IN-SITE PERMEABILITY PACKER TESTING

Test Equipment

Test equipment included a pump, water meter, pressure gauges and a double packer assembly.

The double packer assembly consisted of two single packer units separated by the perforated pipe cut to a length such that the dimension between packer seals is 5.0 feet.

Each packer unit is made up of a rubber hose sealed securely into a metal coupling at each end. Fixtures in the metal couplings allow gas pressure to enter each rubber hose to seal the bore-hole. The metal couplings are designed for attachment of water pipes.

The double packer may be converted to a single packer by removing the bottom packer and the perforated pipe. This allows water to be pumped through the entire system to a zone isolated between the hole bottom and the bottom packer seal.

Test Procedure

In operation the packer assembly is lowered into a test hole to the desired depth. Gas is released from a pressure bottle to inflate the packer units isolating a formation zone five feet in thickness. A holding test is then performed. Water is pumped in at a predetermined pressure and the valve is closed so that pressure is held against the formation. If the pressure drop is less than 10 psi. per minute the

formation is judged to be imprevious and the test proceeds to the next 5 foot interval. The holding test is performed for periods up to 10 minutes. It is understood that the formation may be very slightly permeable but the permeability is too small to measure with this equipment.

If the pressure drop exceeds 10 psi. a flow test is then performed. Water is pumped into the isolated zone at predetermined pressure heads and corresponding flows read from the water meter and recorded.

The flow was recorded at each of 3 steps in pressure: low, intermediate, and maximum. The first two steps were repeated after maximum was reached. If the flow at step one is reduced by the second test the formation is thought to be self-sealing. If no change is noted, then permeability is expected to remain constant with time. If flow increases when the first step is repeated, then the formation is being opened up and an increase of permeability is expected with time.

Double packer testing was begun at the test hole bottom and proceeded upward in increments of five feet. This procedure was followed to the extent possible at each test hole. Logs of cores obtained from each test location were studied. If the logs indicated a likely problem zone the even five feet increments were varied to allow thorough testing of such zones.

Computations

Permeability coefficients (k) were calculated from double packer test results by the following general formula:

$$k = \frac{Q}{2\pi Lh} \quad \text{Log}_e \quad \frac{(L)}{r}$$

where: k = permeability,
Q = constant rate of flow into the hole.
L = length of test section, ($L \geq 10r$).
h = differential head of water.
r = radius of test section.

To convert Q from Gpm to Ft^3/day so that k is expressed in Ft./Day, (actually ft. ^{3}/ft. ^{2}/day) multiply Q by 1,440 minutes and divide by 7.481 gal./ft. 3, or use 192.5 Q. Therefore:

$$k = \frac{192.5\ Q}{2\pi Lh} \quad \text{Log}_e\left(\frac{L}{r}\right)$$

For the double packer system used, L and r are usually 5.0 feet and 0.125 feet, respectively. The dimensionless π is a constant value of 3.14.

Since L and r are constant, $\log_e \left(\frac{L}{r}\right)$ is constant and equals log $\frac{(5.0)}{0.125}$ or $\log_e$ (40) which equals 3.69.

Substituting constant values into the equation gives:

$$K = \frac{192.5\,Q}{2\pi\,Lh}\,\text{Log}_e\,\frac{(L)}{r} = \frac{192.5\,Q}{(2)(3.14)(5.0)(h)} \qquad (3.69)$$

$$= 22.62\,\frac{Q}{h}$$

For Single Packer: $k = \frac{30.6\,Q}{Lh}\,\log_e\,\frac{(L)}{r}$

The value for Q is read directly from the water meter in gallons per minute.

The value of h is expressed in feet of water and is computed by adding gauge pressure to test depth below the gauge and subtracting friction losses within the test system. Gauge readings in pounds per square inch (psi) are converted to feet of water by multiplying the gauge reading times the conversion factor 2.31. Feet of head are converted to psi. by multiplying by 0.433.

Friction of head losses increase as flow increases. Values of head loss at various flows are determined by calibrating the system and preparing a calibration chart.

Permeability characteristics vary with viscosity and viscosity properties of a liquid vary with temperature. Standard temperature for determining permeability coefficients is 20°C. or 60°F. Permeability coefficients calculated from test results were adjusted by temperature correction factors to obtain the coefficients at 20°C.