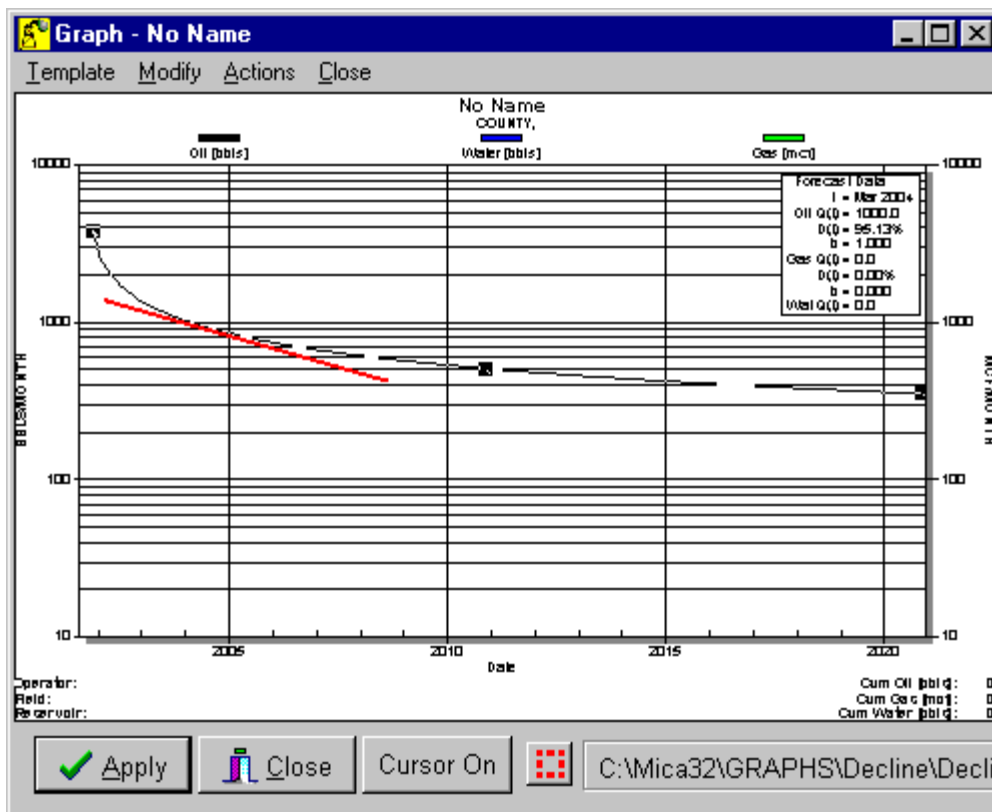


How To Set Up A Minimum Decline Rate For Hyperbolic Declines

March 25, 2004

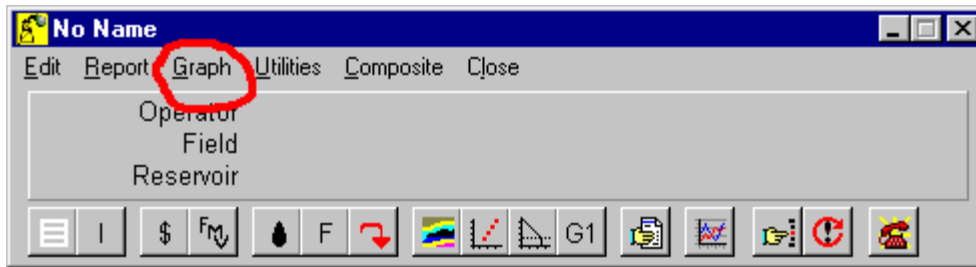
Often times when a projected hyperbolic decline curve has a large hyperbolic exponent, the production projection may flatten out and continue for an extraordinary amount of time. This may not be desirable in that the decline rate in later years of production may be unrealistically small. In order to avoid this problem, MICA has the capability to automatically switch from a hyperbolic decline to an exponential decline whenever the instantaneous decline rate falls below a user specified level. This paper describes how to do this.

