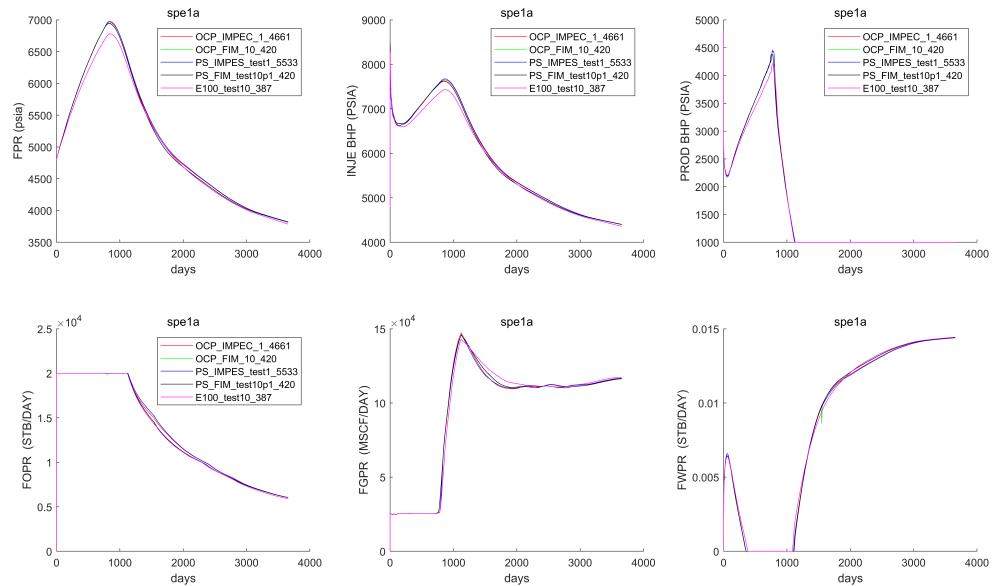


# SPE1A




---

## 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\_IMPES\_1

0.1 1 0.1

```
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:  0.794s (59.696%)
Simulation time:   1.331s
```

---

## 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

1 10 0.1

precond\_type = 64

```
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: 4.950s (94.546%)
Simulation time: 5.235s
```

---

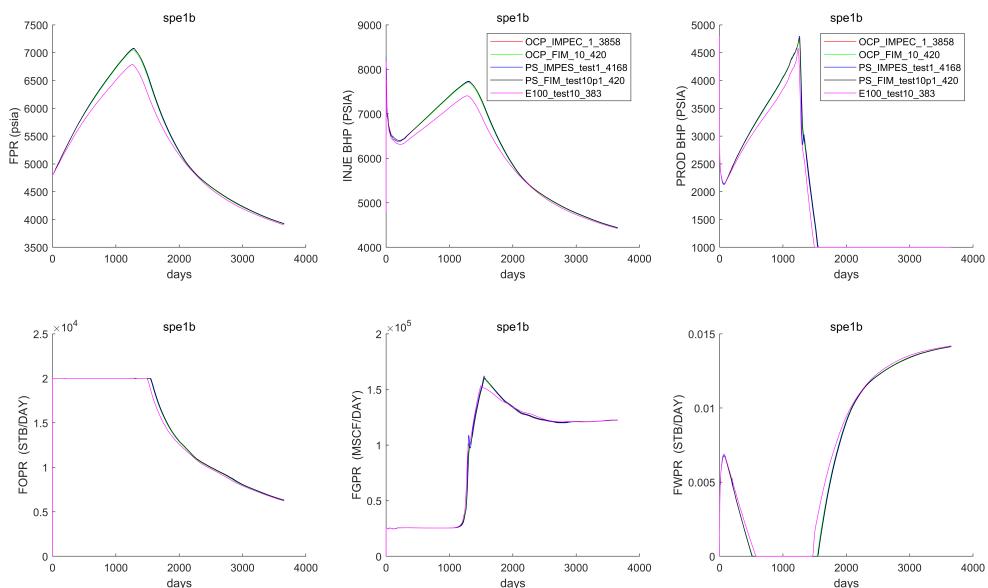
### OCP\_FIM\_10

1 10 0.1

precond\_type = 69

```
Final time: 3655.500 Days
Total time steps: 420
Total Newton steps: 480 (+1 wasted steps)
Total linear steps: 6288 (+18 wasted steps)
Linear solve time: 0.456s (60.876%)
Simulation time: 0.749s
```

