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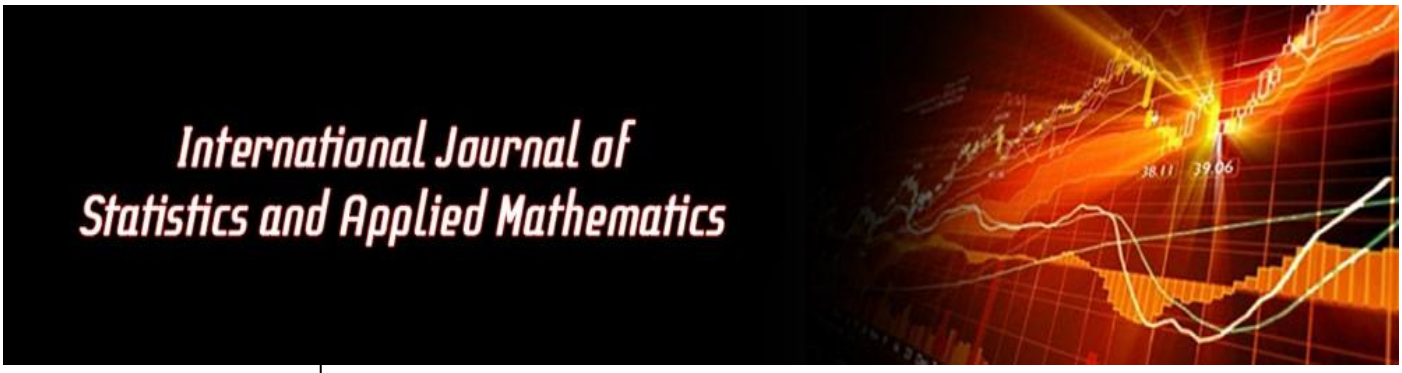

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A study on casing damage based on effect of water injection pressure

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Abstract
The water flooding extraction of the oilfield, the quantity and increasing speed of oilfield casing damage are rising obviously. Casing damage creates the loss of economy and also affect the development of the oilfield. The problem of casing damage has become an urgent problem an the oilfield. This paper gives a study of casing damage based on effect of water injection pressure in a particular oil field and the datas are analysed and the results are tabulated.

Mechanism of casing damage is discontinuous deformation in the overloading strata and the discontinuous deformation includes interlayer sliding and fault movement induced by subsidence, which results in casing shear damage. The oil pressure goes down axial compression and bending of casing are caused by large vertical displacement. The casing damage in the middle of production floor is because of the largest axial strain and casing bent because of excessive axial load and its surroundings without sufficient lateral support.

Channeling is easily caused when water injection pressure fracture pressure in the case of poor cementing quality. In the case of water channel, immersion area forms and strata stress is out of balance, which results in that the casing damage area from in large immersion area. However, there is no effective way to prevent and slow the damage of casing well. Example as pubei oilfield in china "Casing damage on effect of water injection pressure" The distribution of casing damage is raised and the effect rule and mechanism that water injection pressure acts on casing damage of injection wells and oil wells are studied.

Keywords: Casing damage, water injection pressure, flooding extraction

Introduction

General Situation and Distribution of Casing Damage in Pubei Oilfield

General situation of casing damage

The number of casing damaged wells in the seventh oil production plant of daqing oilfield is 355, among which 247 are injection wells, and 108 are oil wells. Casing damaged injection wells accounts for 80.28% of the total casing damaged wells. There are 285 casing damaged wells in the pubei oilfield, which accounts for 80.28% of the total number of the seventh oil production plant of daqing oilfield. The main forms of casing damage are deformation and dislocation.168 wells emerge casing dislocation and deformation appear in 153wells. Casing damaged wells two kinds of forms account for 90.42% of the total casing damaged wells. In vertical casing damage mainly emerge in reservoirs. The second and third blocks are main casing damage blocks in Pubei oilfield, and the number of casing damaged wells is 163, which accounts for 64.68% of total casing damaged wells in pubei oilfield. Casing damaged wells account for 19.52% of the oil and water wells in the second block. Casing damaged wells account for 16.23% of the oil and water wells in the third block.

Distribution of casing damage

Analyze the distribution statistical data of casing damaged wells along north and south direction in the second block with regression method to obtain the curve and mathematical relation of casing damage rate.

Distribution of statistical data in second block

Water injection pressure (well array number)	Casing damage rate (percentage %)	Oil production in pressure (Mpa)
62	10.5	9.5
65	10	8.5
68	12	13.5
74	20	7.2
79	34	13.2
82	69	14.2
84	43	15.8
86	32	16

Here, Mathematical statistics method will be used to analyze the casing damage.By using polynomial regression method,

$N = a + bS_n + cS_n^2 + dS_n^3$

$N = 152.846 - 11.337\ S_n + 0.2268\ S_n^2 + 0.0012 S_n^3$ ..... (1)

N = casing damage rate
S_n = well array number

Table 1

S. No	Well array number (S_n)	Casing damage rate (%)
1.	60	29.906
2.	62	35.776
3.	65	44.621
4.	68	53.334
5.	70	58.976
6.	72	64.415
7.	75	72.071
8.	77	76.754
9.	79	81.356
10.	80	54.562
11.	81	43.834
12.	82	41.751
13.	83	35.248
14.	84	32.248
15.	86	30.456
16.	89	28.567

Based on this tabulated values the figure 1 will be drawn. Figure1 shows that the rate of casing damage increases gradually from north to south and reaches a maximum in the 79th row wells after that rate of casing damage decreases gradually.
Analyze the distribution statistical data of casing damaged wells along north to south direction in the third block with regression method to obtain the curve and mathematical relation of casing damage

