

# Designing gravel pack placement in screens for selective completions

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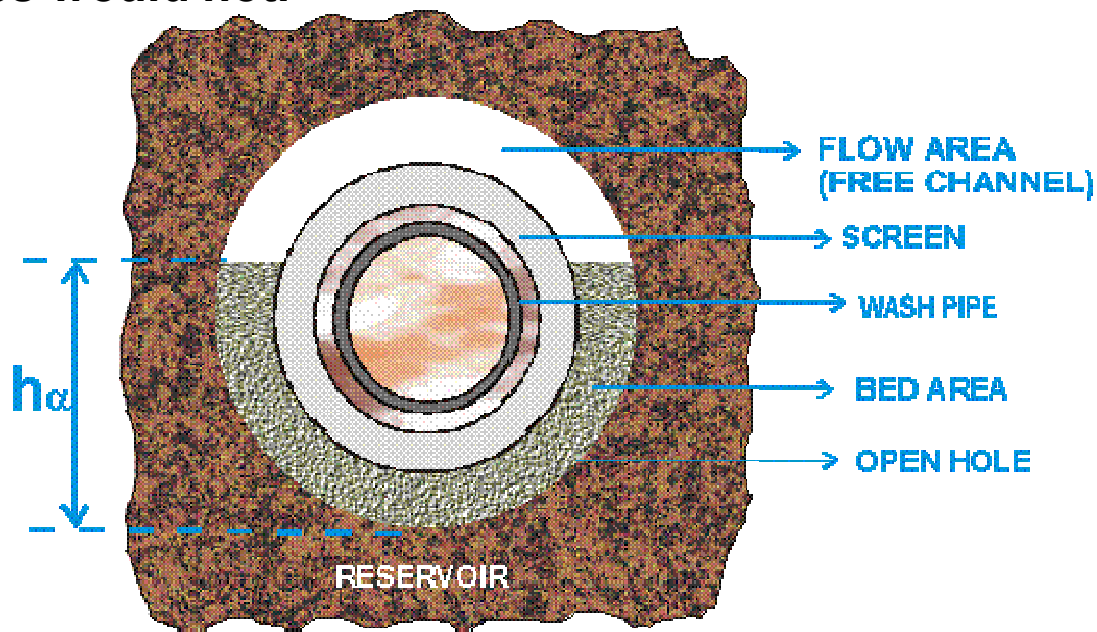
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# Introduction

## What is Gravel Pack Technique?

This technique consists in filling out the annular space between screen and producer formation with sand, ceramics or other solid particles with selected grain diameter. The idea is to create a second porous medium with a pore throat diameter smaller than the formation grain diameter allowing oil to flow easily through the gravel pack while formation fines would not.



# Introduction

What means selective completion in this case?

Sometimes in reservoirs we need to isolate different zones, to do this we can use several devices. ECP's (External Casing Packer's) are used to promote this isolation, inside well, through pump operation that lead rubber expansion (seal element).



# Introduction

- In operations of gravel pack should be avoided deposition of sand in annular space of the ECP to have the complete sealing of this device after the rubber expansion.
- The specification of minimum flow needed for such an operation can be obtained from different criterions to drag particles in the well.



# Hypothesis

- The flow should not provide the deposition or accumulation of sand in the ECP;
- The height of the alpha wave obtained for a given flow indicate that the rates of erosion and deposition of sand in alpha wave are equals;

# Methods

- Method I:
  - Area of annular space in the ECP is equal to area of flow in the gravel;
  - Flow in annular space in the ECP is equal to flow in the gravel;
  - Rates of deposition and erosion are equals;
  - Procedure:
    - *Step I:* Chosse  $D_{\text{ecp}}$  and determine  $A_{\text{ecp}}$ ;
    - *Step II:*  $A_{\text{ecp}} = A_{\text{flow\_gravel}}$ ;
    - *Step III:* Determine  $h_{\alpha}$  (equilibrium);
    - *Step IV:* Determine  $Q$ ;

