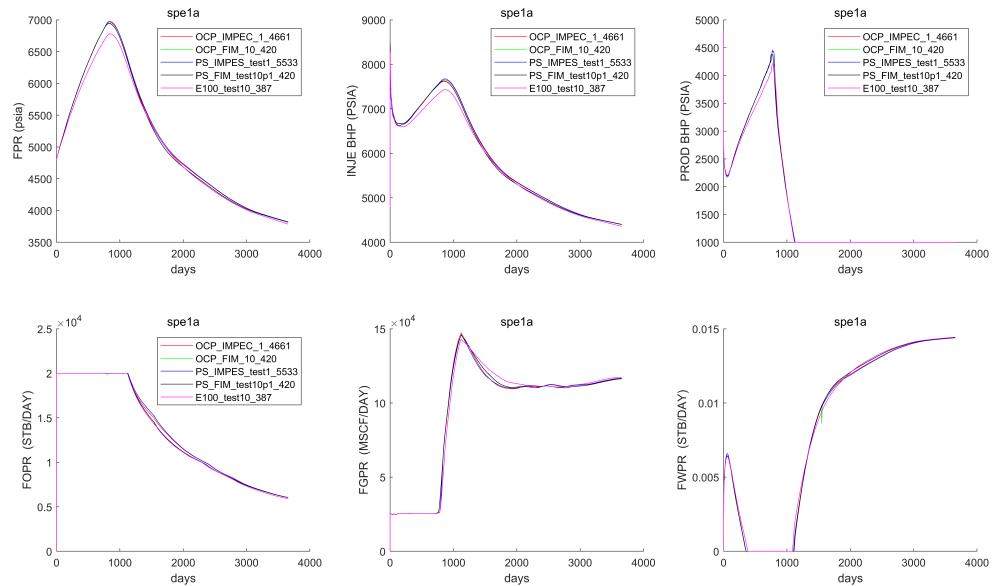


SPE1A



PS_IMPES_1

```

Final time:      3655.5 Days
Total time steps: 5533
Total nonlin steps: 5533
Total linear steps: 8828
Linear solver time: 0.932773s
Simulation time: 2.44659s

```

OCP_IMPES_1

```

Final time:      3655.500 Days
Total time steps: 4661
Total Newton steps: 4661 (+51 wasted steps)
Total linear steps: 7785 (+99 wasted steps)
Linear solve time: 0.786s (58.841%)
Simulation time: 1.337s

```

PS_FIM_10

```

Final time:      3655.5 Days
Total time steps: 420
Total Newton steps: 434
Wasted Newton steps: 1
Total linear steps: 1235
Linear solver time: 3.62965s
Simulation time: 4.08421s

```

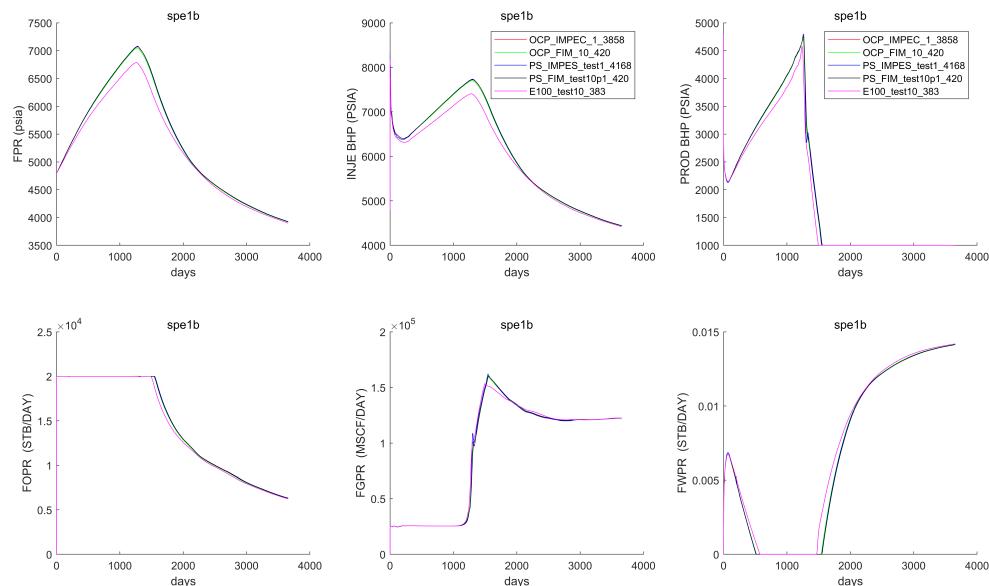
OCP_FIM_10

```

Final time:          3655.500 Days
Total time steps:    420
Total Newton steps: 474 (+1 wasted steps)
Total linear steps: 1414 (+4 wasted steps)
Linear solve time:  5.004s (94.434%)
Simulation time:    5.299s