In hyperbolic declines the rate of decline changes with time. In fact the instantaneous rate of decline is simply the tangent of the decline at any point in time as shown below:

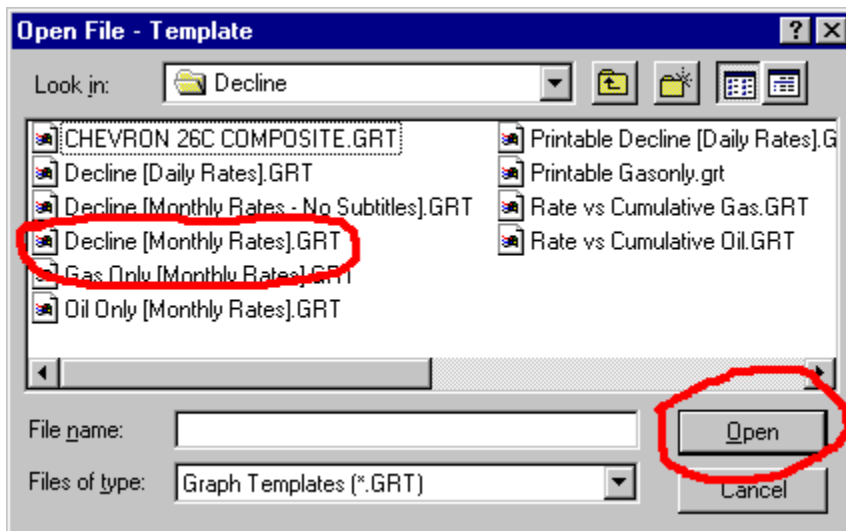


You can see that as time increases the instantaneous rate of decline will decrease, that is the slope of the tangent line will decrease. To prevent the instantaneous decline rate from decreasing indefinitely perform the following steps.

Step 1 – Open a decline graph for the well. Select the “Graph” menu item from the well form as shown below:

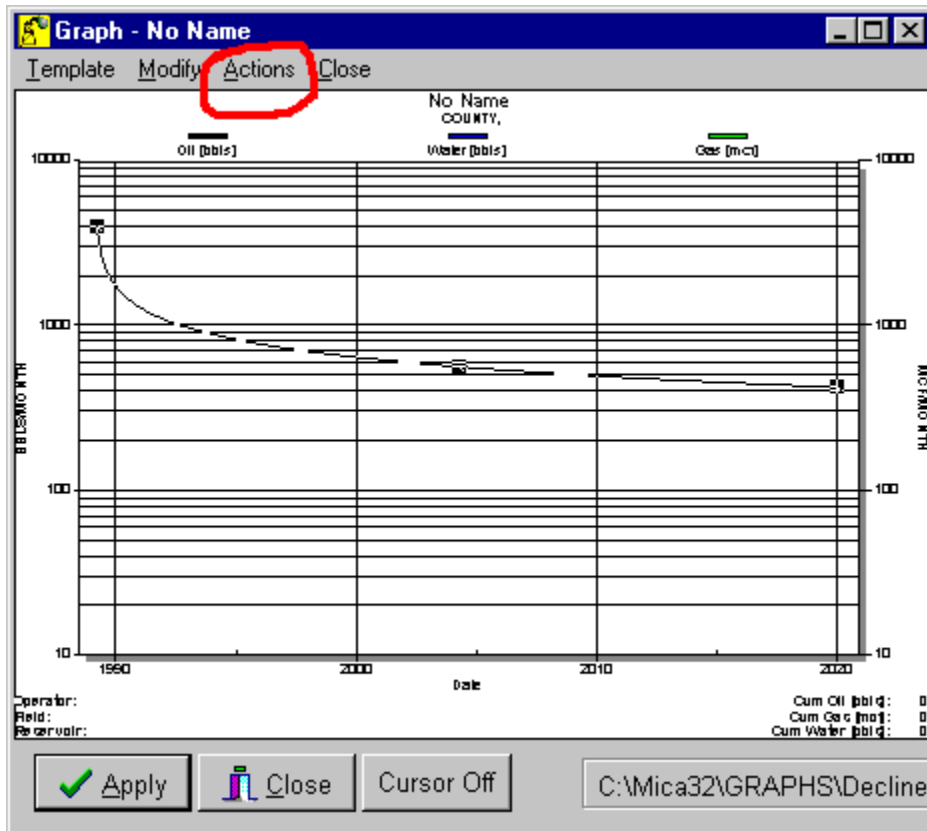


When the Open File – Template form appears select the “Decline” folder and then select the “Decline [Monthly Rates].GRT” graph template as shown below:

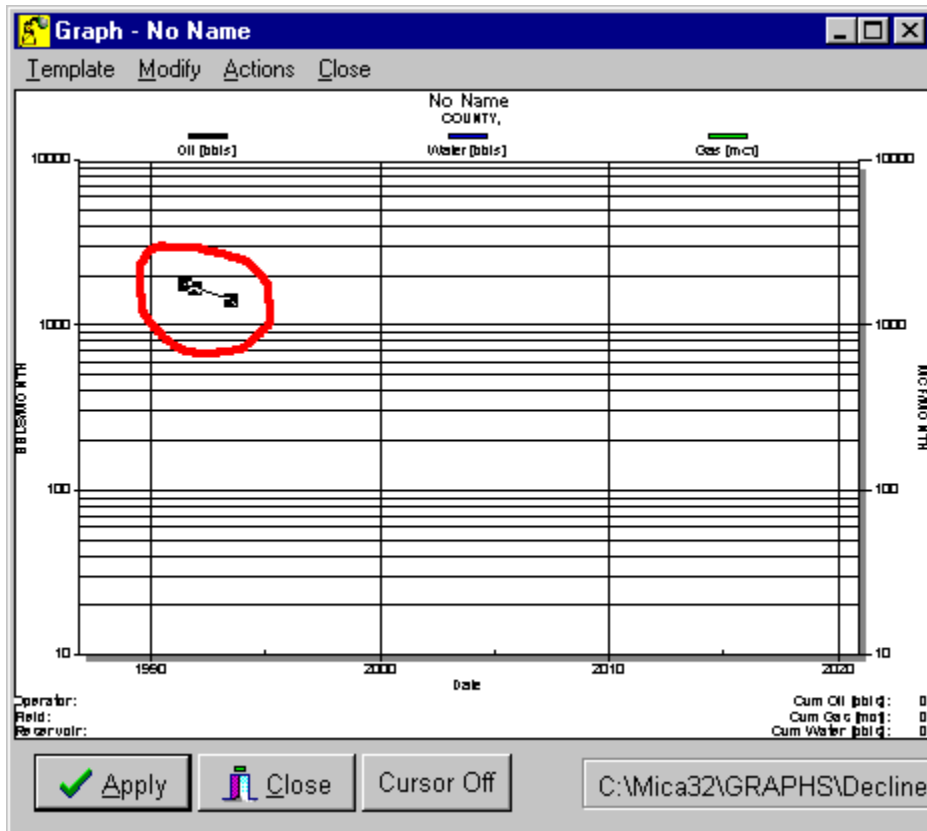


Then click the open button on the form. This will open a semi-log decline graph. The decline segments will not appear until you open the Arps Analysis form.

Step 2 – Open the Arps Analysis Form. From the graph form, select the “Actions/Arps Analysis menu item.



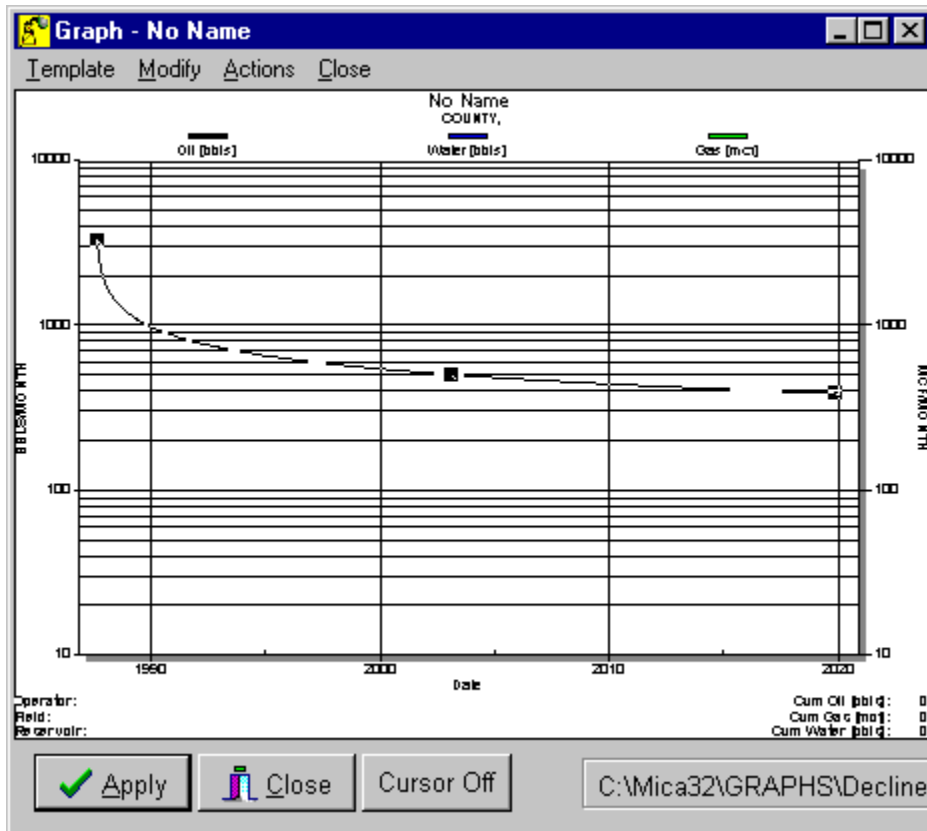
If a decline segment does not already exist, you must create one. You can do this by either analyzing existing production history, or selecting the “New” option on the Mode panel and clicking once on the graph to create a new decline segment. For this example, select the “New” option on the Arps Analysis form and click once on the graph. You will see a new segment similar to the one shown below:



Now select the "Move" option on the Arps Analysis form as shown below:

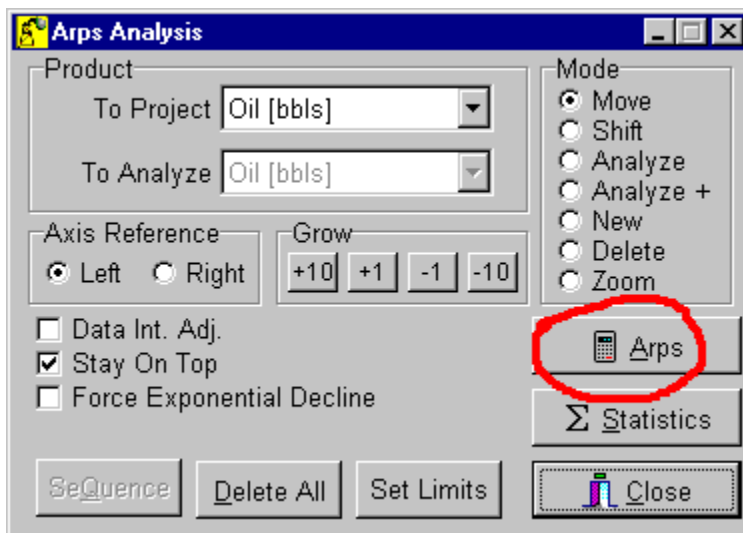
The screenshot shows the "Arps Analysis" dialog box. It has a "Product" section with "To Project" and "To Analyze" both set to "Oil [bbls]". The "Axis Reference" section has "Left" selected. The "Grow" section has buttons for "+10", "+1", "-1", and "-10". There are checkboxes for "Data Int. Adj.", "Stay On Top" (checked), and "Force Exponential Decline". The "Mode" section has radio buttons for "Move" (selected), "Shift", "Analyze", "Analyze +", "New", "Delete", and "Zoom". At the bottom, there are buttons for "Arps", "Statistics", "SeQuence", "Delete All", "Set Limits", and "Close".

Click and drag the anchor points of the new segment on the Graph form until you have a decline segment that appears similar to the one shown below:



Click and drag the left most anchor point (small black block) to move the initial point of the decline segment. Click and drag the right most point to move the end point of the decline segment. And click and drag the middle point down to add curvature to the line. If your decline segment appears as shown above, it has a large hyperbolic exponent.

Step 3 – Open the Arps Calculator and set the “Minimum Di”. Open the Arps Calculator by clicking the Arps button on the Arps Analysis form.



