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ATTACHMENT 16

Waste Front Radius and Pressure Front Calculations

Waste Front Radius Calculation
Assumes Equal Injection Volume in Four Wells

Company: **Hilmar Cheese Company**
Zone: **Paleocene-Cretaceous Sands** — Q (BPD): **12,000**
Field: **N/A** — Net H (ft): **500**
Well No. **Hilmar Cheese Company Class I Injection Wells** — Porosity: **25.0%**

Time, years	Injection Volume (Cu Ft)	Cumulative Volume (Cu Ft)	Waste Radius with No Dispersion (ft)	Waste Radius with Dispersion (ft)	Wastefront Rate with Dispersion (ft/yr)
1	24,591,773	24,591,773	250	313	313
2	24,591,773	49,183,546	354	429	214
3	24,591,773	73,775,318	433	516	172
4	24,591,773	98,367,091	500	590	147
5	24,591,773	122,958,864	560	654	131
6	24,591,773	147,550,637	613	712	119
7	24,591,773	172,142,410	662	765	109
8	24,591,773	196,734,182	708	814	102
9	24,591,773	221,325,955	751	860	96
10	24,591,773	245,917,728	791	903	90
11	24,591,773	270,509,501	830	945	86
12	24,591,773	295,101,274	867	984	82
13	24,591,773	319,693,046	902	1,022	79
14	24,591,773	344,284,819	936	1,058	76
15	24,591,773	368,876,592	969	1,093	73
16	24,591,773	393,468,365	1,001	1,127	70
17	24,591,773	418,060,138	1,032	1,160	68
18	24,591,773	442,651,910	1,062	1,192	66
19	24,591,773	467,243,683	1,091	1,222	64
20	24,591,773	491,835,456	1,119	1,252	63
21	24,591,773	516,427,229	1,147	1,282	61
22	24,591,773	541,019,002	1,174	1,310	60
22	24,591,773	565,610,774	1,200	1,338	61
24	24,591,773	590,202,547	1,226	1,365	57
25	24,591,773	614,794,320	1,251	1,392	56
26	24,591,773	639,386,093	1,276	1,418	55
27	24,591,773	663,977,866	1,300	1,444	53
28	24,591,773	688,569,638	1,324	1,469	52
29	24,591,773	713,161,411	1,348	1,494	52
30	24,591,773	737,753,184	1,371	1,518	51
	1,475,506,368	737,753,184	1,371	1,518	

Calculations based on Warner & Lehr, eqns 3-10, 3-11

r = {V/(pi*h*phi)}^0.5
r' = r+2.3*(D*r)^0.5

Where: r = radial distance of wastewater front from well
r' = radial distance of wastewater front from well with dispersion
V = cumulative wastewater injection in cubic feet
pi = 3.1416
h = net reservoir thickness
phi = average effective porosity
D = dispersion coefficinet; 3' for sandstone; 65' for limestone/dolomite

Note: Porosity calculated from sonic log = 28.8% (Pacific Geotechnical Associates, 2004b)

Pressure Front Calculation

Company: **Hilmar Cheese Company**
Zone: **Paleocene-Cretaceous Sand**
Field: **N/A**
Well No: **Hilmar Cheese Company Class I Injection Wells**

Q (BPD):	**12,000**	h (ft):	**500**
Porosity:	**25.0%**	t (years):	**30**
Uw (cp):	**1**	Ct:	**5.90E-06**
k (md):	**500**		

Radius, ft	Delta P, psi
4,000	27.44
3,500	28.34
3,000	29.39
2,500	30.63
2,000	32.14
1,500	34.09
1,000	36.84
750	38.79
500	41.54
250	46.24
100	52.45
1	83.67

Calculations based on Warner & Lehr; eqn 3.9a

Delta P = {(162.6*Q*Uw)/(k*h)}*{log(k*t)/(phi*Uw*Ct*r^2)-3.23}

Where: Delta P = psi reservoir pressure change at raidus r (ft) and time t (years).
Q = injection rate, BPD
Uw = injectate viscosity, centipoise
k = reservoir permeability
h = net thickness, ft
t = injection time, years
phi = reservoir porosity, %.
Ct = reservoir compressibility. Psi^-1
r = radius of interest, ft