80] As part of the CWA's requirements, the EPA must publish an "Effluent Guidelines Program Plan" every other year.[81] In 2010, the EPA published a plan to develop regulations for wastewater disposal from natural gas production.[82] The plan stipulates the gathering of additional data and continued consultation with industry and public health groups.[83] At the conclusion of this process, the EPA will propose federal regulations to govern the disposal of wastewater from wells drilled in coalbed and shale formations.[84] Federal and state

---

[74] Gerken, *supra* note 41, at 118 (describing Colorado's trade secret disclosure regulations as the most comprehensive in the country and as an apt model for other states).

[75] *Id.* at 100–01.

[76] *Id.* (calling for mandatory disclosure laws at the federal level).

[77] Abayev, *supra* note 22, at 311.

[78] *See id.* at 311–12.

[79] *See id.* at 293 (describing the issues caused by the constant flux of revisions to state wastewater regulation).

[80] *See* Gerken, *supra* note 41, at 102–03.

[81] *Id.* at 103 (citing U.S. ENVTL. PROT. AGENCY, EPA 820-F-11-0005, FINAL 2010 EFFLUENT GUIDELINES PROGRAM PLAN 1–2 (Oct. 2011), *available at* http://water.epa.gov/lawsregs/lawsguidance/cwa/304m/upload/factsheet2011.pdf) ("Effluent guidelines are national regulations that control the discharge of pollutants from industry to surface waters and to publicly owned treatment works (POTWs).").

[82] *Id.*

[83] Enesta Jones, *EPA Announces Schedule to Develop Natural Gas Wastewater Standards/Announcement is Part of Administration's Priority to Ensure Natural Gas Development Continues Safely and Responsibly*, EPA (Oct. 10, 2011), http://yosemite.epa.gov/opa/admpress.nsf/6427a6b7538955c585257359003f0230/91e7fadb4b114c4a8525792f00542001!OpenDocument&Start=1&Count=5&Collapse=1.

[84] *Id.* ("To ensure that these wastewaters receive proper treatment and can be properly handled by treatment plants, EPA will gather data, consult with stakeholders, including ongoing consultation with industry, and solicit public comment on a proposed rule for coalbed methane in 2013 and a proposed rule for shale gas in 2014.").

Volume XIV – Fall 2013 ● ISSN 2164-800X (online)
DOI 10.5195/tlp.2013.137 ● http://tlp.law.pitt.edu

regulations continue to undergo drastic changes as new case studies and local environmental and health concerns arise.[85]

III. GASFRAC AND FRACING WITH LPG GEL

Through its proprietary LPG gel fracking method, GasFrac claims it has the ability to recover nearly 100% of its fracing fluid within days of injection.[86] The key to this method is the use of LPG gel, comprised predominantly of liquid propane converted into a gel with phosphate ester and iron sulfide.[87] Magnesium oxide is also added to delay the breakdown of the LPG gel.[88] LPG flows from storage tanks to a specialized "sand blender."[89] The sand blander may add phosphate ester, iron sulfide, and magnesium oxide to the LPG to create LPG gel, but it is unclear exactly when and how the LPG gel is formed.[90] The sand blender undoubtedly adds proppants to the LPG gel.[91] The LPG gel and proppants are then injected into the well bore through "specialized high pressure pumping units," or "stimulators."[92] Once the fracing process is complete and the pressure of the well is lowered, the LPG gel gradually breaks down and reverts to a gaseous state.[93] The vaporized LPG is easily extracted along with the natural gas and/or oil produced from the well.[94] The phosphate ester, iron sulfide, and magnesium oxide remain in the well.[95] GasFrac claims these chemicals are non-toxic in the quantities used for

[85] Abayev, *supra* note 22, at 290–93; *see supra* Part II noting several predominant environmental and health concerns associated with traditional fracing fluids.

[86] GasFrac Proprietary, *supra* note 9.

[87] *Id. See also GasFrac (GFS.TO)*, REYNDERS, MCVEIGH CAPITAL MGMT., LLC (June 18, 2013), *available at* http://www.reyndersmcveigh.com/research/pdfdocs/Gasfrac%202013-06-18-updt.pdf [hereinafter REYNDERS MCVEIGH].

[88] REYNDERS MCVEIGH, *supra* note 87; *In the mix: What fracking chemicals are used in fracking fluids?*, HYDRAULIC FRACKING (Sept. 19, 2013), http://www.hydraulicfracking.co.uk/in-the-mix-what-fracking-chemicals-are-used-in-fracking-fluids [hereinafter HYDRAULIC FRACKING].

[89] *Integrating Innovative Technology*, GASFRAC, http://www.gasfrac.com/equipment-profile.html (last visited Nov. 3, 2013).

