جامعة الملك سعود
King Saud University

كلية الهندسة
جامعة الملك سعود
King Saud University
College Of Engineering

Well Stimulation and Sand Production Management (PGE 489)

Sand Production Management

By
Dr. Mohamed A. Khamis
3-05-2016

Sand Problem

- Erosion of downhole tubulars
- Erosion of valves, fitting and surface flow lines
- Wellbore filling up with sand
- Collapsed casing (lack of formation support)
- Disposal of the produces sand (specially at offshore fields)

Sand Problem

Solution?

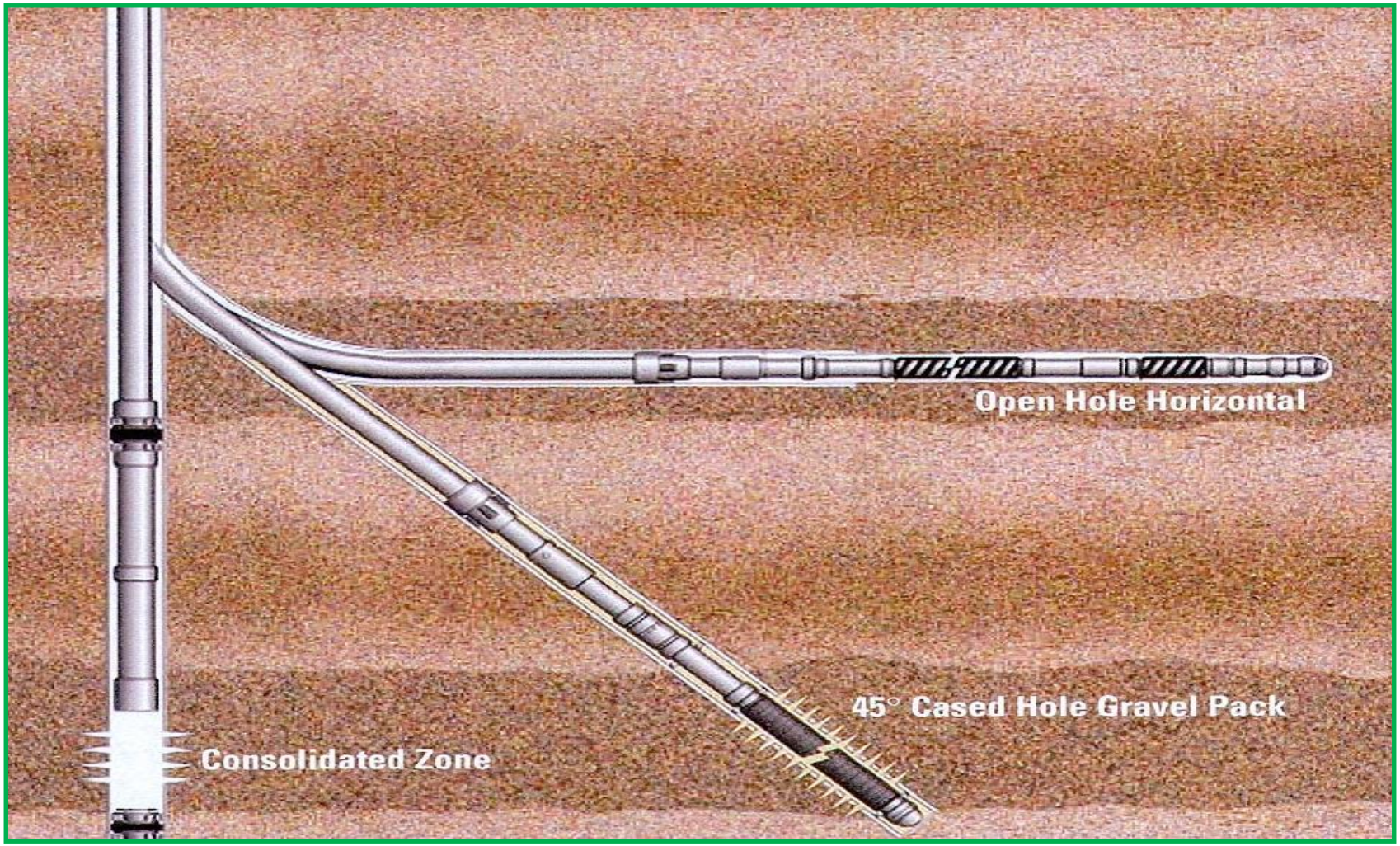
Completion

Completion Strategy

- Open Hole
- Slotted Liner
- Pre-packed Screen
- Gravel Pack
- External Casing Packers
- Cemented Casing

Completion

Completion Strategy



Completion

Rock Mechanics/Hole Stability

It is *extremely* important to understand rock stability!