# Methods

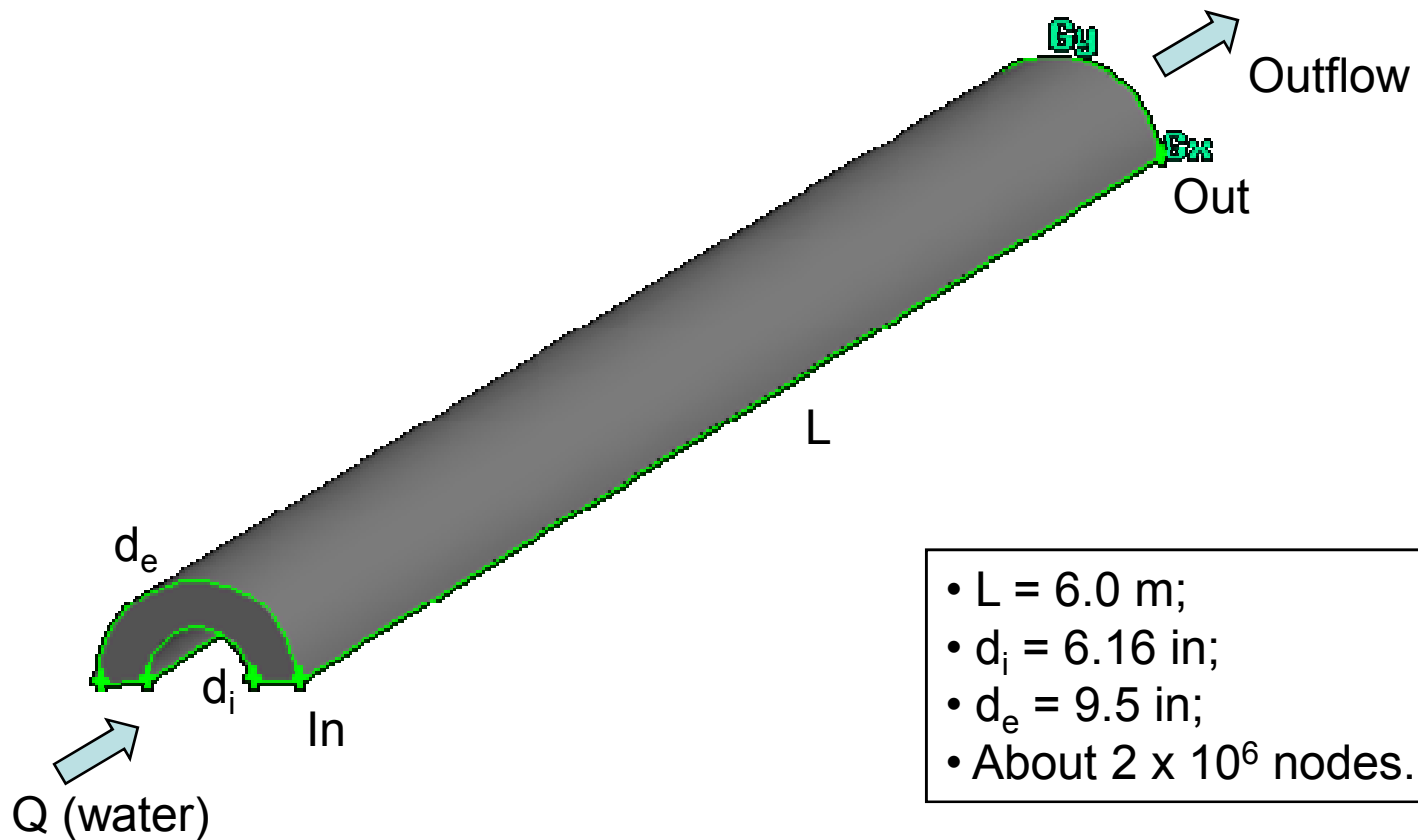
- Method II:
  - Mean shear stress on the alpha wave surface is equal to shear stress on the wellbore surface to do not deposit sand in annular space of the ECP;
  - Rates of deposition and erosion are equals;
    - Procedure:
      - *Step I*: Choose Q for gravel pack operation ( $Q_{\text{gravel}}$ );
      - *Step II*: Determine  $h\alpha$  (equilibrium);
      - *Step III*: Simulate the flow in the gravel and determine the shear stress on the alpha wave surface;
      - *Step IV*: Use recursive method, knowing  $\tau_{w\alpha}$ , to determine flow in the annular space of the ECP for a given  $D_{\text{ecp}}$ ;
      - $Q_{\text{ecp}} \leq Q_{\text{gravel}}$ ;

