Current and Evolving Issues Pertaining to Produced Water and the Ongoing Development of Coal Bed Methane

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Abstract

The United States is faced with the challenge of providing sufficient supplies of safe water to its citizens now and in the future. Factors like prolonged droughts, rapid population growth, competing user demands and environmental health concerns, place additional stress on available water resources. Government organizations, such as the U.S. Department of Energy's National Energy Technology Laboratory, have funded significant research pertaining to managing produced water, beneficial uses of produced water and produced water treatment. In August, 2008, the Bureau of Reclamation opened its Brackish Groundwater National Desalination Research Facility to facilitate research regarding treating and development options using water requiring treatment, possibly including produced water. Additionally, the Bureau of Land Management has completed a variety of NEPA related documents in which produced water is a significant concern. In areas such as the Powder River Basin, managing produced water has evolved into the single most costly aspect of Coal Bed Methane (CBM) development and has sparked major controversy in state governments.

The challenges presented in managing produced water are a growing concern relative to CBM development in the United States and abroad. Understanding the evolution of CBM produced water issues that have arisen, combined with water issues unrelated to CBM development, can offer insight into forecasting the future challenges produced water management may pose. This paper leverages a variety of research projects to discuss current and future produced water issues important to the CBM development industry.

Introduction

As the development of coal bed methane continues to rise, produced water issues remain prevalent in the decision making processes in the CBM industry. The consideration of produced water as a beneficial use has become a common practice among producers of CBM, however, the varying quality of water from region to region does not allow for a universal alternative to the management of CBM produced water. Treatment of produced water and beneficial re-use is fast becoming a reality in areas where water sources are scarce. Typically, applicable regulations, produced water quality, and cost will dictate potential beneficial use of produced water. With the movement of produced water management alternatives, additional environmental issues are raised due to affects caused by lower water quality. Concentrations of the constituents found within produced water will vary for any given water source, depending on certain factors such as coal seam depth, peat metabolism processes, aquifer recharge, etc., and in some cases will require treatment prior to beneficial use. Decisions to develop CBM wells depend on the issues associated with the production of water and the potential benefits of the development. This paper briefly addresses produced water issues created by the development of new sources of natural gas from coal fields.

Current Produced Water Issues Pertaining to Development

Economical Impacts

Development of CBM wells expand economic activity for the areas in which production is occurring. This economic activity, brought on by capital investments and new jobs, will generate increased tax revenues for federal, state and local governments. Landowners and governmental entities also see an increase in income from royalties and production taxes. With the development of CBM wells in question due to produced water, state and local improvements to the economy, due to the increased flow of funds brought by CBM production, could be limited. The abundance of produced water from CBM wells causes concern for developers to economically manage produced water in an effective and environmentally safe manner.

Cherokee Basin CBM Well

Approximately 60% of water produced with conventional oil and gas is disposed of via deep well injection at a cost of $0.50 to $1.75/bbl in wells that cost $400,000 to $3,000,000 to install (Argonne National Laboratory, 2002). Management costs associated with water disposal can potentially impact realized profits of the natural gas industry, and possibly halt production operations. Movement towards beneficial use of produced water has brought on many uncertainties with the respect of economically producing CBM.

Water Rights

Water rights, with regard to CBM produced water, is a very complex issue that is critical in understanding how states, operators, and the public can maximize beneficial water uses and minimize or mitigate the impact of production. This complexity is due to the fact that water rights are managed, to a great extent, under state law. Therefore, it is important to have a good understanding of the water rights laws of each individual state and how they apply to CBM. The scarcity of water in the Western United States has led to the development of doctrines that guide water rights. Special attention is paid to the states' water rights systems, the application processes, groundwater regulations, the general adjudication process, and the states' instream flow programs.

Water rights in Montana, for example, are guided by the prior appropriation doctrine, that is, first in time is first in right. A person's right to use a specific quantity of water depends on when the use of water began. The first person to use water from a source established the first right; then the second person could establish a right to the water that was left, and so on. In an effort to protect surrounding ranchers and farmers from damage from the inevitable drawdown, water well mitigation agreements are advocated by both the MDNRC and MBOGC. The agreements between ranchers and farmers with the CBM operators will allow the aquifer pump-down that is necessary for CBM development, but will require delivery of the same quality of water that is being impacted when groundwater supplies are impacted. These agreements are vital in the cooperation between landowners and producers of CBM.