- While drilling:

Vertical hole stability is NOT equal to horizontal hole stability!

- While producing:

  ALL exposed rock types must be stable!

Completion

Pre-packed Screen/Slotted Liner

Needed in:

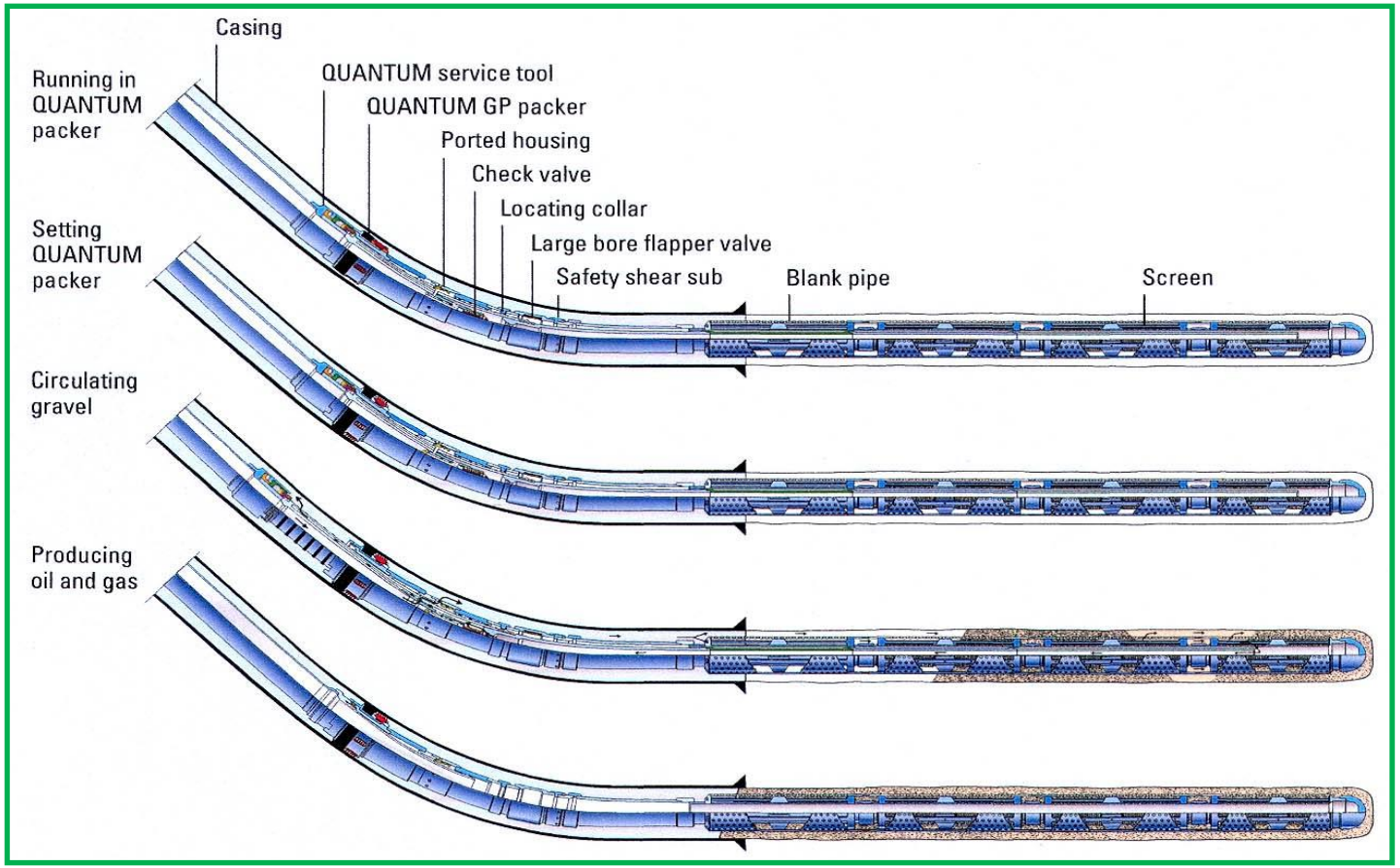
- Unstable formations
- Unconsolidated formations

Not requiring gravel packing

Completion

Gravel Pack

Required in unconsolidated formations for optimum production.



Completion

External Casing Packers

For zonal isolation:

- Slotted Liners
- Perforating

Completion

Cemented Casing

Required for

- Wells with vertical permeability barriers needing stimulation
- Fluid isolation of gas/oil/water

Completion

Completion Conclusion

- Hole stability
- Reservoir BHP
- Artificial lift system
- Clean up
- Stimulation

Completion

The completion drives the bus!

