An Interdisciplinary Response to Mine Water Challenges - Sui, Sun & Wang (eds)
©2014 China University of Mining and Technology Press, Xuzhou, ISBN 978-7-5646-2437-8

Study on Draining the Aquifer Overlying Coalbeds Prior to the Extraction of Coalbed Methane

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Abstract A majority of coalbed methane (CBM) wells produce much more water than the storage content of coalbed, along with the problem that reservoir pressure could not drop efficiently. These wells usually have a long period of water drainage with no gas production, indicating that ground water recharge rate probably be comparable to drainage rate. Increasing depressurization rate would lead to a reservoir damage due to the high sensitivity of coal reservoir, such as reservoir stress sensitivity, sand and pulverized coal migration, airlock effect and so on. We put forward a new drainage scheme to shorten single water phase flow stage and avoid reservoir sensitivity problems. It is generally accepted that the additional water mainly derives from the confined aquifers above coalbed. This happens because that hydraulic fracturing fractures not only the target coal seam but also adjacent aquifers above or below the coal seam. Based on the above, our proposal is to drain the groundwater in overlying aquifer prior to the extraction of CBM. The scheme includes two stages. The first stage is to depressurize the overlying aquifer. After the target coal seam is fractured, close the coal seam and open the overlying aquifer, then pump out a certain amount of water. When a stable drawdown cone has been formed, close the aquifer and turn into next stage. At the second stage, reopen the coal seam and conduct well drainage in conventional way. During the first stage, the reservoir pressure in coal seam should be larger than the critical desorption pressure. The critical height of working fluid level (relative to target coal seam) is defined to identify the point of stages switching. The new drainage scheme is based on specific stratigraphic textures that one or more layers of aquifer occur above coal seam directly or with a short distance. These stratigraphic textures are very common in North China, especially in Taiyuan formation. Thus, the new drainage scheme may be broadly applicable. Compared to the conventional one, the new drainage scheme has many advantages. Firstly, because permeability of aquifers is normally much larger than that of coalbeds, the water drainage rate in stage 1 is large. Therefore, reservoir pressure can drop efficiently and initial single water phase flow period can be much shorter. Secondly, drawdown cone extents faster and further in aquifers than in coalbeds. Thirdly, new scheme reduces several reservoir damage problems. For example, there is almost no water flow in coalbed at the first stage, which prevents the migration of sand and pulverized coal. Also, with no gas desorption, airlock effect can be avoid in stage 1. In Liulin CBM field which is located at the west of Shanxi Province, China, a majority of CBM wells produce a great quantity of water when exploiting the No.8 coal seam. Because hydraulic fracturing fractures links up the roof aquifer with the No.8 coal seam. Fig.1 shows the distribution of aquifers and coalbeds in Taiyuan Formation. Taking X1 CBM well in Liulin Block as an example, the critical height of working fluid level and the influence radius of drawdown cone were calculated. The critical height of working fluid level is 112.2 m and the original height is 370.9 m. During stage 1, the value of drawdown in wellhole would be 258.7 m. Under this circumstance, the influence radius in aquifer would be 320 m at the end of stage 1, while, the influence radius in coalbed should be 108.8 m without links between coalbed and aquifer. Thus, it is recognized that the working fluid level could drop 258.7 m by draining aquifer with high drainage rate and the drawdown transmits far in aquifer.

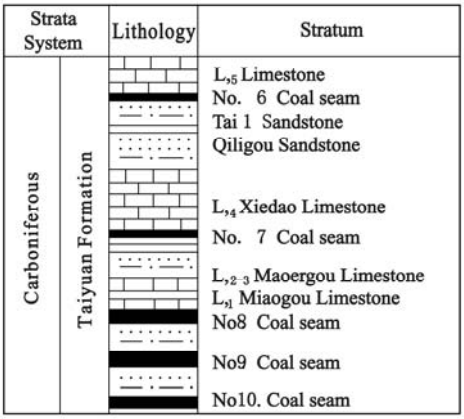

Fig. 1 *Stratigraphic column of Taiyuan Formation aquifers and coal seams*

Keywords coalbed methane, drainage, aquifer, drawdown, reservoir damage