[90] *Id.*

[91] *Id.*

[92] *Id.*

[93] HYDRAULIC FRACKING, *supra* note 88.

[94] Anna Driver, *Propane Substitutes for Water in Shale Fracing*, REUTERS (Nov. 22, 2011, 11:17 AM), http://www.reuters.com/article/2011/11/22/us-shale-propane-idUSTRE7AL1ML20111122.

[95] REYNDERS MCVEIGH, *supra* note 87.

Volume XIV – Fall 2013 ● ISSN 2164-800X (online)
DOI 10.5195/tlp.2013.137 ● http://tlp.law.pitt.edu

fracking.[96] GasFrac also claims the LPG gel fracing method can be more efficient than tradition methods.[97] LPG gel vaporizes during extraction, allowing for the free flow of natural gas.[98] Water often absorbs into the fractured rock formations hindering the flow of natural gas.[99]

GasFrac claims to have developed automated safe guards and "remote command modules" to allow for remote operation from a safe distance.[100] Nonetheless, the use of LPG gel, an extremely flammable liquid, raises a number of safety concerns, including the increased risk of explosion or fire during the fracing process.[101] While most states fail to address the safety concerns raised by the LPG gel fracking method,[102] Wyoming has recently enacted safety regulations to govern the use of flammable fracing fluids.[103] Looking past safety concerns, operators should consider the substantial cost of switching to this new fracing method.[104] Operators would need to replace most of their current fracing equipment with new equipment from GasFrac and rework their logistical infrastructure to account for the purchase, transportation, and storage of LPG and LPG gel.[105] Overall, the LPG fracing method could be worth the switch.

A. Safety Concerns

Since 2008, GasFrac has pioneered the use of LPG gel as a fracing fluid.[106] It has successfully performed over one thousand fracs in Canada and the United States using the LPG gel fracing method.[107] As a result, GasFrac has received the go-ahead to continue fracing with LPG gel in Canada, and various regulators have

---

[96] *Id.*

[97] Brian Nearing & Anthony Brino, *Cutting Waste in Gas Drilling*, TIMES UNION, http://www.timesunion.com/local/article/Cutting-waste-in-gas-drilling-2254667.php#page-2 (last updated Nov. 7, 2011, 9:00 AM). *See also* GasFrac Operator Advantages, *supra* note 12.

[98] *Id.*

[99] *Id.*

[100] GasFrac Propriety, *supra* note 9.

[101] Driver, *supra* note 94.

[102] *See, e.g.*, N.Y. COMP. CODES R. & REGS. tit. 6, § 556.4 (2013); 25 PA. CODE § 78.73 (2013).

[103] *See, e.g.*, WYO. ADMIN. CODE ch. 8, § 2 (2013), OSHA—Oil and Gas Well Specifications, *available at* http://soswy.state.wy.us/Rules/RULES/3744.pdf; WYO. ADMIN. CODE ch. 9, § 1(d) (2013), OSHA—Oil and Gas Well Specifications, *available at* http://soswy.state.wy.us/Rules/RULES/3745.pdf.

[104] Nearing & Brino, *supra* note 97.

[105] *Id.*

[106] *Id.*

[107] *Id.*

Volume XIV – Fall 2013 ● ISSN 2164-800X (online)
DOI 10.5195/tlp.2013.137 ● http://tlp.law.pitt.edu

reviewed its fracking method in the United States.[108] Still, the use of LPG gel in place of water invokes a different gamut of concerns.[109] To address these concerns, GasFrac has developed new technologies, including computerized and remotely controlled fracing systems, to minimize the need for on-site workers.[110] As the pioneer of a burgeoning technology, GasFrac continues to develop its fracing method as issues arise.[111]

GasFrac likely heightened its focus on safety following an incident in 2011 in which fire broke out during the LPG gel fracing process.[112] The incident involved a flash fire at a well in Alberta, Canada, operated by Husky Energy, where three workers suffered non-life threatening burns.[113] The cause of the incident was an undetected propane leak.[114] In response, GasFrac raised the number of propane sensors used during the fracing process from three to twenty.[115] The fracing process poses inherent risks to on-site workers,[116] but fracing with flammable fluids poses substantially greater risks.[117] As GasFrac continues to develop its fracing method, federal and/or state agencies should provide a regulatory framework with minimum safety requirements to protect on-site workers during the LPG gel fracing process.

B. The Need for Regulation

While fracing with water and chemical additives may pose environmental and health concerns,[118] fracing with LPG gel poses more immediate concerns with regard to the safety of on-site workers.[119] Federal and state agencies have

---

[108] Driver, *supra* note 94.

[109] *Id.*

[110] *Designed for Maximum Safety*, GASFRAC, http://www.gasfrac.com/safer.html (last visited Nov. 3, 2013).