Sand Problem Solution

- Sand production can be controlled by using;
  - Gravel pack completions
  - Slotted liner completions
  - Sand consolidation treatment

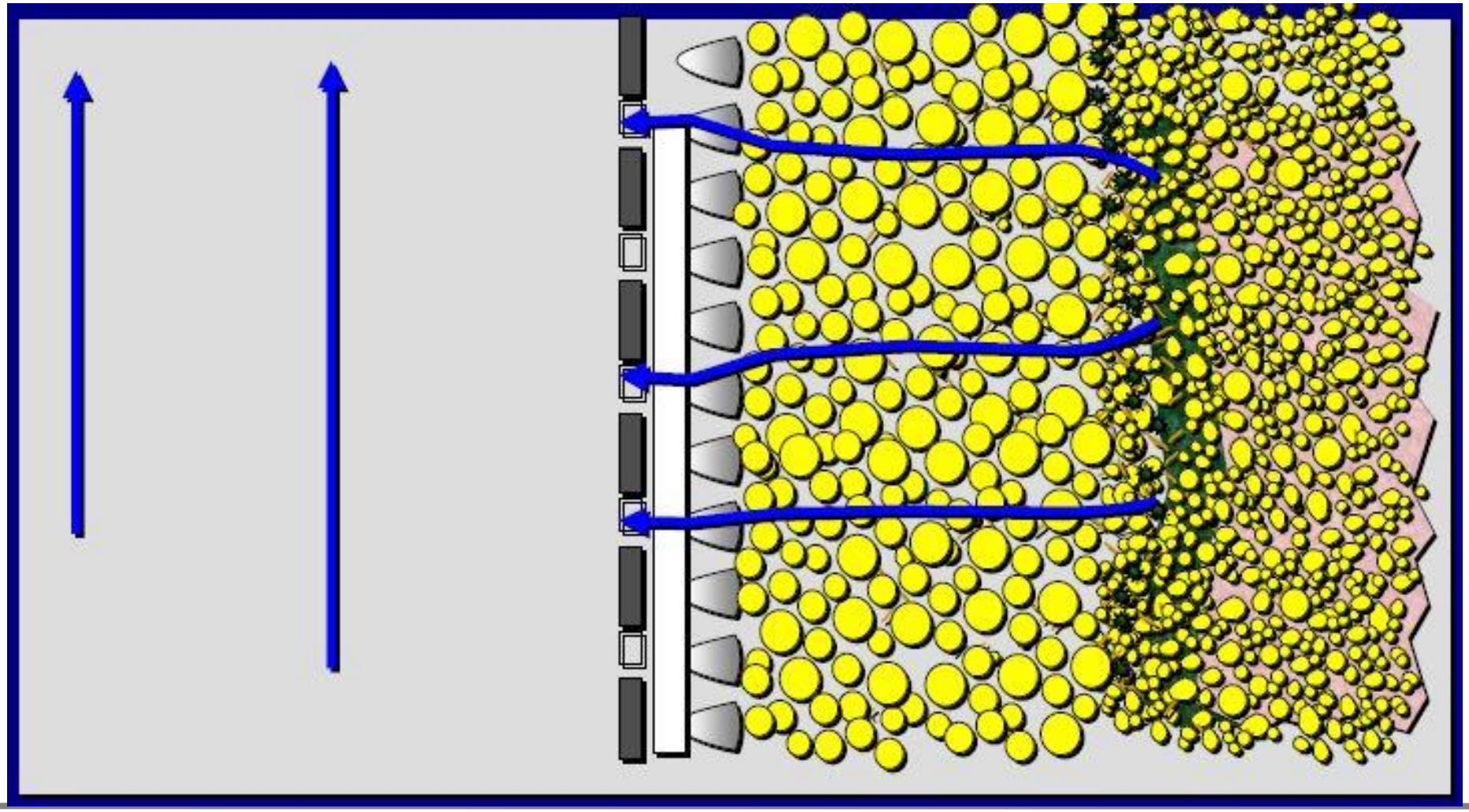
Sand Problem Solution

Gravel pack completions

- Decide whether or not a gravel pack is needed.
- The essence of a gravel pack is to provide a filter to hold back fine particles from coming into the well screen.
- Gravel packs are needed if the particles are fine and uniform (non-graded).
- In fine, uniform situation, fine slots are needed.