```

SPE1B



PS_IMPES_1

```

Final time:          3655.5 Days
Total time steps:    4168
Total nonlin steps: 4168
Total linear steps: 7601
Linear solver time: 0.824397s
Simulation time:    1.99241s

```

OCP_IMPES_1

```

Final time:          3655.500 Days
Total time steps:    3858
Total Newton steps: 3858 (+19 wasted steps)
Total linear steps: 7215 (+35 wasted steps)
Linear solve time:  0.666s (59.798%)
Simulation time:    1.114s

```

PS_FIM_10

```

Final time:          3655.5 Days

```

```

Total time steps:      420
Total Newton steps:   437
Wasted Newton steps:  1
Total linear steps:   1212
Linear solver time:   2.6363s
Simulation time:      3.08908s

```

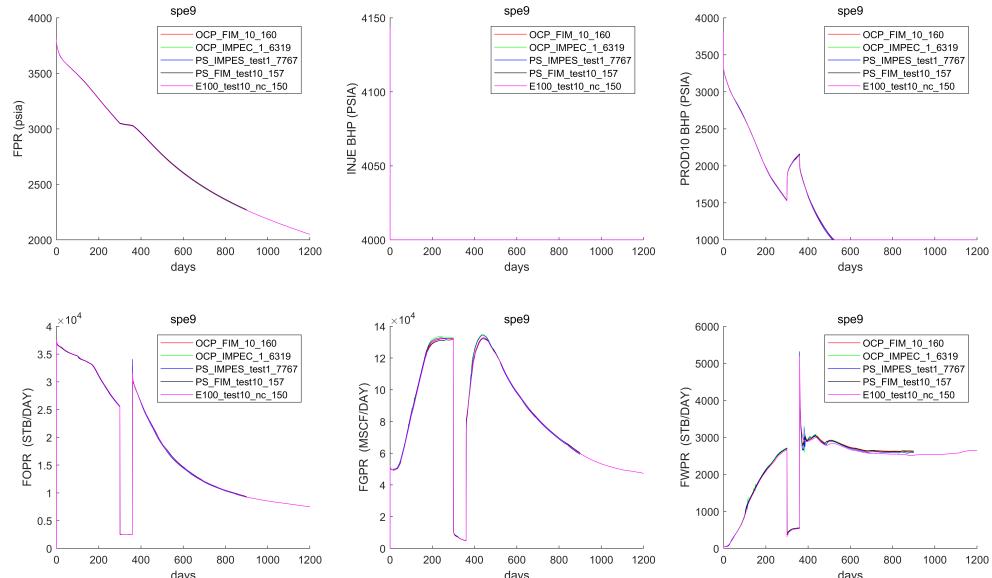
OCP_FIM_10

```

Final time:            3655.500 Days
Total time steps:     420
Total Newton steps:   502 (+1 wasted steps)
Total linear steps:   1495 (+4 wasted steps)
Linear solve time:    3.356s (91.629%)
Simulation time:      3.663s

```

SPE9



PS_IMPESS_1

```

Final time:            900 Days
Total time steps:     7767
Total nonlin steps:   7767
Total linear steps:   12465
Linear solver time:   57.9099s
Simulation time:      276.62s

```

OCP_IMPESS_1

```

Final time:            900.000 Days
Total time steps:     7492
Total Newton steps:   7492
Wasted Newton steps:  42
Wasted linear steps:  95

