Lease to Well Production Allocation

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Since production is reported at a lease level for many states, breaking that data down to the well level is important for any well-level analysis. To develop allocation percentages for each well, certain information is required about the wells that may or may not be public. Completion dates, first production dates, plug dates and well tests are generally available from each state, but shut-in dates, temporarily abandoned dates and convert to injection dates may not be available. By not having dates when the wells stopped/started producing (from shut-in or TA status for example) the allocation will have some inherent error due to the lack of information. Allocating state lease production data, even with the error potential, results in useful information for quickly determining the production trends of each well on the lease.

When allocating lease production from state data sources there are three main assumptions that must be made:

- Each well is producing from its first production, completion or spud date, whichever is available. If no date is available, then the well is assumed to produce the entire life-span of the lease.
- Each well is producing until its plug date.
- All production test values are assumed to be reported on the same time-scale.

The three allocation methods currently used are:

1. **1/N** – Divide lease production by the number of wells producing every month to get the allocation percentage and apply it to the lease production.
2. **Step** – Use the most recent test data to calculate a well's allocation percentage every month and apply it to the lease production.
3. **Straight-Line** – Decline the test data by calculating the line between the most recent pair of test values every month, find the allocation percentage from the calculated test values and apply it to the lease production.

The 1/N method is the simplest and most straightforward. This gives well production data when no other information is available to calculate allocation percentages. When only approximate data is needed, this method will provide results. If the test data for an area is questionable, the 1/N method may provide the most reasonable results for field-wide statistical studies.

The Step method uses a production ratio for each well calculated from its comparison with the test values from all the wells on the lease for each production month. Whenever a test happens, that value is used until the next test value becomes current, resulting in stair-stepped test values (see Figure 1). By using test data to calculate the allocation percentage, the error is reduced by a closer representation of each well's production.

The Straight-Line method uses the same principles as the Step method to calculate each well's production ratio, but results in a smoother transition between test values. The test values used to calculate the production ratios for each month are calculated from the projected line between the two tests.

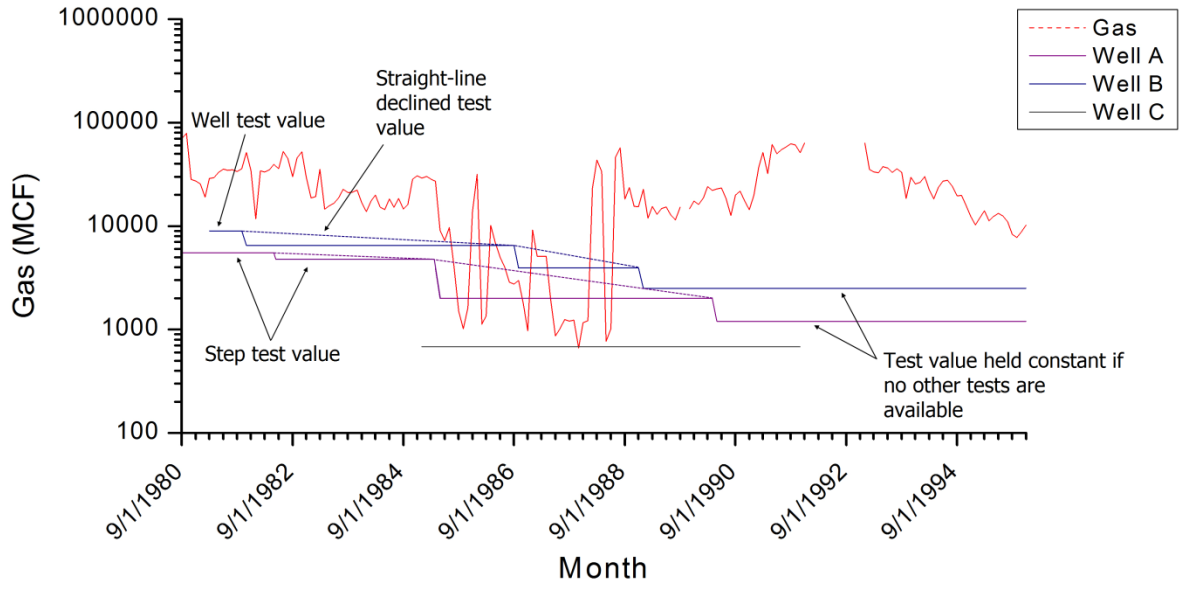

Figure 1 – Step and line allocation examples

Each allocation method has its strengths and weaknesses. The 1/N allocation method is very straightforward, fast and easy to understand. However, by not adjusting the allocation percentage to match the well test ratios, some error is introduced. The 1/N method must be used as a backup method within the Step and Straight-Line allocation methods when no tests are available for specific wells.

Figure 2 shows the lease gas production and the allocated production for a well using the above methods. Upon inspection, each method gives a similar result. The Step curve differs from the 1/N and the Line curves due to a large difference between the two test values for that interval. This highlights how the Straight-Line allocation method smooths out the large test value differences resulting in a more accurate allocation.

