CenterPoint Energy:
Natural Gas Solutions for the Industrial Process Industry

“Efficiency Concepts and Strategic Process Heat Recovery”

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Tom Tucker, P.E.
Principal
Outline

- Energy Concepts (1st & 2nd Law)
- Identifying Efficiency Opportunities
- A Few Project Examples
Basic Concepts – 1st Law

- Energy is not created or destroyed.
- Energy in = Energy out (no exception).
- Considers quantity only - ALL energy resources are treated the same, regardless of origin.
- The first law efficiency is most commonly stated.
Basic Concepts – 2\textsuperscript{nd} Law

- Considers quantity \textit{& quality} – Enter the concept of “availability” or $\phi$
- ALL energy conversions \textit{destroy} availability: $\phi_{in} \neq \phi_{out}$
- Says that the energy source \textit{does} matter
- Minimize availability destruction in part by “temperature matching.”
Basic Concepts Cont’d

The “Source” is any energy source and the “Approx. % Relative Availability” is the potential of the resource to do work.

Note the steam examples. This is why power plant boilers operate at high pressure and temperature.

<table>
<thead>
<tr>
<th>“Source”</th>
<th>Approx. % Relative Availability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity</td>
<td>100</td>
</tr>
<tr>
<td>Fuel</td>
<td>79</td>
</tr>
<tr>
<td>Hot Oil</td>
<td>45</td>
</tr>
<tr>
<td>600-psig Steam (725°F)</td>
<td>32</td>
</tr>
<tr>
<td>125-psig Steam (353°F)</td>
<td>22</td>
</tr>
<tr>
<td>50-psig Steam (298°F)</td>
<td>15</td>
</tr>
<tr>
<td>15-psig Steam (250°F)</td>
<td>7</td>
</tr>
<tr>
<td>Hot Water</td>
<td>~2</td>
</tr>
</tbody>
</table>
Example: Basic Concepts Cont’d

- Pressure reducing valves (PRV) are used:
  - In steam systems to reduce steam pressure
  - In refrigeration and air conditioning to reduce refrigerant pressure
- Pressure reduction is used to match fluid conditions (flow, pressure, temperature, etc.) to need.
Example: Basic Concepts
Cont’d
Example: Pressure reducing valve efficiency

Steam:
- P = 600 psig
- T = 725 F
- H = 1,364 Btu/lb
- A = 510.5 Btu/lb

1st Law Efficiency: 100%

2nd Law Efficiency: 69%

Steam:
- P = 40 psig
- T = 663 F
- H = 1,364 Btu/lb
- A = 352.9 Btu/lb

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Suggestions on Identifying Thermal Opportunities

- Make a list of heat “sinks” (heat needed) and sources (heat available).
- Do not focus on the heat source first. This is a common error.
- Follow temperature matching & availability concepts.
- Consider the whole “system,” not just the individual parts.
Suggestions on Identifying Thermal Opportunities

- Consider how individual “systems,” can be integrated (or interconnected).
- Don’t assume if it worked in one plant it will in another, **even on the same process**.
- Consider equipment modifications or changes in operating conditions. Can provide opportunity where none existed.
A Few Real Examples...
EX 1. Systems Integration

- Challenge - Process is fairly well integrated already.
- There are opportunities for energy recovery, but the question was: “Can we do better”?
- Applied what Kinergetics calls “PseudoPinch” for integration.
EX 1. Continued

- “PseudoPinch”: Application of 1st and 2nd Law principles (in part, temperature matching) and design practice in an iterative design process.
- Result is a practical design that can be implemented.
Existing Integration Layout

**Notes:**
- Hot Stream are being cooled
- Cold Stream are being heated
- Steam Heater
- Cooling Water

Stream 1
Stream 2
Stream 3
Stream 4
Stream 5
Stream 6
Stream 7
Stream 8
Stream 9
Stream 10

Hot In (°F)
- 320
- 280
- 227
- 185
- 115

Hot Out (°F)
- 320
- 280
- 180
- 92

Cold Out (°F)
- 165
- 161
- 140
- 207
- 205

Cold In (°F)
- 165
- 161
- 140
- 142
- 92
Improved Integration Layout
EX 1. Results Summary...

- Heat Recovery improved from 27.5 to 41.4 MMBTU/Hr (~13.9 MMBTU/Hr).
- Annual fuel cost savings with gas at $4.36/MMBTU and a boiler efficiency of 83% is ~$617,000/Yr.
- Considering additional pumping, net cost savings is ~$570,000/Yr.
- Simple payback is ~3 to 3.5 years.
EX 2: Temperature Matching (Oilseeds)

- **Heat sources:**
  - Flash steam at ~10 PSIG (239°F).
  - Saturated process exhaust at 168°F.

- **Available heat sinks:**
  - Outdoor process air (~45°F) heated to greater than 200°F with steam.
  - De-solvantizing process that uses sparge steam at 5 PSIG (+/-).
EX 2: Continued

- Easy & Inexpensive: Heat process air with flash steam (what plant did).
- Problem – There is no “sink” for the 168°F exhaust & flash is not available.
- Better:
  - Use flash steam for the sparge.
  - Use the saturated process exhaust at ~168°F to heat outdoor air.
EX 2: Continued - RESULTS

- Replace flash steam coils with direct contact column and coils to use hot glycol for inlet air preheating.
- Install sparge line and control valve.
- Value: $83,000/Yr
- Simple Return: ~4 years
- What if we did not have to undo what was done?
EX 3: Process Condensate Heat Recovery

- **Issue:** “Process” condensate cooled with tower water before treatment, representing a heat loss.

- **Opportunity:** Use a thermocompressor to put condensate under vacuum, & cool it, and use TVR discharge to offset “live” steam use.
EX 3: Continued

- HP (motive) Steam
- LP Suction Steam (flash)

Thermocompressor (TVR)

MP process Steam
Start early so you can master the concepts!
“Any fool can know. The point is to understand.” – Albert Einstein