The invaded zone's effect on the inflow of perforated wells

Created by:

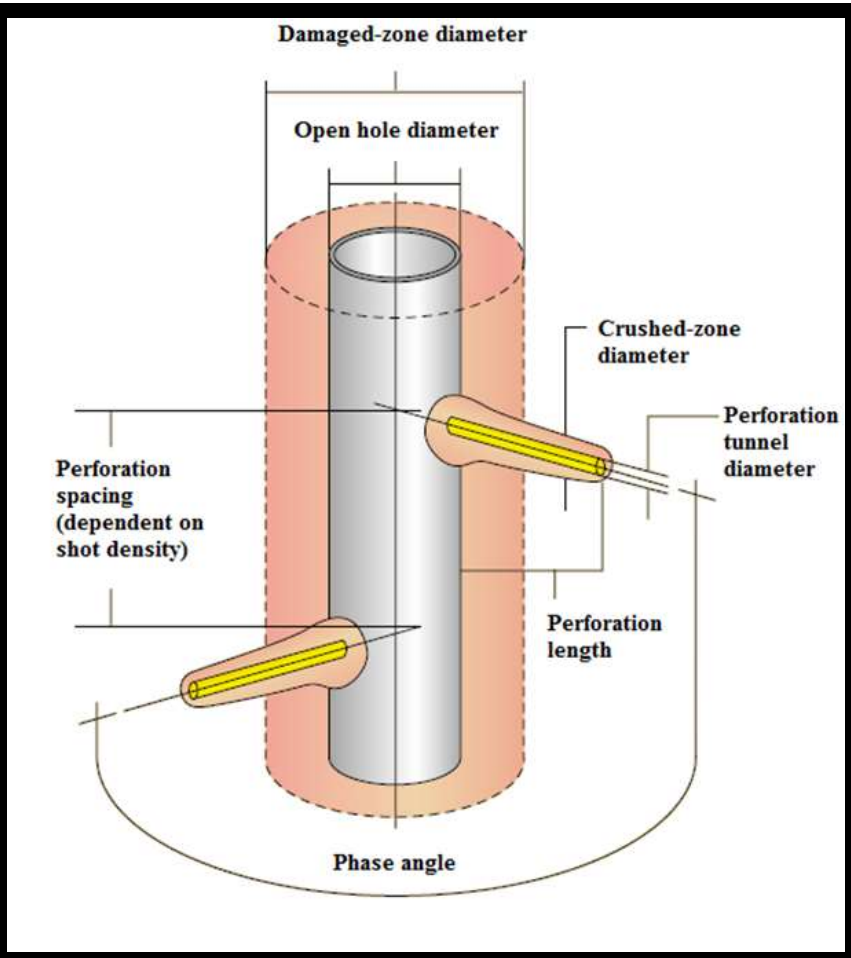
Ádám Viktor Pásztor

Low and volatile oil price environment

Technical responses in the Pannonian Basin Conference

November 17, 2016

Perforation parameters



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- Open hole radius r_w
- Perforation tunnel radius r_p
- Crushed zone radius r_c
- Perforation length L_p
- Phase angle Θ
- Shot density ns
- $k_{crushed}/k_{res}$ α

Data of the wells

Perforation parameters						
L_p [ft]	ns [spf]	α	h_p [ft]	θ [°]	r_p [ft]	r_c [ft]
1	5	0.3	25	0	0.015	0.056667

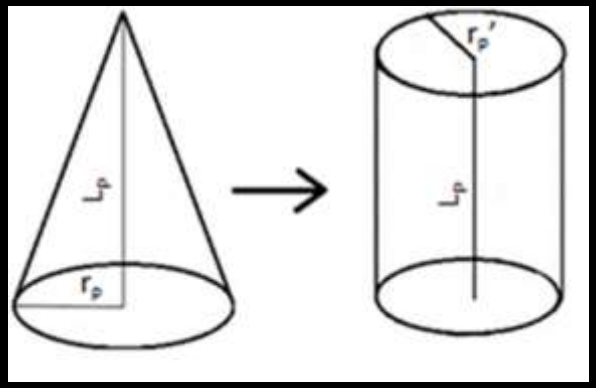
Reservoir parameters					Well parameters	
k [mD]	r_e [ft]	P_r [psi]	k_H [mD]	k_V [mD]	r_w [ft]	h [ft]
50	1000	3000	50	5	0.292	25

Oil Properties			Gas Properties			
API density	μ_o [cP]	B_o [bbl/STB]	T [R°]	z	μ_g [cP]	γ_g
45.375	0.751	1.16	630	1	0.01933	0.64

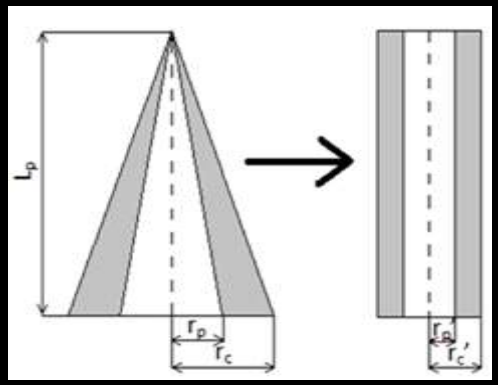
Analytical IPR equation – Base concept

- The flow is separated into two sections:
  - Flow perpendicular to the axis of the well
  - Flow perpendicular to the axis of the perforation channels
- The perforations are assumed to be small wells .
- Modification of the radius of the perforation channels and the crushed zone (Pásztor Á. & Kosztin B. 2015).

Modification of r_p:

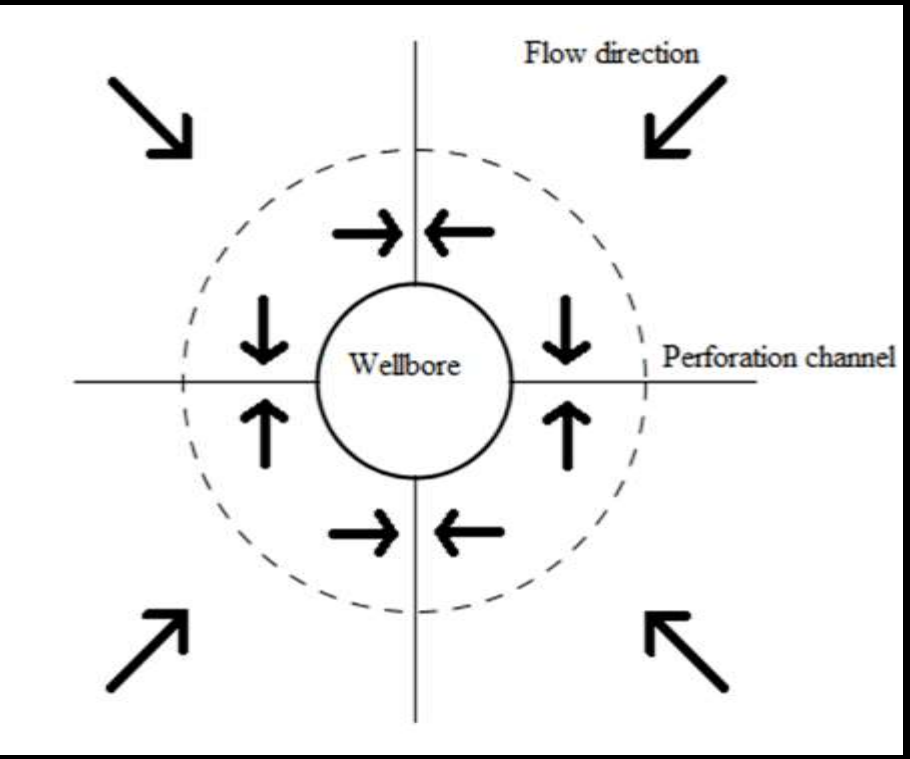


Modification of r_c:

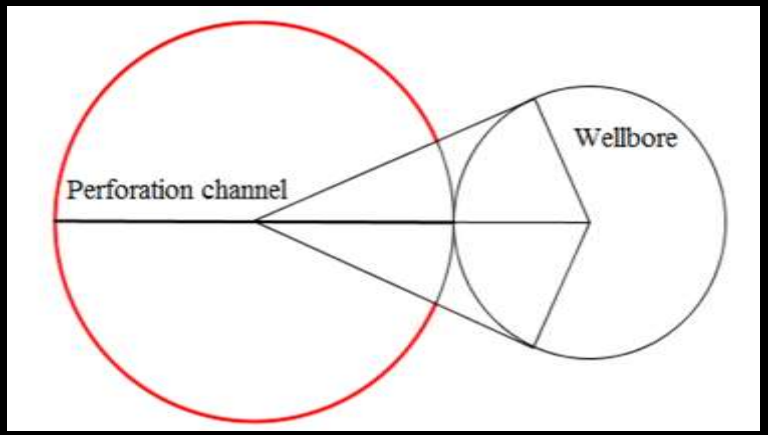


The extended wellbore

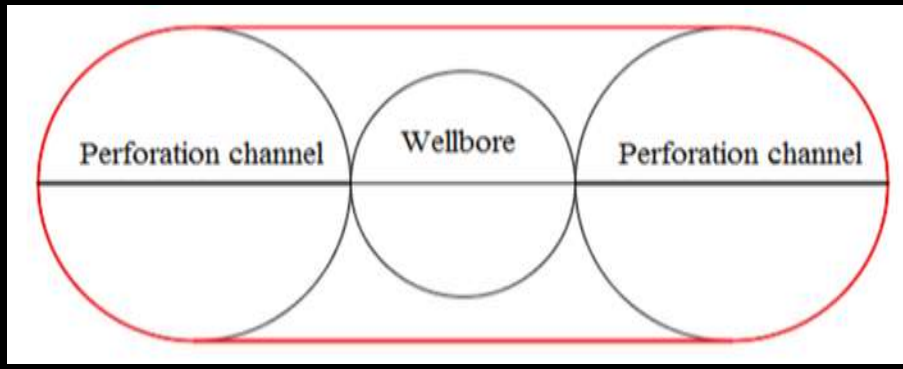
Θ=120° / 90° / 60° / 45°



Θ=360°

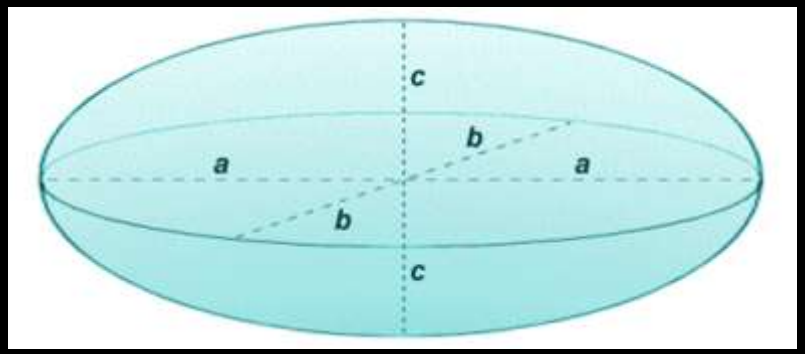


Θ=180°

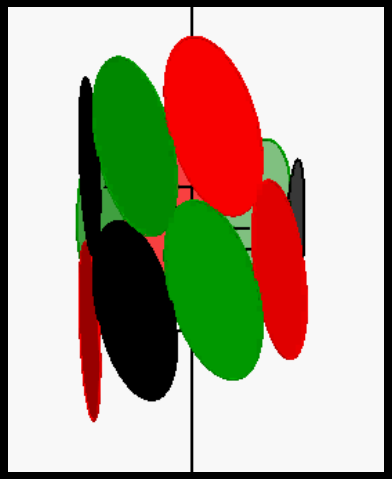


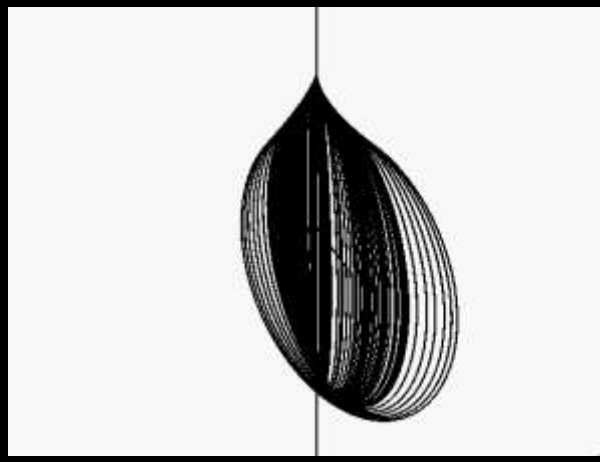
The perforation channels' drainage space

