ITP's Top Low- or No-Cost Improvements

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Michael B Muller

- Mechanical Engineer
- Developed and maintains IAC database
- Qualified Specialist and Energy Expert in
  - Steam, Pumps, Fans, & Process Heating
- Has conducted multiple ESA, IAC, and similar style industrial energy assessments.

Topics to be Covered:

- Overview of:
  - Low/No Cost Improvements
  - ITP Assessments

Specific LNC Improvements resulting from:

- IAC Assessments
- ESA: Steam
- ESA: Compressed Air (Keith A. Woodbury)
- ESA: Process Heating (Dr. Kelly Kissock)

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Why are these Opportunities Missed?

- Perceived Safety/Avoiding Risk
- Standard/Consistent Operation
- Distributed Responsibility
- Lack of Instrumentation
- Being Unaware of Other Options
- Understanding
- Resistance to Change
- Comfort & Convenience

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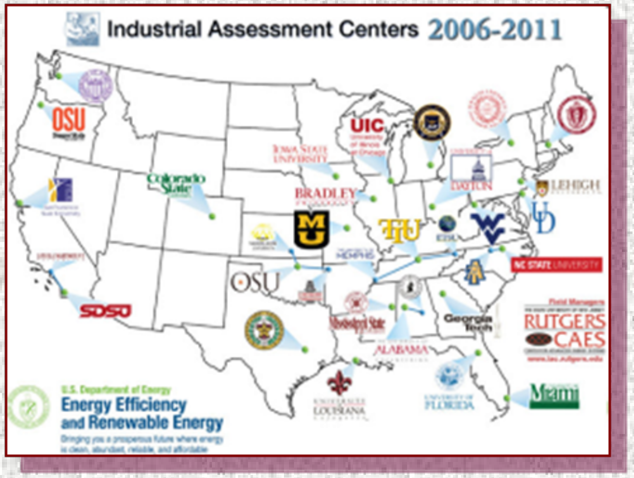
How do you find these Opportunities?

Optimization

IAC – Industrial Assessment Centers

- Small to Medium Plants
- University Based
  - Currently 26 centers
- 1 Day Multi-System
- Assessment Results Available Online
  - 14,492 Assessments
  - 105,784 Recommendations



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ESA – Energy Savings Assessments

- Designed for Large Plants
- Performed by DOE Energy System Experts
- 3 Day Single-System Assessment & Training
  - Steam
  - Process Heating
  - Pumps
  - Fans
  - Compressed Air
  - Multi-System-Paper (NEW)

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IAC Low/No Cost Improvements

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IAC Low/No Cost Improvements