```

```

Simulation time: 93.851s
Total linear steps: 9903
Linear solve time: 57.371s (61.130%)

```

PS_FIM_10

```

Final time: 900 Days
Total time steps: 157
Total Newton steps: 216
Wasted Newton steps: 53
Total linear steps: 1061
Linear solver time: 12.3944s
Simulation time: 27.515s

```

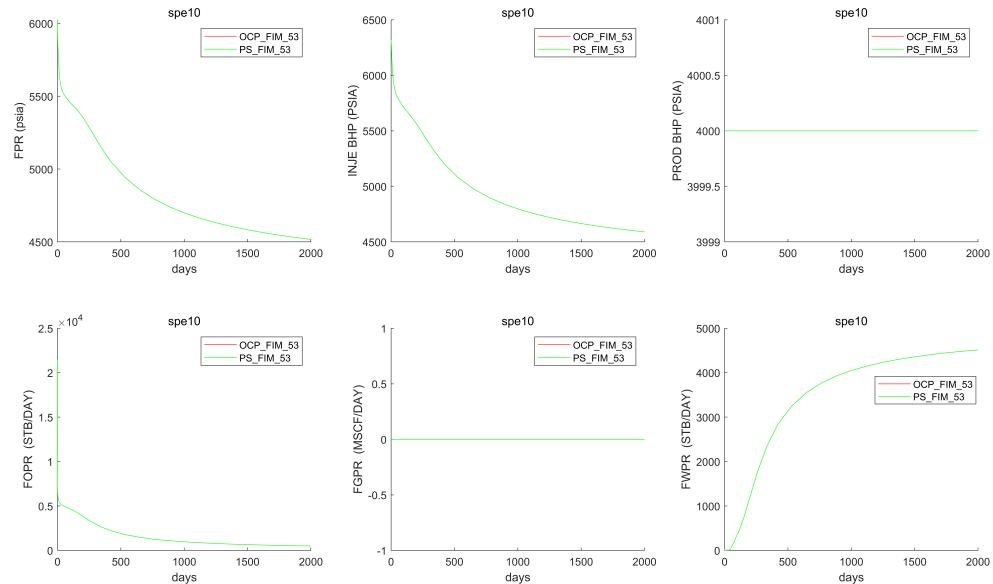
OCP_FIM_10

```

Final time: 900.000 Days
Total time steps: 161
Total Newton steps: 225 (+58 wasted steps)
Total linear steps: 854 (+247 wasted steps)
Linear solve time: 13.387s (67.102%)
Simulation time: 19.949s

```

SPE10



PS_FIM

```

Final time: 2000 Days
Total time steps: 53
Total Newton steps: 215
Wasted Newton steps: 5
Total linear steps: 1305
Linear solver time: 1413.86s
Simulation time: 2905.24s

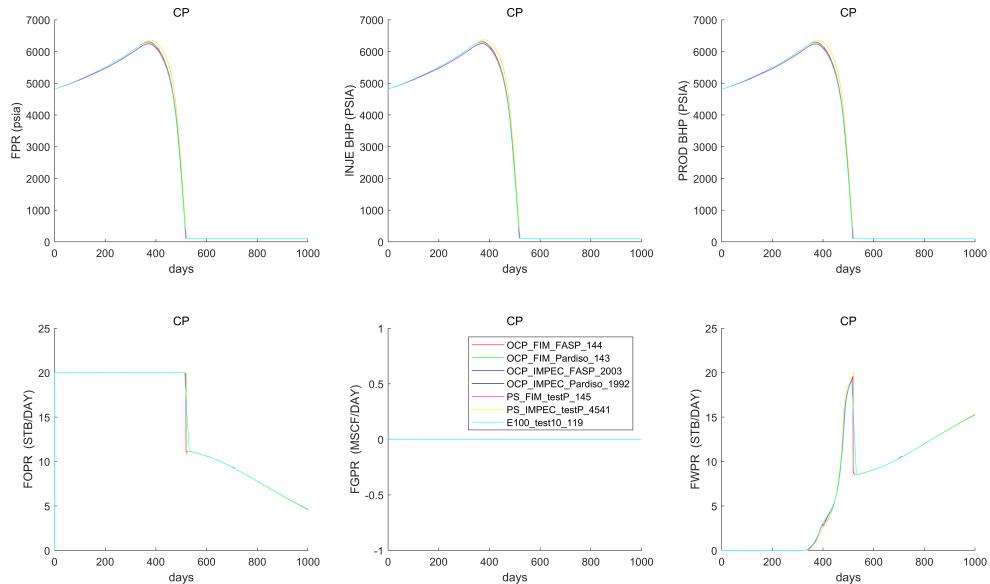
```