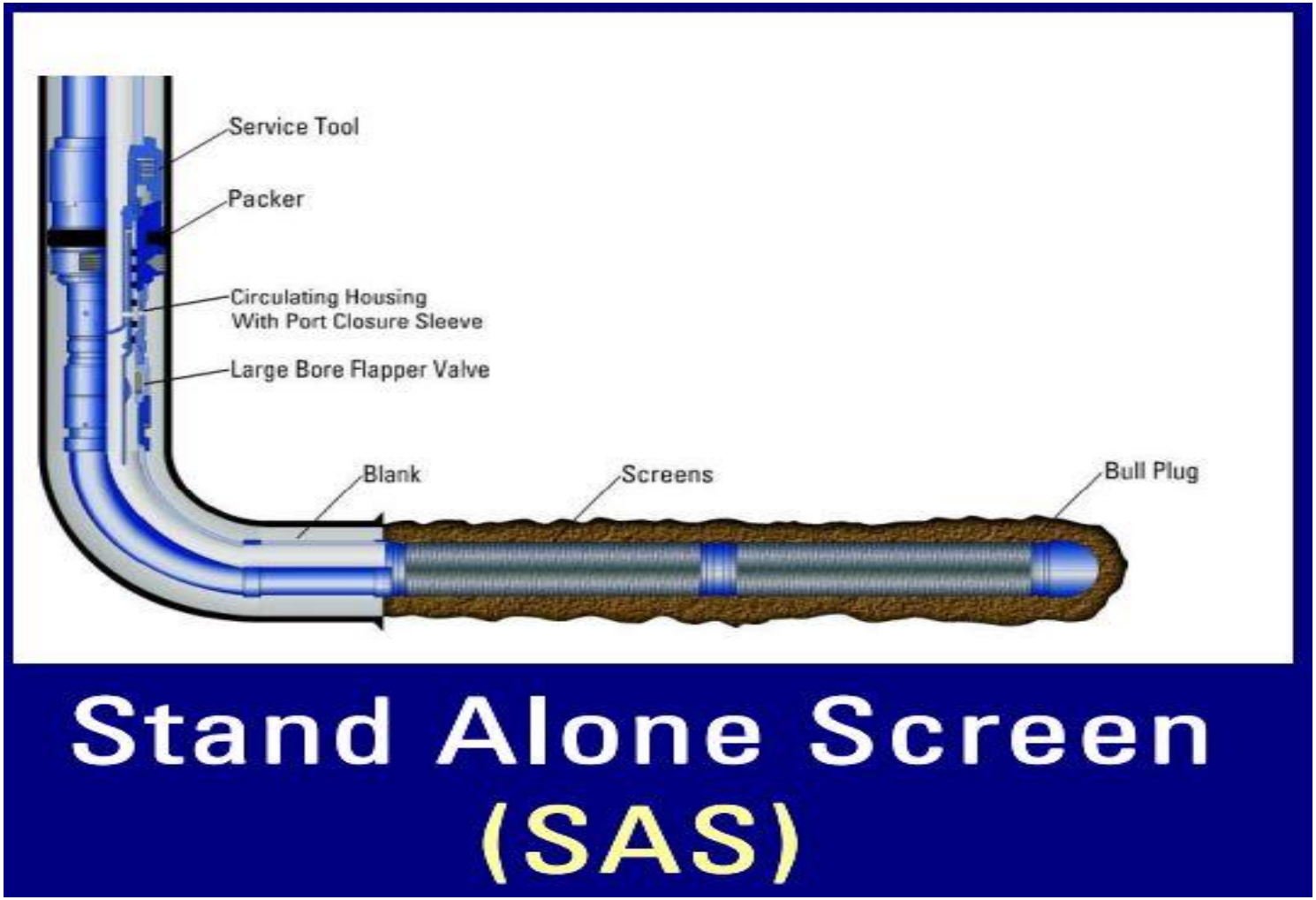
Sand Problem Solution

Gravel pack completions



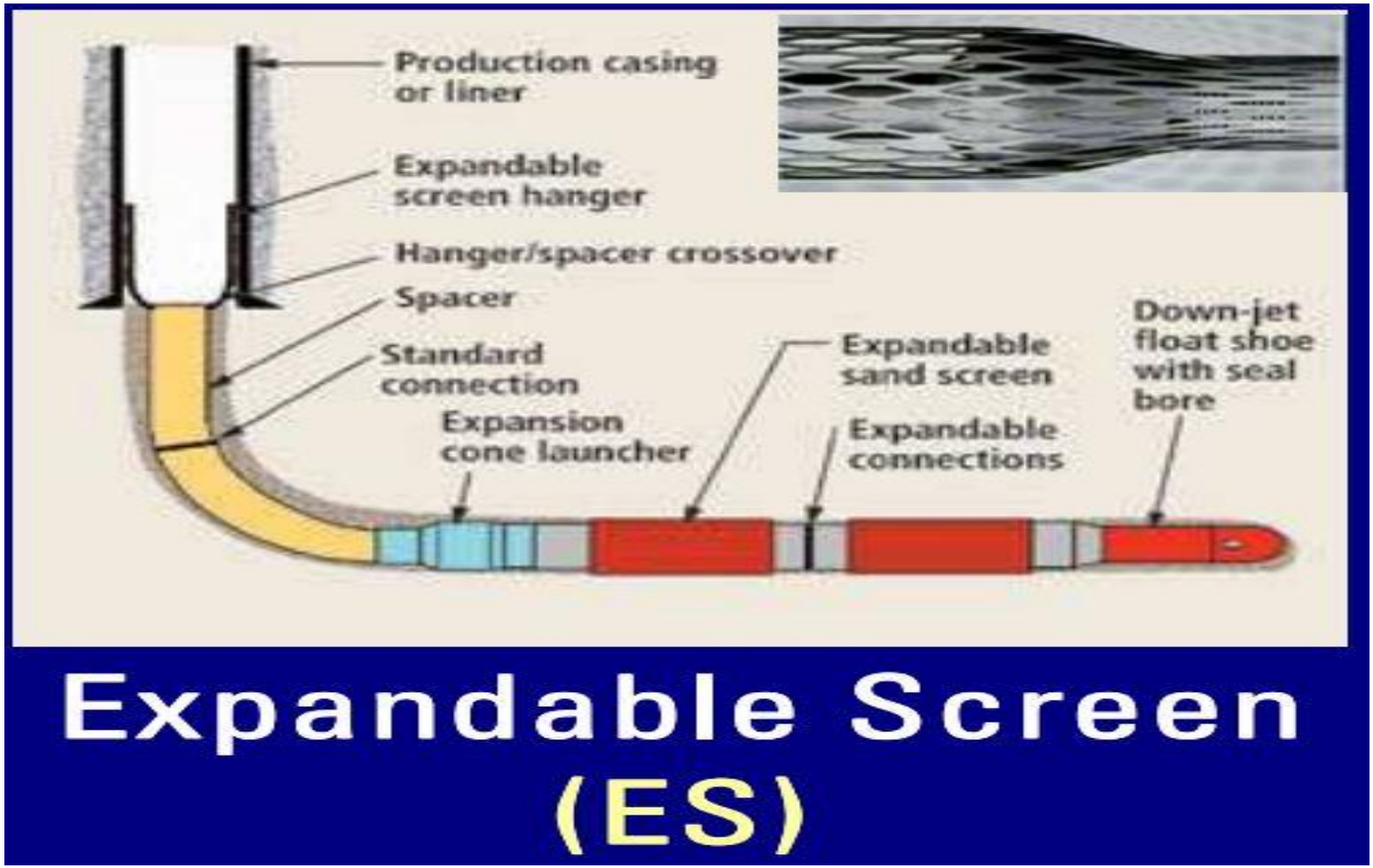
Sand Problem Solution

Open Hole Sand Control techniques



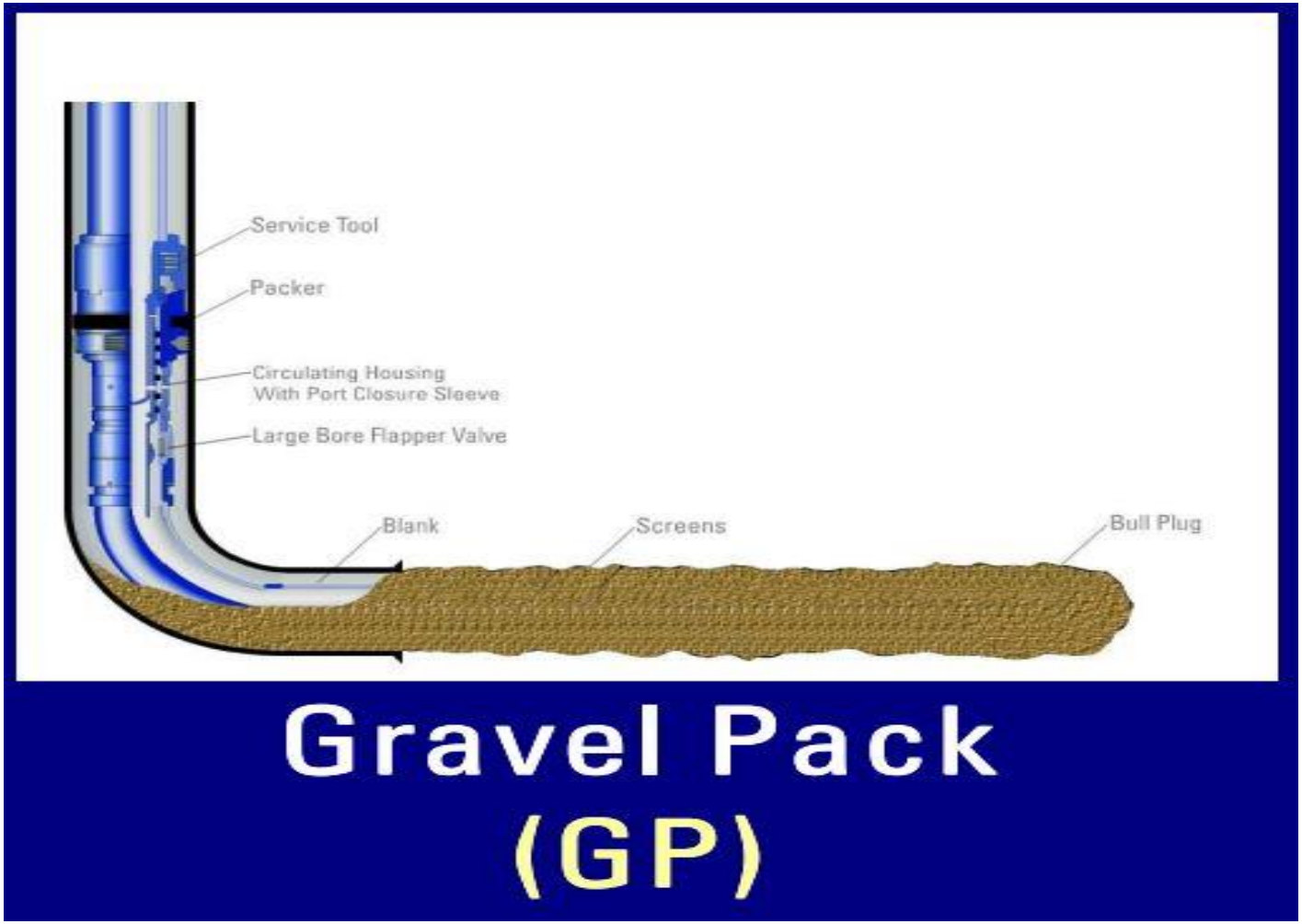
Sand Problem Solution

Open Hole Sand Control techniques



Sand Problem Solution

Open Hole Sand Control techniques



Sand Problem Solution

Open Hole Sand Control techniques

http://www.slb.com/services/completions/sand_control/transcend/openhole_gravel_pack_completions.aspx

Sand Problem Solution

Selection considerations

A critical element in designing a gravel pack completion is the proper sizing of the gravel and the screen or slotted liner. To perform its sand control function and maximize the permeability of the gravel pack, the gravel must be small enough to retain the formation sand, yet large enough that clay