## 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\_IMPES\_1

0.1 1 0.1

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: 0.678s (60.894%)  
Simulation time: 1.113s

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

1 10 0.1

precond\_type = 64  
  
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

OCP\_FIM\_10

1 10 0.1

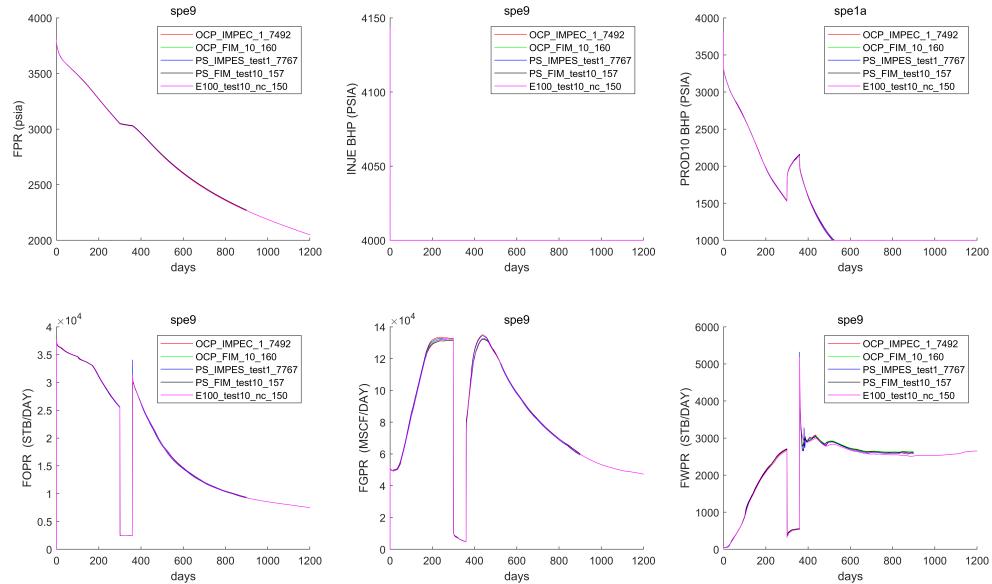
precond\_type = 69

```

Final time:          3655.500 Days
Total time steps:    421
Total Newton steps: 507 (+1 wasted steps)
Total linear steps: 6362 (+19 wasted steps)
Linear solve time:  0.469s (61.180%)
Simulation time:    0.767s

```

## 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\_IMPEPS\_1

0.1 1 0.1  
dplim dslim dnlim dverrlim  
300 0.0005 0.3 0.001

```

Final time:          900.000 Days
Total time steps:    7492
Total Newton steps: 7492 (+42 wasted steps)
Total linear steps: 9903 (+95 wasted steps)
Linear solve time:  54.309s (62.283%)
Simulation time:    87.197s

```

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

1 10 0.1

```
precond_type = 64

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: 12.950s (67.510%)
Simulation time: 19.182s
```