OCP_FIM

```
Final time: 2000.000 Days
Total time steps: 53
Total Newton steps: 217
Wasted Newton steps: 5
Simulation time: 1937.163s
Total linear steps: 1334
Linear solve time: 1463.019s (75.524%)
```

```
Final time: 2000.000 Days
Total time steps: 53
Total Newton steps: 214
Wasted Newton steps: 5
Simulation time: 2015.620s
Total linear steps: 1314
Linear solve time: 1531.146s (75.964%)
```

CP



网格规模较少，使用 Pardiso 直接法进行求解

PS_IMPEC_1

```
Final time: 1000.000 Days
Total time steps: 4541
Total nonlin steps: 4541
Total linear steps: 4543
Linear solver time: 2.269s
```

```
simulation time: 28.627s
```

OCP_IMPEC_1

```
Final time: 1000.000 Days
Total time steps: 2003
Total Newton steps: 2003 (+3 wasted steps)
Total linear steps: 13544 (+35 wasted steps)
Linear solve time: 0.043s (40.780%)
Simulation time: 0.106s
```

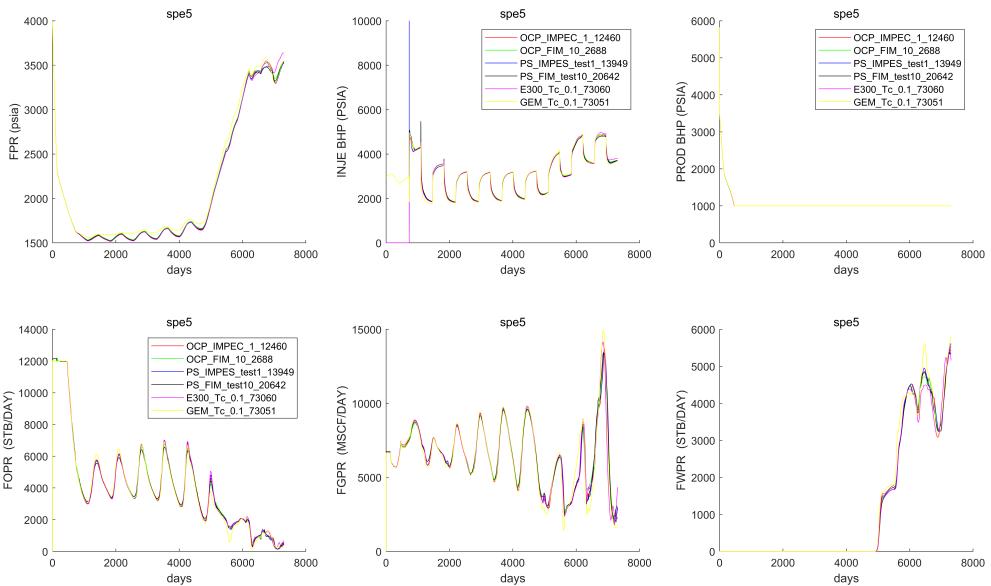
PS_FIM_10

```
Final time: 1000.000 Days
Total time steps: 145
Total Newton steps: 256
Wasted Newton steps: 4
Total linear steps: 263
Linear solver time: 0.745s
Simulation time: 1.654s
```

