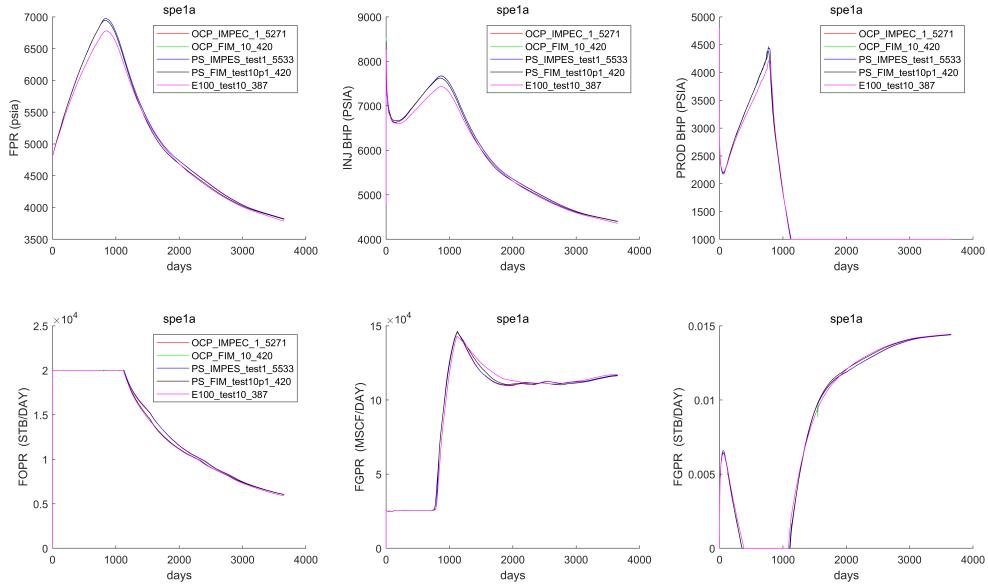


Numerical Results for Comparison

SPE1A



PS_IMPES_1

0.1 1 0.1

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_IMPEC_1

.\OpenCAEPoro.exe ..\..\data\spe1a\spe1a.data IMPEC 0.1 1 0.1

Final time: 3655.500 Days
Total time steps: 5271
Total Newton steps: 5271 (+39 wasted steps)
Total linear steps: 8327 (+73 wasted steps)
Linear solve time: 0.816s (57.926%)
Simulation time: 1.408s

PS_FIM_10

1 10 0.1

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

```
. \OpenCAEPoro.exe ...\\data\\spela\\spela.data  FIM  1  10  0.1
```

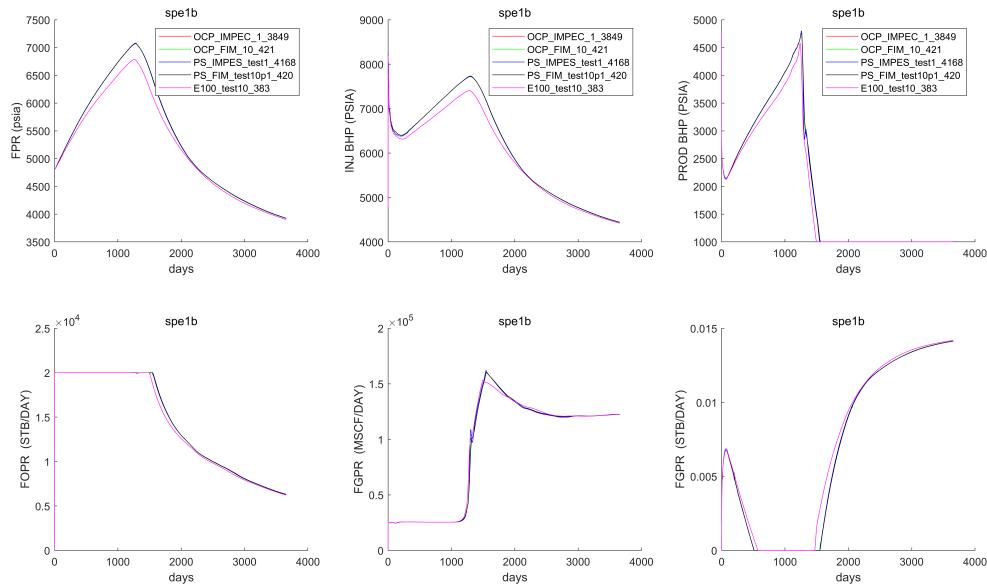
```
precond_type          = 69
```

```

Final time:           3655.500 Days
Total time steps:    420
Total Newton steps:  481 (+1 wasted steps)
Total linear steps:  6301 (+18 wasted steps)
Linear solve time:   0.460s (62.080%)
Simulation time:     0.741s

