More on steam systems

Steam System Optimization Opportunities

ADVANTAGES OF STEAM

- Extremely efficient heating source;
- Constant temperature;
- High heat transfer coefficients;
- Highest amount of transferable energy per unit mass.

Conservation of mass

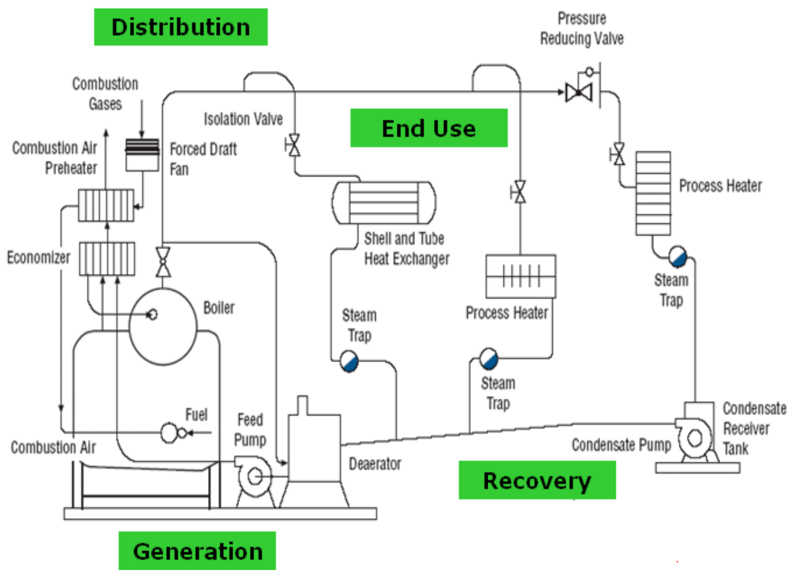
Mass can neither be created nor destroyed in a control volume. It can only change its state.

Conservation of energy (1st Law on thermodynamics)

The conservation of energy states that energy can neither be created nor destroyed in a control volume. It can only be changed from one form to another.

Principle of Steady State Steady Flow (SSSF)

SSSF means that the rate of change of mass and energy in a control volume are each equal to zero which implies that there is no storage of mass or energy in the control volume that is being analyzed. The operating parameters do not vary over the time period for which the analysis is being conducted.



Generic Steam System
(Courtesy: US DOE Steam BestPractices Program – Steam System Sourcebook)

- Any generic steam system comprises four major areas – generation, distribution, end-use and/or cogeneration, and condensate recovery.
- Generation usually encompases the following major components: boilers and auxiliaries, economizers, air preheaters, dearators, pumps etc.
- Distribution area consists of steam piping, pressure reducing valves, steam accumulators etc.
- End-use and/or cogeneration encompases heat exchangers, stripping columns, evaporators, cookers, dryers, steam turbines.
- Condensate recovery uses steam traps, condensate collection tanks, pumps and piping.

UNIDO Steam System Optimization (SSO) programme promotes the importance of and builds competencies for a system approach in understanding and evaluating the performance of industrial energy systems. This approach points out the need and benefits of considering the system as a whole rather than focusing on a single component exclusively. Energy and cost savings can usually be 3 to 10 times bigger.

The steps for optimization usually involve (1) identifying the current system conditions and operating parameters, (2) understanding the supply and demand side, (3) detecting possible areas for improvement and conducting measures, (4) continuos monitoring and evaluation of current vs. previous state.

SSO is usually based on the following targets and goals: minimizing steam use, reducing system-wide energy losses, reducing GHG emissions, and reducing steam system operating costs.

In order to achieve optimal system configuration, it is often necessary to develop a system model, that accurately reflects its overall state. A number of commercial software tools are availiable to do this, based on the fundamental laws of conservation of mass and energy, preserving steam balance on headers, economics and impact cost, component modeling analysis, and the use of a systems approach.

While it is important to highlight that production processes can differ greatly from site to site, all steam systems share several common areas for improvement.

These areas usually correspond: generation, distribution, end-use/cogeneration, and condensate recovery.

Steam Systems Optimization Opportunities

Optimization opportunities in the steam generation area usually include minimizing excess air, installing heat recovery equipment, cleaning boiler heat transfer surfaces, improving water treatment, installing an automatic boiler blowdown controller, recovering energy from boiler blowdown, adding/restoring boiler refractory, minimizing the number of operating boilers, investigating fuel switching, optimizing deaerator operations.

The steam distribution area serves as conduit for moving the steam from the generation to the end-use area. The several optimization opportunities include: repairing steam leaks, minimizing vented steam, ensuring good insulation of the equipment, minimizing flow through pressure reducing stations, reducing drop in headers, draining condensate from steam headers etc. The system needs to be monitored continously in order to ensure that the process receives the correct amount of steam, at the required temperature and pressure.

Optimization opportunities of end-uses, specific to industrial processes and plants, are difficult to identify, and most important, if applied incorrectly, they could negatively impact the process. The main strategy is to eliminate or minimize steam usage in the end-processes, and then shift all or part of the steam demand to a waste heat source.
Regarding condensate recovery, the several optimization opportunities include implementing an effective steam-trap management and maintenance programme, recovering as mush as possible of available condensate, recovering condensate at the highest possible thermal energy and flashing high pressure condensate to make low pressure steam.

SSO in North Macedonia

- Steam System Assessments were conducted within the GEF-UNIDO project in North Macedonia in six companies: Pivara Skopje AD, ELEM Energetika, Pekabesko, CHP TE-TO, Sokotab Ltd,
- National trained SSO consultants together with facilities' engineers identified several potential opportunities for reducing energy waste/consumption, including upgrading combustion control of fired boiler for reducing excess air levels, recovering waste-heat from the boiler stack, insulating bare steam and condensate valves to reduce heat loss, improving low pressure condensate recovery by 5%, initating steam trap and leak management programmes.
- Additional potential energy saving opportunities identified include installing speed controllers to ID & FD fans and maintaining correct draft profile in boiler, installing a low pressure boiler and running only in district heating mode, installing additional flow meters to monitor utility use in water treatment area, and many others.

IMPORTANT

The laws on conservation of energy and mass, and the SSSF principle are the basis on which system optimization opportunities are built.

The facility's engineers need to have in-depth knowledge and understanding of the steam system dynamics in order to apply optimization measures correctly.

Need a SSO Expert?

Please check the list of UNIDO qualified SSO Experts here.

Operating data measurements of process and utility variables:

Temperature, pressure, flow, combustion analysis, energy usage, water chemistry, power production

Portable instrumentation

Lack of suitable measuring equipment makes it difficult to analyze industrial steam systems and identify optimization opportunities. For instantaneous monitoring of operating data, the following equipement can be used: thermal imaging camera, infrared temperature gun, immersion temperature gun and probe, handheld digital thermometer, ultrasonic leak detector etc.

ACKNOWLEDGEMENTS

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