By Gibbs isotherm, we have [11]

$$dy = \Gamma RT \int_{P_i}^{P_f} \frac{dP}{P} \quad (12)$$

Where

$$d\mu = RT \int_{P_i}^{P_f} \frac{dP}{P} \quad (13)$$

For a particular component of liquid in a capillary we have

$$A = \frac{RT}{y} \int \frac{\ln P}{P_o} dn$$

$$\frac{Ah}{x} = \frac{RTh}{xy} \int \frac{\ln P}{P_o} dn \quad (14)$$

Where h =depth of the coal seam, x = thickness of coal sheet
From equation 5,7 & 14

Pressure and volume relation plays an important role for determining the filling of the voids [13]. The surface exposed to gas and other things is constant bombarded with molecules and a freshly prepared surface is covered very quickly [11]. This is due to the no. of collisions which is determined by collision flux Z_w.

Total gas in coal = absorbed gas + gas in the fracture system (-/+)volume of liquid/gas in the system

$$V_e = \left(\frac{V_L P}{P_L + P}\right) + V_L \Phi_{f_o} e^{c_f(P-P_o)} - V_L \Phi_{lg} Z_w \left(\frac{RTh}{xy}\right) \int \frac{\ln P_{lg}}{P_o} dn \quad (15)$$

$$V_e = \left(\frac{V_L P}{P_L + P}\right) + V_L \Phi_{f_o} e^{c_f(P-P_o)} - V_L \Phi_{lg} Z_w \left(\frac{RTh}{xy}\right)\left(\frac{\ln P_{lg}}{P_o}\right)\left(\frac{n_f - n_i}{N_A}\right) \quad (16)$$

Where Φ_{lg}, Z_w & P_{lg} are the content of the liquid/gas, collision flux & pressure of the liquid/gas exerted on the surface of solid respectively.

If an activated species C of volume V_c gas as it binds with a transported species A of volume V_A gas then dissociation of AC is such that,

$$AC \rightarrow A + C$$

$$k = \frac{[A][C]}{[AC]}$$

For the equation $C_o \rightarrow C + AC$, where V_{C_O} is the final concentration of the transported species, then, by calculations

$$[AC] = \frac{[A][C_o]}{A} + k$$

Hence the rate of diffusion of gas J can be given by fick's law as [14]

$$J = \frac{dV_{C_o}}{dt} = k_{AC}\tau_{AC}\left\{\frac{V_A}{V_A + K}\right\}\left(\frac{1}{h}\right)$$

differentiating the above equation w.r.t. t

$$\ln V_{C_o} = k_{AC}\tau_{AC}\left\{\frac{V_A}{V_A + k}\right\}\left(\frac{t}{h}\right) + c \quad (17)$$

where $k_{AC} = \frac{[AC]_o}{[AC]_s}$ and $c = \frac{([A]_o + K)}{[A]} * [AC]$

Where, V_{C_o} is transported matrix gas concentration, τ is sorption time (days); V_e is the equilibrium methane concentration described by Langmuir isotherm, $\tau_{AC} = 5 days$, $[A]_o$ or V_{Ao} and $[C]$ or V_C = initial concentrations of A and C , $[A]$ or V_A and $[C]_o$ or V_{C_o} = concentrations of A and C at time t, $[AC]_s$ or and [AC]s or V_{AC_S} = concentrations in the bulk of the whole system.

6. Nomenclature

A =surface area
c_f = pore compressibility
$d\mu$ = chemical potential
K_a = Adsorption constant
K_d =Desorption constant
k_f = fracture permeability
k_{f_o} = initial fracture permeability
K = Rate Constant
$n(j)$ = one component in overall amount for a system of several components j.
N_A =Avagrodro number
P= Pressure (Pa)
P_o =vapour pressure of fluid
P_L = Langmuir pressure
θ = Rate of change of surface coverage due to adsorption
ΔadH = enthalpy of chemisorptions and physisorption.
R = Gas constant (8.31Jmol^{-1}K^{-1})
T = absolute temperature
V_e = Total volume at equilibrium
V_L = Langmuir volume
Φ_f = fracture porosity

Φ_{fo} = initial fracture porosity

Γ = surface excess

x = thickness of the sheet of coal seam

τ =desorption time

7. Results and Discussion

Based on the acquisition of relevant reservoir parameters by means of adsorption laws, complete data for gas production and water drainage were obtained after reservoir stimulation. The presented mathematical model was solved simultaneously by the fully implicit method and a relevant reservoir simulator was also developed to simulate the CBM Well on south Qinshui basin. The simulation parameters are listed in Table 1.

The graph have been drawn by taking some assumed values based on the data given on adsorption and some other references [8]. Some of the standard values are estimated from references [7,13,15]. History data matching was done to stimulate the gas production w.r.t. time and a graph is plotted between these parameters by using the equations 16 and 17. From the graph (figure1), the calculated values of gas production on increasing time are nearly consistent with the field data. Initially the gas production increases rapidly but after some days the production of gas decreases and become constant with increase in time assuming the values of pressure and temperature to be taken as constant.

Table1-Parameters of coalbed methane reservoir simulation

With values of reservoir pressure 3.17 MPa, Langmuir pressure 0.31 MPa, Langmuir volume 35.0 m^3/t, Porosity 0.21 f, coal thickness 7.23m, burial height 472.37m, reservoir temperature 23°C, primary water saturation 0.79, water pressure 40 MPa, and gas water pressure 24MPa.

Time (days)	Daily production m^3/day
1	181.8
40	359.5
80	698.5
120	979.3
160	1149.3
200	1889.4
240	1333.5
280	1209.6
320	3078.1
360	2234.5
400	1521.3
440	1390.5

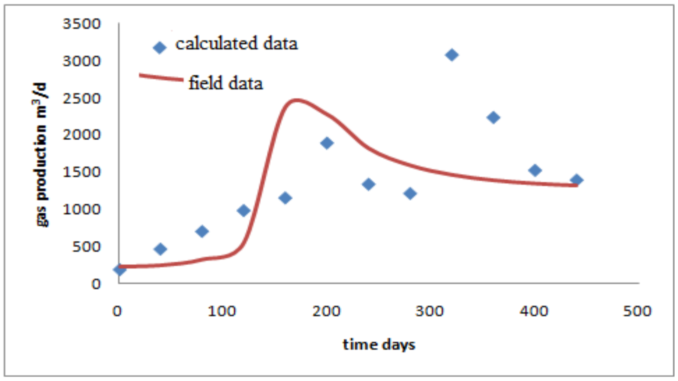

Figure 1: History curve for the gas production rate for the south Qinshui basin

8. Conclusion

This attempt has been made to derive a formula with the help of adsorption isotherm principle such as Langmuir isotherm to know the generation of methane gas in coal seams. The 2-D model representation of the formula helps us to know the role of all the parameters as discussed above. This can be explained in the real time scenario as well, with some assumptions. The formulae is also useful to proceed with the 3-D model of the situation and attempts are being made to make this type of model by the principles of statistical and quantum mechanics which will further replicate the exact situation in the coals seams. Although values in this paper are taken from references, the formulae developed in this investigation can be applied in the real time scenario to understand CBM generation from adsorbed particles. However the gas needs to be considered as an ideal gas [12]. It is established that this kind of approach will have a potential applicability in understanding the complex CBM reservoirs, by mathematically simulating them by such modeling studies.

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