Energy Efficiency Improvement Opportunities in Process Heating for The Forging Industry

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Energy Cost in Forging Plants

• Energy cost represents 10% to 12% of the cost of production for a forging/heat treating plant.

• Energy cost is expected to rise at a higher rate than other costs for the plant.

• Energy cost is controllable in a short term through assessment, analysis and cost-effective energy conservation measures
Trends in Forging Industry

International Scene

- Forging industry is moving towards high capacity continuous furnace operations in countries such as India and China.
- The newer units are considerably more efficient due to better furnace design and energy saving systems.
- In some cases, induction is replacing fuel fired systems for two reasons: one being energy use per lb. and the other being lack of availability of clean fuel such as natural gas.
- For fuel fired systems, use of recuperators and regenerative systems helps reduce energy use by 25% to 40%.
- Use of improved controls such as pulse firing helps in continuous as well as batch operations.
- The energy use observed is in the range of 1.6 MM Btu/ton to 1.8 MM Btu/ton using “good” operating practices.
- How does this compare with your energy use?
Major Energy User Systems for Forging Plants

- Electric Motors
- Air Compressors
- Pumps (various fluids)
- Fans and Blowers
- Boilers
- Gas fired furnaces
- Induction heaters
- Atmosphere Generators
Energy Consumption and Saving Opportunities

<table>
<thead>
<tr>
<th>System</th>
<th>Typical Energy Consumption Rates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Process Heating/Furnaces/Boilers</td>
<td>60 – 80%</td>
</tr>
<tr>
<td>Electric Motor Systems</td>
<td>10-15%</td>
</tr>
<tr>
<td>Pumping Systems</td>
<td>7-15%</td>
</tr>
<tr>
<td>Compressed Air Systems</td>
<td>2-7%</td>
</tr>
<tr>
<td>Other*</td>
<td>&lt; 2%</td>
</tr>
</tbody>
</table>

* Other ancillary energy usages such as lighting represent less than 2% of energy consumption.

Potential Savings:
- 10% to 30%
- 5% to 10%
- 10% to 20%
- 10% to 20%
- 5% to 10%
Observations on Energy Use Pattern for Forging Industry

• For most forging industry plants furnaces or heating systems such as induction heating uses the largest amount of heat.

• Large amount of total plant energy, somewhere between 65% to 80%, is used for reheating and heat treating of the production parts – commonly known as process heating operations.

• For some plants boiler energy use can be between 20% to 30% of the fuel energy used in the plant.

• The process heating equipment (furnaces, ovens etc.) have relatively low efficiency, between 20% to 60%, compared to higher than 75% for many boilers.

• Waste heat from furnaces and ovens represents the largest amount of energy wasted in the plant.
Energy Savings in Process Heating
Areas of Possible Improvement

1. Load/Charge Material
2. Material Handling
3. Heat generation Combustion System
4. Furnace Exhaust and Heat Recovery
5. Furnace Walls
6. Openings Furnace Doors etc.
7. Water or air cooling (if any)
8. Control System
9. Auxiliary Systems
10. Other Energy Losses
Energy “Accounting” For Fuel Fired Furnaces
Sankey Diagram for a Furnace

- Flue losses: 25% to 50%
- Wall loss: 3% to 5%
- Opening loss: 3% to 7%
- Useful output (heat to load): 20% to 40%
- Fixtures - Conveyors etc.: < 2% to 5% to 15%

Available heat
Net fuel input
Gross fuel input
Energy “Accounting” For a Box Furnace

Box forging furnace operating at 2350 deg. F., heating 3000lb/hr. of steel. Burners set at 10% excess air. Cold combustion air. Two shift operation. (Note: Those in no-ferrous metal forging do not do any better!)
Energy Efficiency Improvement in Furnaces
What is Being Done?