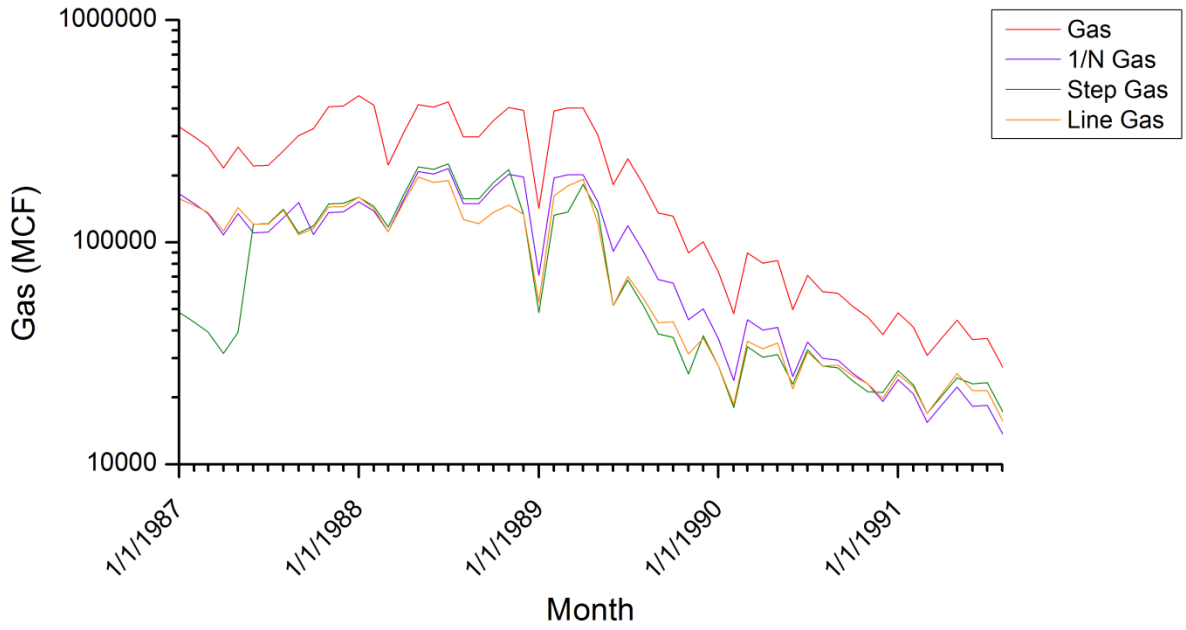

Figure 2 –Allocation sample

While the Straight-Line method allows for a smoother transition between the test data points, the Step method is useful if there is reason to believe stair-stepped test values are a better approximation of the well's decline rate – in the case of major recompletions, for example. But in general the line approximation is likely the most accurate.

Technical Notes:

The allocation for each method starts with a few key pieces of information: the lease production, start/stop dates for each well and test dates for each well. Which wells are producing each month and which wells have or do not have tests are also required data.

The 1/N method calculates the allocation percentage by dividing the lease oil, gas or water values by the count of wells producing that month. The 1/N method is straight-forward and does not require any special case handling.

The Step and Straight-Line methods use the most recent test values for each lease production month to calculate the allocation percentages. The Step method uses the most recent test value on or before a given production month. If no prior test is available, then it uses the first test after the current production month. The Straight-Line method uses the most recent tests before and after a given month to calculate the linear equation between the points. The test value used for each month's allocation percentage is found from this equation. If a well does not have tests before and after, then the Step method is used until a line can be drawn between the two points.

The allocation percentage is determined by dividing the sum of the tests for a given production month by each well's test value at the current production month. The Step method uses a constant test value, while the Straight-Line method uses a calculated test value each production month as seen in Figure 1.

In an ideal scenario, each well would have complete test data publically available and production start/end dates, but unfortunately they do not. Instead there is a smattering of data ranging from nothing more than information that a well is part of a lease, to the ideal data scenario. Handling the wide range of possible data combination requires a few more assumptions and logic in the calculation:

- If only one well on a multi-well lease has test data, its tests are ignored and the 1/N method is applied to the entire lease. Since test data is used to calculate the allocation percentage based on the ratio of a well's tests to the sum of all the tests on the lease for the current month, having fewer than two wells with tests makes the test data extraneous.
- If more than one well on a lease has tests and if any wells on the lease do not have tests, the wells with no tests are allocated using the 1/N method and the wells with tests are allocated by calculating the allocation percentage from the test values. The allocation percentages are then applied to the remaining production after removing the amount used for the 1/N allocation.
- If a lease has more than one well with tests and the sum of all the active wells' tests for the current month is zero and the lease production value (oil, gas, or water) is greater than zero, the Step and Line methods will use the first non-zero test value for each well and will use those test values to calculate the allocation percentage. If no non-zero tests are found, the allocation percentage is adjusted for the wells that were allocated with the 1/N method to make sure all the production is given to all the wells that are producing.

Each test value for oil, gas or water is regarded as its own test data point. If a given test date has values for oil and water for example, but no value for gas, then there is no gas test for the given test date. If there are no gas tests for the well even though it has oil and water test values, then the gas data for the well will be allocated using the 1/N method.

- Since a few states switch from lease production to well formation production, pseudo tests are calculated for all wells that produce across this boundary but have no test data during the lease production period. The well formation production ratio for a given well is found by comparing the first month of well formation production to the sum of all the wells' first month of well formation production. A test value is calculated using the current tests before the well formation production boundary and the well's calculated well formation production percentage. By reflecting a well's first known production ratio back to the lease production as a set of test values at the well's first production date, a more accurate allocation can be determined than resorting to the 1/N method.

Summary: Each of these assumptions and methods is intended to make the best use of the available data to calculate the most accurate allocation percentages. Having several allocation methods also allows for a customizable approach to calculating the most accurate data for a well. If other parameters are provided such as well shut-in or TA dates, workover dates and pre-post workover rate tests, the allocation can be further refined to reflect what actually happened to each well on the lease.

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Geographical Coverage:

The described allocation methodology has been applied to all state/regions that have some, or all, of their raw volume data at the Lease Level. TGS allocation coverage includes: TX, LA, OK, AR, KS, CO, NE, MI, MO and GOM.