Learn More
- Assessment Protocol
- Glossary of Terms

Industry Classification:
- SIC
- NAICS

Search By:
- Assessments
- Recommendations

Recommendation Index

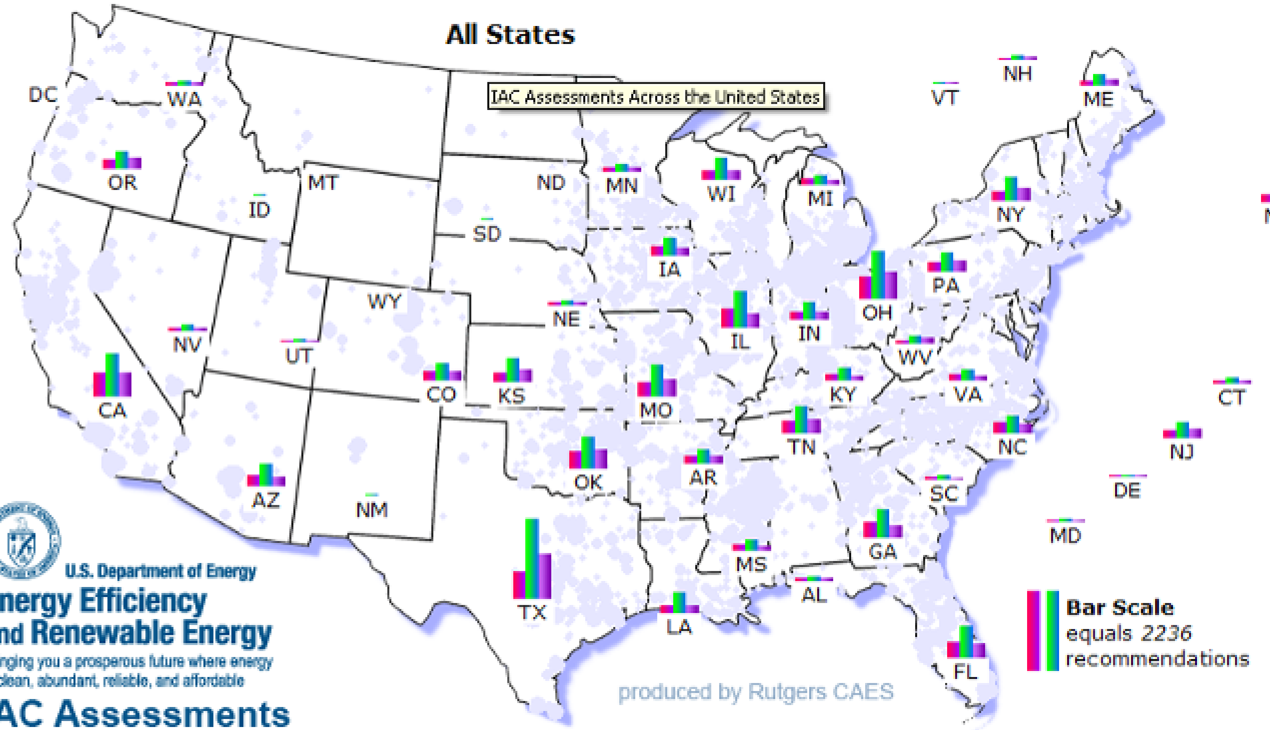
IAC Geography
- Summary by State

IAC Webcast Series

State	Assessments	Recommendations
All	10156	20840 (10897)

Assessments
Recommendations
Implemented

All States



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IAC Assessments

State	Assessments	Recommendations	Payback (Years)	Implemented	Payback (Years)	Imp %
Alabama	91	152	0.1	71	0.1	46.71%

IAC Most Common

	ARC	Description	# of Recc'd	Average Savings	Average Cost	Average Payback	Implementation Rate
1	2.4231	Reduce The Pressure Of Compressed Air To The Minimum Required	2,343	$2,761	$17	0.01	45.50%
2	2.4111	Utilize Energy-efficient Belts And Other Improved Mechanisms	1,604	$2,316	$4	0	58.29%
3	2.4236	Eliminate Leaks In Inert Gas And Compressed Air Lines/ Valves	991	$2,766	$29	0.01	75.68%
4	2.7142	Utilize Higher Efficiency Lamps And/or Ballasts	985	$1,483	$19	0.01	56.85%
5	2.6218	Turn Off Equipment When Not In Use	715	$5,756	$6	0	60.56%
6	2.3131	Reschedule Plant Operations Or Reduce Load To Avoid Peaks	696	$9,399	$1	0	39.51%
7	2.7124	Make A Practice Of Turning Off Lights When Not Needed	549	$2,654	$6	0	65.57%
8	2.7111	Reduce Illumination To Minimum Necessary Levels	510	$3,032	$15	0.01	48.63%
9	2.6212	Turn Off Equipment During Breaks, Reduce Operating Time	494	$3,568	$5	0	56.88%
10	2.4314	Use Synthetic Lubricant	437	$2,882	$4	0	43.71%