- Air-fuel ratio control,
- Use of O2 enrichment,
- Air preheating,
- Turn down capability
- Flame size, shape

- Enhanced heat transfer,
- Temperature profile control
- Optimal process atmosphere

- Optimum insulation
- Radiation losses
- Pressure control
- Cracks, openings etc.
Energy Efficiency Improvement Opportunities
Furnaces – Process Heating Systems

- Combustion air preheating
- Load preheating
- Steam generation
- Heat cascading

- Draft – pressure control
- Controlled “head” heating
- Burner firing control (pulse?)
- Use of process models

- Use of low-NOx burners
- Control to eliminate rich firing
  - no soot or CO etc.
- Fugitive emission control
Heat Generation

1. Maintain minimum required free oxygen (typically 1% to 2%) in combustion products from furnaces

2. Eliminate formation of soot, excessive amount (typically more than 30 to 50 ppm) of Carbon Monoxide or unburned hydrocarbons

3. Use oxy-fuel burners or oxygen injection in combustion air for furnaces where possible and economical

4. Reduce - eliminate air leakage into the furnace

• Energy Saving Potential
  – 2% to 10%

• Typical implementation time
  – 1 to 8 weeks

• Typical payback period
  – 1 to 6 months

It is possible to save up to $10,000 to $100,000 Every Year!
Savings Through Air-Fuel Ratio Control

Reduction of excess air from 25% to 15% can save up to $35,000 per year for a forging reheat furnace

<table>
<thead>
<tr>
<th></th>
<th>Current</th>
<th>New</th>
</tr>
</thead>
<tbody>
<tr>
<td>Furnace flue gas temp. (F)</td>
<td>1,200</td>
<td>1,200</td>
</tr>
<tr>
<td>Percent O2 (dry) in flue gases</td>
<td>5.00</td>
<td>3.00</td>
</tr>
<tr>
<td>% Excess air</td>
<td>27.97</td>
<td>14.92</td>
</tr>
<tr>
<td>Combustion air temperature (F)</td>
<td>80</td>
<td>700</td>
</tr>
<tr>
<td>Fuel consumption (MM Btu/hr) - Avg. current</td>
<td>5.50</td>
<td>4.31</td>
</tr>
<tr>
<td>Fuel savings (%)</td>
<td>Base</td>
<td>21.62%</td>
</tr>
<tr>
<td>No. of operating hours</td>
<td>4250</td>
<td>4250</td>
</tr>
<tr>
<td>Therms used per year (Therms/year)</td>
<td>233,750</td>
<td>183,203</td>
</tr>
<tr>
<td>Therms saved per year (Therms/year)</td>
<td>Base</td>
<td>50,547</td>
</tr>
<tr>
<td>Cost of fuel ($/Million Btu)</td>
<td>$7.00</td>
<td>$7.00</td>
</tr>
<tr>
<td>Annual savings ($/year)</td>
<td>Base</td>
<td>$35,383</td>
</tr>
<tr>
<td>CO2 savings (tons/year)</td>
<td>Base</td>
<td>296</td>
</tr>
<tr>
<td>Total cost</td>
<td>$</td>
<td>$5,000</td>
</tr>
<tr>
<td>Payback period</td>
<td>years</td>
<td>0.14</td>
</tr>
</tbody>
</table>
Oxygen Enrichment or Oxy-Fuel Burners
Are these for you?

- Oxygen enrichment (adding oxygen to combustion air) can help increase production
- Economic issues to consider when using oxygen:
  - Increased productivity
  - Reduction in emissions
  - Maintenance cost reduction
  - Product quality improvement
  - Cost of oxygen
  - Increase in dross or oxidation losses
  - Possible increase in furnace wall temperature – maintenance cost
- For most high temperature (>1,600°F) heating applications the use of O₂ cannot be justified on the basis of energy savings only. Several factors mentioned above can help to justify use of oxy-fuel burners.
- The exhaust-gas heat cannot be used to preheat combustion “air” or oxygen when the O₂ content of the “air” is greater than 30%
### Gas vs. Electricity Cost Comparison Calculator