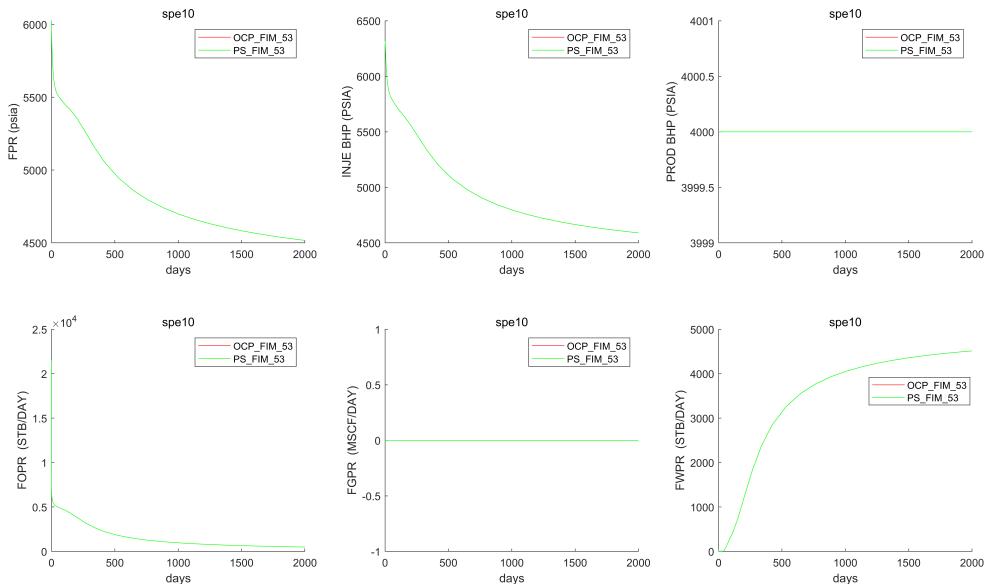
OCP\_FIM\_10

1 10 0.1

```
precond_type = 69

Final time:      900.000 Days
Total time steps: 162
Total Newton steps: 227 (+60 wasted steps)
Total linear steps: 3260 (+808 wasted steps)
Linear solve time: 8.466s (56.374%)
Simulation time: 15.017s
```

## 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%)

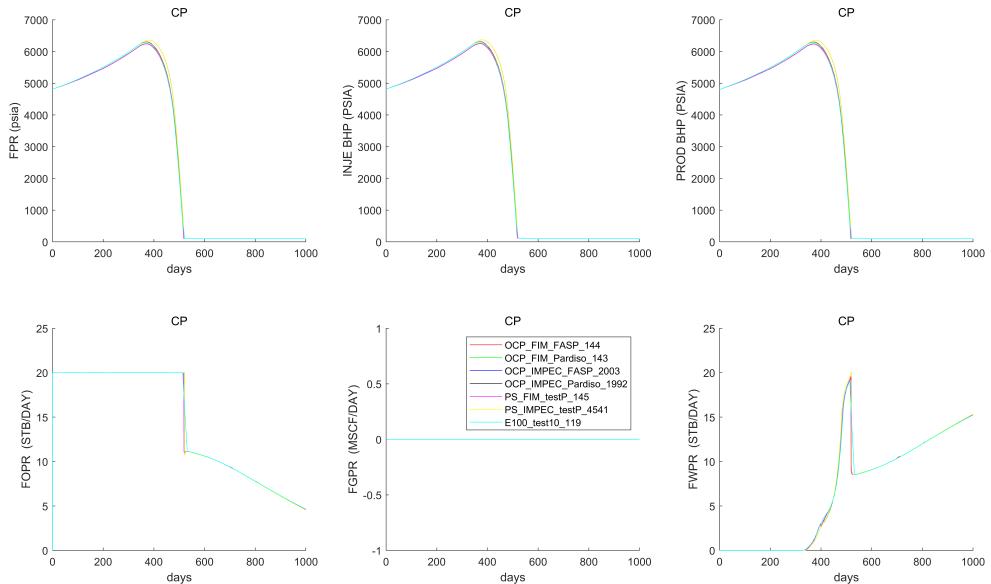
```

```

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



---

## 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

0.1 1 0.1

```
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 (41.612%)
Simulation time:    0.103s
```