# Methods

- Method II: (Simulation)
  - The conservation equations were discretized via the finite volume method;
  - The SIMPLE algorithm was used to obtain the velocity-pressure coupling;
  - The standard  $k-\varepsilon$  turbulence model was used to investigate the 3-D axial steady flow in the annular space model for turbulent flow;
  - The power Law discretization scheme was used for equations of mass, momentum, turbulent kinetic energy and dissipation turbulent rate;
  - Comercial code: Fluent 6.12.16;

# Methods

- Example of geometry for problem discretization.



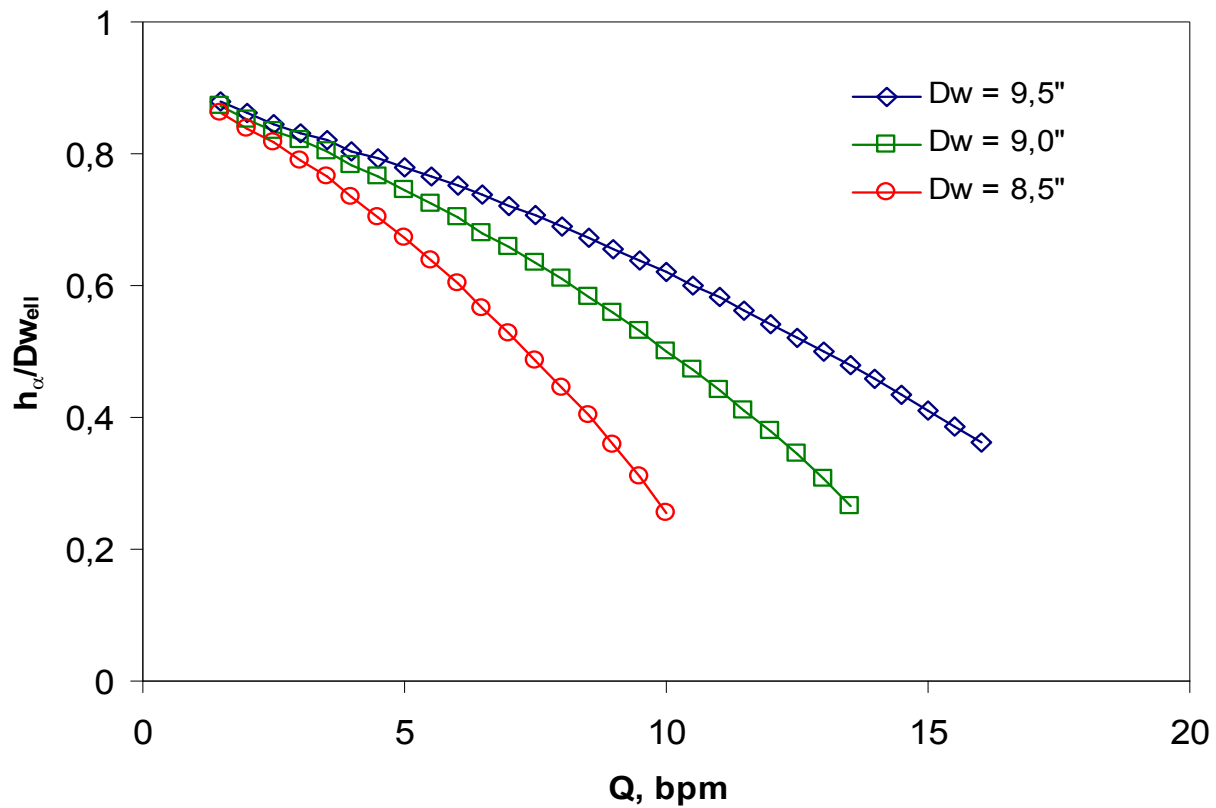
# Results

The results show the minimum flow required in the gravel/ECP according to the diameter of the well, screen, and ECP, considering the process:

