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What Is Data Reconciliation and How Is It Used?

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If a process change is made, for example, a process unit begins using a new catalyst or a new process control is implemented, and after the change production of a key product increases – is the production increase from the process change or did someone simply zero a meter?

Data Reconciliation provides the answer!

Uses of Data Reconciliation

Data Reconciliation (DR) is usually defined as a system to resolve inconsistencies between plant measurements and mass balances (and other balances such as energy or component balances) throughout the plant.

Data Reconciliation is usually used in the following five ways[1]:

1) To provide accurate information to monitor and optimize the operation of process units. For example, DR is used to obtain accurate product yield information to determine product and feed stock values. In this model, DR is used as a pre-processor of flow data for process planning, analysis and optimization. Before a rigorous on-line model is used to optimize a process, typically the flow data is reconciled.
2) DR helps to identify sources and magnitudes of losses. These could be (for instance):
   - Flaring or venting losses
   - Leaks
   - Erroneous feed meters
   - An open slip-stream or bleed-stream that is thought to be closed
3) Using DR on a regular basis (daily) can typically reduce the weight percent of losses from 0.75 +/- 0.5% to 0.3 +/- 0.1%. This is especially important for plants with multiple owners and where the products are distributed to the various owners.
4) Using DR helps prioritize instrument maintenance. (It helps to answer the question, “Which flow meter should I calibrate next?”)
5) Using DR provides economic justification and shows optimal locations for instruments.

Theory of Data Reconciliation

The practical theory behind DR is:

1) First a mass balance software model of the input and output process streams is built on a mass basis.

2) Next, the DR software should ideally provide a feature called Solvability Analysis. Solvability Analysis is the process in which each mass flow stream is categorized as redundant, non-redundant, solvable or unsolvable. Each of these terms is defined below[2].

Redundant Stream: A metered or unmetered stream whose flow can be calculated at least two ways. It would require the failure of at least two meters to make this stream unsolvable.

Non-redundant Stream: A metered or unmetered stream whose flow can only be calculated one way. If one critical meter fails, then this stream will become unsolvable.

Solvable Stream: Any stream in which it is possible to deduce its flow.

Non-Solvable Stream: A stream in which it is impossible to deduce its flow.

3) A Tolerance is determined for each metered flow stream.

Tolerance: The acceptable allowance, expressed as a percentage, that a flow measurement is reasonably adjusted to correct a mass balance. Instrument tolerance is a function of many factors including:

- meter type
- stream viscosity and cleanliness (a clean thin stream is easier to measure then a thick, dirty stream)
- the percentage of range a meter is operating in (accuracy of meters diminishes when the meter is run close to 0% or close to 100%)
- date of the meter's last calibration
- closeness of actual flow conditions (temperature, pressure, etc.) to design conditions

Therefore a meter that was recently calibrated, is running at 50% of meter range, in a clean fluid (for example water) and close to design conditions might be assigned a tolerance of 3% while an asphalt flow meter, running at 95% of meter range, that has not been calibrated for 8 years, and is running 30 degrees from design temperature might be assigned a 20% tolerance.

4) The final step of DR is to simultaneously adjust each of the flow stream measurements within the tolerance of the flow instruments in such a way that the process mass balance is closed with the minimum number and size of total adjustments[2].

Note that the process mass balance may include several "envelopes" of mass balance that are simultaneously balanced including:

- A distillation column mass balance that is part of a bigger envelope including a…
  - Gas plant mass balance that is part of a bigger envelope including a…
    - Process unit mass balance that is part of a bigger envelope including …
      - The entire plant mass balance

In addition to overall mass, balancing additional variables such as energy balance and component balance (for example hydrogen or carbon) may provide greater accuracy to the reconciliation.

References

(1) Lawrence, P.J., “Data Reconciliation: The Art of Converting Data to Information”, paper presented at AIChE, 1990 Spring Meeting, March 18 – 20, 1990, Orlando, Florida.

(2) Lawrence, P.J., “Data Reconciliation: Getting Better Information”, Hydrocarbon Processing, June 1989, Page 55.