particles and other formation fines flow through the pack. Thus, the optimal gravel size is related to the formation particle size distribution. The screen must be sized to retain all of the gravel.

Sand Problem Solution

Selection considerations

The first step in determining the gravel size is to measure accurately the formation particle size distribution. A representative sample of formation material can be obtained, in order of preference, from rubber-sleeve cores, conventional cores, or sidewall cores. Produced sand samples or bailed samples should not be used to size gravel. Produced sand will tend to have a larger proportion of smaller grain sizes, while bailed sand will have a larger proportion of larger grain sizes.

Sand Problem Solution

Selection considerations

The formation grain size is obtained with a sieve analysis, using a series of standard sieve trays; the sieve opening sizes for U.S. standard mesh sizes are given in Table 6-1 (Perry, 1963). The results of the sieve analysis are usually reported as a semilog plot of cumulative weight of formation material retained versus grain size. Typical grain size distributions from California and U.S. Gulf Coast unconsolidated sands are shown in Fig. 6-5 (Suman et al, 1983).

Sand Problem Solution

Selection considerations

Standard Sieve Sizes[a]

U.S. Standard Mesh Size	Sieve Opening (in.)	Sieve Opening (mm)
2 1/2	0.315	8.00
3	0.265	6.73
3 1/2	0.223	6.68
4	0.187	4.76
5	0.157	4.00
6	0.132	3.36
7	0.111	2.83
8	0.0937	2.38
10	0.0787	2.00
12	0.0661	1.68
14	0.0555	1.41
16	0.0469	1.19
18	0.0394	1.00
20	0.0331	0.840
25	0.0280	0.710
30	0.0232	0.589
35	0.0197	0.500
40	0.0165	0.420
45	0.0138	0.351
50	0.0117	0.297
60	0.0098	0.250
70	0.0083	0.210
80	0.0070	0.177

