

preprocessinc

Chemical Engineering for Entrepreneurs

Process Development Cultural Tools

Process Development is a complex chemical engineering work flow that requires rigor, discipline and organization. The more refined and simple that information generated is presented the greater degree of continued success.

Simplification and communication enables:

1. Data based decision making
2. Mass and Energy Balances
3. Validated Test Methods

Mass Balance

All lab scale, pilot (demo) scale and commercial scale plant units, systems and equipment testing, evaluation, and operation shall be based on constituent level mass and energy balances.

These balances shall be compiled from the mass based (not volume) measurements of composition from the analytical lab, and the mass based flow measurements from the on line systems or by collection and weighing of the batch run materials. Temperature measurements shall be used to determine and resolve the energy balances for all systems. In cases where the direct mass flow measurement is impractical, as for example in the demo plant or the commercial plant, equivalent volumetric flow measurements combined with a density measurement will be used to determine the calculated mass flow.

The composition measurements shall focus on the needed constituents of concern and the analytical test methods used in the compilation of the mass balances shall be validated using accepted statistical methods. The error in the measurement shall be displayed as part of the reported values in any mass balance. For example: the total flow shall be reported as 1.0 +/- 0.1 lb/hr or for example the total Ca concentration in that flow shall be reported as 250 +/- 10 mg/kg. The mass flow of the Ca in the stream would be calculated using the combination of the analytical composition measurement and the total mass flow measurement. The error propagation must be carried through the calculation.

All test plans and EOs will include mass balance sampling plans and energy balance sample plans. Key learnings reports will issue the mass balance and energy balance according to the corresponding sample plan.

Design Experiments for Scale Up

When we design experiments think in terms of what we need to have for an accurate scale up of the plant. Must consider capital costs, operating costs, scalability.

3SC - “The Build Plan”

Used whenever a system needs to be built

Includes:

- Scope
- Schedule
- Sketch
- Cost

EO or Test Plan- “The Run Plan”

An EO (Experimental Order) is used whenever Operations is conducting an experiment

A Test Plan is used whenever an experiment is conducted on the lab scale.

Includes:

- Objective
- Mass Balance Sampling Plan
- Energy Balance Sampling Plan when conducting experiments at scale
- FLRC – Factors, Levels, Responses, and Constants
- Summary Run Plan
- Pre-work (Any non-routine activity that is not already covered in 3SC document. Examples include prerun of equipment to confirm appropriate starting factors; development, validation, and qualification of a new test method; highlight of new testing level not already validated. A PSSR should not be listed as prework as that is routine to starting any new system.)

Clarity in Conclusions

Key Learnings – “The Run Report”

Used to report conclusions from any EO or Test Plan.

Includes:

- Title block which includes:
 - Study Name:
 - Date:
 - Reference: (Lab notebook number and page where process conditions and raw data can be found)
 - Objective:
- Mass Balance
- Energy Balance (when conducting experiments at scale)
- OAG (Obvious at a Glance) Presentation of Data
- Key Learnings
- Recommendations and Next Steps

This entire report can be as short as one page. Data beyond the OAG Presentation shall be included in an appendix.

Reproducible Data

All analytical measurements and online measurements must have the validation or calibration statistics to clearly state capable range of measurement, statistical confidence intervals, and, where applicable, drift.

To learn more about test method validation and analyst qualification read the article [Data Analysis Expectations and Requirements](#).