#### Find Equivalent Electric Rate

<table>
<thead>
<tr>
<th>Gas Equipment Efficiency</th>
<th>60%</th>
<th>% - Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electric Heating Efficiency</td>
<td>85%</td>
<td>% - Percent</td>
</tr>
<tr>
<td>Gas Cost</td>
<td>$7.00</td>
<td>per million Btu (Mcf)</td>
</tr>
<tr>
<td>Gas equipment provides cost savings when electric power cost is equal to (or higher) than this power rate</td>
<td>3.4</td>
<td>Cents/kW</td>
</tr>
</tbody>
</table>

#### Find Comparable Gas Rate

<table>
<thead>
<tr>
<th>Electrical Equipment Efficiency</th>
<th>85%</th>
<th>% - Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas Equipment Efficiency</td>
<td>60%</td>
<td>% - Percent</td>
</tr>
<tr>
<td>Electricity Cost</td>
<td>9.0</td>
<td>Cents/kwh</td>
</tr>
<tr>
<td>Gas equipment provides cost savings when gas cost is equal to (or below) this gas cost</td>
<td>18.62</td>
<td>$/MM Btu (Mcf)</td>
</tr>
</tbody>
</table>
Energy Saving Methods for Electrical Furnaces and Ovens

- Peak demand management to reduce demand charges
- Use of proportional control vs. on-off control
- Properly installed, better, higher value insulation for furnace walls
- Proper spacing of electrical elements
- Clean the heating elements
- Shield elements to avoid possible shorting due to mismanaged load
- Use radiation shields- insulation and seals to avoid radiation losses and air leaks
- Consider shutting down the furnace when not in use. Consider energy used for heat-up time vs. idling
- Reevaluate purge requirements and purge flows depending on application and process
**Induction Heating**

**Energy Efficiency Improvement Opportunities**

- Maximize equipment utilization (operation at full-design loading conditions. Part load is highly inefficient.
- Use proper coil design to meet heating application requirements
- Eliminate or reduce openings between zones to reduce radiation heat losses
- Streamline downstream processes to avoid long delays after heating, streamline temperature measurement and material handling.
- Use selective heating – heat just the area or section that needs to be heated for the subsequent operations (forged, quenched etc.)
- Consider use of hybrid (combined gas and electric) heating for large parts or multiple heating – heat treating operations
- Evaluate use of “controlled Cooling” to eliminate heat treating steps

Source: Inductotherm
Heat Transfer

1. Use of high convection – radiation systems (i.e. burners, jets etc.)

2. Frequent cleaning of heat transfer surfaces (radiant tubes, recuperator tubes, electrical elements, boiler tubes etc.)

3. Replace steam heating by direct fired systems (i.e. wash-rinse systems, space heating, pickle tanks etc.)

4. Use direct firing to replace indirect heating (i.e. replace radiant tubes in annealing furnaces)

- Energy Saving Potential
  - 5% to 10%

- Typical implementation time
  - 1 to 12 months

- Typical payback period
  - 6 to 30 months
Heat Containment

1. Use of proper and adequate insulation for cooling surfaces (i.e. rolls, skids, walking beam rails etc.)

2. Furnace pressure control to maintain balanced pressure at all operating conditions

3. Regular maintenance of insulation, seals and refractories for furnace walls, doors etc.

4. Close-plug unnecessary openings, install radiation shields and curtains where possible.

- **Energy Saving Potential**
  - 2% to 10%

- **Typical implementation time**
  - 1 to 8 weeks

- **Typical payback period**
  - 1 to 6 months

*It is possible to save up to $150,000 Every Year!*
Cost of Air Leakage
(You would never guess correct....)