- Well diameter: 8.5"; 9.0"; and 9.5";
- Screen diameter: 6.16"
- Density: 9.1 lb/gal (1,000kg/m<sup>3</sup>);
- Viscosity: 1cP;
- Sand: mesh 20/40;
- Concentration: 1lb/gal.

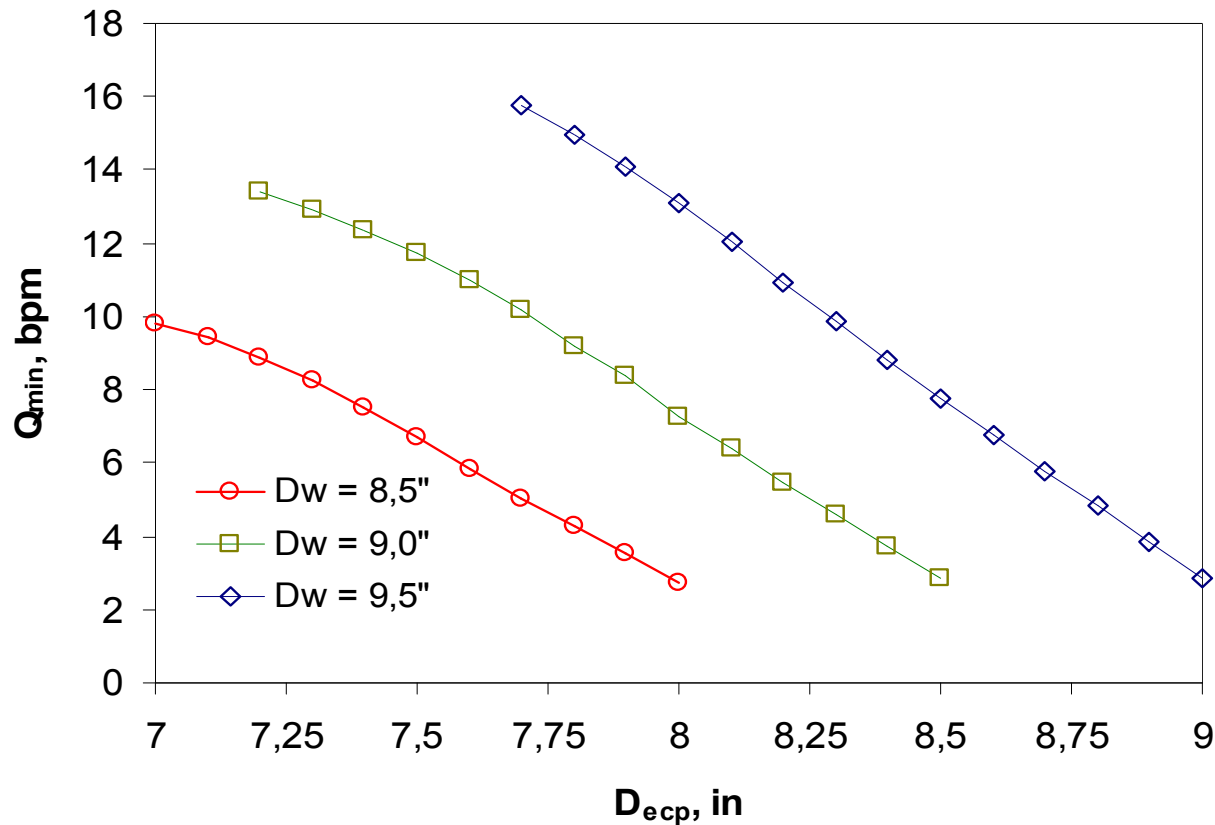
# Results

- Relative height of alpha wave in the gravel versus flow imposed.



