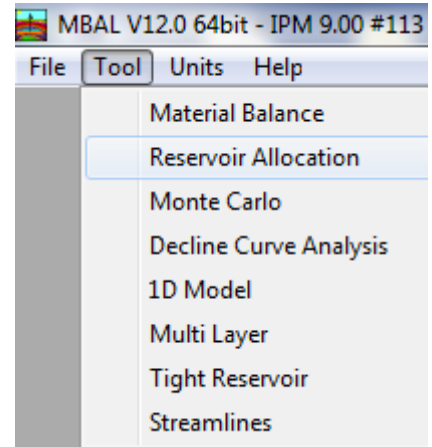# RESERVOIR ALLOCATION

Context and use of the Reservoir Allocation tool in MBAL

Introduction

Commingled production from multiple wells or reservoirs is common place in the industry, alongside the lack of measurements of rates on a well by well basis. The question then becomes how much does each well/layer produce?

This rate information is required to manage, forecast or optimise a fields production, and to do this we need to have an understanding of the system behaviour. As such, a methodology is required which can back-calculate the contributions of each reservoir or well. This article explores how to do this in MBAL, using the production allocation tool that has been available for many years.

Context for the reservoir allocation tool

Historically, methods available within the industry have focused primarily on the kh (permeability * layer height) of each layer. Implicit to this approach, is the assumption of constant pressure depletion over time with the same fluid, rock properties and size for a multilayer reservoir. This is a gross simplification of what actually happens in reality.

Most wells will produce from layers of varying sizes, fluids and rock properties, ignoring (i) layer inflows (IPRs) and (ii) varied depletion rates (as is the case when employing the kh alone) will lead to errors at the design and operation stage of a field. It was for this challenge that the reservoir allocation tool was developed.

The reservoir allocation tool was designed to take surface rates and attribute it to producing layers, and it does this in two ways:

- The inflow on a layer by layer basis is defined (accounting for different deliverability of each layer)
- This is combined with material balance for each timestep (capturing the varying rates over time as the each layer depletes)

The advantages of this approach are that (i) depletion over time (varying rates) is captured, and (ii) any cross flow between layers can also be accounted for.

This approach within MBAL can be applied to oil, gas or retrograde condensates, allowing engineers to carry out this approach regardless of the fluid type being dealt with.

How it works

The IPRs for each layer are referred to the same node so that an overall IPR can be achieved for the entire well:
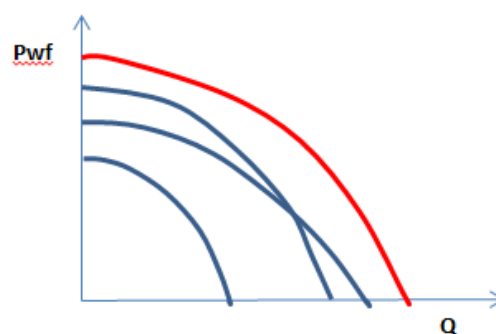
MODELLING

Context and use of the Reservoir Allocation tool in MBAL

Integrated Visualisation Management (IVM)

IVM is made up of the **Data Manager** and the **Integrated Visualisation** component.

Interest in the system and the associated results is unlikely to remain with the engineers alone. Different disciplines across an oil company such as managers and the business departments would also likely wish to view any information relevant to them concerning the project. In this case, we will be referring to the engineers' perspective in which visualisation formats were configured to provide: high level views of the field, performance of single components to generate reports, alarms and notifications based on real-time results to pre-process input data for the system as well as outputs from the workflows. This approach is intended to make it easy to maintain, extend and upgrade the system.

IVM allows daily or high frequency monitoring of the production deviations from targets which trigger revisiting the well model and perform its updates (all of which can be generated into specific reports for the operations team).

The Approach

The total surface rate is known for the well (red IPR curve in below diagram). Using this, the individual rates and flowing bottomhole pressures are determined (see green rates calculated from IPRs)

Timestep 1:
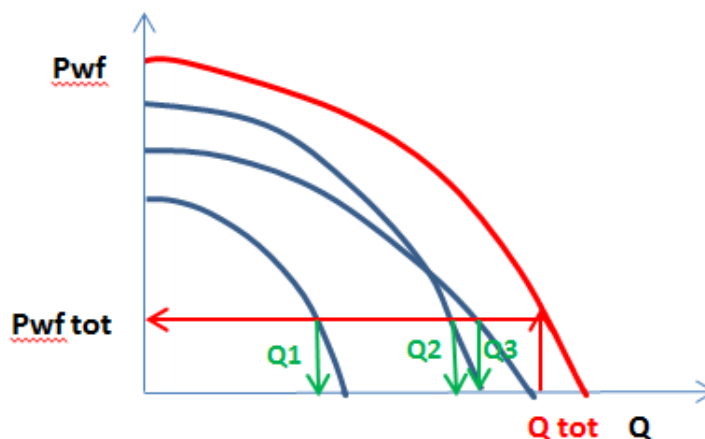
Timestep 2:

To determine how much each layer could contribute at the second timestep in historical production, the updated layer IPRs are required (i.e. an update of the reservoir pressures for each layer).

As the reservoir pressure is a required entry, a reservoir model (i.e. a tank in MBAL) is necessary. Material balance is carried out to define the layer pressures based on the production from each layer at the previous timestep. This ensures that the impact of; aquifer effect, pore volume compressibility and water expansion are all accounted for to predict the reservoir pressure with respect to the fluid being withdrawn from the reservoir.

This allows the IPRs for each layer to be updated and a new solution node bottomhole pressure to be calculated as outlined in Timestep 1.

This process continues until all of the historical surface production rates have been allocated.

Example: finding GIIP

The workflow for calculating the Gas Initially in Place (GIIP):

- Taking the field measured values for
  - Reservoir pressure
  - Cumulative rates produced at surface (from multiple layers)
- Engineer assume a GIIP for the reservoir
- Open MBAL and select the reservoir allocation tool.
- Perform the calculation to allocate the surface production to the defined reservoir layers.
  - To do this we need two pieces of information
    - IPRs for each completion
    - Description of the reservoir layer properties
- Having obtained the allocated rates, press **Tools| Material Balance**, which then opens up the material balance tool.
  - Here we can use the allocated rates for each layer as the basis by which to perform a history match.
  - This will yield a GIIP based upon the production rates
- Compare the two GIIP and if they are significantly different the initial estimate of GIIP should be reviewed.
- Enter Production allocation tool again with new GIIP and follow this logic iteratively until convergence occurs.

Summary

In summary, taking the surface measured rates the production allocation tool can allocate the production to producing layers using a combination of (i) IPRs and (ii) Material balance.

The reservoir allocation tool also allows for quality checks to be carried out. One approach is to compare the calculated and measured CO_2 content of the stream. If the CO_2 injection has been measured and a comparison against the calculated mol% of CO_2 shows any disagreement, this would indicate that our input data requires some review (usually GIIP or IPR).