Sand Problem Solution

Selection considerations

http://petrowiki.org/Gravel_pack_design

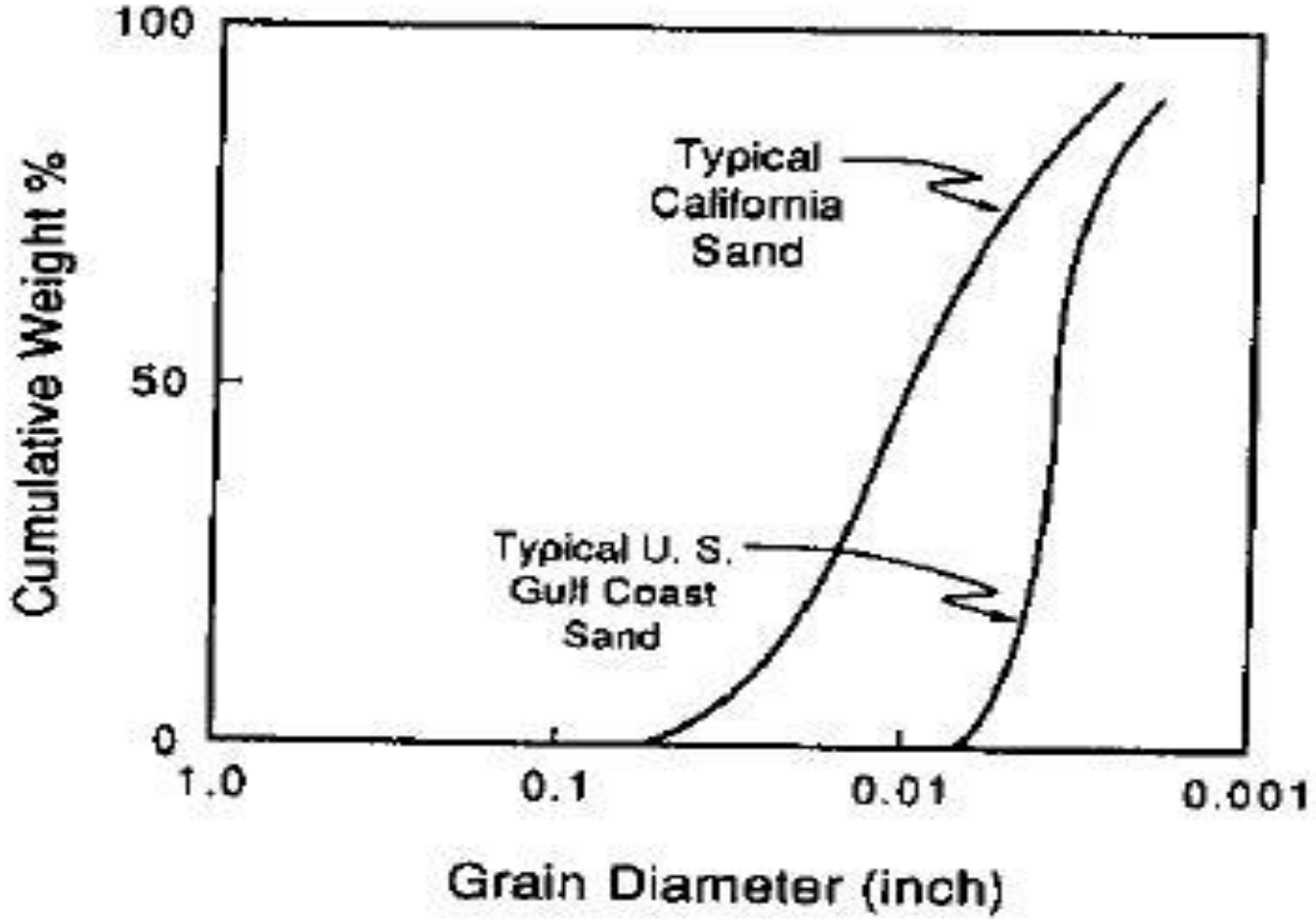
Standard Sieve Sizes[a]

U.S. Standard Mesh Size	Sieve Opening (in.)	Sieve Opening (mm)
100	0.0059	0.149
120	0.0049	0.124
140	0.0041	0.104
170	0.0035	0.088
200	0.0029	0.074
230	0.0024	0.062
270	0.0021	0.053
325	0.0017	0.044
400	0.0015	0.037

[a]From Perry, (1963).

