WATER ACCOUNTING IN THE FAYETTEVILLE SHALE PLAY: AN APPLICATION OF THE DEPTH-AVERAGED NAVIER-STOKES EQUATION TO HORTONIAN OVERLAND FLOW

Oluwafemi Taiwo*
Greg Thoma
Toyin Aseeperi
Jackson Cothren
University of Arkansas
Ralph E. Martin Department of Chemical Engineering
3202 Bell Engineering Center
Fayetteville, AR 72701
Voice: 479-966-7776
Fax: 479-575-7926
mtaiwo@uark.edu

Sustainable water resources are required for many industrial and agriculture applications in the Fayetteville Shale. While agriculture places the most demands on water in the Shale area, energy production also places significant demands on water resources. Water is used in producing energy and energy, in turn, is needed to produce water. Water is also used in natural gas exploration and production for drilling fluids, dust suppression, cleaning and flushing and for hydraulic fracturing. Developing unconventional gas reservoirs like the Fayetteville Shale involve horizontal drilling and hydraulic fracturing. A decision support system is being proposed that will make water accounting in the Fayetteville Shale Play – our example of a natural gas-shale – an open and transparent process. At the core of this decision support system is a water resource model that will be developed using mass and energy conservation laws.

The St. Venant Equation, an approximation of the Navier-Stokes equation which is used to model overland flows, will be used to model the water flow and discharge. The St. Venant equations are highly non-linear partial differential equations and to solve them numerically, finite difference approximations will be used. Finite difference routines of the St. Venant equations based on McCormack time-splitting scheme give a velocity flow field and fluid depth given a rate of fluid discharge. The model inputs would be the peak flow, rainfall rate and the measured gauge heights. The model will be simulated initially for relatively small Digital Elevation Models (DEM) and for short periods. The output of the model is the flow velocity, the net volume increase and the water balance of the river.

The result from the model is to be compared to that obtained from well known hydrological models like Soil Water Assessment Tool (SWAT). The model is to posses the distinct advantage of being able to predict along with the overall watershed properties that SWAT is capable of, characteristics of smaller catchment and point source effects.

###