Θ=360° / 180°

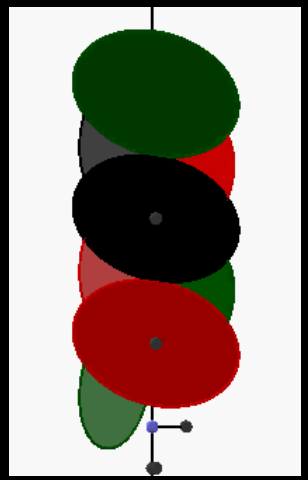


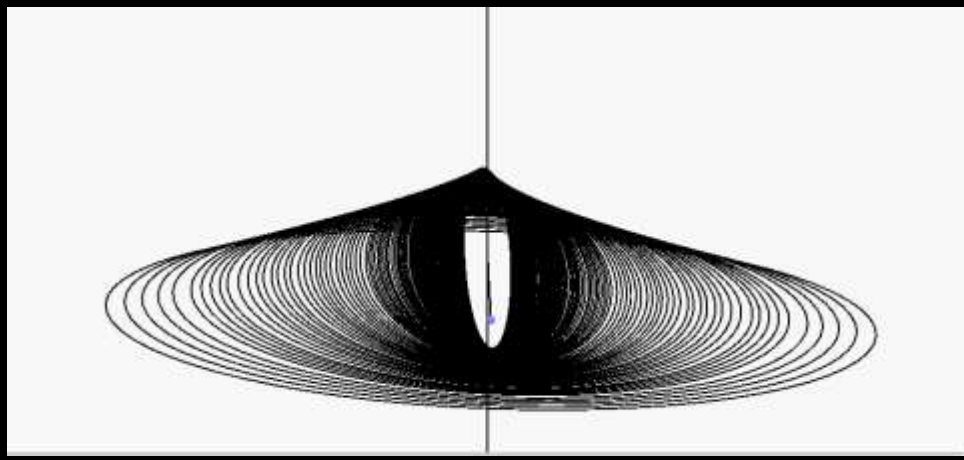
Θ=45°



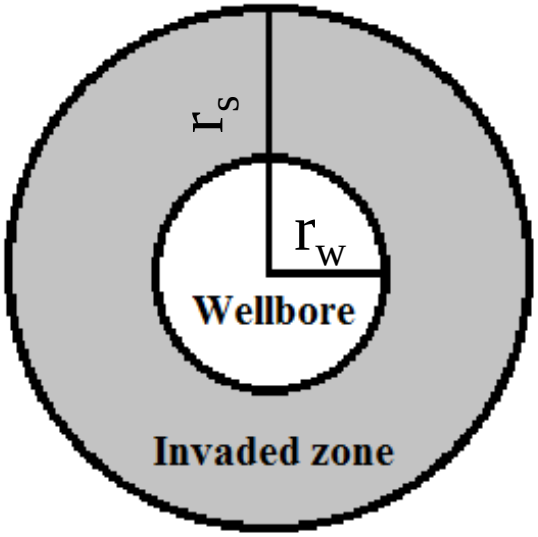


Θ=120°





The invaded zone – open hole completion



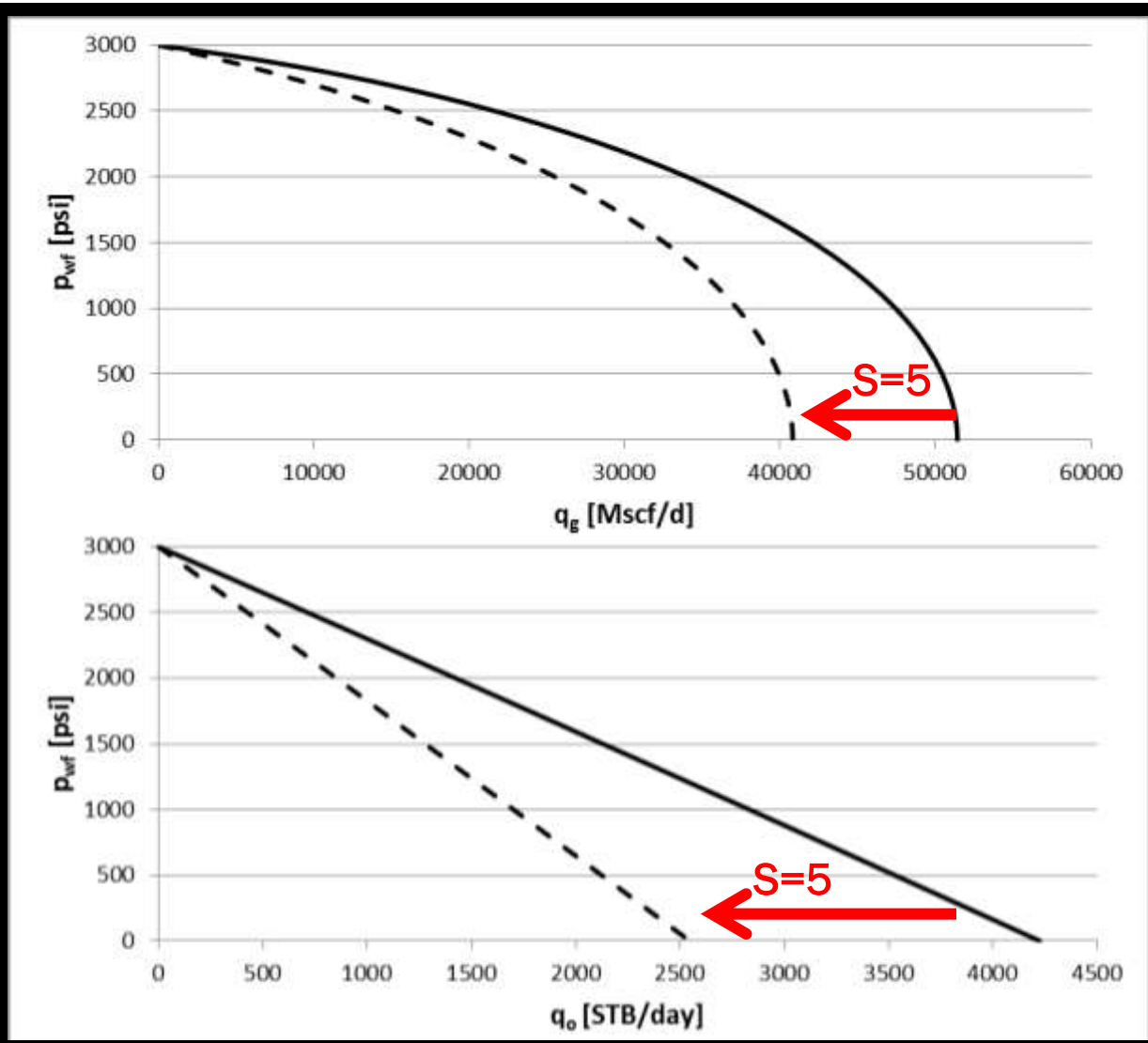
$$S = \left(\frac{k}{k_s} - 1\right) \ln\left(\frac{r_s}{r_w}\right)$$

r_s: invaded zone radius

r_w: wellbore radius

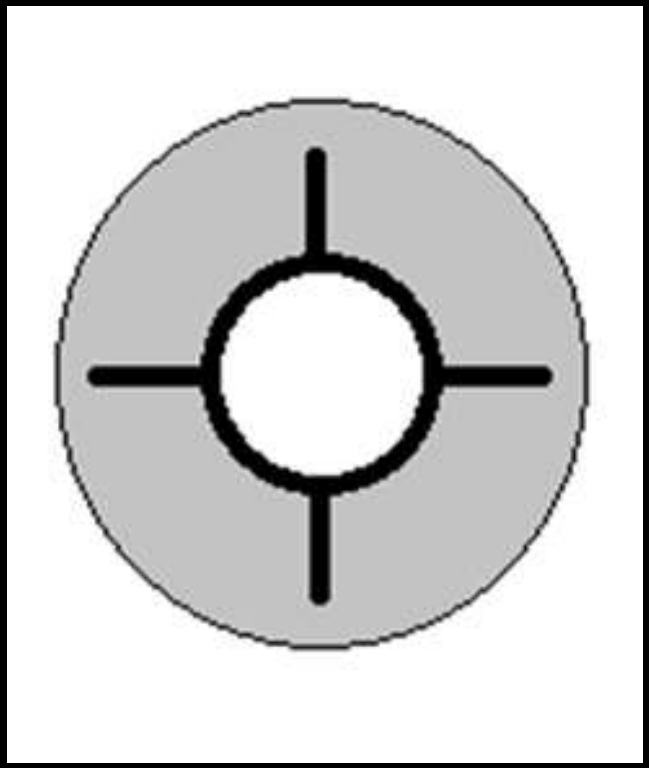
k_s: invaded zone permeability

k: reservoir premeability

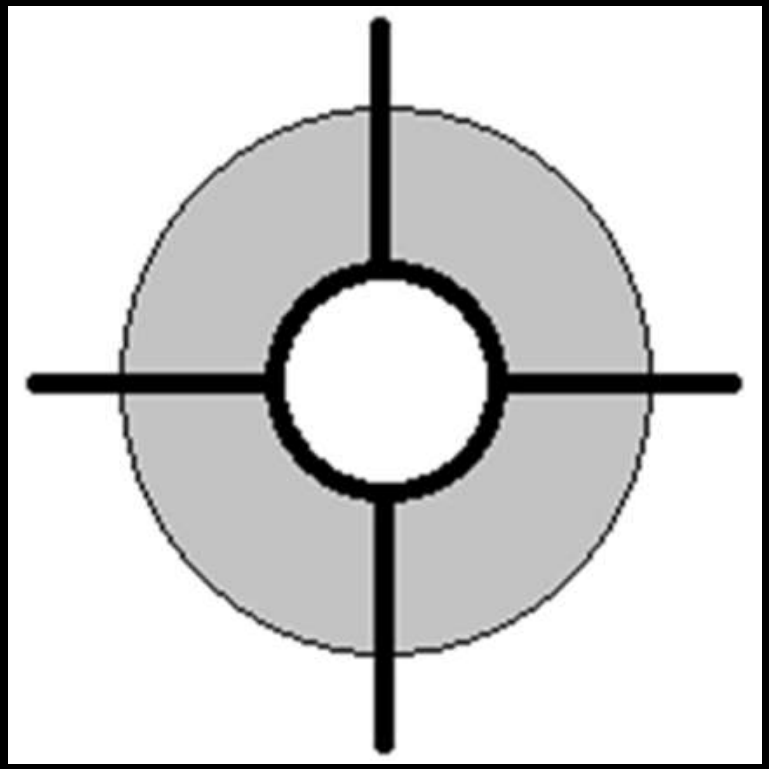


The invaded zone – perforated wells

Perforations don’t reach the clean zone



Perforations reach the clean zone



The invaded zone – perforated wells

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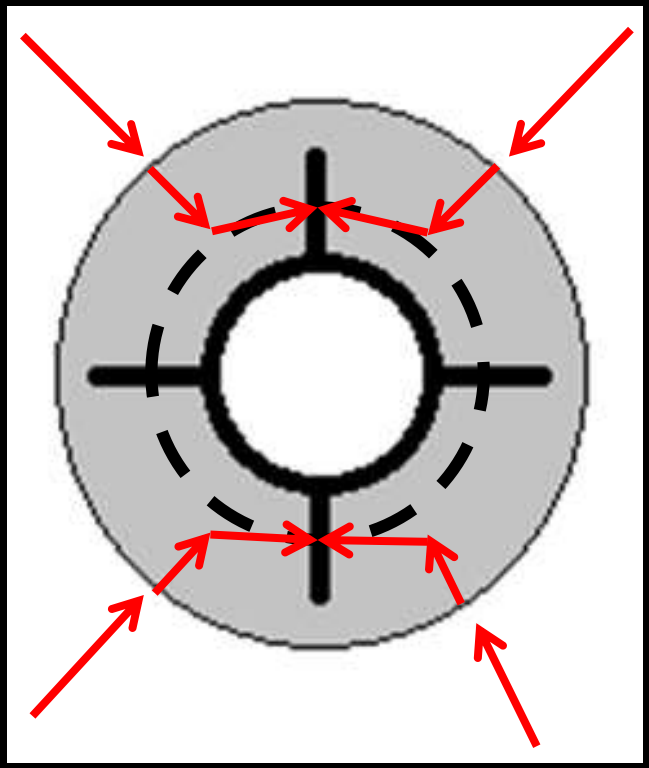


