



**PETE 693—WELL STIMULATION, Spring 2014**  
**Instructor: Dr. Dare Awoleke**

**PART B—Final exam, Friday, 9<sup>th</sup> May, 2014**

**Duration: 9:00—11:00am**

**Instructions**

- **Open book. Open notes. Use all you can except your neighbour.**
- **Write your answers in this booklet. You might want to use a pencil just in case of erasures.**
- **You need writing material and a simple calculator.**



## Question 1

### Sandstone Acidizing (25 points)

#### Data

##### Reservoir fluid

Oil API gravity: 30

Gas gravity: 0.6

Initial reservoir pressure: 4,000psi

Bubble point pressure: 4,000psi

Reservoir temperature: 160 degF

Reservoir porosity: 0.2

Horizontal permeability: 100 md

Formation thickness: 100ft

Oil viscosity: 7 cp

##### Well completion: open hole

Wellbore radius: 0.35ft

Drainage radius: 1490 ft

##### Formation damage

Damaged permeability=10md

Damage extends 0.5 ft from the wellbore

##### Formation mineralogy

Kaolinite: 3%

Feldspar: 3%

Iron Chlorite clay: 5%

Calcium carbonate: 4%

Quartz: 85%

Design a matrix acidizing treatment for the well described below. The design should give the recommended acid types, concentrations, volumes for the preflush, mainflush and afterflush acid stages, and a table showing the evolution of skin with volume of acid injected. The table should contain at least 3 rows. Assume the acid restores the damaged region of the reservoir to initial conditions. Include the effect of viscous skin (oil viscosity is greater than viscosity of the acid). Acid viscosity~1cp.

## Question 2

### Carbonate Acidizing

#### Data

Acid type: 15% HCl

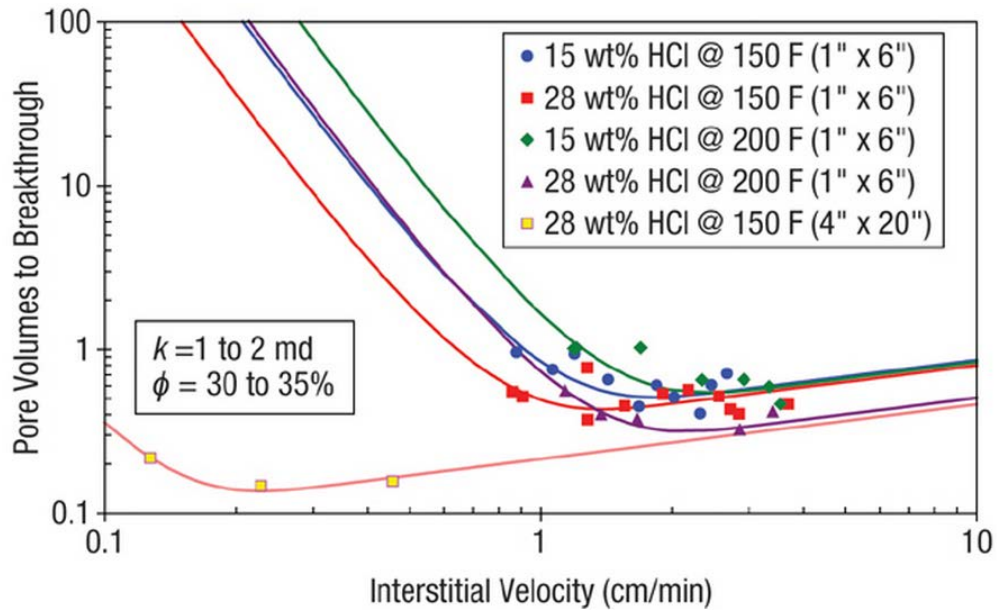
Treating temperature: 200 degF

Injection rate: 0.05 bpm/ft

Well radius: 0.35ft

Formation porosity: 0.25

- a) Calculate the radius around the well to which a wormhole has penetrated assuming 50 gals/ft of acid is pumped into the chalk formation. Use the **Volumetric model** and the core flood results shown in Figure 16-8 of the PPS book or **Figure 1** below. (10 points)



(From Furui et al., 2010.)

Figure 1



- b) Using the **Buijse-Glasbergen model**, what is the wormhole radius (ft) and wormhole velocity (ft/min) when
- i. Time = 0
  - ii. Time = 5 minutes
  - iii. Time = 10 minutes

Also, use either Figure 16-8 of the PPS book or **Figure 1** above. **(15 points)**