Rejections

Lack of staff for analysis and/or implementation	15%
Unacceptable operating changes	12%
Impractical	11%
Not worthwhile	9%
Unknown	7%
Process and/or equipment changes	7%
Suspected risk or problem with equipment or product	6%
Facility change	5%
Disagree	5%
Bureaucratic restrictions	5%
Personnel changes	4%
Risk or inconvenience to personnel	4%
Material restrictions	4%
Production schedule changes	3%
Rejected after implementation failed	3%

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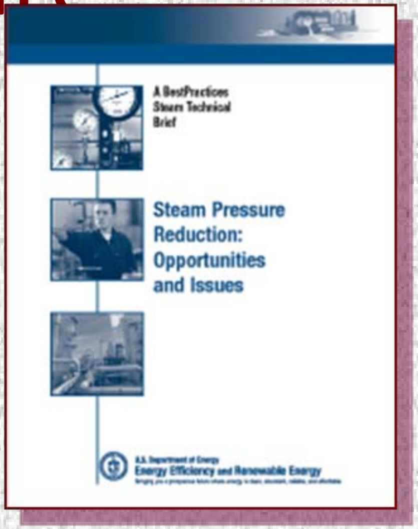
Steam Low/No Cost Improvements

- Reduce Boiler Pressure
- Reduce Combustion Air Flow Rate
- Reduce Blowdown Rate
- Reduce DA Flow Rate
- Increase Condensate Recovery
- Add & Repair Insulation

Reduce Boiler Pressure



- Reduces Boiler Temperature
- Increased Boiler Efficiency
- Suitable for oversized/over-pressured systems
- Should be adjusted in same increments and evaluated.
- Some parts of the steam system may have minimum pressure limitations that should be consider (Ex. Some steam traps may blow at lower pressures.)

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Reduce Boiler Blowdown Rate

- Often high because of poor controls and/or overly precautious operation.
- Commonly unchanged from initial settings, failing to incorporate new water treatment and operating conditions.
- Acts as a heat loss, even if heat exchangers and flash recovery systems are in place.
- Can reduce electrical generation if steam has steam turbines.

Reduce DA Flow Rate

- DA venting is a required steam lea
- Many DA vents have an adjustable valve or orifice.
- Better opportunity for larger plants.

For a DA vent operating at 0.5% of a steam flow rate 50 klb/hr, if this could lowered to 0.1%, this would save 1,752 klb/yr $10,500/yr at a marginal steam cost of $6 per klb

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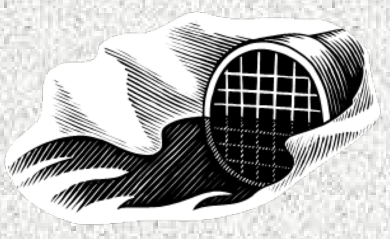
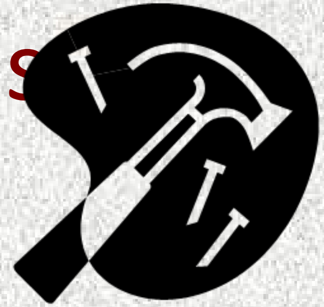
Increase Condensate Recovery



- Feedwater Temp: 55°F
- Condensate Temp: 180°F
- Energy Lost: 125 Btu/lbm
- @ 2 gpm => 1096 MMBtu per year
- @ $6 per MMBtu => $6,575 per year

DOE Tools and Resources



- IAC Database – http://iac.rutgers.edu/database
- DOE ITP Technical Publications – http://www1.eere.energy.gov/industry/bestpractices/publications.asp
- DOE ITP Software Tools – http://www1.eere.energy.gov/industry/bestpractices/software.html
- DOE ITP Training – http://www1.eere.energy.gov/industry/bestpractices/training.html
- DOE ITP Industrial Assessments – http://www1.eere.energy.gov/industry/bestpractices/plant_assessments.html

