Fractured shales

Oil and gas have been produced in significant quantities from fractured shale reservoirs since the early 1900's, usually from organic-rich, bituminous, black shales
which are common source rocks for many conventional reservoirs.
These organic facies may be deposited in several different environments, from restricted marine basins to non-marine delta plains, and are fairly common throug136
hout the world. Production from the shales themselves is usually low, but gross reserves are high and production habit depends entirely upon the nature of the fracture permeability.

Fractured shales :

consist mainly of consolidated clay -sized particles and generally characterized by an ultra -low permeability . In oil shale forms the geological seal that preventing hydrocarbons from escaping to the surface .However, in some cases, layers of shale of hundreds of feet thick and covering millions of acres,, are identified both the source and the reservoir for nature gas .In general, Shale is characterized by :

1-very low permeability .

2-relatively flat formation .

3-very thick pay zone .

- Typically, the methane in organic shales was created in the rock itself over millions of years .This thermo genic gas forms when organic matter left in the rock breaks down under rising temperature .The gas that that is generated is then adsorbed onto the organic materials expelled through leaks in the shale, or captured within pores of the shale .In some cases, however, however, an influx water and the presence of bacteria will support the generation of biogenic gas .

Californian fractured shale reservoirs'

By 1953, 93% of some 290,000,000 barrels of generally heavy crude oil had been extracted from upper Miocene fractured chert and siliceous shale reservoirs within the Santa Maria Basin of western California; the remaining 7% having been produced from similar reservoirs within the southwest of the San Joaquin Basin Between 1902 and 1953 several hundred wells had been drilled in these two basins and a number of common characteristics proved in each:

1. The production is from fractured zones within rocks
2. Oil can be found in various kinds of structural traps.
3. Production rates increase in the more cherty areas, but are limited to those areas with a Pliocene cap-rock and varies markedly with the variations in fractures.
4. Fractures vary in nature and origin between the two basins.
5. Zones are easily overlooked without lengthy production tests.
6. Drilling habits are similar in potentially productive zones, including slow drilling
7. Oil shows while drilling are poor and are usually limited to oil in frac

the source for most Californian oil.

Fractured sandstones .

- Properties of sandstone reservoirs are assumed to be controlled by depositional environment and daigenesis during subsequent burial .However, open fractures when present in sandstone reservoirs can have significant influence on reservoir flow and performance .These natural fractures not only enhance the overall porosity and permeability of these reservoirs, but also create significant permeability anisotropy, which causes the drainage area around the wells to be elliptical .

Behavior of Naturally Fractured Reservoirs

- Naturally fractured reservoirs contain essential amount of the known hydrocarbons worldwide . occurring fractures f with significant permeability anisotropy .The connected porous space in these reservoirs has been characterized and categorized by two types of porous media :matrix and fractures .Because of the different fluid storage and conductivity characteristics of the matrix and fractures, these reservoirs are often called dual-porosity reservoirs and described by the following dualporosity systems :
- 1-Matrix porosity, porosity, categorized as primary porosity ϕm
- 2-Fracture porosity, categorized as secondary porosity ϕf

- Primary porosity ϕm is established when the sediment is first deposited; thus, it inherits the original characteristic of the rock .It is highly inter connected and usually can be correlated with permeability since it is largely dependent on the geometry size, and spatial distribution of the grains .
- Secondary porosity ϕf, also known as induced porosity, is the result of geological processes after the deposition of sedimentary rock and has no direct relation to the form of the sedimentary particles . Most reservoirs with secondary porosity are either limestone or dolomite .In general secondary porosity is due to solution, recrystallization, fractures, and joints .

- In general, the matrix has a large bulk porosity and relatively low permeability compared with the fracture, which has a very small bulk porosity and relatively large permeability .However, fracture porosity is defined as fracture volume divided by total :

$$\phi_f = \frac{\text{fracture volume}}{\text{total volume}} = \frac{V_f}{V_T}$$

- Matrix porosity is also defined with respect to total volume .Therefore,
- matrix porosity is not the same as un fractured core porosity ϕ core measured in the laboratory, that is :

$$\phi_m = \phi_{core}(1 - \phi_f)$$

The fracture permeability kf is given by :

$$k_f = \frac{k_e}{\phi_f}$$

where ke is the effective permeability as calculated from a pressure -buildup test .Another expression that has been used to approximate fracture permeability is given by Poiseuille 's law as :

$$k_f = 54 \times 10^9 w_f^2$$

where

k_f = fracture permeability, md
w_f = fracture width, inches

The two expressions just given can be combined to give the correct width to be used in Poiseuille's law as :

$$w_f = \sqrt{\frac{k_e}{54 \times 10^9 \phi_f}}$$