Cost of Air Infiltration in a Furnace

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Furnace draft (neg. pressure) inch. W.C.</td>
<td>0.050</td>
</tr>
<tr>
<td>Opening size - area ft^2</td>
<td>1.00</td>
</tr>
<tr>
<td>Combustion air temperature (F)</td>
<td>80</td>
</tr>
<tr>
<td>Temperature of flue gases (F)</td>
<td>2000</td>
</tr>
<tr>
<td>Excess air used in burners (%)</td>
<td>10.00</td>
</tr>
<tr>
<td>Available heat for burners (%)</td>
<td>41.90</td>
</tr>
<tr>
<td>Fuel cost $/Million Btu</td>
<td>7.00</td>
</tr>
<tr>
<td>Operating hours/year</td>
<td>6000</td>
</tr>
<tr>
<td>Heat reqd. (net) to heat air Btu/hr.</td>
<td>1,520,311</td>
</tr>
<tr>
<td>Gross heat reqd. Btu/hr</td>
<td>3,628,307</td>
</tr>
<tr>
<td>Air infiltration from the opening (SCFH)</td>
<td>40,188</td>
</tr>
<tr>
<td>Cost of fuel wasted per year</td>
<td>152,389</td>
</tr>
<tr>
<td>Cost of pressure control system</td>
<td>40,000</td>
</tr>
<tr>
<td>Simple payback period (months)</td>
<td>3.15</td>
</tr>
<tr>
<td>CO2 emission reduction</td>
<td>1,274</td>
</tr>
</tbody>
</table>

Added Benefits:
Better temperature uniformity and Less scale

3/24/2010
Arvind Thekdi: FIA March 24, 2010
Conference
Methods for Furnace Draft Control

- **Mechanical Damper**
  - Counterweighted Damper
  - Less common for high temperature furnaces

- **Air Jet Damper**
  - Drilled Air Manifold
  - Motorized Control Valve
  - Damper Air Blower
  - Common for high temperature furnaces
Fixed and Variable Opening Loss

- Radiation loss from openings is a preventable heat loss
- Different types of openings result in radiation heat loss:
  - Fixed openings, such as a hole or crack in the furnace walls or doors, an open stack facing the sky, etc.
  - Variable openings such as a door opened during charging or discharging of material
- Simple actions or modifications could save thousands of dollars per year. Usually the payback period is less than few months.
Savings
Reduce Furnace Opening Size

<table>
<thead>
<tr>
<th>REDUCE LOSS FROM A FURNACE OPENING</th>
<th>Current</th>
<th>New</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average furnace temperature (F)</td>
<td>2,100</td>
<td>2,100</td>
</tr>
<tr>
<td>Ambient temperature (F)</td>
<td>80</td>
<td>80</td>
</tr>
<tr>
<td>Radiation heat Loss [Btu/(hr<em>ft^2)]</em></td>
<td>59,476</td>
<td>59,476</td>
</tr>
<tr>
<td>Opening area (ft^2)</td>
<td>1</td>
<td>0.25</td>
</tr>
<tr>
<td>Furnace flue gas temp. (F)**</td>
<td>2,200</td>
<td>2,200</td>
</tr>
<tr>
<td>% Oxygen in flue gases</td>
<td>3.0</td>
<td>3.0</td>
</tr>
<tr>
<td>Combustion air temp. (F)</td>
<td>80</td>
<td>80</td>
</tr>
<tr>
<td>Total heat required to compensate heat losses (Btu/hr)</td>
<td>121,575</td>
<td>30,394</td>
</tr>
<tr>
<td>Furnace operating hours per year (incl. hold time)</td>
<td>7,500</td>
<td>7,500</td>
</tr>
<tr>
<td>Cost of fuel ($/MM Btu)</td>
<td>$7.00</td>
<td>$7.00</td>
</tr>
<tr>
<td>Energy savings per year (MM Btu/year)</td>
<td>Base</td>
<td>684</td>
</tr>
<tr>
<td>Cost of fuel used for losses ($/year)</td>
<td>$6,383</td>
<td>$1,596</td>
</tr>
<tr>
<td>Savings $/year per furnace</td>
<td>Base</td>
<td>$4,787</td>
</tr>
<tr>
<td>Cost of installing a door or other device</td>
<td>$500.00</td>
<td></td>
</tr>
<tr>
<td>Simple payback -months</td>
<td>1.25</td>
<td>40</td>
</tr>
<tr>
<td>CO2 savings (tons/year)</td>
<td>Base</td>
<td>40</td>
</tr>
</tbody>
</table>

Reducing furnace opening of 1 sq. ft. to 0.25 sq. ft. can save almost $5,000 per year. Payback can be less than 2 months.