```

SPE1B



PS_IMPES_1

```
0.1  1  0.1
```

```

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_IMPEC_1

```
.\OpenCAEPoro.exe ..\..\data\spe1b\spe1b.data IMPEC 0.1 1 0.1

Final time:      3655.500 Days
Total time steps: 3849
Total Newton steps: 3849 (+9 wasted steps)
Total linear steps: 7198 (+15 wasted steps)
Linear solve time: 0.654s (60.250%)
Simulation time: 1.086s
```

PS_FIM_10

```
1 10 0.1

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
```

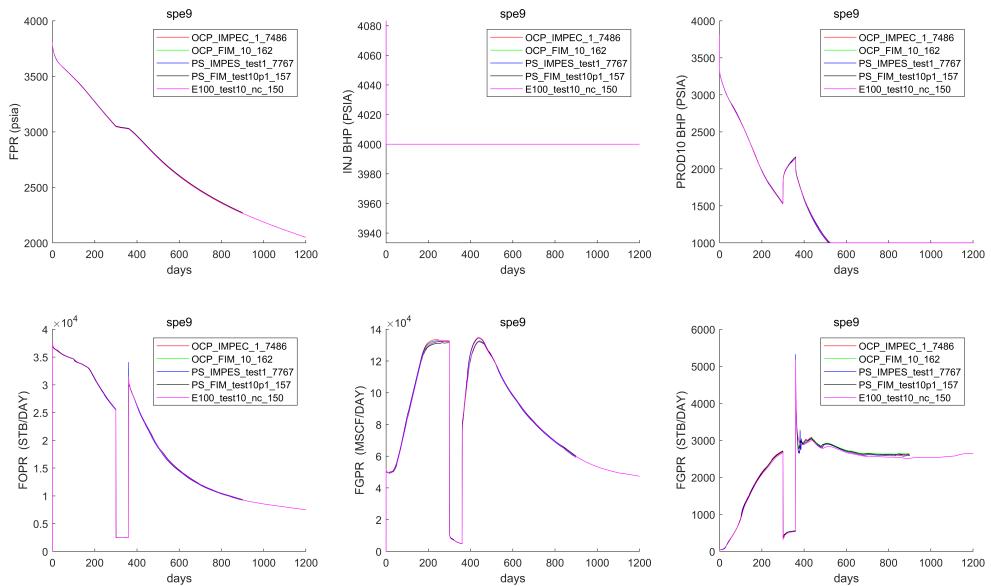
OCP_FIM_10