---

## 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
```

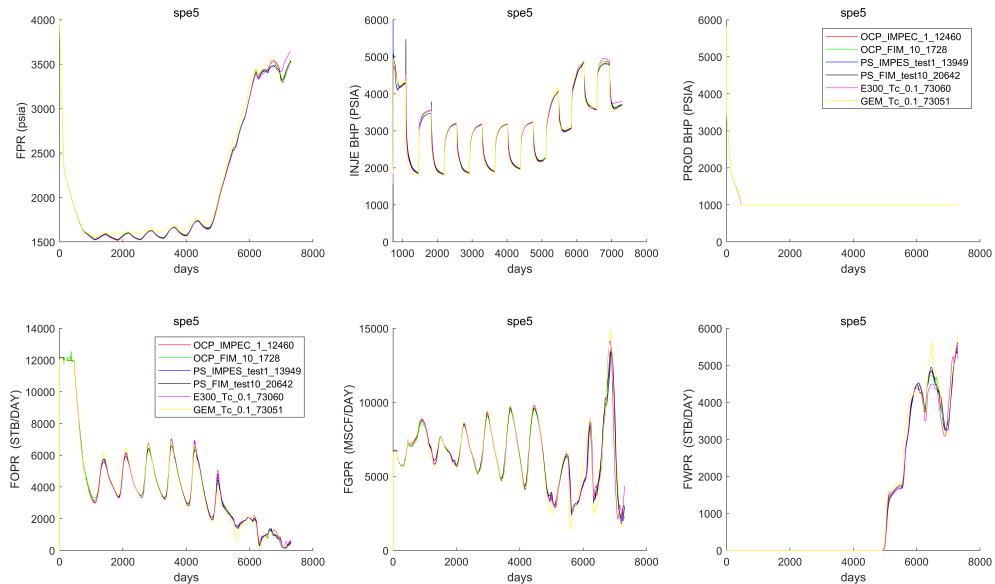
```
Linear solver time: 0.745s
Simulation time: 1.654s
```