Sand Problem Solution

Selection considerations



Sand Problem Solution

Selection considerations

correlation depends on the uniformity of the formation and the velocity through the screen, but for most conditions (nonuniform sands) is

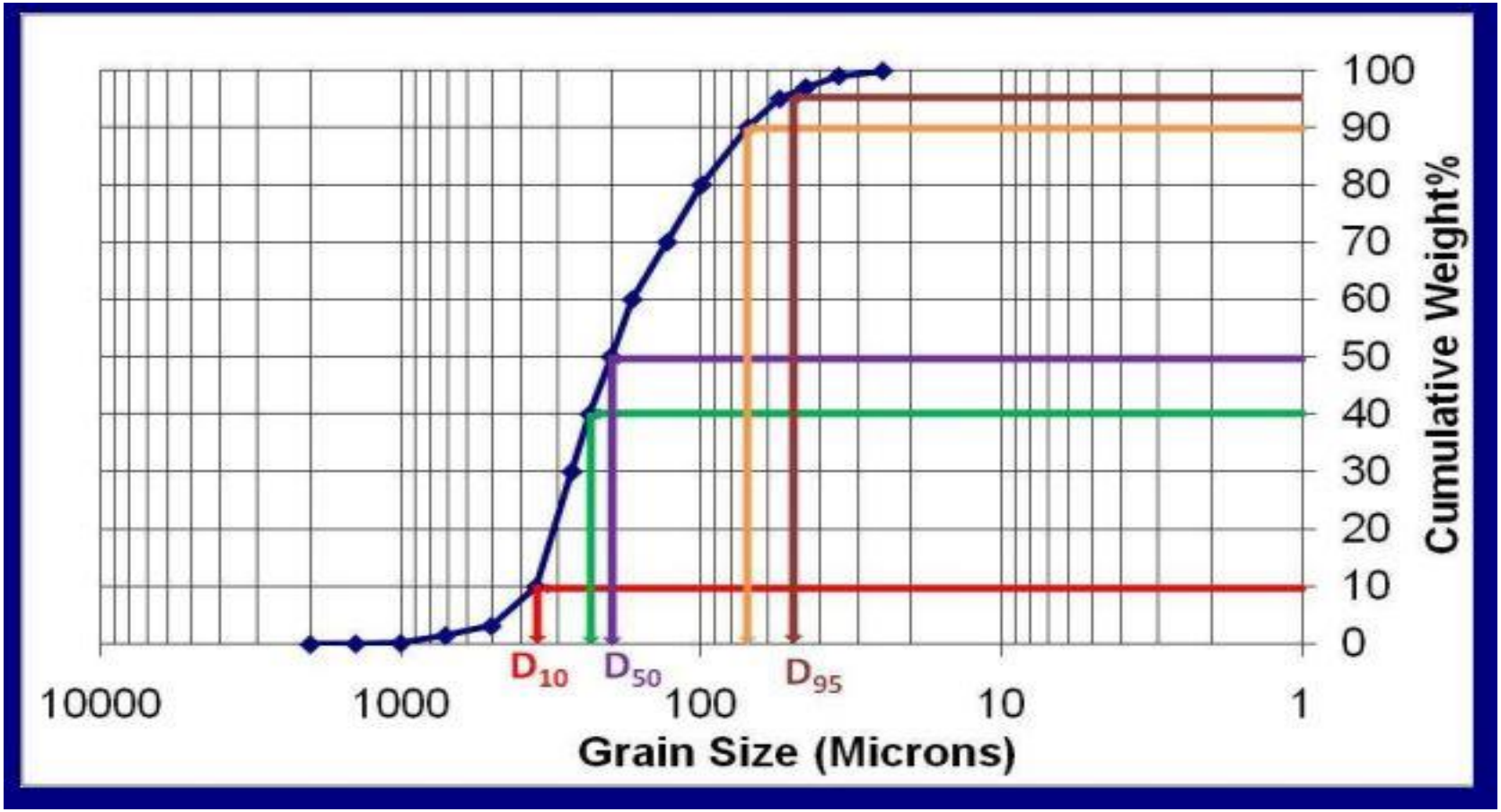
$$D_{g40} = 6D_{f40}$$

where D_{g40} is the recommended gravel size and D_{f40} is the diameter of formation sand for which 40 wt% of the grains are of a larger diameter. To fix the gravel size distribution, Schwartz recommends that the gravel size distribution should plot as a straight line on the standard semilog plot, and a uniformity coefficient, U_c, defined as

$$U_c = \frac{D_{g40}}{D_{g90}}$$

Sand Problem Solution

Selection considerations



D_{50} , $C_U = D_{40}/D_{90}$, $C_S = D_{10}/D_{95}$, % Fines (< 44 µ)

Sand Problem Solution

Selection considerations SPE 39437

C_S (= D_{10} / D_{95}) < 10 ⟹ SAS

C_S > 10 or C_U > 5 or Fines > 5% ⟹ GP

Sand Problem Solution

Selection considerations

https://www.youtube.com/watch?v=V7EyFFtn3vs

https://www.youtube.com/watch?v=IB1TTa-q4wQ

https://www.youtube.com/watch?v=RVuSKRj8Zl0

http://www.slb.com/services/completions/sand_control/transcend/openhole_gravel_pack_completions.aspx