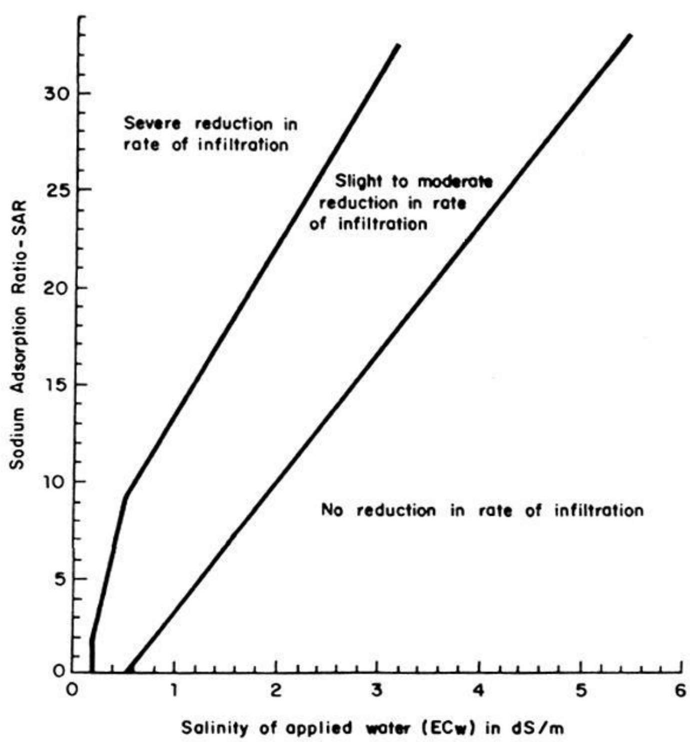
Water Resource Impacts

Restrictions on surface water discharge are set forth by federal and state regulations protecting stream and river water quality. The 1977 amended Clean Water Act (CWA) established the basic structure for regulating discharges of pollutants into the waters of the United States. It gave EPA authority to implement pollution control programs, including wastewater standards for industry. Previously established requirements were also continued under the CWA that set water quality standards for all contaminants in surface waters, making the discharge of any pollutant from a point source into navigable waters illegal, unless a permit was obtained under its provisions. In order to obtain a National Pollutant Discharge Elimination System (NPDES) permit, operators must prepare monitoring requirements which include; best management practices plans, spill prevention plans and monitoring of discharges, sediments, or fish tissues.

Discharge of CBM produced water can bolster seasonal flows of local rivers and accommodate more beneficial uses. Various discharge scenarios can be considered based on the quantity and quality of the receiving water and produced water. During discharge planning, site-specific issues dealing with water quantity changes due to the discharges, including increased erosion, infiltration into the local bedrock, and changes to biota along the drainage, will generally need to be examined. Depending upon water management priorities and water quality, surface discharges may be curtailed or eliminated as a management option. Discharge into streams can lead to significant changes brought about by increased flow volume either seasonally or throughout the year. The site-specific vulnerabilities of the stream can constrain or even prevent such discharges.

Agricultural Impacts

Farmers and ranchers in the area of CBM production can also take advantage of the produced water generated from the production wells. The utilization of produced water for agricultural purposes can help relieve water shortage concerns for farmers and ranchers that need sufficient amounts of water to supplement crops and livestock. The suitability of CBM produced water for use in agricultural irrigation is largely governed by the quality of the water and the physical and chemical properties of the irrigated soils. The quality of CBM produced water should be evaluated with respect to salinity (EC) and sodicity (SAR) to provide an initial indication of the general suitability for irrigation. In addition, trace constituents should be evaluated to identify any potential affects to irrigated soils and plants.



Source: Ayers and Westcot, 1985.

Irrigation water characterized by an elevated SAR has the potential to swell and disperse clays in the soil, which can result in decreased pore size and soil permeability (ALL, 2003). Agricultural productivity can be affected with the additional use of the lower quality produced water. Increased salinity in the soil pore water reduces the availability of water for plant use. Plants must then expend more energy to extract water from the soil when elevated concentrations of soluble salts are present in the root zone (Barbour, 1995).

Evolving Produced Water Issues Pertaining to Development

Treatment Technologies

Typically, water treatment technologies are limited to treating specific constituent types concentrated in water, e.g., dissolved solids, organics, conductive ions, etc. Depending on the eventual use of the water and the desired constituent concentrations, treatment processes are often coupled together to achieve required water use objectives. The quality of produced water varies from basin to basin, and some treatment technologies may be applicable in one basin but not in another basin or region. CBM operators produce large volumes of water, particularly during early phases, and the quality as well as the volume may change during the approximately 20 years of life of a well (Rawn-Schatzinger, 2003). The variability of water quality produced throughout basins and regions creates issues for producers in economics and meeting regulatory requirements.

Ion Exchange Produced Water Treatment System (Montana)

Treated water can be mixed with raw water to better match the receiving water quality of surface discharge to eliminate impacts due to water quality restraints set by discharge permits. By mixing treated and raw water, the discharged water can be changed seasonally to match the changing water quality of the receiving stream. In spite of this compatibility of quality, the larger volume of discharge water may enlarge or even change the once intermittent or ephemeral stream into a perennial stream. This change in flow regime will alter the conditions for plants and animals within the riparian area, which could lead to various adverse environmental impacts. When the riparian environment is affected, the ripple effect could be wide ranging.