No/Low Cost Energy Saving Opportunities in Compressed Air Systems

Keith A. Woodbury

Director, Alabama Industrial Assessment Center

Alabama Industrial Assessment Center

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Overview

- Compressed Air ESA
- Compressed Air Energy Saving Improvements
  - Big three:
    - 1. Reduce air pressure
    - 2. Repair Leaks
    - 3. Recover compressor waste heat
  - Others:
    - 4. Reduce use of pneumatic tools
    - 5. Reduce/eliminate inappropriate uses

Energy Savings Assessments (ESAs)

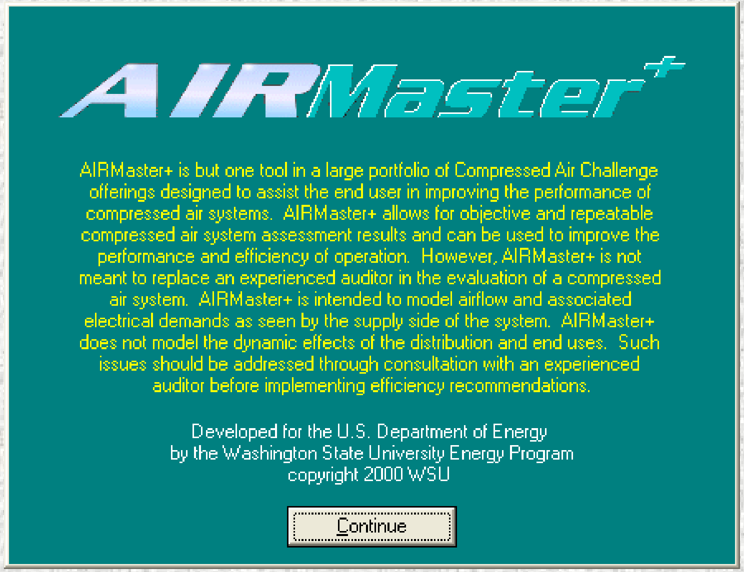
- national initiative of the Industrial Technologies Program (ITP)
  - Goal: reduce industrial energy intensity by 25% in 10 years.
- plant annual energy consumption must be 300 billion Btu or more (about $2.5M/yr)
  - IAC assessments are available to smaller companies

ESA process

- A three-day on-site visit focusing on a single system (e.g., compressed air)
- Energy Expert will guide assessment…
- …But plant personnel are required to actively participate
  - Training of company personnel is a significant component of the ESA process