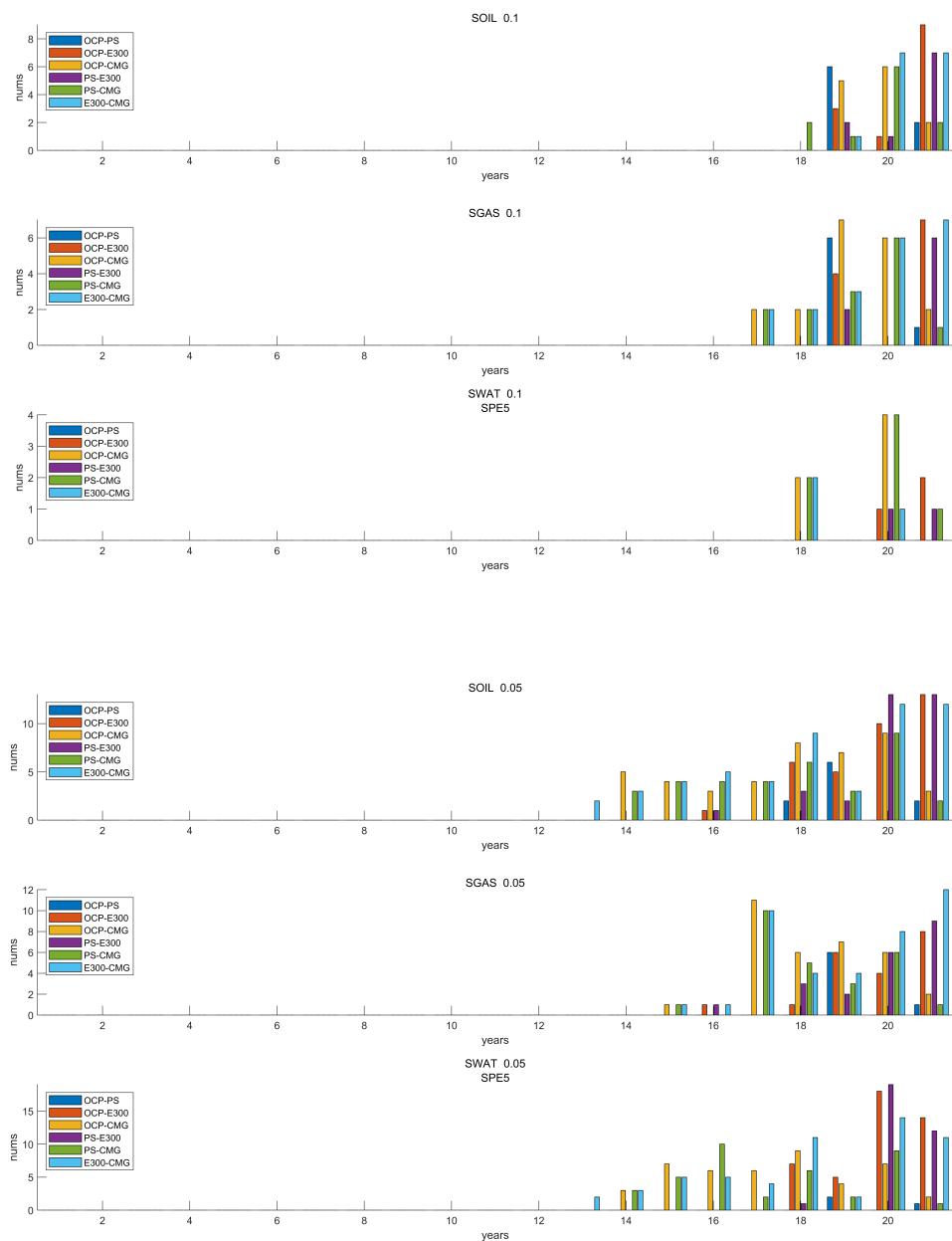
OCP_FIM_10

```
Final time: 1000.000 Days
Total time steps: 143
Total Newton steps: 245 (+6 wasted steps)
Total linear steps: 2290 (+57 wasted steps)
Linear solve time: 0.037s (44.159%)
Simulation time: 0.085s
```