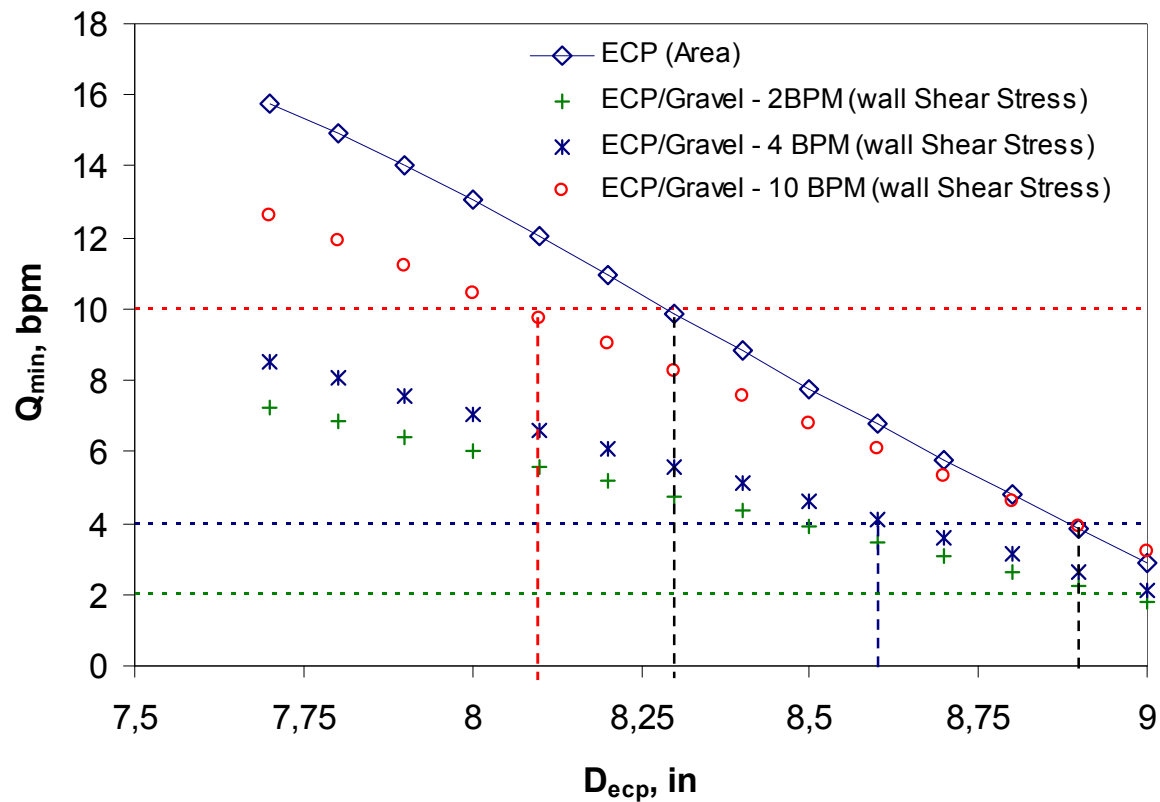
# Results

- Flow minimum necessary in ECP according to the well diameter and the ECP. *Method I: flow area in the gravel and ECP annular area are the same.*



# Results

- Determining the range of ECP diameters from the criteria of equal areas and interfacial shear stress. ( $D_w = 9.5$  in)



## Final Remarks

- Different criteria can be used to specify the flow of the process or the correct choice of the diameter of the ECP for a proper cleaning of the ECP, although only two methods in this work were presented.
- Others cases should be investigated to consolidate the results, and the method.
- The method II, shear stress criteria, should presents better results than the method I, but it is necessary experimental confirmation.

# Future ...

- Use Eulerian method with particles to study deposition process;
- Study Lagrangean method to study the trajectory of particles in the flow;
- Apply element discrete method and Fluent to study the efficiency of the deposition and cleaning process in the annular space between ECP and well.