```
-----  
OCP_FIM_10
```

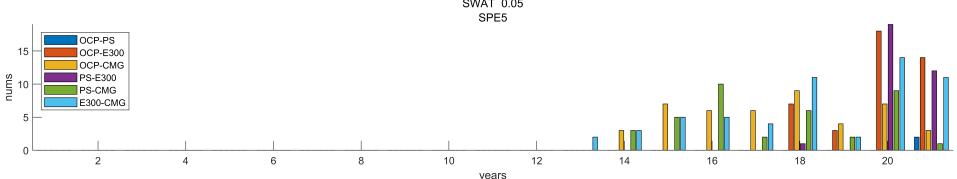
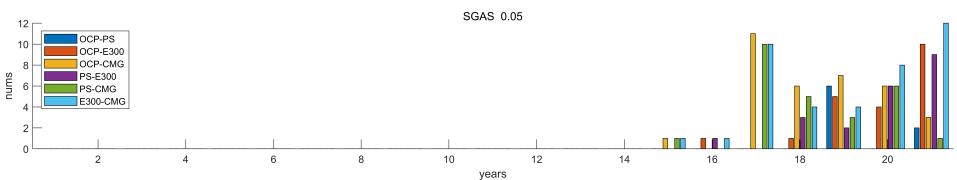
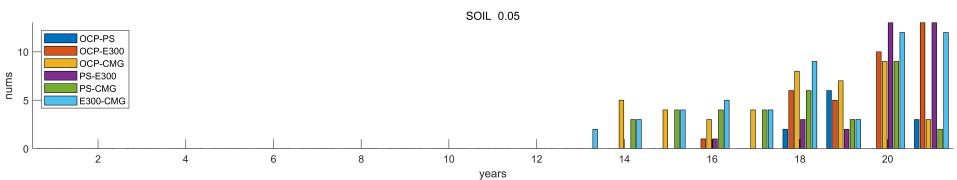
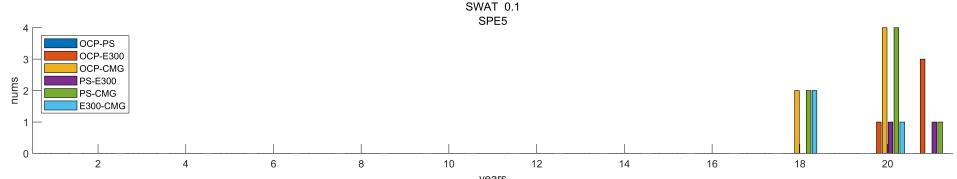
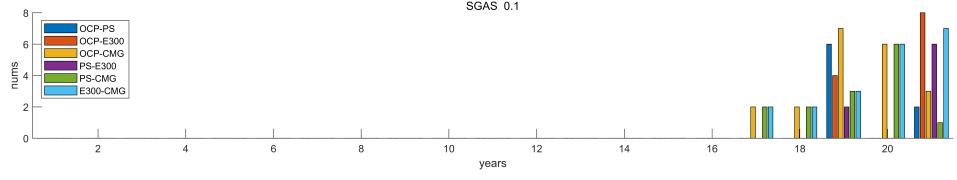
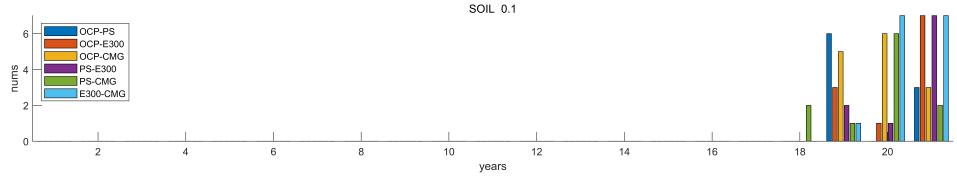
```
1 10 0.1
precond_type = 69
```