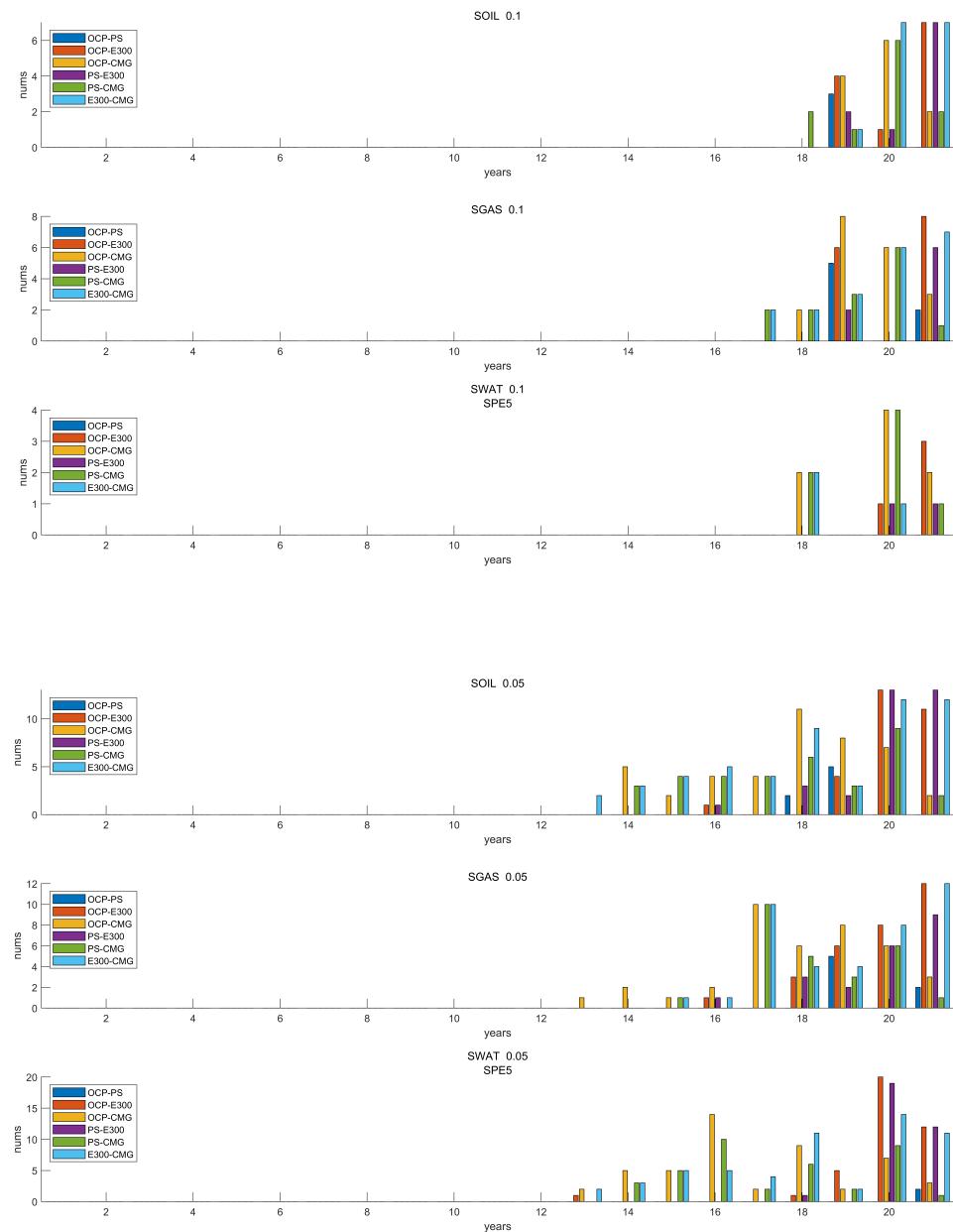
SPE5



饱和度差异对比 (OCP_FIM)



饱和度差异对比 (OCP_IMPEC)



OCP 的 Flash 部分存在效率问题

PS 数据图与下列数据有些差异，但结果几无二致。

PS_IMPES

TMARCH

0.1 1 0.1 5 0.3 0.3 300 0.2 0.3 0.001

```

Final time:          7305 Days
Total time steps:    14228
Total nonlin steps:  14228
Total linear steps: 20914
flux time(MassConerve): 0.246282s
flux time(updateproperty): 0.133042s