I. Flow to the invaded zone

II. Flow to the extended wellbore

III. Flow to the perforation channels

The invaded zone – perforated wells

I. Flow to the first extended wellbore (q)

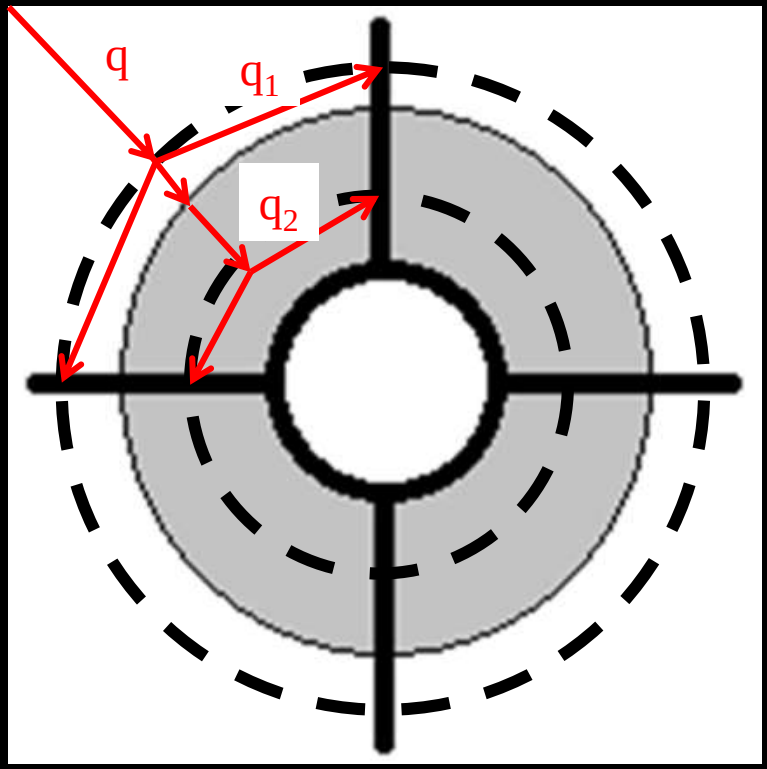
II. First flow to the perforation channels (q_1)

III. Flow to the invaded zone (q_2)

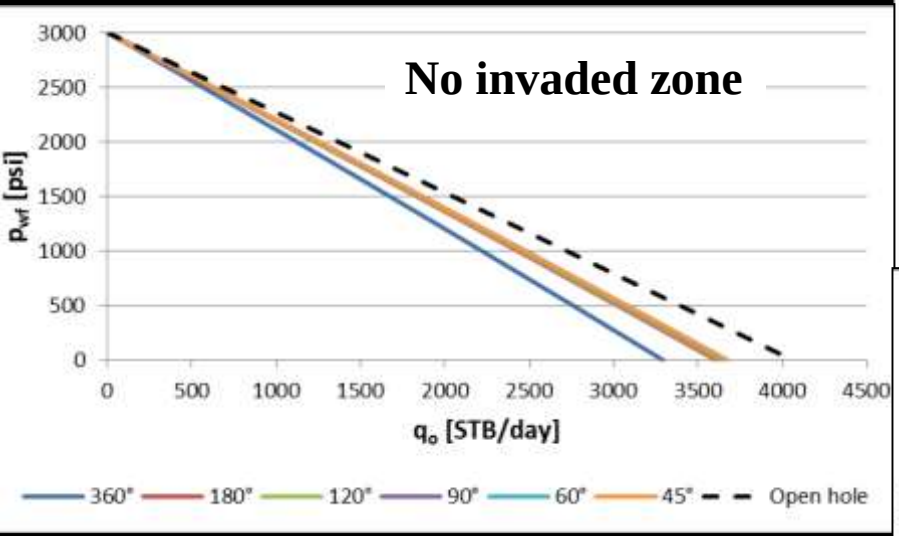
IV. Flow to the second extended wellbore (q_2)

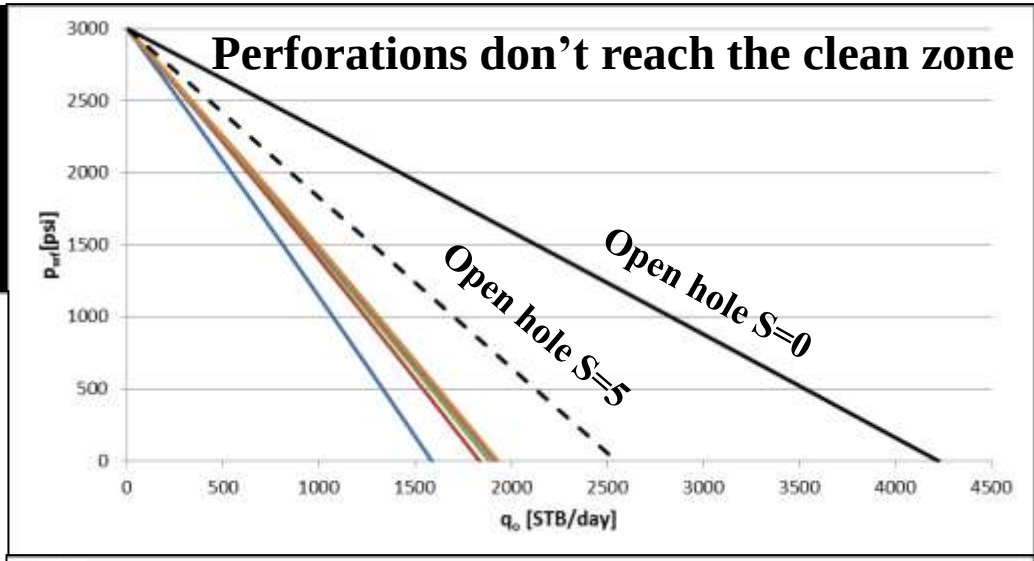
V. Second flow to the perforation channels (q_2)

