STEAM BALANCING:
THE FIRST STEP IN STEAM SYSTEM OPTIMIZATION

SEPTEMBER 28, 2017

KELLY PAFFEL
TECHNICAL MANAGER
INVENO ENGINEERING LLC
WWW.INVENOENG.COM
KELLY.PAFFEL@INVENOENG.COM
239-289-3667
WHAT IS STEAM BALANCING?

- Steam balance is always the first step in any steam system optimization and management program
  - Efficient way to gain knowledge
    - steam generation
    - distribution
    - end users
    - condensate-recovery systems

- Creating and maintaining a steam balance
WHAT IS STEAM BALANCING?

- Steam balance leads to setting a road map to use the steam system in the most efficient way.

- Provides the understanding necessary to increase steam system thermal cycle efficiency.

- Today’s competitive business environment - every plant needs to achieve the highest steam thermal cycle efficiency possible.
**STEAM BALANCE**

- A steam system in perfect balance has the end users (steam processes) achieving the correct volume of energy at the correct steam pressure/temperature with the proper steam quality

[Image]
Perfect steam balance has no energy losses
- steam leakage
- excessive low-pressure steam venting
- flash steam venting
- condensate loss, etc
STEAM BALANCE

- Establishing the correct steam balance can be very challenging because of all the different dynamics in a steam system
  - modulating steam loads
  - variable production times
  - unaccountable losses
  - insulation inefficiencies
  - turbine operation
  - etc.
PERFECT STEAM BALANCE

- Advantages of a steam system in perfect balance are as follows:
  - higher sensible energy content in the condensate;
  - reduced flash steam, with no need for flash steam recovery, because the deaerator will consume the small percentage of flash steam.
**PERFECT STEAM BALANCE**

- Advantages of a steam system in perfect balance are as follows:
  - smaller diameter condensate piping;
  - higher feedwater temperatures, thus a higher boiler efficiency; and
  - higher steam system thermal cycle efficiency
PERFECT STEAM BALANCE

- A perfect steam balance cannot exist for several reasons
  - Modulated steam pressures or flows to system processes
  - Dynamics of condensate drain devices
  - Condensate system’s dynamics can also limit on how high a pressure the plant can maintain in the condensate return system
WHY STEAM BALANCES ARE NOT ACCOMPLISHED

- High percentage of time - fragmented
  - Boiler plant
  - End users
  - Steam distribution
  - Condensate recovery
STEAM BALANCE

Difficult to establish a single or dual set of prints
- CAD library might contain multiple different PID prints
  - Different owners of the plant
  - Different engineering directions on system designs and prints
  - Different engineering firms
- All of the above could have used a different format
- Plants sometimes do not keep their CAD prints up-to-date
ACCOMPLISHING A STEAM BALANCE

- Impossible to optimize a steam and condensate system without a steam balance
- Steam balance flow diagram
  - Aspen software
  - AutoCAD
  - Solid Works
  - Microsoft Visio
IMPLEMENTING A STEAM BALANCE

Steam balance
- Steam generation, distribution, end-user requirements, and condensate recovery can be an extremely challenging goal in any industrial steam plant operation

Industrial plant can have several different steam-generating sources and a multitude of end users with varying steam pressure and steam flow demands
- Steam turbine operation for electrical generation or drive units plays an important role in the balance
- Steam pressure letdown valves (pressure-reducing valves) need to be minimized to ensure maximum steam flow to the steam turbine operation
IMPLEMENTING A STEAM BALANCE

- Four types of condensate recovery systems are added into the balance
  - System dynamics get even more complex

- Steam balancing is a continuous program, not a one-time venture
IMPLEMENTING A STEAM BALANCE

Steam balance will eliminate the waste:

- Unusable low-pressure steam being vented to the atmosphere
- Steam flow to the end users (steam turbines, heat exchangers, reboilers, etc.)
- Discharging the condensate/flash steam to the steam cascade systems to successfully consume the flash steam
- Low-pressure steam can be thermocompressed to medium steam pressure grids until a steam balance is achieved in the system
STEAM BALANCE EXAMPLE
STEAM BALANCE EXAMPLE
STEAM BALANCE EXAMPLE
SEAM BALANCE EXAMPLE
WITHOUT A STEAM BALANCE

- Low steam system thermal cycle efficiency
- Energy losses
- Emissions
- Safety
- Process performance
- Low steam quality
**END RESULT OF A STEAM BALANCE**

- a better understanding of the steam and condensate system,
- the ability to set a road map for changes that will improve the system,
- opportunities to improve energy efficiency,
- opportunities to reduce emissions, and
- opportunities to increase reliability.
THANK YOU

Kelly Paffel
Technical Manager
Inveno Engineering LLC
Tampa, Florida, USA
www.invenoeng.com
kelly.paffel@invenoeng.com
239-289-3667