When you do this the Arps Calculator form will appear similar the one shown below:

The screenshot shows a dialog box titled "Arps Calculator" with the following fields and controls:

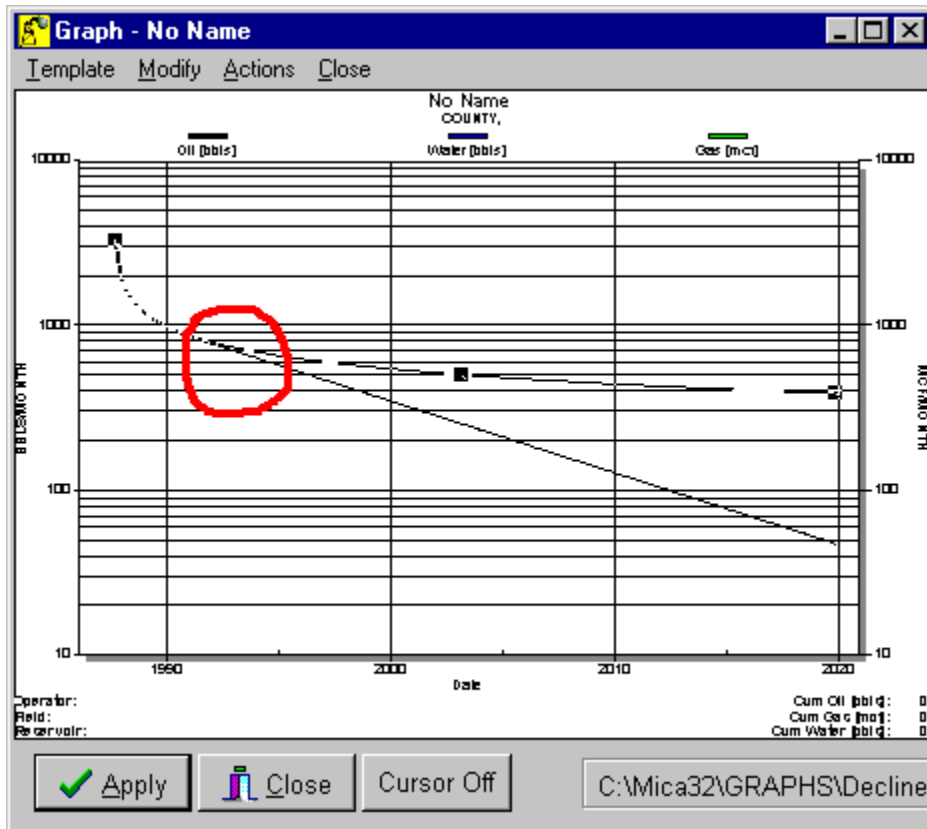
- Qi [bbls or mcf]: 3178.594
- Qa [bbls or mcf]: 380.2493
- Di [Nominal]: 4.219837
- b: 2.8
- ta [Years]: 32.24592
- Np [bbls or mcf]: 224460.1
- Start Date: 09/1987
- Min Di [Nominal]: 0 (circled in red)
- Production Units: Daily, Monthly, Yearly
- Stay On Top
- Buttons: OK, Close, Calculate, Clear

The Arps Calculator displays all of the parameters for the selected decline segment. You will need to set the “Min Di” field and then click the “OK” button. Min Di is the minimum decline rate that you want the projection to obtain. When the instantaneous decline rate drops below the value specified in Min Di, it will switch from a hyperbolic decline to an exponential decline at the rate specified. For our example enter 0.10 and click the “OK” button.

Note: Clicking the OK button will take the decline parameters shown in the Arps calculator and force the selected decline segment to those parameters. So, you could potentially use this method to specify any decline segment.

When you click OK on the Arps Calculator form in our example, the decline segment will not change since we did not modify other decline parameters such as Qi, Di, Qa, or b. However, when you click “Apply” on the lower left corner of the graph, the forecast generated will have the desired characteristics.

Step 4 – Click “Apply” on the graph form. When you do this MICA will generate a monthly forecast using the decline segments you have set up. In our example you will see a graph similar to the one shown below:



As shown on the graph above, the monthly forecast diverges from the hyperbolic decline segment and continues on at a decline rate of 0.10.

Step Review:

- Step 1 – Open a decline graph for the well.**
- Step 2 – Open the Arps Analysis Form.**
- Step 3 – Open the Arps Calculator and set the “Minimum Di”.**
- Step 4 – Click “Apply” on the graph form.**

Comment:

This paper describes one way to set the “Minimum Di”. You can also set it using the Decline Parameters form which can be opened by selecting the Edit/Decline Parameters menu item from the well form.