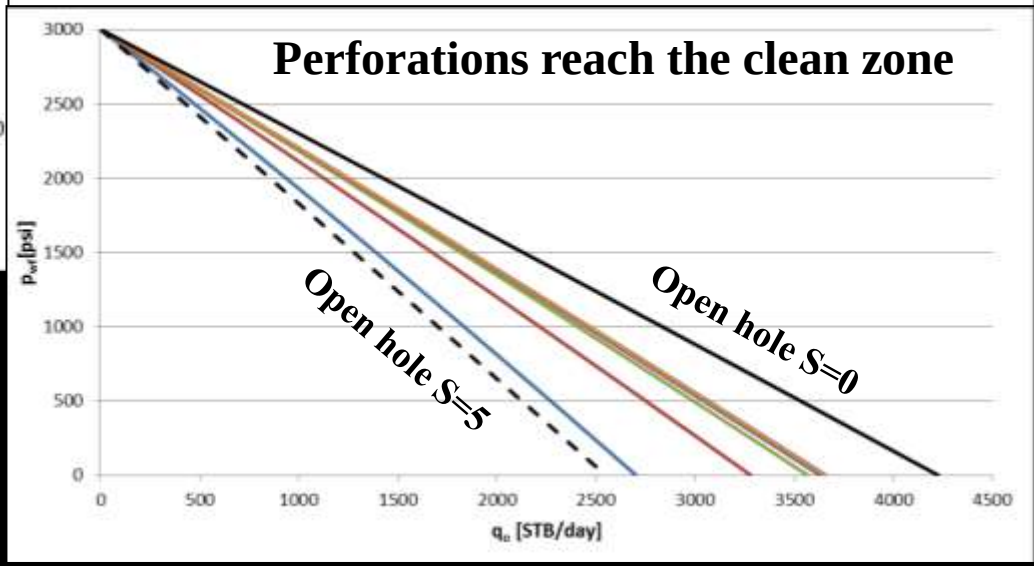
Perforations reach the clean zone



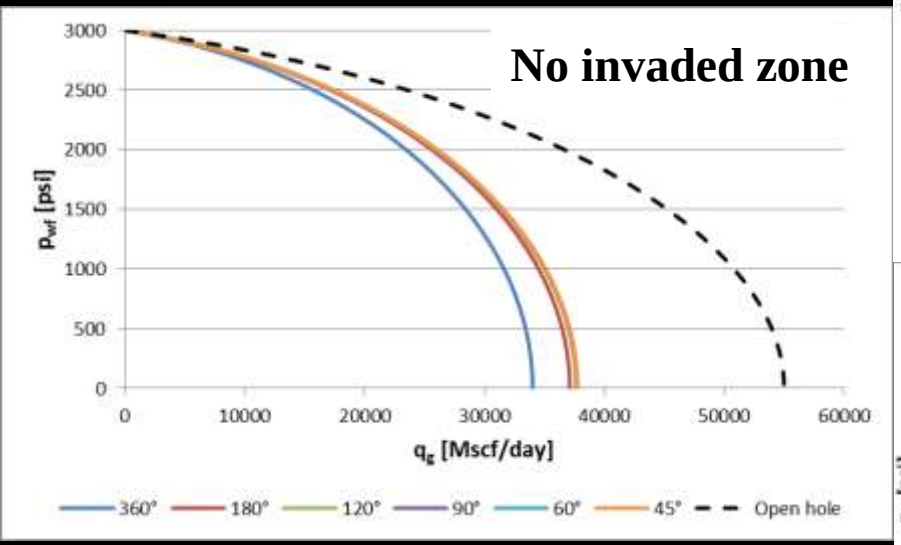
The invaded zone – perforated wells

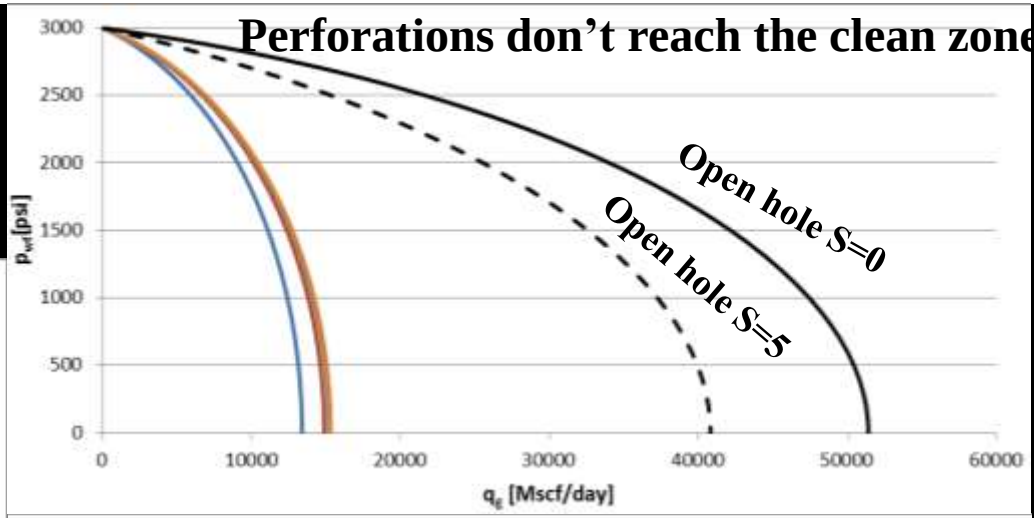


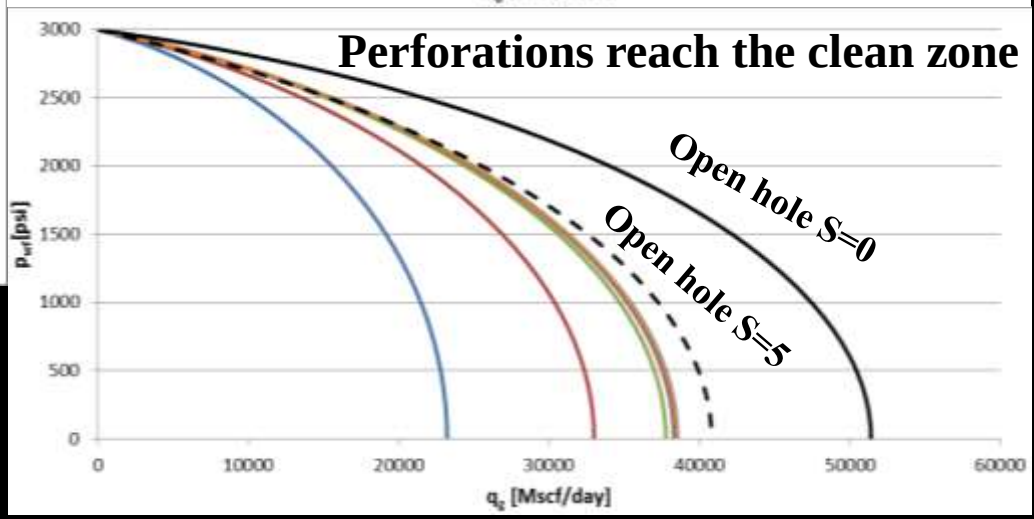




