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Hydraulic fracturing consumes the largest share of water in shale gas production

An average shale gas well in the Marcellus formation will use around 20 000 m^3 of freshwater over its life cycle, new research suggests. In total, 65% of this is directly consumed at the well site and 35% is consumed further along the supply chain

The extent of shale gas developments is expected to increase across the globe in the coming decades. In the US alone, the shale share of dry gas production is projected to rise from 23% in 2010 to 49% in 2035. One of the major concerns about such developments is their effects on water resources.

This study assessed the life cycle water consumption (from well-pad preparation to well closure) and wastewater pollution impacts of an average well in the Marcellus formation, US. The researchers used water data reported to the environmental authorities from around 500 Marcellus wells to calculate water consumption for an average well. Water is required for drilling and hydraulic fracturing operations and is indirectly used along the supply chain, for example, to prepare 'proppant' such as sand, which is needed to hold open fractures during hydraulic fracturing, as well as in general use in the production of fuels, electricity and materials.

The results revealed that under current conditions, one average shale gas well in the Marcellus formation, US consumes around 20 000 m^3 of water during its life cycle. Of this, approximately 12 000 m^3 is directly consumed at the well site. The water is required for a short period of time, primarily for approximately 10–14 days of hydraulic fracturing.

Approximately 10-15% of the water used for hydraulic fracturing returns to the surface after fracturing and around 90-95% of this would be reused for fracturing another well. Freshwater is required to make up for the water consumed. In addition, around 8000 m^3 of water is indirectly used along the supply chain.

Hydraulic fracturing consumes most of the freshwater (86%) across the life cycle of a well. Of this, 76% is directly used in the fracturing fluids and 24% is indirect water use, mainly related to the production of sand and additives needed for the fracturing fluids. Well-pad preparation accounts for 11% of the total water consumption, most of which is indirectly consumed in construction processes.

Wastewater is produced from: (i) drilling the well, (ii) after hydraulic fracturing operations when water used is returned to the surface and (iii) the production phase of the well when the gas is extracted. Wastewater from this last phase consists of some fracturing fluid, which is not necessarily the same composition as the liquid injected, as it may react with chemicals underground, and water from the shale formation itself, which may contain naturally occurring radioactive materials and toxic metals.

The researchers estimated the maximum toxicity of wastewater by assuming the theoretical case of discharging these waters back into the environment without treatment (which is prohibited by law in the Marcellus). The potentials for eutrophication, ecotoxicity (mainly due to the presence of barium) and non-carcinogenic (also dominated by barium) impacts were all higher for drilling water and produced waters than for the supply chain wastewaters. The supply chain waters were found to be worst for their carcinogenic potential.

The researchers also used an alternative way to assess the impact of wastewater pollution on water quality, based on water treatment costs. These reflect the potential pollution impact, as it is more costly to remove higher levels of contaminants. For example, using desalination methods to treat wastewater to return it to pre-use levels and remove all pollutants would cost US$ 59 000-270 000 (€42 327-€193 701) for each well.

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