Distribution of statistical data in third block

Water injection pressure (well array number)	Casing damage rate (percentage %)	Oil production in pressure (Mpa)
62	11.5	7.8
65	19	12.5
67	21	10.5
68	11	13.2
73	8.4	12
75	14	13.5
77	12.4	12.5
78	13	14.2

Here, Mathematical statistics method will be used to analyze the casing damage. By using linear regression method,
$N = a + b\ S_n$
S_n = well array number
N = casing damage rate

$$b = \frac{N \sum xy - \sum x \sum y}{N \sum x2 - (\sum x)2}$$

$$b = \frac{8\,(837.68) - (70.625)(13.81)}{8(5018.625) - (70.625)2} = 0.16285$$

$$a = \frac{\sum y - b(\sum x)}{N}$$

$$a = \frac{13.81 - 0.1628(70.625)}{8} = 0.28903$$

$N = a + bS_n$
$N = 0.2890 + 0.1628\ S_n$ ……. (2)

Table 2

S. No	Well array number (S_n)	Casing damage rate (N)
1	60	10.057
2	61	10.2198
3	62	10.3826
4	63	10.5454
5	64	10.871
6	65	11.1966
7	69	11.5222
8	72	12.0106
9	75	12.497
10	77	12.8246
11	78	13.1502
12	80	13.313
13	84	14.2898
14	90	15.266

Based on this tabulated values the figure2 will be drawn. Figure2 shows that the rate of casing damage increases linearly from north to south. The most serious casing damage is in the 90th row wells and the rate of casing damage is 15%.
The comparison between figure1 and figure2, it shows that casing damage in the second block is much more serious than in the third block. Casing damage of oil water wells is directly related to water injection of oilfield.

Relationship between water injection pressure and casing damage of injection well

Distribution of casing damage

The oil pressure distribution of the second block 2007 and third block 2010 taken as examples, the relationship between oil pressure and well array of water injection wells is analyzed.
Here, Mathematical statistics method will be used to analyze the casing damage. By using linear regression method,
$P = a + b\ S_n$
S_n = well array number
P = oil pressure

$$b = \frac{N \sum xy - \sum x \sum y}{N \sum x2 - (\sum x)2}$$

$$b = \frac{8\,(941.48) - (75)(12.31)}{8(5698.25) - (75)2} = 0.1653$$

$$a = \frac{\sum y - b(\sum x)}{N}$$

$a = \frac{(12.312)-0.1653(75)}{8} = -0.01068$

$P = a + bS_n$

$N = -0.01068 + 0.1653\ S_n$ …….….. (3)

Table 3

S. No	Well array number (S_n)	Oil pressure (Mpa)
1	60	9.9073
2	62	10.2379
3	64	10.5685
4	66	10.8991
5	68	11.2297
6	70	11.5603
7	72	11.8909
8	74	12.2215
9	76	12.5521
10	78	12.8827
11	80	13.2133
12	82	13.5439
13	84	13.8745
14	86	14.2051

Figure 3 shows that the oil pressure of water injection wells in the second block increases linearly from north to south, which is basically consistent with the curve of casing damage rate.

Oil pressure distribution of the third block 2010

Here, Mathematical statistics method will be used to analyze the casing damage. By using linear regression method,

$P = a + b\ S_n$

S_n = well array number

P = oil pressure

$b = \frac{N \sum xy - \sum x \sum y}{N \sum x2 - (\sum x)2}$

$b = \frac{8(1021.65) - (70.625)(14.475)}{8(5018.25) - (70.625)2} = 0.2033$

$a = \frac{\sum y - b(\sum x)}{N}$

$a = \frac{(14.475) - 0.2033(70.625)}{8} = 0.014625$

$P = a + bS_n$

$N = 0.014625 + 0.2033\ S_n$ …….. (4)

Table 4

S. No	Well array number (S_n)	Oil pressure (Mpa)
1	60	12.1946
2	62	12.6006
3	64	13.0258
4	66	13.4324
5	68	13.8390
6	70	14.2456
7	72	14.6522
8	74	15.0588
9	76	15.4654
10	78	15.8720

Figure 4 shows that the oil pressure of water injection wells in the third block increases linearly from north to south, which is basically consistent with the curve of casing damage rate.

Relationship between water injection pressure and casing damage in oil well

Great diastrophism will be caused when water injection pressure is too high, resulting casing damage of oil wells around water injection wells. Through the field data, It shows that when mudstone layer is not hydrous, relative slipping layer is in the mudstone layer above water injection layer, but not in water injection layer. The slipping occurs in the fault.

Analyze the distribution statistical data of the second block with regression method to obtain the curve and mathematical relation of oil pressure

$P = 0.3893 + 0.3164\ (N)$ ……. (5)

Table 5

S. No	Casing damage rate (%)	Oil pressure (Mpa)
1	14	4.8189
2	18	6.0845
3	25	8.2993
4	34	11.1469
5	42	13.6781
6	54	17.4749
7	66	21.2717
8	76	24.4357
9	78	25.0685
10	80	25.7013

Analyze the distribution statistical data of the third block with regression method to obtain the curve and mathematical relation of oil pressure,

$P = 0.13287 + 0.7951\ (N)$ ……. (6)

Table 6

S. No	Casing damage rate (%)	Oil pressure (Mpa)
1	18	14.4446
2	23	18.423
3	28	22.3956
4	34	27.1662
5	42	33.5270
6	48	38.2976
7	56	44.6584
8	65	51.8143
9	72	57.3800
10	78	62.1506

Conclusion

Thus this paper gives a study of Casing damage based on effect of water injection pressure in one of the oil field. The relationship between water injection pressure and casing damage in oil well, distribution of casing damage and general situation of casing damage are generally discussed and the results are tabulated and compared using statistical data.

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