The invaded zone – perforated wells

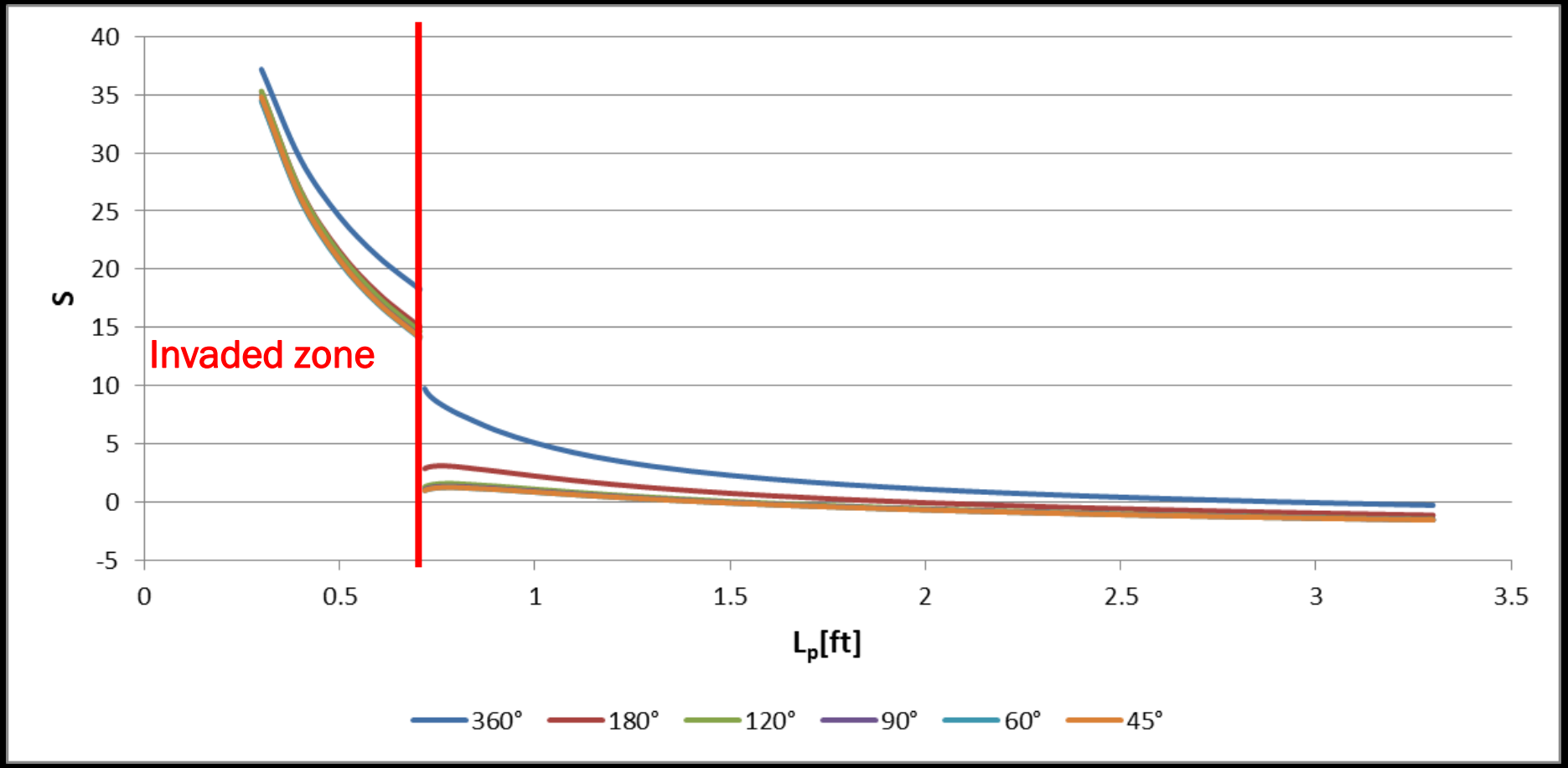






Skin vs L_p

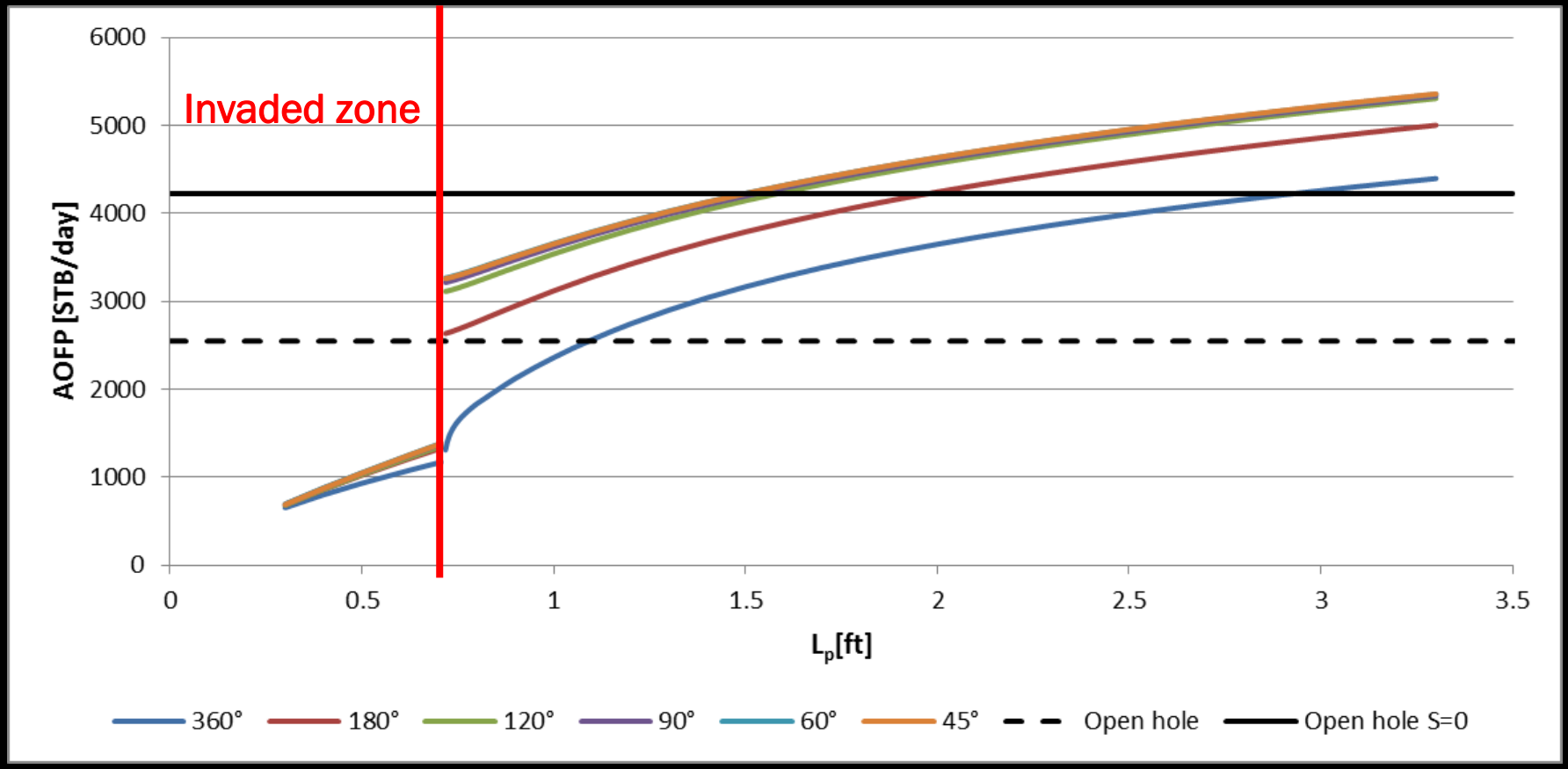
($k_s/k=0.2$)



AOFP vs L_p

Oil wells

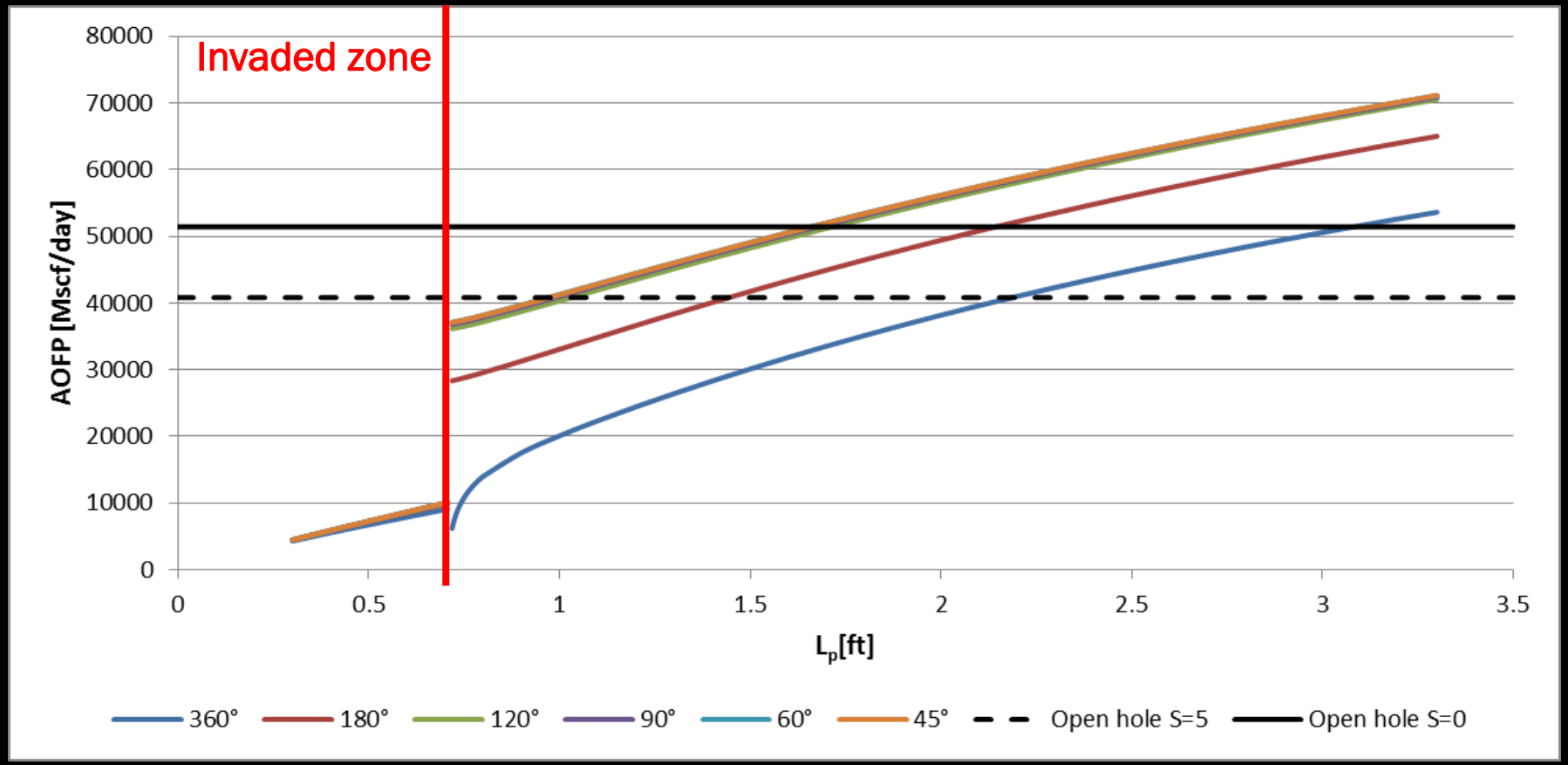
($k_s/k=0.2$)