```
.\OpenCAEPoro.exe ..\..\data\spe1b\spe1b.data FIM 1 10 0.1

precond_type = 69

Final time:      3655.500 Days
Total time steps: 421
Total Newton steps: 507 (+1 wasted steps)
Total linear steps: 6361 (+19 wasted steps)
Linear solve time: 0.467s (61.599%)
Simulation time: 0.759s
```

SPE9



PS_IMPEPS_1

0.1 1 0.1

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_IMPEC_1

.\OpenCAEPoro.exe ..\..\data\spe9\spe9_IMPEC.data

Final time: 900.000 Days
 Total time steps: 7486
 Total Newton steps: 7486 (+43 wasted steps)
 Total linear steps: 9897 (+96 wasted steps)
 Linear solve time: 55.544s (61.784%)
 Simulation time: 89.900s

PS_FIM_10

1 10 0.1

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

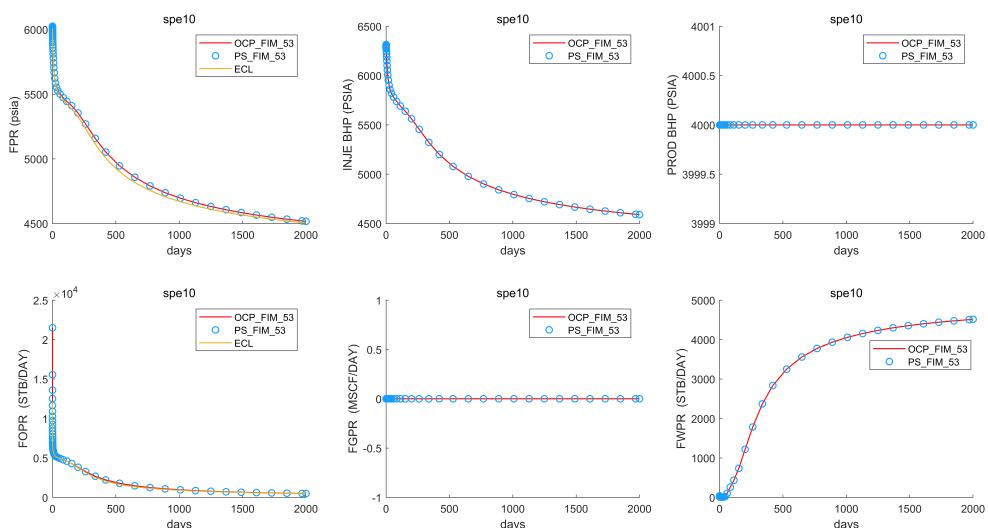
OCP_FIM_10

.\OpenCAEPoro.exe ..\..\data\spe9\spe9_FIM.data

precond_type = 69

Final time: 900.000 days
Total time steps: 162
Total Newton steps: 227 (+60 wasted steps)
Total linear steps: 3284 (+824 wasted steps)
Linear solve time: 8.752s (55.793%)
Simulation time: 15.686s

SPE10



PS_FIM

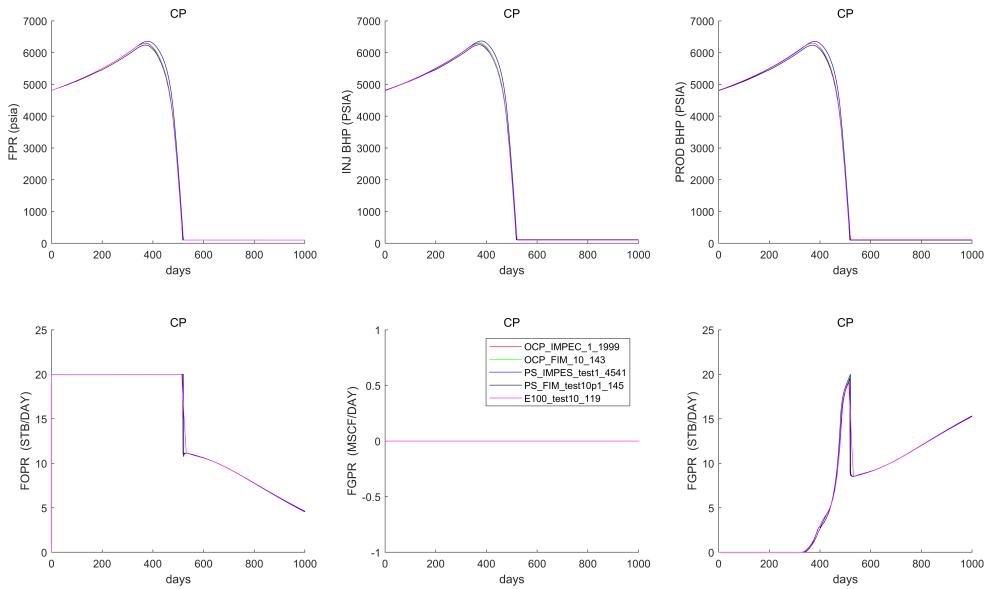
Final time: 2000 days
Total time steps: 53
Total Newton steps: 215
Wasted Newton steps: 5
Total linear steps: 1305
Linear solver time: 1413.86s
Simulation time: 2905.24s

OCP_FIM

.\OpenCAEPoro.exe ..\..\data\spe10\spe10.data

Final time: 2000.000 days
Total time steps: 53
Total Newton steps: 215 (+5 wasted steps)
Total linear steps: 1278 (+40 wasted steps)
Linear solve time: 1403.826s (74.590%)
Simulation time: 1882.050s

CP



PS_IMPEC_1

0.1 1 0.1

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

. \OpenCAEporo.exe ..\..\data\cornerpoint\CP.data IMPEC 0.1 1 0.1

Final time: 1000.000 Days
Total time steps: 1999
Total Newton steps: 1999 (+3 wasted steps)
Total linear steps: 13516 (+35 wasted steps)
Linear solve time: 0.045s (38.852%)
Simulation time: 0.115s

PS_FIM_10

1 10 0.1

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