Infrastructure

Development of CBM fields and treatment facilities can involve invasive infrastructure. Facility operations would depend on the infrastructure in place to effectively transport the produced natural gas and water. Pipelines, buildings and roads would be a few of the necessary additions to the current practice of the produced water management. Surface disturbances can lead to significant erosion and noxious weed concentrations if they are not properly managed and maintained. One stretch of road or trail ten feet wide, crossing a section of land (one mile), equates to a little over an acre (1.2 ac) of disturbance (Regele, 2000).

Placement of CBM wells is dependant upon producible coal seams throughout a particular region which can dominate the landscape in certain areas. When water treatment is applicable, decisions will have to be made to determine location, size and the number of the treatment plants that are necessary to successfully treat and manage produced water. New water treatment facilities will need appropriate construction and discharge permits applicable to state and federal regulations. In Wyoming, new technologies apply for a Wyoming Oil and Gas Conservation Commission (WOGCC) pilot plant temporary permit that can be converted into a statewide construction permit after at least 12 months of operating data can show the stability and effectiveness of the facility. An increase in the number and size of the facilities may lead to public protests due to the increased noise, traffic and visual presence required by treatment facilities. Currently, with only a few treatment plants in operation in the Powder River Basin, most citizens have looked upon the facilities as good for the environment. The possibility of exponential growth could cause citizens to be less encouraged and protest construction permits.

Conclusion

Development of CBM has many complexities that must be analyzed in order to determine how to best manage all aspects of the resource. The impacts from increased development could potentially pose risks to the existing environment. These impacts can be limited and controlled through the use of mitigation measures and best management practices set forth by CBM producers. Understanding and following laws and regulations set forth to protect the surrounding environment will be critical in the decision making processes in order to produce CBM effectively and economically. With the use of conservation, proper disposal methods and beneficial use alternatives, impacts from CBM produced water can be minimized. The ever changing attitude of CBM produced water as an asset to be used to supplement water shortages in the western United States and surrounding areas will provide incentive to discover new technologies and practices to effectively manage produced water. Issues pertaining to produced water from CBM wells are prevalent in today's decision making process and will also be a factor in the future development of this resource.

There are also several areas and/or issues that require or could benefit significantly from additional research. Examples of these include things such as implications of produced water management to green house gases; planning and interaction between coal mines and coal bed methane production as well as the associated management of coal seam waters; synergies among conventional, unconventional and alternative energy development and produced water; ongoing research into expanded water treatment and the beneficial use of produced water; geospatial techniques and tools that could aid in both identifying and planning for produced water management; research resulting in models and/or tools that can be used to assess water management alternatives on a geospatial basis given local or regional criteria (including economics); environmental risk analysis and human/health risk analysis methods/standards to aid in evaluating risks from various water management alternatives; and training/technology transfer related to items of significance.

References

ALL Consulting, U.S. Department of Energy, National Energy Technology Laboratory, and Wyoming State Planning Office. “Feasibility Study of Expanded Coal Bed Natural Gas Produced Water Management Alternatives in the Wyoming Portion of the Powder River Basin Phase II.” February 2006.

ALL Consulting, Ground Water Protection Research Foundation, U.S. Department of Energy National Energy Technology Laboratory and Bureau of Land Management. Handbook on Coal Bed Methane Produced Water: Management and Beneficial Use Alternatives. July 2003.

Anderson ZurMuchlen & Co., P.C., “Coalbed Methane Development, Powder River Basin of Montana: Economic and Social Impacts of Proposed Development”, June 2001.

Argonne National Laboratory, Argonne Research Programs, Facilities and Capabilities. United States Department of Energy Laboratory operated by University of Chicago, 2002.

Arthur, J.D., Langhus B.G., David Epperly, Brian Bohm, Tom Richmond, and Jim Halvorson, “Coal Bed Methane in the Powder River Basin of Montana”, September 2001.

Ayers, R.S. and Westcot, D.W, “Water Quality for Agriculture, FAO Irrigation and Drainage Paper No. 29 (Rev 1)”. 1985.

Barbour, M.G., Burk, J.H., Pitts, W.D., Gillian, F.S., and Schwartz, M.N., Terrestrial Plant Ecology. November 1998.

Rawn-Schatzinger, Viola, Arthur, Dan; Langhus, Bruce, “Coalbed Natural Gas Produced Water: Water Rights and Treatment Technologies”. Fall 2003.

Regele, S., and Stark, J., “Coal-Bed Methane Gas Development in Montana, Some Biological Issues,” September 2000.