The water demand of ammonia production to fertilize crops

Peter H. Pfromm
Department of Chemical & Petroleum Engineering, The University of Kansas, Lawrence, KS 66045, USA, peterpfromm@ku.edu

James Bloodgood
College of Business Administration, Kansas State University, 1301 Lovers Lane, Manhattan, KS 66506, USA, jblood@k-state.edu

Mary C. Hill
Department of Geology, Earth, Energy, and Environment Center, 1414 Naismith Drive, University of Kansas, Lawrence, KS 66045, USA, mchill@ku.edu

Ammonia production is an important area of the Food-Energy-Water nexus that has been the subject of significant research over the last decades, including the FEWtures project led by Dr. Mary Hill at the University of Kansas and funded by the National Science Foundation (https://ipsr.unit.ku.edu/FEWtures/index.shtml).

Here, water usage for renewable ammonia production for fertilizers is put into perspective relative to the water demand to grow the crops that require the fertilizer. This is motivated by numerous discussions with stakeholders where any additional water demand in areas where water resources are already stressed is viewed with great trepidation. An additional motivation is the apparent absence of this direct and quantitative comparison in published information.

“Green” ammonia production using renewable electricity to hydrolyze water and obtain hydrogen has come into focus to decarbonize nitrogeneous fertilizer production, and due to the emerging use of ammonia as a renewable energy vector. This approach requires water to obtain hydrogen, and (in a worst case scenario) additional water to cool the process.

Our results show that the water consumption of ammonia production is about 3.2 kilogram of water per kilogram of ammonia produced. For an example of irrigated corn this amounts to 0.015% of the water needed to irrigate the corn.

Issues such as the cost and availability of energy, capital investment, de-risking of agriculture, and attitudes of stakeholders should be considered regarding renewable ammonia. Our results show that water demand for renewable ammonia has no impact and can be safely ignored.

The results discussed above will be discussed in-depth in a forthcoming journal publication.

Funding: This work was supported by the National Science Foundation under Grant No. 185084 for the FEWtures project.