```
.\\OpenCAE\\Poro.exe ..\\..\\data\\cornerpoint\\CP.data FIM 1 10 0.1
```

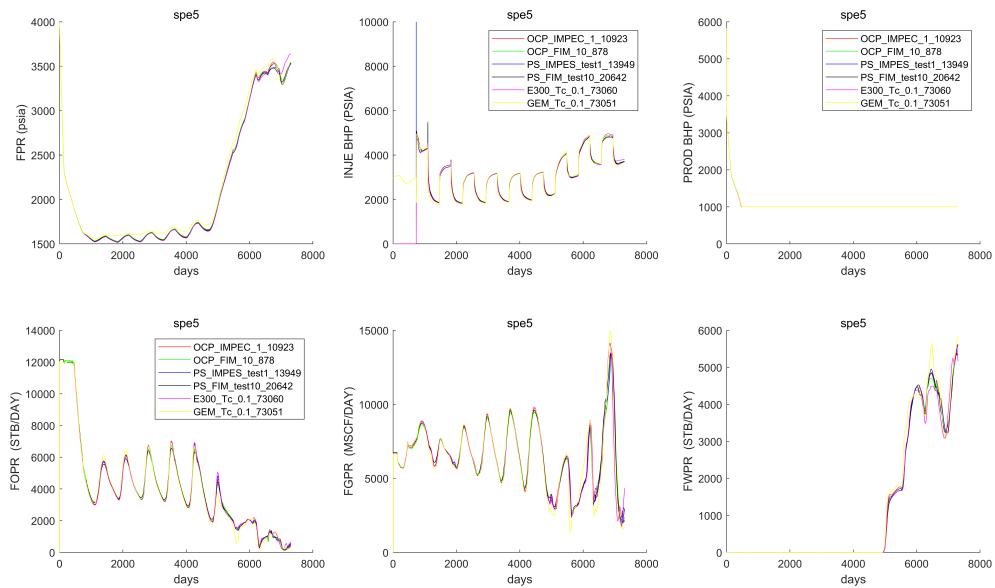
```
precond_type = 69
```