Hard part is to train the people!
Waste Heat Recovery

1. Combustion air preheating using flue gases
2. Charge – load preheating using furnace flue gases or separate heating system
3. Cascading of hot gases to lower temperature in-line processes
4. Possible use of waste heat boiler for large continuous reheat furnaces

- Energy Saving Potential
  - 10% to 30%

- Typical implementation time
  - 4 to 16 weeks

- Typical payback period
  - 1 to 30 months

It is possible to save up to $90,000 and up… Every Year!
Use of a preheated combustion air in “cold-air” forging reheat furnace can save >$90,000 dollars per year.

<table>
<thead>
<tr>
<th>Savings by Preheating Combustion Air</th>
<th>Current</th>
<th>New</th>
</tr>
</thead>
<tbody>
<tr>
<td>Furnace flue gas temp. (F)</td>
<td>2,200</td>
<td>2,200</td>
</tr>
<tr>
<td>Percent O2 (dry) in flue gases</td>
<td>3.00</td>
<td>3.00</td>
</tr>
<tr>
<td>% Excess air</td>
<td>14.92</td>
<td>14.92</td>
</tr>
<tr>
<td>Combustion air temperature (F)</td>
<td>80</td>
<td>1,100</td>
</tr>
<tr>
<td>Fuel consumption (MM Btu/hr) - Avg. current</td>
<td>5.50</td>
<td>3.27</td>
</tr>
<tr>
<td>Fuel savings (%)</td>
<td>Base</td>
<td>40.48%</td>
</tr>
<tr>
<td>No. of operating hours</td>
<td>6000</td>
<td>6000</td>
</tr>
<tr>
<td>Energy used per year (MM Btu/year)</td>
<td>33,000</td>
<td>19,640</td>
</tr>
<tr>
<td>Energy saved per year (MM Btu/year)</td>
<td>Base</td>
<td>13,360</td>
</tr>
<tr>
<td>Cost of fuel ($/Million Btu)</td>
<td>$7.00</td>
<td>$7.00</td>
</tr>
<tr>
<td>Annual savings ($/year)</td>
<td>Base</td>
<td>$93,519</td>
</tr>
<tr>
<td>Cost of preheated air system - installed</td>
<td>$/MM Btu per hour</td>
<td>$30,000</td>
</tr>
<tr>
<td>Cost of preheated air system - installed</td>
<td>$</td>
<td>$66,800</td>
</tr>
<tr>
<td>Additional cost - burners, piping etc.</td>
<td>$</td>
<td>$150,000</td>
</tr>
<tr>
<td>Total cost</td>
<td>$</td>
<td>$216,800</td>
</tr>
<tr>
<td>Payback period</td>
<td>years</td>
<td>2.32</td>
</tr>
</tbody>
</table>
Use of Waste Heat Recuperator for Combustion Air Preheating

Added Benefit Potential:
Increased production by 5% to 20% energy savings
Regenerative Burners
Operating Principle

For direct-fired furnaces
Regenerative Burners

- The regenerative burner system includes a specially designed burner and associated regenerator
- The burners are always used in a pair
- The regenerative system is used for combustion air preheating
- The system is used for relatively high-temperature applications such as steel reheating in forging industry
- Overall heat-recovery efficiency is in the range of 70% to 85%
- Major issues for this type of system include: plugging of the bed resulting in frequent maintenance, furnace pressure control, size of the burner-regenerator system, space requirement around an existing furnace, and higher initial cost
- In most applications the payback period is 2 to 3 years
Combustion Air Preheating
So..why isn’t every one doing it?

