Pritchard & Abbott, Inc. (P&A), has added an optional **hyperbolic** production forecast feature for our appraisers to use in their appraisals of mineral interest value. This type of production forecast is most helpful when trying to model initial production after a well is first drilled, particularly wells in "tight" (low permeability) formations such as Barnett Shale, Haynesville Shale, Eagle Ford Shale, Granite Wash, etc.

In hyperbolic production decline situations, the production will fall very rapidly to begin with, but will decline at a lesser and lesser percentage rate over time. This type of production forecast is distinguishable from an exponential production forecast in which production falls at a fairly constant rate over time (say, 10% decline every year).
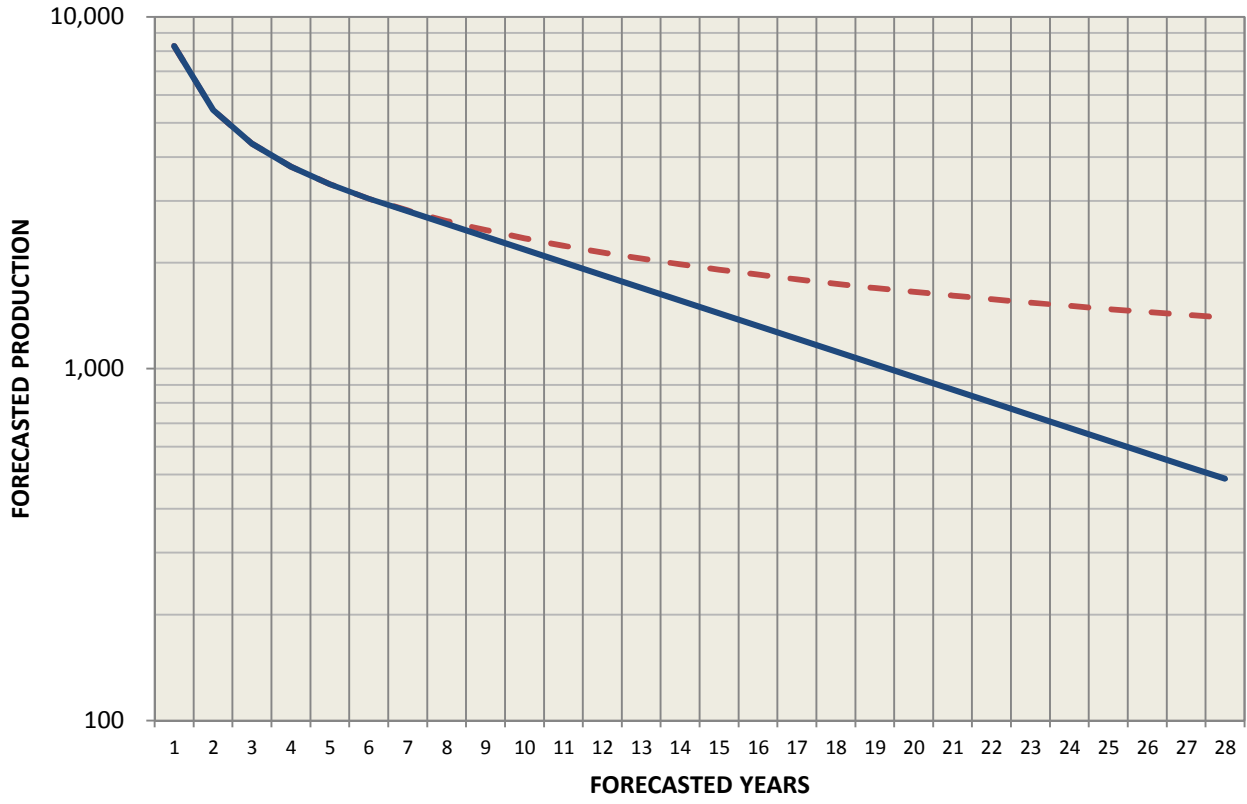
P&A appraisers have always had the ability to approximate a hyperbolic forecast used several segments of forecasted production decline. For example, 50% decline for the first year, 30% decline for the next year, 20% decline for the next year, and so on. These segmented declines work fairly well and are easy to understand. However, there is a mathematical formula developed by Arps many decades ago that exactly models a more gradual "decline curve" over time that is theoretically more "accurate" for our needs (if any forecast can be styled as such). Sophisticated decline curve software such as Landmark's Aries™ gives us the parameters needed for use in this equation, such as:

- Qbeg = initial production rate on January 1, either in monthly or daily terms;
- b = hyperbolic factor (also called the exponent) that essentially defines how fast the future production will turn from a large initial decline to a more shallow decline;
- De = initial decline rate on January 1.

This hyperbolic forecast we've implemented is only an option for our appraisers to use in lieu of segmented declines. Any hyperbolic parameters entered by the appraiser will override any segmented decline parameters also entered for that production stream, and segmented decline parameters will not be shown on the appraisal report. Each production stream (oil, gas, or products) can be forecast independently from each other in our appraisal program using either segmented declines or hyperbolic forecast.

As an additional option for the appraiser should they choose to use a hyperbolic forecast, a terminal decline feature has been added (shown as "Dt" on the appraisal report) that will limit the projected annual percentage decline rate to no less than the Dt chosen by the appraiser. We installed this terminal decline feature because the Arps formula by itself will keep forecasting a smaller and smaller decline rate over time, sometimes to an unrealistically low percentage decline rate which can result in excessive projections of economic life and reserves. In other words, we may want to forecast less production in our appraisals than the Arps formula will produce. See the plot below for an illustration of how a terminal decline rate chosen by the appraiser can limit the forecasted production decline rate versus the hyperbolic formula's results.

Production Decline Curve

Chart showing forecasted production (y-axis, log scale from 100 to 10,000) versus forecasted years (x-axis, 1 to 28). Two series: Hyperbolic Production (dashed red line) and Adjusted Production* (solid blue line).

Legend: – – – Hyperbolic Production   —— Adjusted Production*

*NOTE: Adjusted production per appraiser's called terminal decline rate will override production as calculated by Aries hyperbolic curve formula.