3.

**SPEED**

Lagging Coefficient method is visibly faster as compared with fully implicit method.

The fully implicit method is taking longer time to calculate the residuals for each cell for both oil and water.

I have formed a Residual function which is being called frequently and is taking up quite a lot of time in the fully implicit method. Alternatively, I could have written the residuals directly which would have made the code long but fast. I did not choose to do so since longer code would be more prone to coding errors.

**ACCURACY**

1. The lagging co-efficient method is highly inaccurate. The lower skin values are giving a lower cumulative oil production in lagging co-efficient method.

The fully implicit method is giving the higher cumulative oil production for lower skin values which is logical.

1. The oil rates in the lagging co-efficient method jump to a single value from the beginning and stay there until there is water breakthrough for all the three skin cases.

The rates in the fully implicit method grow gradually. Skin lowering accelerates the rate growth in this method. The oil rates finally stabilize for all the cases but at different times which is logical since the cases have different skins.

1. There is an oscillation in oil rate in the lagging coefficient method just after breakthrough in the lagging co-efficient method for all the cases.

There is no oscillation of oil rates in the Fully implicit method at any time for all the cases.

**COMPLEXITY**

The fully implicit method is much more complex than the lagging co-efficient method. The residual and Jacobian matrix computation in the fully implicit method is much more memory and time intensive as compared to simple Transmissibility matrix calculation in the lagging co-efficient method.

A way out could be the AIM method. The cells which require implicit treatment would be treated implicitly and which don’t would be solved by IMPES.

4. Iterative solvers are not making much of a difference in solution times. The solution times are to the order of 3rd place of decimal in seconds and are almost comparable for the direct and the iterative solvers.

5. **Lagging Co-efficien**t

Any time step greater than 1 day is causing the simulator to be unstable.

The saturation is going out of bounds. So I performed my simulation with a time-step size of 1 day for the lagging co-efficient methods.

**CASE-I, Skin=0**

**PRESSURE MAP**

[\\pe-file\grads\soumyadipta.sengupta\Desktop\PETE-656\_finalproject\Pressure\_LC\_s0.avi](file:///\\pe-file\grads\soumyadipta.sengupta\Desktop\PETE-656_finalproject\Pressure_LC_s0.avi)

As you will see in the movie, the pressure is reaching as high as 14000 psi in the later stages.

**SATURATION MAP**

[**\\pe-file\grads\soumyadipta.sengupta\Desktop\PETE-656\_finalproject\Saturation\_LC\_s0.avi**](file:///\\pe-file\grads\soumyadipta.sengupta\Desktop\PETE-656_finalproject\Saturation_LC_s0.avi)

**CASE-II, Skin=-3.5**

**PRESSURE MAP**

[**\\pe-file\grads\soumyadipta.sengupta\Desktop\PETE-656\_finalproject\Pressure\_LC\_sn.avi**](file:///\\pe-file\grads\soumyadipta.sengupta\Desktop\PETE-656_finalproject\Pressure_LC_sn.avi)

The pressures observed in this are lower than that of the zero skin case. This is logical since the oil can come out easily from the well because of lower skin which leads to lower pressure buildup.

**SATURATION MAP**

[**\\pe-file\grads\soumyadipta.sengupta\Desktop\PETE-656\_finalproject\Saturation\_LC\_sn.avi**](file:///\\pe-file\grads\soumyadipta.sengupta\Desktop\PETE-656_finalproject\Saturation_LC_sn.avi)

**CASE-III, Skin=+2.5**

**PRESSURE MAP**

[**\\pe-file\grads\soumyadipta.sengupta\Desktop\PETE-656\_finalproject\Pressure\_LC\_sp.avi**](file:///\\pe-file\grads\soumyadipta.sengupta\Desktop\PETE-656_finalproject\Pressure_LC_sp.avi)

The pressures in this positive skin case are the highest as high as 20,000 psi for the later stages.

**SATURATION MAP**

[**\\pe-file\grads\soumyadipta.sengupta\Desktop\PETE-656\_finalproject\Saturation\_LC\_sp.avi**](file:///\\pe-file\grads\soumyadipta.sengupta\Desktop\PETE-656_finalproject\Saturation_LC_sp.avi)

**OIL RATE**

****

There are oscillations in the oil rates at the breakthrough front. Higher skin is giving higher rates throughout which are not logical.

**WATER RATE**

****

The water rates after breakthrough are almost comparable.

**Cumulative Oil Production(Lagging Co-efficient)**

****

The lower skin is giving lower cumulative production. This is not correct and would be corrected by the fully implicit method.

**FULLY IMPLICIT**

**CASE-I, Skin=0**

**PRESSURE MAP**

[**\\pe-file\grads\soumyadipta.sengupta\Desktop\PETE-656\_finalproject\Pressure\_FI\_s0.avi**](file:///\\pe-file\grads\soumyadipta.sengupta\Desktop\PETE-656_finalproject\Pressure_FI_s0.avi)

The pressure is reaching around 9000 psi at later stages which is way lower than that computed by the lagging co-efficient method. The pressure wave moves slowly as compared to the lagging co-efficient method.

**SATURATION MAP**

[**\\pe-file\grads\soumyadipta.sengupta\Desktop\PETE-656\_finalproject\Saturation\_FI\_s0.avi**](file:///\\pe-file\grads\soumyadipta.sengupta\Desktop\PETE-656_finalproject\Saturation_FI_s0.avi)

**CASE-II, Skin=-3.5**

**PRESSURE MAP**

[**\\pe-file\grads\soumyadipta.sengupta\Desktop\PETE-656\_finalproject\Pressure\_FI\_sn.avi**](file:///\\pe-file\grads\soumyadipta.sengupta\Desktop\PETE-656_finalproject\Pressure_FI_sn.avi)

The pressure is lower than the zero skin case as well as lower than the corresponding pressures calculated using the lagging co-efficient method. The pressure wave moves slowly as compared to the lagging co-efficient method.

**SATURATION MAP**

[**\\pe-file\grads\soumyadipta.sengupta\Desktop\PETE-656\_finalproject\Saturation\_FI\_sn.avi**](file:///\\pe-file\grads\soumyadipta.sengupta\Desktop\PETE-656_finalproject\Saturation_FI_sn.avi)

**CASE-III, Skin=+2.5**

**PRESSURE MAP**

[**\\pe-file\grads\soumyadipta.sengupta\Desktop\PETE-656\_finalproject\Pressure\_FI\_sp.avi**](file:///\\pe-file\grads\soumyadipta.sengupta\Desktop\PETE-656_finalproject\Pressure_FI_sp.avi)

The pressure is slightly higher than the zero skin case (around 10,000 psi). This is logical as well as significantly lower than the pressures calculated by the lagging co-efficient method. The pressure wave moves slowly as compared to the lagging co-efficient method.

**SATURATION MAP**

[**\\pe-file\grads\soumyadipta.sengupta\Desktop\PETE-656\_finalproject\Saturation\_FI\_sp.avi**](file:///\\pe-file\grads\soumyadipta.sengupta\Desktop\PETE-656_finalproject\Saturation_FI_sp.avi)

**OIL RATE (IMPLICIT)**

****

The lower skin value is initially showing higher rate. After Breakthrough, the lower skin value is showing higher rate too. This is reasonable.

**WATER RATE (IMPLICIT)**

****

The lower skin value is showing higher water rate after breakthrough. This is the way it should be. As compared with lagging co-efficient, there are considerable variations in water rate.

**Cumulative Oil Production (IMPLICT)**

****

The stimulated well is giving the highest cumulative oil production.