AOFP vs L_p

Gas wells

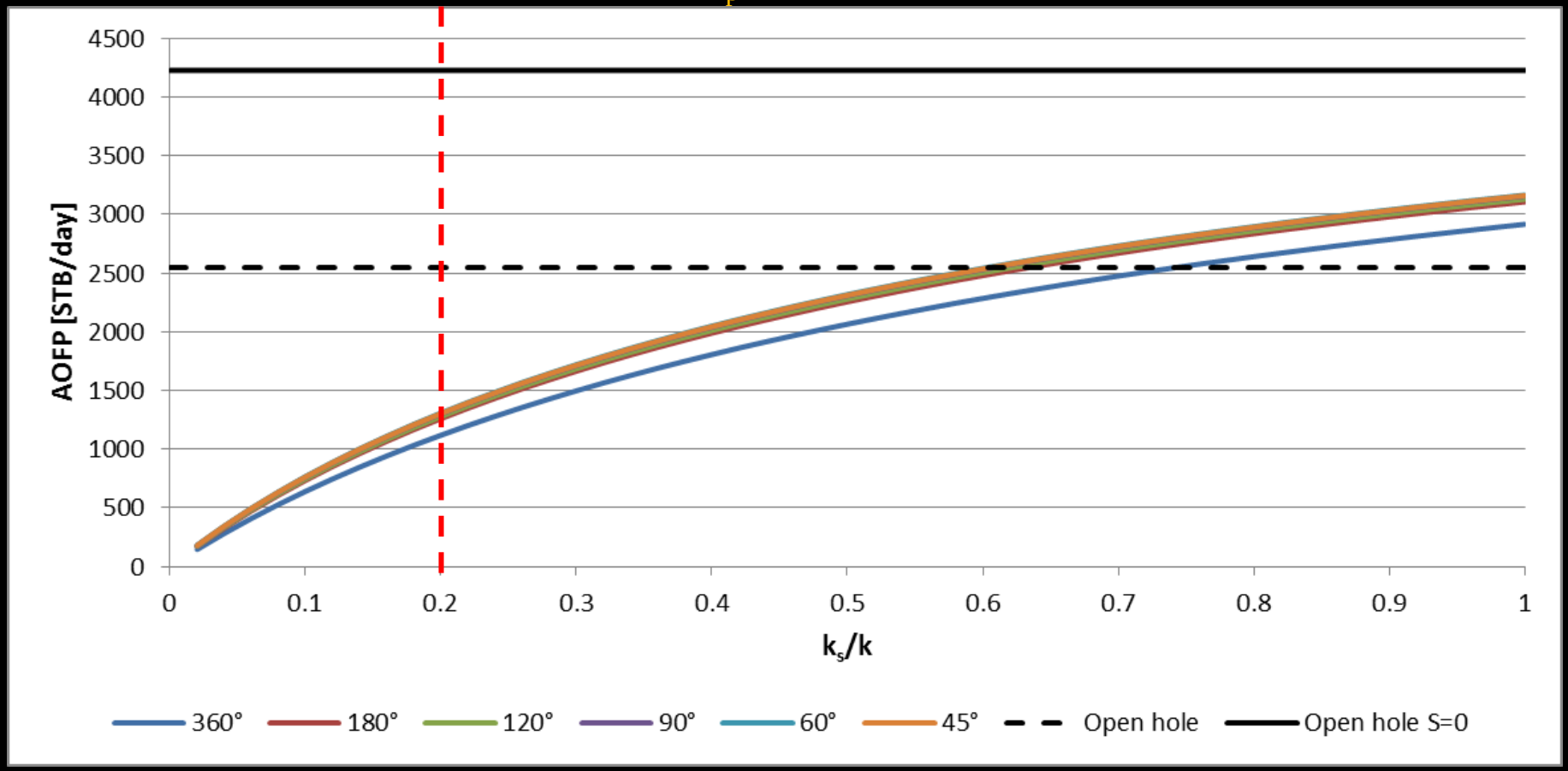
($k_s/k=0.2$)



AOFP vs k_s/k

Oil wells

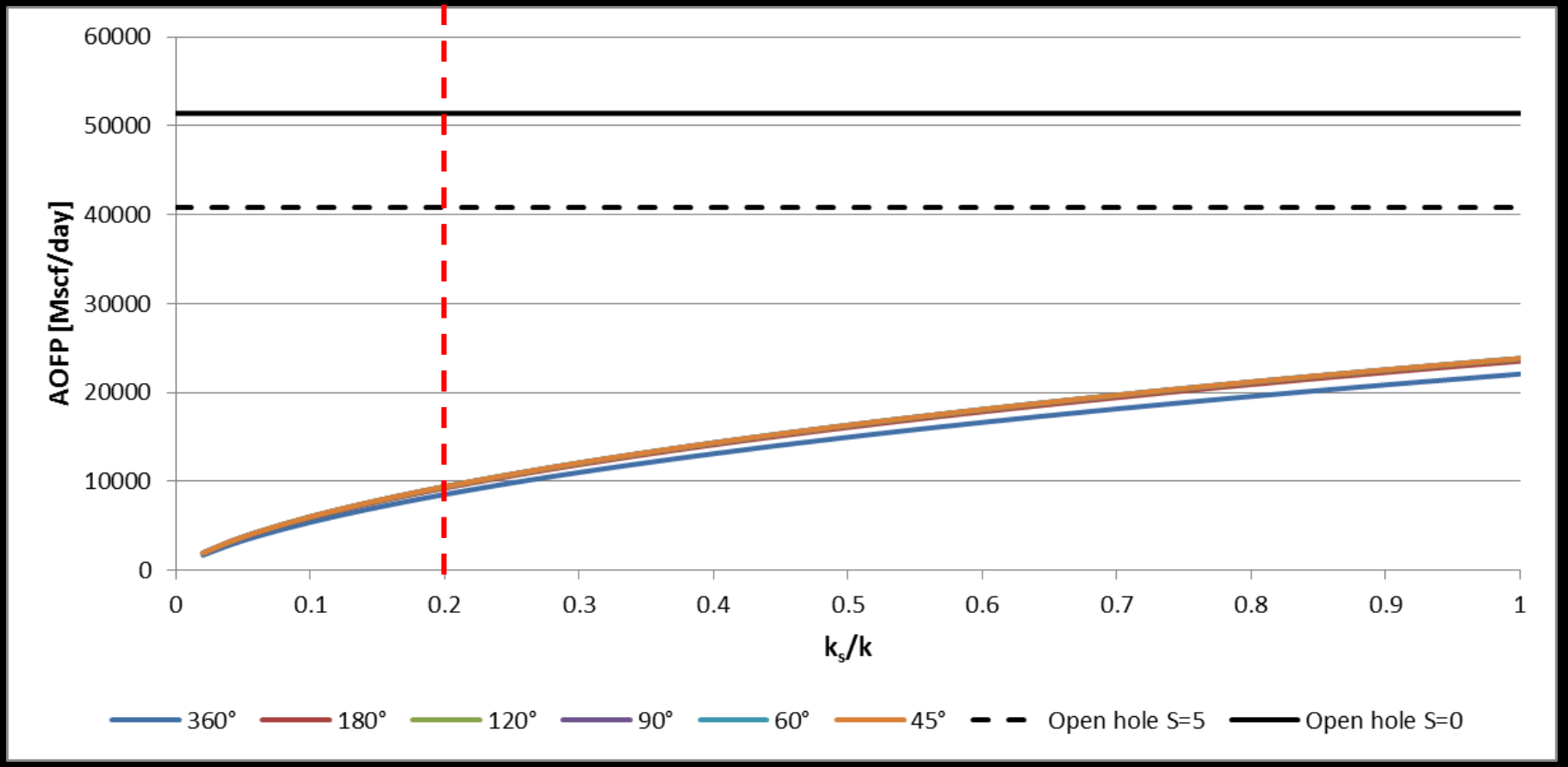
(L_p=0.65 ft)