```
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: 0.034s (42.420%)
Simulation time: 0.079s
```

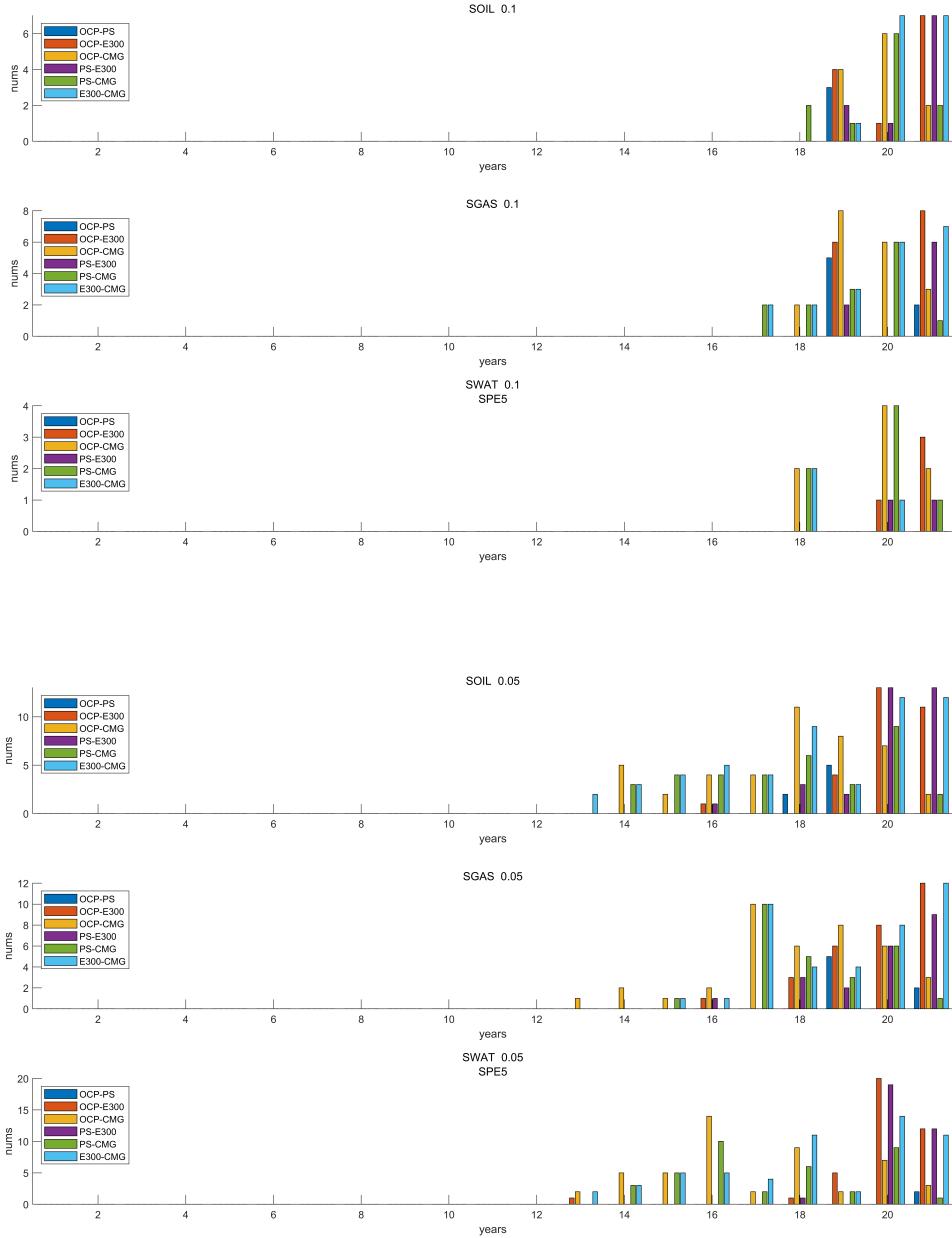
## SPES



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: 1.244s (1.772%)  
Simulation time: 70.237s

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: 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**

1 10 0.1  
precond\_type = 64

Final time: 7305.000 Days  
Total time steps: 1908  
Total Newton steps: 3007 (+2987 wasted steps)  
Total linear steps: 7282 (+6728 wasted steps)  
Linear solve time: 24.216s (34.318%)  
Simulation time: 70.562s

Method	iters	maxIt	tol
SSMSTA	39656359	100	1E-12
SSMSP	15674142	100	1E-6
NRSP	367994	55	1E-12

```

// add muP, mux

Final time:          7305.000 Days
Total time steps:    1728
Total Newton steps: 2788 (+2285 wasted steps)
Total linear steps: 7260 (+5406 wasted steps)
Linear solve time:  24.260s (37.009%)
Simulation time:    65.550s

Method      iters      maxIt      tol
SSMSTA     32395484    100       1E-12
SSMSP      13511784    100       1E-6
NRSP       354268      55        1E-12

-----
OCP_FIM

1 10 0.01
precond_type           = 69

Final time:          7305.000 Days
Total time steps:    2000
Total Newton steps: 2908 (+3888 wasted steps)
Total linear steps: 16701 (+15006 wasted steps)
Linear solve time:  5.784s (10.063%)
Simulation time:    57.475s

Method      iters      maxIt      tol
SSMSTA     45609608    100       1E-12
SSMSP      16616453    100       1E-6
NRSP       386537      55        1E-12