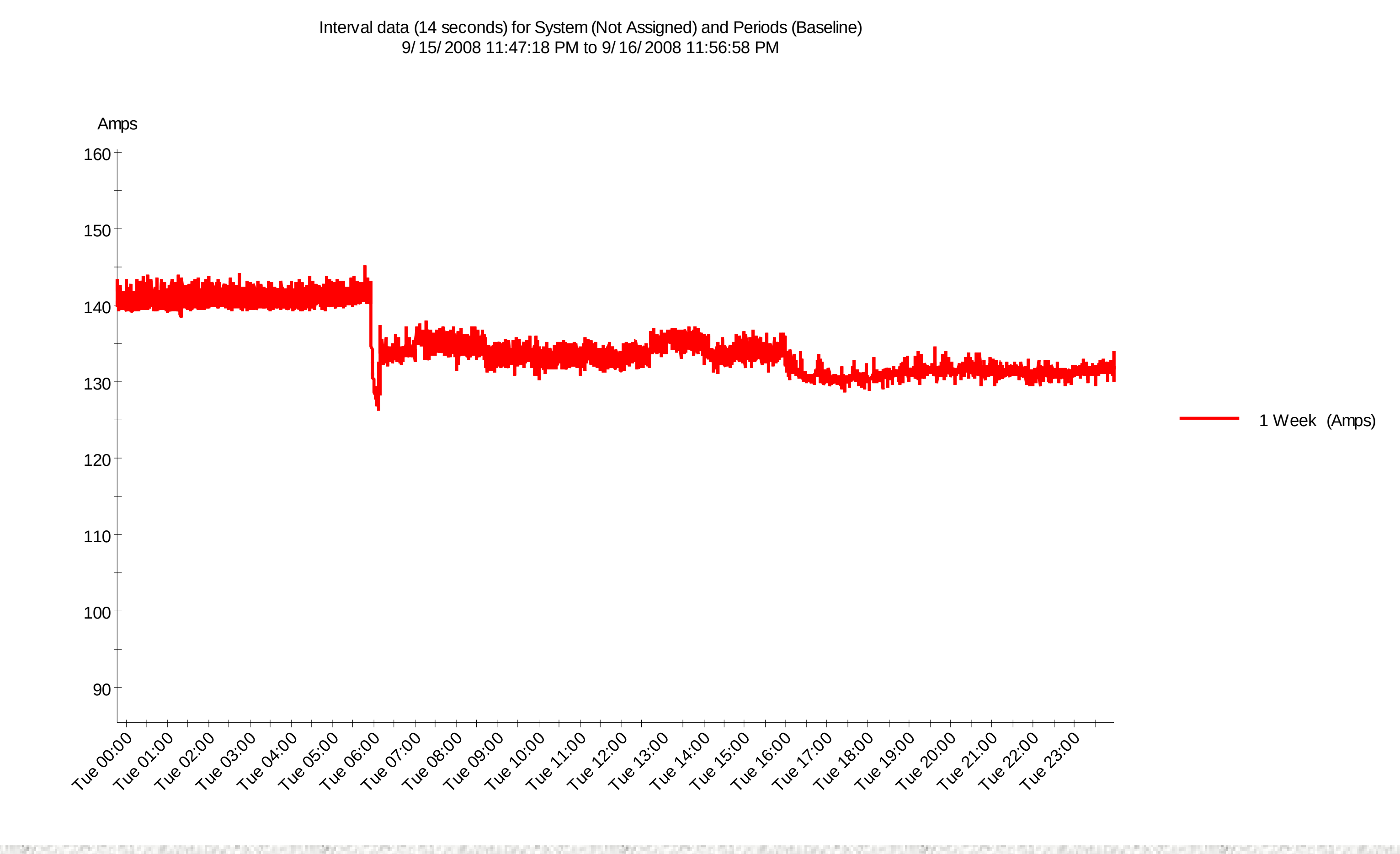
Compressed Air ESA

- Focus on ITP Best Practice tool AIRMaster+
- Work with plant personnel to gather data for baseline operation
- Profile baseline operation using AIRMaster+
- Explore "Energy Efficiency Measures" using AIRMaster+



Compressed Air Opportunities – No Cost

1. Reduce system pressure to lowest possible level



1. Reduce system pressure to lowest possible level (cont.)

- Rule of thumb: every 2 psi reduction saves 1% of compressor input
- AIRMaster+ results for 150hp compressor reducing from 110psig to 100 psig:

Data Entry | **Savings Summary**

Description	Energy Savings, kWh	Energy Savings, $	Energy Savings, %	Demand Savings, kW	Demand Savings, $	Installed Cost, $	Total Savings, $	Simple Payback, years
Reduce System Air Pressure	56,210	2,668	8.8	9.2	451	0	3,118	0.0
TOTALS	56,210	2,668	8.8	9.2	451	0	3,118	0.0

Double-click row to view corresponding measure input data

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Compressed Air Opportunities – Low Cost

2. Repair leaks
   - Plant with no air system maintenance program may have 20+% leaks
   - Well-maintained facility may still have 10% leaks
   - Leaks are direct waste of precious resource
   - Relatively inexpensive to repair

2. Repair leaks (cont.)

- Example: 2 x 250hp compressors, 8,400 hrs/yr, average flow 500 acfm, $54,200/yr
- AIRMaster+ results if reduce leaks from 20% to 10%:

Data Entry | **Savings Summary**

Description	Energy Savings, kWh	Energy Savings, $	Energy Savings, %	Demand Savings, kW	Demand Savings, $	Installed Cost, $	Total Savings, $	Simple Payback, years
Reduce Air Leaks	61,196	3,978	3.5	63.4	0	0	3,978	0.0
TOTALS	61,196	3,978	3.5	63.4	0	0	3,978	0.0

Double-click row to view corresponding measure input data

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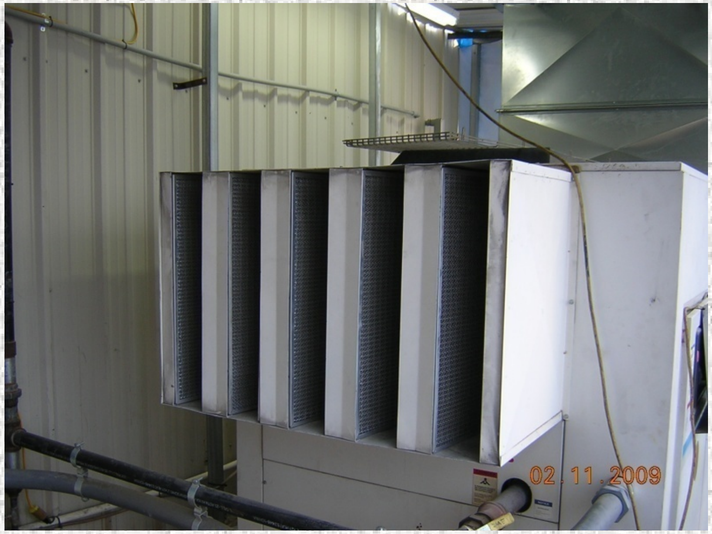
Compressed Air Opportunities – Quick ROI

3. Recover Waste Heat
   - only 10% to 20% of electric power of compressor is used to raise pressure
   - Remainder is dissipated as heat
   - Up to 50% of this heat can be captured and put to good use for
     - Comfort heating
     - Hot water heating
     - Feedwater pre-heating

3. Recover Waste Heat (cont.)

- Simple example



3. Recover Waste Heat (cont.)

- Example: 125hp compressor, 4000 heating hrs/yr, $8.00/MMBtu (gas for heating)
- Estimate 60% input power to space heat

➔ Avoided cost for heating = $7,600/yr

Compressed Air Opportunities – Low Cost

4. Reduce use of pneumatic tools
   – only 10% to 20% of electric power of compressor is used to raise pressure

➔ air-powered tools are highly inefficient

4. Reduce use of pneumatic tools (cont.)

- Example: 150 hp compressor, 6,350 hrs/yr operation, $0.075/kWh
  ➔ compressed air costs $0.28 per 1000 cf
- Example: 1.35 hp grinder uses 55 CFM air
  ➔ cost to operate for 1 hr = $0.92
- Example: 1.35 hp electric grinder
  ➔ cost to operate for 1 hr = $0.089

93% savings

Compressed Air Opportunities – Low Cost

5. Reduce inappropriate uses
   - Because compressed air is expensive, its use should be limited to applications for which no alternative is reasonable
   - Potentially inappropriate uses should be eliminated

5. Reduce inappropriate uses (cont.)

Application	Alternative(s)
Open blowing	Broom; brush; blower/fan
Vacuum generation	Dedicated vacuum pump
Personnel cooling	Fractional horsepower fan
Cabinet cooling (Vortex tubes)	Mechanical cooling; fans

Summary

- To reduce operational costs related to compressed air:
  1. Reduce operating pressure
  2. Repair leaks
  3. Recover waste heat
- Other improvements
  - Reduce use of pneumatic tools
  - Eliminate inappropriate uses

Low-Cost Measures for Energy Efficient Process Heating

By

Kelly Kissock Ph.D. P.E
Director: University of Dayton Industrial Assessment Center