1. High exhaust gas temperature – in excess of 1600 deg. F. for most of the time – is a concern for cost, maintenance and life. Of the equipment.
2. Batch operation with long soak or hold times.
3. Not enough “up-time” – one or two shift operations to justify cost.
4. Presence of scale particles and other contaminants in flue gases.
5. Maintenance issues for recuperators as well as regenerators.
6. For retrofit applications it is necessary to change combustion system (burners, piping etc.) when preheated air is used.
7. Cost of heat recovery system including piping, burners etc. – lack of funding availability.
8. Unrealistic payback period limits (one year?)
9. Concern about NOx emissions, repermitting, “grand father” clause etc.
10. “Gas prices may drop” – why spend money?
Charge Preheating for a Forging Furnaces

Charge preheating in a medium size forge furnace can save up to $175,000 per year in energy cost and may increase production.

| Calculations for Savings - Furnace Charge Preheating using Exhaust Gases |
|-----------------------------|-----------------------------|
|                            | Base                | New                |
| Charge Initial temp (F)     | 80                  |                    |
| Charge Preheat temp (F)     | 80                  | 450                |
| Final steel temp. (F)       | 2100                | 2100               |
| Flue gas temp from furnace  | 2200                | 2200               |
| Airpreheat temp.            | 80                  | 80                 |
| Current O2 in flue gases (%)| 3.00                | 3.00               |
| Available heat (%)          | 34.66               | 34.66              |
| Current Furnace Energy use (Btu/lb) | 1250.00 |                |
| % Fuel savings              |                    | 12.8%              |
| Energy Cost $/MM Btu        | $7.00               | $7.00              |
| Energy Cost $/lb            | $0.009              | $0.007             |
| Production lbs./hr          | 20000.0             |                    |
| Energy cost/hr.             | $175.00             | $145.64            |
| Operating Hrs./year         | 6000                | 6000               |
| Savings - Energy cost $/year|                    | $176,133           |
External Charge Preheater

[Diagram of an external charge preheater system with labeled components: circulating fan, heater damper motor, burner damper motor, high temp cut out, furnace burner controller, melting furnace, preheater.]
Heat Cascading

- In a heat cascading system, heat from furnace exhaust gas (primary process) is transferred to a lower-temperature (secondary) process.

- Most commonly used methods are:
  - Building heating in colder climate locations using glycol water systems.
  - Water heating for the plant processes such as parts washer or make-up water heating for boilers if used.
  - Air heating for use in other processes such as drying or heat treating furnaces.
  - Steam generation only for large systems such as firing rate of larger than 15 to 20 MM Btu/hr.
Heat Cascading

Issues to Consider

1. Is the temperature of the flue gases high enough to heat the secondary process?
2. Do the flue gases contain enough transferable energy?
3. Are the flue gases compatible with the secondary process (cleanliness, corrosiveness)?
4. Is the primary process able to deliver energy to the secondary process in time?
5. Are the two processes in close proximity, so that excessive heat loss during waste gas transport can be avoided?
6. Will the flue gases leave the secondary process at a high enough temperature to avoid problems with moisture condensation?
7. Can the exhaust ductwork and secondary process be designed to avoid excessive pressure resistance to the flue gases, or are additional means like exhaust fans necessary?
Energy Savings

Other Plant Energy Systems

• For forging industry substantial amount of energy can be saved by taking actions for other energy systems.
• The main systems to be considered are:
  – Electric motors
  – Pumping system (pumps, valves, piping, leaks, recirculating water etc.)
  – Compressed air systems (compressors, after coolers, accumulators, piping, leaks etc.)
  – HVAC, lighting etc. (not addressed here)
• In each case it is possible to take simple steps that can save large amount of energy.
• In most cases these steps do not require large capital investment: just good operating practices, house keeping, personnel training and simple maintenance have several thousands of dollars.
• We have seen this implemented successfully in many countries.
Electric Motor Systems

Find your route to more efficient Electric Motor System

Electric Motor Consumption: 10-25% of total usage
Electric motors used for fans and blowers, conveyors, doors, material processing, pumps etc.