[111] *See* Nearing & Brino, *supra* note 97 (describing GasFrac's response to the incident in Alberta).

[112] *Id.*

[113] *Id.*

[114] *Id.*

[115] *Id.*

[116] S.E. Smith, *Fracking: Bad for the Environment, the Community and Workers*, CARE2 (Feb. 9, 2013, 6:00 AM), http://www.care2.com/causes/fracking-bad-for-the-environment-the-community-and-workers.html (listing several incidents in which on-site workers suffered injuries related to the fracing process).

[117] *See* Nearing & Brino, *supra* note 97.

[118] *See supra* Part II discussing the environmental and health concerns associated with traditional fracking fluids.

[119] *See* Nearing & Brino, *supra* note 97.

Volume XIV – Fall 2013 ● ISSN 2164-800X (online)
DOI 10.5195/tlp.2013.137 ● http://tlp.law.pitt.edu

regulatory frameworks in place governing the minimum safety requirements for traditional fracing methods and the transportation, storage, and use of LPG.[120] So far, only Wyoming has enacted regulations addressing the added safety concerns implicit in the use of flammable fracing fluids, such as LPG gel.[121] Wyoming's safety procedures include: using hose covers on supercharged suction hoses when using flammable fluid;[122] covering spilled flammable fluid with soil prior to pumping;[123] and shutting down all non-essential internal combustion equipment, electrical equipment, and flames within seventy-five feet of the well bore when pumping flammable fluids.[124] These safety procedures further include: preventing flammable fluids from bleeding back into open measuring tanks on equipment designed for pumping;[125] performing all fracing operations involving flammable fluid during daylight hours;[126] and placing fracturing tanks containing flammable fluid at least seventy-five feet from the well bore.[127] Any regulatory framework that addresses the safety concerns associated with flammable fracing fluids is a step in the right direction. Government agencies cannot allow operators to regulate themselves. Safety regulations must evolve with technological advances.

States with an interest in environmentally friendly oil and gas production should consider enacting regulations catered toward the LPG gel fracing method (i.e. regulations that govern the use of flammable fracing fluids).[128] GasFrac provides a viable solution to water contamination and wastewater disposal issues.[129] New York, a state especially concerned with the contamination of its water sources,[130] and Pennsylvania, a state seeking a long-term method for dealing

---

[120] *See, e.g.*, 29 C.F.R. § 1910.110; N.Y. COMP. CODES R. & REGS. tit. 16, § 255.1; 34 PA. CODE § 13.2 (2013); WYO. ADMIN. CODE ch. 8, § 1910.110 (2013).

[121] WYO. ADMIN. CODE ch. 8, § 2 (2013), OSHA—Oil and Gas Well Specifications, *available at* http://soswy.state.wy.us/Rules/RULES/3744.pdf.

[122] *Id.* § 2(c).

[123] *Id.* § 2(j).

[124] *Id.* § 2(l).

[125] *Id.* § 2(m).

[126] *Id.* § 2(o).

[127] WYO. ADMIN. CODE ch. 9, § 1(d) (2013), OSHA—Oil and Gas Well Specifications, *available at* http://soswy.state.wy.us/Rules/RULES/3745.pdf.

[128] *See, e.g.*, Wendy Post, *eCorp, GasFrac Signing Could Mean Good News for New York Landowners*, NORTHEAST DRILLER (Apr. 24, 2012), http://northeastdriller.com/ecorp-gasfrac-signing-could-mean-good-news-for-new-york-landowners-1.1304098 (announcing plans for the development of 135,000 acres of land in New York for oil and gas production using GasFrac's technology).

[129] *See* GasFrac Proprietary, *supra* note 9.

[130] Post, *supra* note 128.

Volume XIV – Fall 2013 ● ISSN 2164-800X (online)
DOI 10.5195/tlp.2013.137 ● http://tlp.law.pitt.edu

with wastewater,[131] could benefit from GasFrac's LPG gel fracing method. Unfortunately, the regulatory framework in New York and Pennsylvania fails to address safety concerns inherent to the use of flammable fracing fluids.[132] On the state level, a regulatory framework with safety procedures similar to those enacted in Wyoming would be a good start.[133] If GasFrac continues to grow,[134] and the LPG gel fracing method becomes more prevalent, it may be prudent for the Occupational Health and Safety Administration ("OSHA") to regulate safety procedures on the federal level.