```

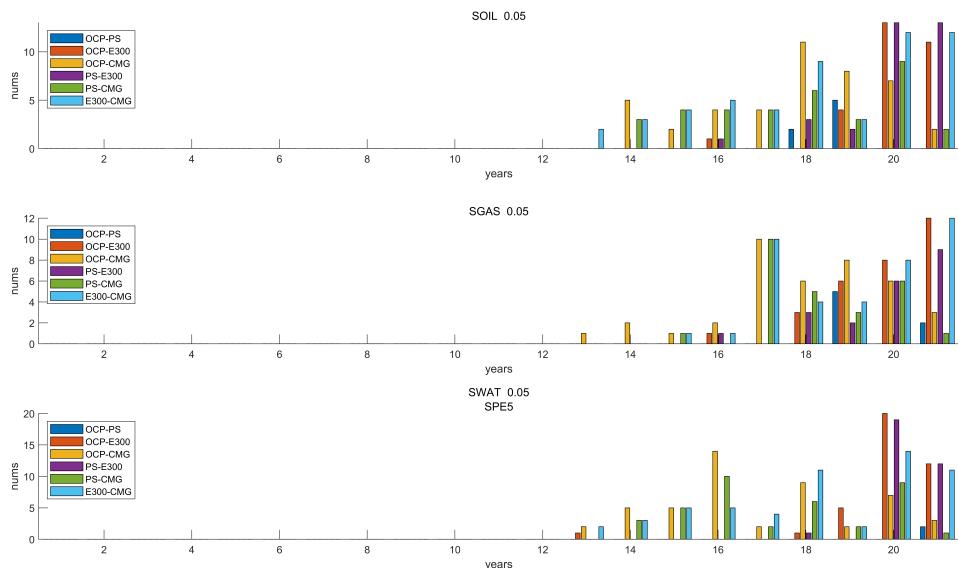
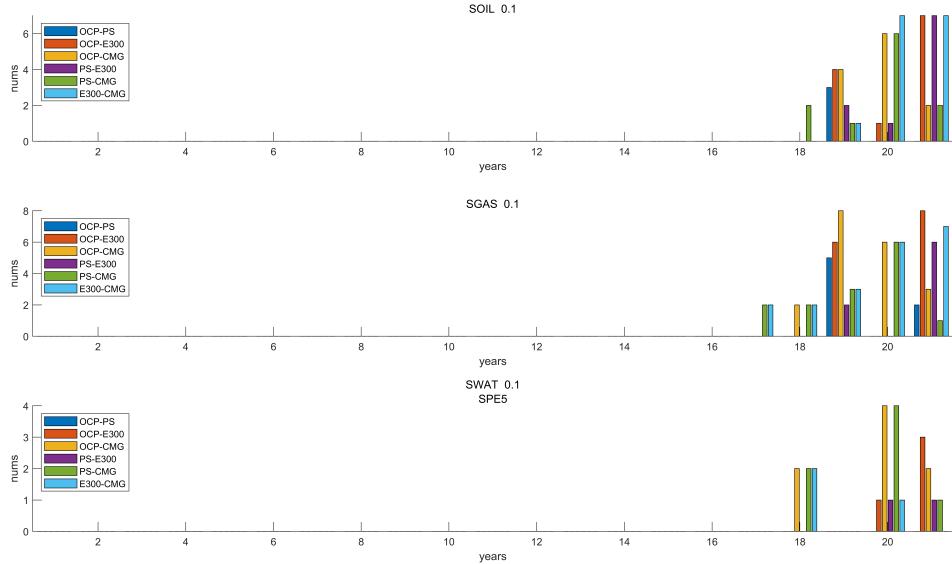
Final time: 1000.000 Days
Total time steps: 143
Total Newton steps: 245 (+7 wasted steps)
Total linear steps: 2293 (+68 wasted steps)