Potential Energy Savings: 5-20% of electric motor energy cost
By selection of proper motors and by improving operations

Steps to Improving Electric Motor System Efficiency
1. Use Adjustable Speed Drives (ASDs) or two-speed motors where appropriate.
2. Consider load shedding. Use controls to turn off idling motors.
3. Consider replacing existing V-belts with cogged belts.
4. Choose energy-efficient motors for new applications. Consider replacement vs. repair for older, inefficient motors.
5. Match motor operating speeds, and size motors for overall system efficiency.
Compressed Air System

Find your route to more efficient Compressed Air system

Compressed air systems: 2 - 5% of total energy usage.

Potential Energy Savings: 5 - 15% of the compressed air system energy cost

Steps to Improving Compressed Air System Efficiency

1. Check, identify and repair air leaks.
2. Review air pressure requirements for the processes and consider use of lower pressure blowers where lower pressure air is used.
3. Ascertain compressor type, its control and the effect on your compressor. Turn off unneeded compressors.
4. Proper maintenance of moisture control system to eliminate excessive moisture and contaminants in compressed air.
5. Add adequate and dedicated storage for high-volume intermittent air requirements.
Pumping Systems

Find your route to more efficient Pumping System

Pumping Systems Consumption: 5 - 10% of total energy usage.

Potential Energy Savings: 10-20% of the pumping system energy cost

Steps to Improving Pumping System Efficiency

1. Use adjustable speed drives or parallel pumps to meet variable flow requirements.
2. Trim impellers, use slower speed motors and/or gear reducers or replace it with a properly sized pump where pumps are dramatically oversized.
3. Use automatic start control or manually turn off a pump that is used intermittently or occasionally.
4. Clean pipe systems to reduce frictional losses when pressure drop becomes excessive.
5. Repair or replace pumps when performance degrades.
New Development
Scale Free Steel Reheating

• A joint program between the US DOE, forging industry (FIA) and the steel industry

• Primary Objective
  – To develop and test a scale free heating process and associated system design that reduces scale formation in steel reheating process

• Approach
  – Use of sub-stoichiometric combustion of natural gas to produce a non-oxidizing furnace atmosphere within the furnace with integration of a heat recovery system to optimize energy efficiency and economics of steel reheating furnaces.

• Benefits
  – Elimination of Scale formation during reheating
  – Reduction in energy use
  – Significant production and maintenance cost advantages
  – Improvement in steel quality
Scale (Iron Oxide) Cost and Issues for the Forging Industry

- Steel reheat temperature - 2100°F to 2300°F
- Scale loss – 2% to 5% of the charged metal
- Product loss cost - $10 to $30 per ton of steel forged based on $400 to $600 per ton of the forging delivered.
- Real savings can be much larger due to other benefits.
- Additional cost issues:
  - Scale build up on dies,
  - Productivity loss,
  - Product surface quality,
  - Scale handling,
  - Equipment maintenance
Applicability of Scale Free Heating in Forging Industry

- Scale free heating system can reduce scale loss from a furnace by 75% to 95%.
- There is a long history (more than 30 years) in forging industry.
- Ideal for large continuous furnaces such as rotary hearth furnaces.
- Payback period for new installations or retrofit vary from 6 months to 2 years.
- Application to batch furnaces require economically justifiable use of “rich” combustion products that may contain large amount of the total heat input in the furnace at certain parts of the heating time or cycle.
- Main incentives are in reduction of scale and associated issues (productivity – down time, product quality, maintenance, die costs etc.) rather than energy savings at the plant.
Suggested Next Steps and Actions

• Contact regional Industrial Assessment Centers for energy audit.
• Contact DOE – Save energy Now team if your plant is large enough to qualify for an energy assessment.
• Attend one day trainings to learn about energy savings and available tools to identify and analyze energy savings in your plant. The courses are offered at selected locations throughout the country.
• Look for programs offered by the local utility companies, gas and electric, for training and financial support for energy efficiency programs.
• Refer to DOE-OIT web page for the training schedule and location in your area. The web page is: www.eere.energy.gov/industry (You may have to copy and paste)
• Contact one of the qualified specialist to help you use PHAST and/or perform energy assessment
Questions and Answers