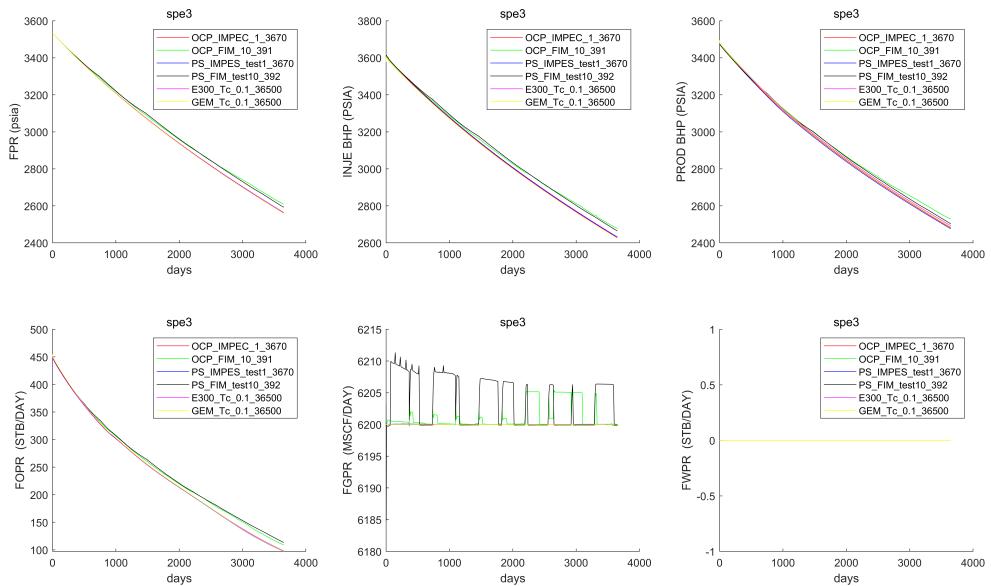
// add muP, mux

Final time:          7305.000 Days
Total time steps:    1904
Total Newton steps: 2955 (+3530 wasted steps)
Total linear steps: 17607 (+14676 wasted steps)
Linear solve time:  5.586s (9.805%)
Simulation time:    56.973s

Method      iters      maxIt      tol
SSMSTA     42671997    100       1E-12
SSMSP      16064087    100       1E-6
NRSP       403550      55        1E-12

```

## 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

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: 1.146s (0.636%)
Simulation time:    180.118s

```

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: 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

1 10 0.1

precond\_type = 64

Final time: 3650.000 days  
Total time steps: 391  
Total Newton steps: 946 (+0 wasted steps)  
Total linear steps: 1490 (+0 wasted steps)  
Linear solve time: 11.052s (16.918%)  
Simulation time: 65.329s

Method	iters	maxIt	tol
SSMSTA	18195829	100	1E-12
SSMSP	26238483	100	1E-6
NRSP	490134	55	1E-12

// add muP, mux

Final time: 3650.000 days  
Total time steps: 392  
Total Newton steps: 945 (+0 wasted steps)  
Total linear steps: 1494 (+0 wasted steps)  
Linear solve time: 10.733s (15.812%)  
Simulation time: 67.880s

Method	iters	maxIt	tol
SSMSTA	18270127	100	1E-12
SSMSP	26270329	100	1E-6
NRSP	488716	55	1E-12

-----

OCP\_FIM

1 10 0.1

precond\_type = 69

Final time: 3650.000 Days  
Total time steps: 391

```
Total Newton steps: 935 (+0 wasted steps)
Total linear steps: 12584 (+0 wasted steps)
Linear solve time: 6.671s (10.947%)
Simulation time: 60.936s
```

Method	iters	maxIt	tol
SSMSTA	18022938	100	1E-12
SSMSP	26019262	100	1E-6
NRSP	485021	55	1E-12

```
// add muP, mux
```

```
Final time: 3650.000 Days
Total time steps: 392
Total Newton steps: 937 (+0 wasted steps)
Total linear steps: 12573 (+0 wasted steps)
Linear solve time: 6.673s (10.534%)
Simulation time: 63.347s
```

Method	iters	maxIt	tol
SSMSTA	18133478	100	1E-12
SSMSP	26093436	100	1E-6
NRSP	484957	55	1E-12