C. The Cost of Implementing an Infrastructure for the LPG Gel Fracing Method

To transport and store LPG gel, operators would need to implement an entirely new infrastructure from that of traditional fracing operations.[135] Traditional fracing operations generally make use of local water sources to create traditional fracing fluids, which keeps transportation costs low initially.[136] Upon completion of the fracing process, however, operators often must transport wastewater from the well to a treatment plant or a deep injection well and pay for its disposal.[137] By contrast, the LPG gel fracing method would require the transportation of LPG, a flammable substance that costs substantially more than water, to the well to create LPG gel.[138] Although trucks carrying LPG would likely need to travel farther,[139] fewer trucks are needed to transport the average quantity of LPG necessary to perform the fracing process than are needed to transport the average quantity of water.[140] Also, LPG converted into a gel and used as fracing fluid, and then

---

[131] Abayev, *supra* note 22, at 287–88.

[132] *See* N.Y. COMP. CODES R. & REGS. tit. 6, § 556.4 (2013); 25 PA. CODE § 78.73 (2013).

[133] WYO. ADMIN. CODE ch. 8, § 2 (2013), OSHA—Oil and Gas Well Specifications, *available at* http://soswy.state.wy.us/Rules/RULES/3744.pdf.

[134] Mark Broer, *What's Going On With GasFrac?*, SEEKING ALPHA (Dec. 8, 2013), http://seekingalpha.com/article/1884391-whats-going-on-with-gasfrac (announcing the economic growth of GasFrac).

[135] Gerken, *supra* note 41, at 124.

[136] Smith, *supra* note 72, 133–34.

[137] *Id.* at 134–35.

[138] Gerken, *supra* note 41, at 124.

[139] LPG would need to be purchased locally or transported from an operator's housing facility. In most cases, local water sources would prove more readily available and require less transportation.

[140] *More results. Less impact.*, GASFRAC, http://www.gasfrac.com/lpg-vs-conventional.html (last visited Nov. 3, 2013) ("Because propane liquid is half the specific gravity of water, there is reduced

Volume XIV – Fall 2013 ● ISSN 2164-800X (online)
DOI 10.5195/tlp.2013.137 ● http://tlp.law.pitt.edu

extracted as a gas from the well, can be sold or converted back into LPG gel and reused, eliminating the expense of wastewater transportation and disposal.[141] Operators would still need to purchase and house large quantities of LPG in strategic regions throughout the United States to avoid long-distance transportation costs. The price of propane, the chief component of LPG gel, is currently low as a result of a growing supply in the U.S.[142] Taking into account cheap propane prices,[143] the ability to sell or reuse LPG,[144] and the elimination of wastewater disposal costs,[145] this new infrastructure could reduce an operator's operating expenses in the long run.

IV. CONCLUSION

Many questions about the potentially harmful effects of fracing fluids when found in water sources remain unanswered. The regulations that govern the chemical additives used in and the methods of disposal for fracing fluids remain in constant flux. Future regulations may increase the cost of traditional fracing methods. GasFrac spearheads an interesting advancement in fracing technology, the use of LPG gel as a fracing fluid. While the LPG gel fracing method may substantially reduce environmental and health concerns associated with traditional fracing fluids, it raises safety concerns for on-site workers. These safety concerns suggest the need for a regulatory framework catered to the use of flammable fracing fluids.

Looking past the inherent safety concerns and the need for regulation, most operators may view the switch to LPG gel as too costly or not worth the risk. The continued use and ultimate success of the LPG gel fracing method depends upon the outcome of a simple cost-benefit analysis. The cost factors include: the expense of GasFrac's proprietary equipment; the expense of implementing a new infrastructure to purchase, transport, and store LPG; and the assumption of greater risk with regard to on-site worker safety. The benefit factors, against which the

trucking to the site and no trucking to transport post stimulation—which can reduce truck traffic by up to 90%.") [hereinafter GasFrac LPG].

[141] *The 4 R's of LPG*, GASFRAC, http://www.gasfrac.com/lpg-vs-conventional.html (last visited Nov. 3, 2013).

[142] U.S. ENERGY INFO. AGENCY, DOE/EIA-0383 (2013), ANNUAL ENERGY OUTLOOK 2013 WITH PROJECTIONS TO 2040, at 48 (Apr. 2013), *available at* http://www.eia.gov/forecasts/aeo/pdf/0383(2013).pdf.

[143] *Id.*

[144] GasFrac LPG, *supra* note 140.

[145] *Id.*

Volume XIV – Fall 2013 ● ISSN 2164-800X (online)
DOI 10.5195/tlp.2013.137 ● http://tlp.law.pitt.edu

costs factors must be weighed, include: the reduction in risk with regard to environmental and health concerns; the purported increase in well productivity; and the elimination of wastewater disposal costs. With continued testing and the implementation of appropriate safety regulations, the LPG gel fracing method could become a prevalent fracing method in the United States.

Volume XIV – Fall 2013 ● ISSN 2164-800X (online)
DOI 10.5195/tlp.2013.137 ● http://tlp.law.pitt.edu