Linear solve time: 0.037s (43.154%)
Simulation time: 0.086s

```

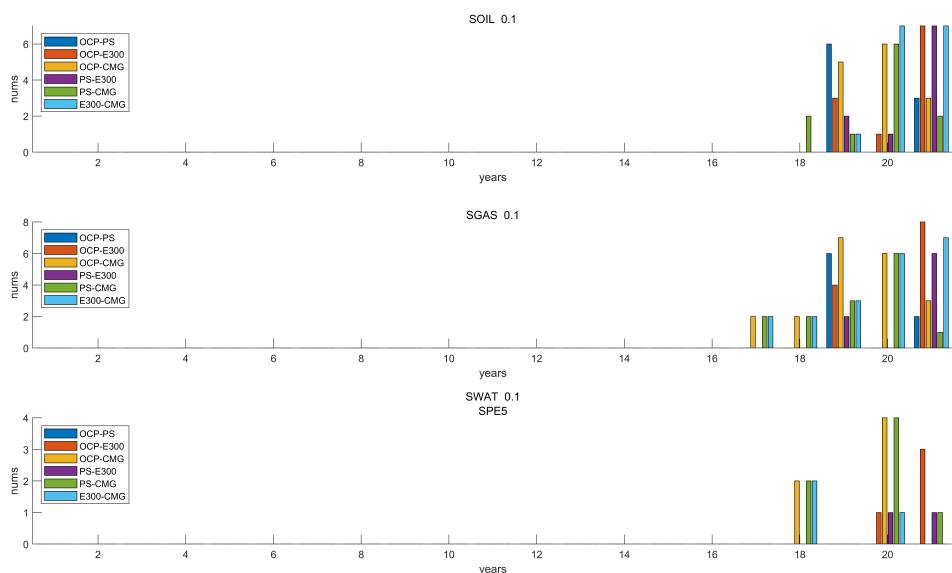
SPE5

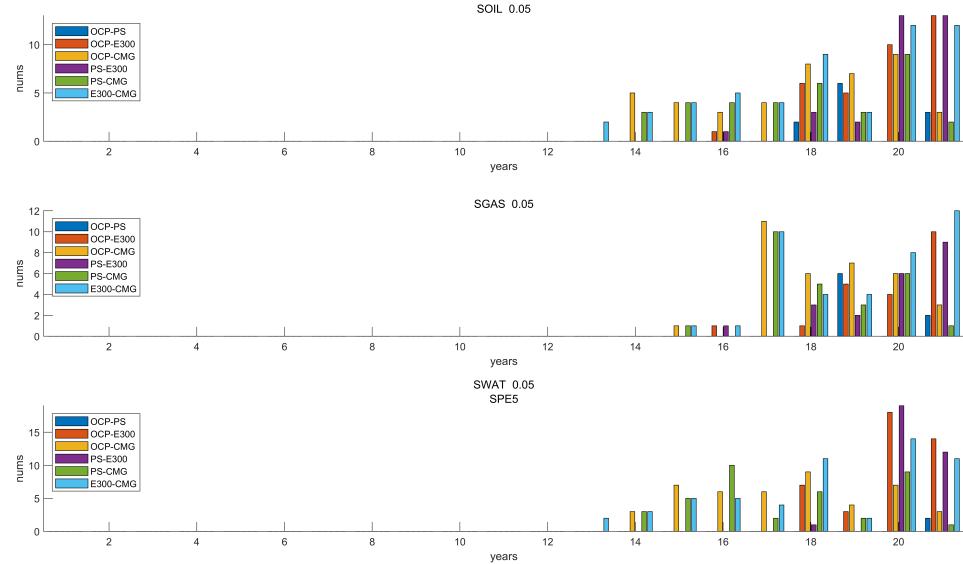


饱和度差异对比 (OCP_FIM)



饱和度差异对比 (OCP_IMPEC)





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