```

```
MassConserve time: 0.596821s
updateProperty time: 47.4394s
Linear solver time: 1.4444s
Simulation time: 51.0602s
```

| Method | iters | maxIt | tol |
|--------|----------|-------|------------|
| SSMSTA | 49846316 | 300 | 1E-12 1E-2 |
| SSMSP | 7802131 | 100 | 1E-5 |
| NRSP | 3091611 | 55 | 1E-6 |

OCP_IMPEC

```
0.1 1 0.1
```

```
Final time: 7305.000 Days
Total time steps: 12460
Total Newton steps: 12460 (+51 wasted steps)
Total linear steps: 18938 (+100 wasted steps)
Linear solve time: 1.247s (1.736%)
Simulation time: 71.844s
```

| Method | iters | maxIt | tol |
|--------|----------|-------|-------|
| SSMSTA | 61652064 | 100 | 1E-12 |
| SSMSP | 23814043 | 100 | 1E-6 |
| NRSP | 1499823 | 55 | 1E-12 |

PS_FIM

```
1 10 0.01
```

```
Final time: 7305 Days
Total time steps: 21060
Total Newton steps: 23072
Wasted Newton steps: 13992
Total linear steps: 55425
Linear solver time: 76.2139s
Simulation time: 313.632s
```

OCP_FIM

```
1 10 0.01
```

```
Final time: 7305.000 Days
Total time steps: 2688
Total Newton steps: 3740 (+1908 wasted steps)
Total linear steps: 7796 (+4190 wasted steps)
Linear solve time: 21.751s (33.347%)
Simulation time: 65.226s
```

```
// modify dxsdxp
Final time: 7305.000 Days
Total time steps: 2738
Total Newton steps: 3741 (+1758 wasted steps)
Total linear steps: 7674 (+3945 wasted steps)
Linear solve time: 21.070s (32.985%)
```

```

Simulation time:      63.877s

// modify dxsdxp and muP,mux
// time-consuming, no improvement
Final time:          7305.000 Days
Total time steps:    3314
Total Newton steps:  4466 (+1972 wasted steps)
Total linear steps:  8788 (+4545 wasted steps)
Linear solve time:   23.122s (29.526%)
Simulation time:     78.309s

```

SPE3

PS_IMPES

```

0.1 1 0.1

Final time:          3650 Days
Total time steps:    3670
Total nonlin steps:  3670
Total linear steps:  7345
flux time(MassConerve): 0.179398s
flux time(updateproperty): 0.175264s
MassConserve time: 0.485313s
updateProperty time: 164.133s
Linear solver time: 1.25312s
Simulation time:     176.526s

```

| Method | iters | maxIt | tol |
|--------|-----------|-------|------------|
| SSMSTA | 102544160 | 300 | 1E-12 1E-2 |
| SSMSP | 22778402 | 100 | 1E-5 |
| NRSP | 6775525 | 55 | 1E-12 |

OCP_IMPEC

```

0.1 1 0.1

Final time:          3650.000 Days
Total time steps:    3670
Total Newton steps:  3670 (+0 wasted steps)
Total linear steps:  7519 (+0 wasted steps)
Linear solve time:   1.221s (0.662%)
Simulation time:     184.439s

```

| Method | iters | maxIt | tol |
|--------|----------|-------|-------|
| SSMSTA | 67713430 | 100 | 1E-12 |
| SSMSP | 93631466 | 100 | 1E-6 |
| NRSP | 1866917 | 55 | 1E-12 |

PS_FIM

```
1 10 0.1
```

```
Final time: 3650 Days
Total time steps: 390
Total Newton steps: 596
Total linear steps: 954
Linear solver time: 6.11755s
Simulation time: 42.1949s
```

```
OCP_FIM
```

```
1 10 0.1
```

```
Final time: 3650.000 Days
Total time steps: 393
Total Newton steps: 584 (+1 wasted steps)
Total linear steps: 900 (+2 wasted steps)
Linear solve time: 7.243s (18.071%)
Simulation time: 40.083s
```