AOFP vs k_s/k

Gas wells

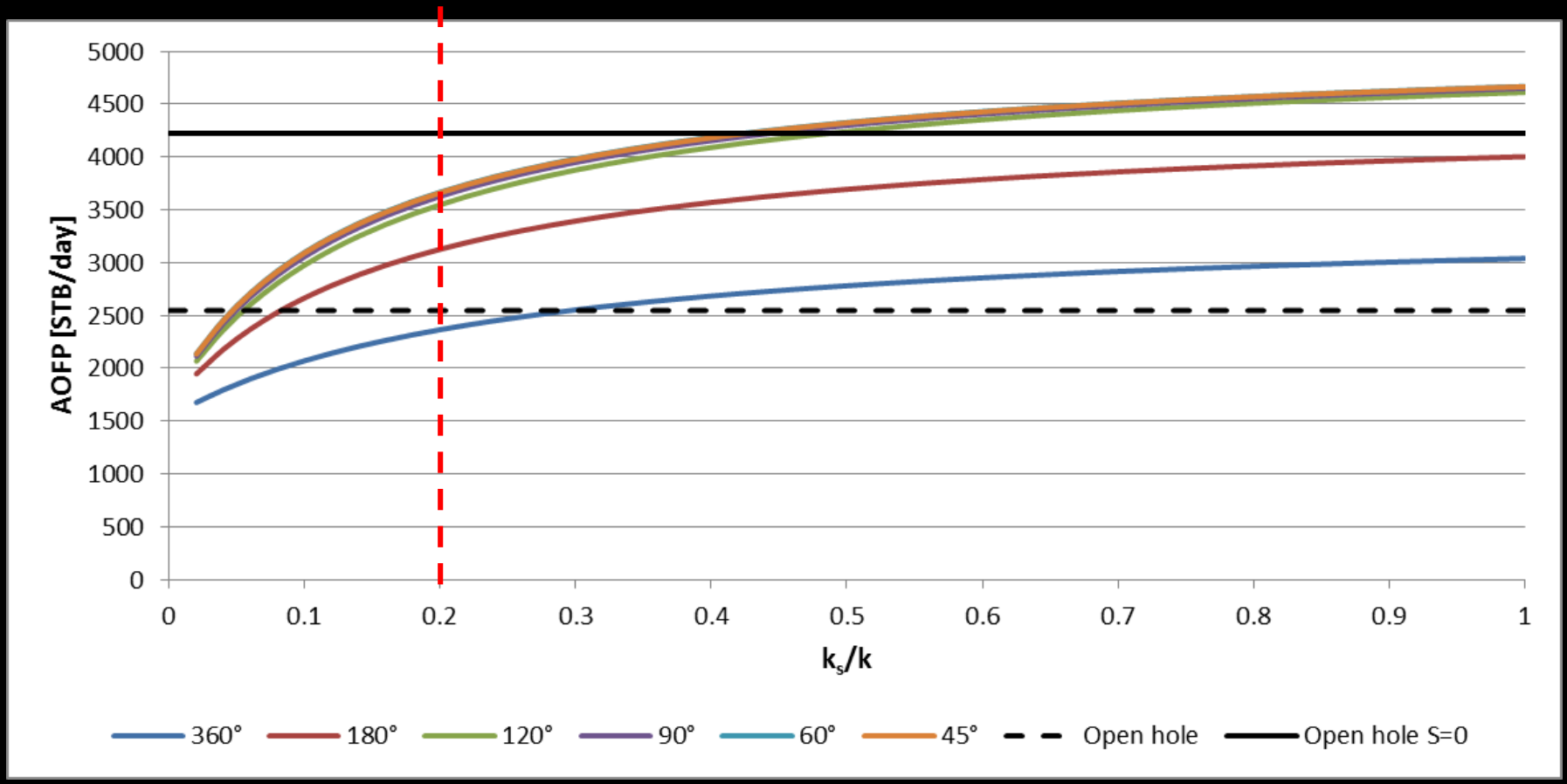
(L_p=0.65 ft)



AOFP vs k_s/k

Oil wells

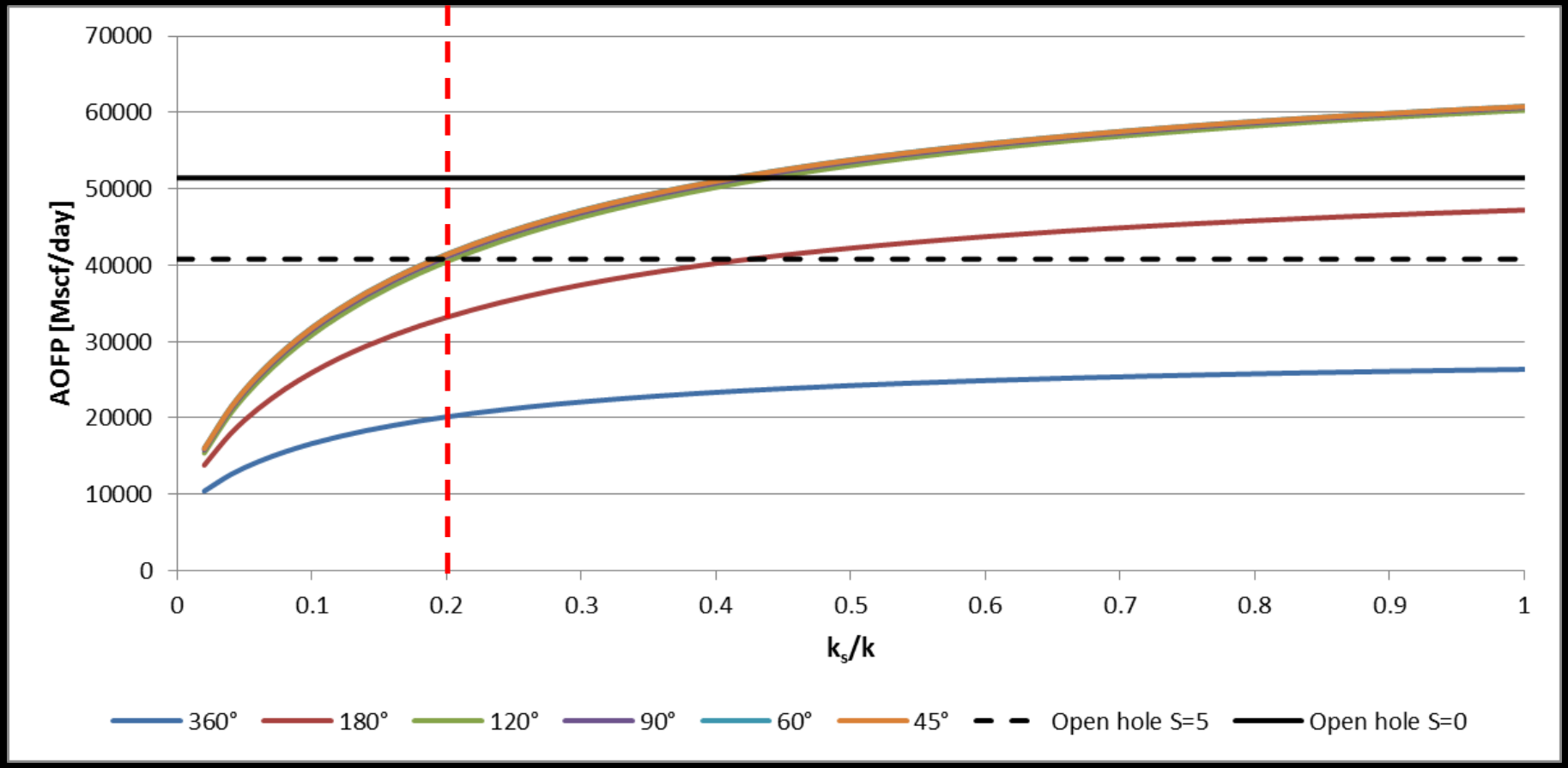
(L_p=1 ft)



AOFP vs k_s/k

Gas wells

(L_p=1 ft)



Conclusion

- High skin value indicates that the perforation channels don’t reach the clean zone
- If the perforations are not long enough to reach the clean zone, better productivity can be achieved with re-perforating the well than with matrix acidizing

Thank you for your attention!