```
.\OpenCAEPoro.exe ..\..\data\spe5\spe5.data IMPEC 0.1 1 0.1
```

```

SSMSTA:      6511743
NRSTA:      20659
SSMSP:      9579276
NRSP:       1741235

```

```

=====
Final time:      7305.000 Days
Total time steps: 10923
Total Newton steps: 10923 (+80 wasted steps)
Total linear steps: 17386 (+156 wasted steps)
Linear solve time: 1.153s (7.288%)
Simulation time: 15.818s

```

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: 74.4161s
Simulation time: 288.01s

| Method | iters | maxIt | tol |
|--------|-----------|-------|-------|
| SSMSTA | 312298023 | 100 | 1E-12 |
| SSMSP | 15015547 | 100 | 1E-6 |
| NRSP | 5624310 | 55 | 1E-12 |

OCP_FIM

.\\OpenCAEPoro.exe ..\\..\\data\\spe5\\spe5.data FIM 1 10 0.1

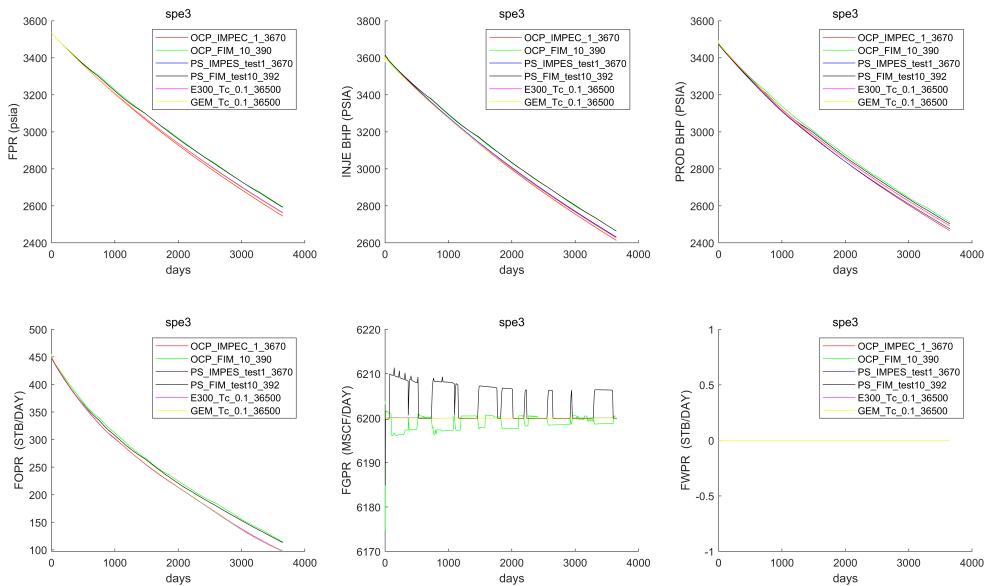
precond_type = 64

SSMSTA: 1156364
NRSTA: 7900
SSMSP: 1710655
NRSP: 242509

=====

Final time: 7305.000 Days
Total time steps: 878
Total Newton steps: 1633 (+26 wasted steps)
Total linear steps: 4970 (+58 wasted steps)
Linear solve time: 13.091s (74.471%)
Simulation time: 17.579s

SPE3



饱和度误差均在 5% 以内

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

```
.\\OpenCAEPoro.exe ..\\..\\data\\spe5\\spe5.data  IMPEC  0.1  1  0.1
```

```

SSMSTA:      23835193
NRSTA:       19507
SSMSP:        24063413
NRSP:         1468770
=====
```

```

Final time:          3650.000 Days
Total time steps:    3670
Total Newton steps:  3670 (+0 wasted steps)
Total linear steps:  7318 (+0 wasted steps)
Linear solve time:   1.037s (2.543%)
Simulation time:     40.777s

```

PS_FIM

1 10 0.1

Final time: 3650 Days
Total time steps: 390
Total Newton steps: 588
Total linear steps: 941
Linear solver time: 5.61642s
Simulation time: 39.5691s

| Method | iters | maxIt | tol |
|--------|----------|-------|------------|
| SSMSTA | 17690167 | 300 | 1E-12 1E-2 |
| SSMSP | 3674930 | 100 | 1E-5 |
| NRSP | 1222903 | 55 | 1E-12 |

OCP_FIM

.\\OpenCAEPoro.exe ..\\..\\data\\spe3\\spe3.data FIM 1 10 0.1

precond_type = 64

SSMSTA: 3984873
NRSTA: 10756
SSMSP: 3929150
NRSP: 238198

=====

Final time: 3650.000 Days
Total time steps: 390
Total Newton steps: 559 (+0 wasted steps)
Total linear steps: 747 (+0 wasted steps)
Linear solve time: 4.464s (30.473%)
Simulation time: 14.649s