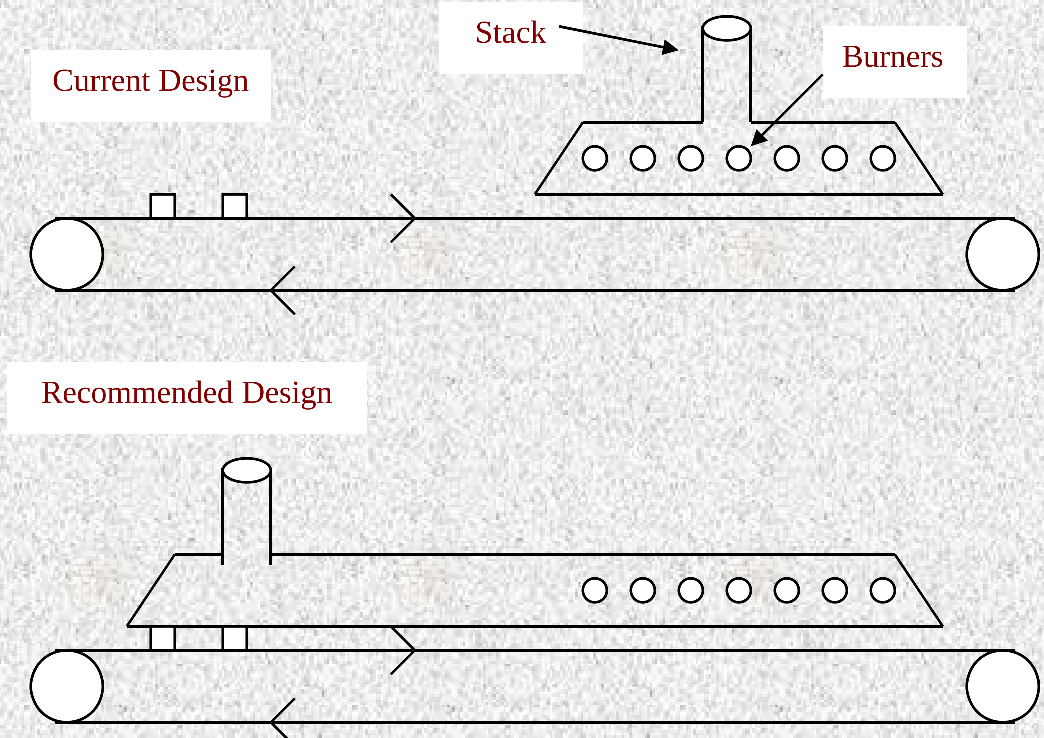
Insulate Hot Surfaces

- Insulation is best “employee”
- Comes to work every day
- Does it’s job every day
- Works for nothing

Cover Heated Tanks

- Lid or floats
- Reduces
  - Evaporation heat loss
  - Convection heat loss
  - Radiation heat loss

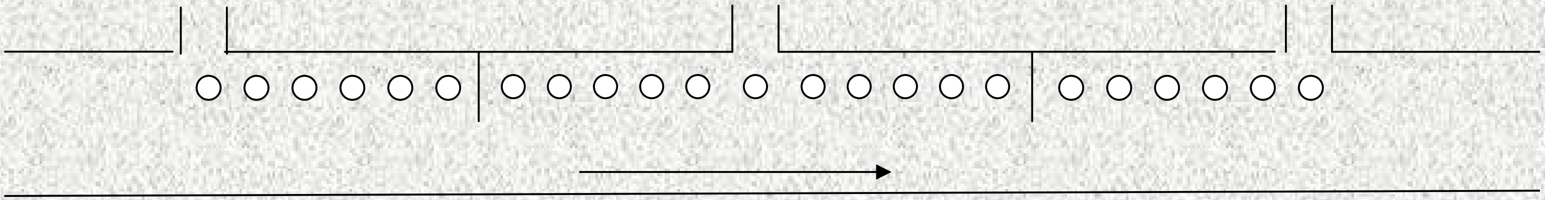
Counter-flow Heat Treating



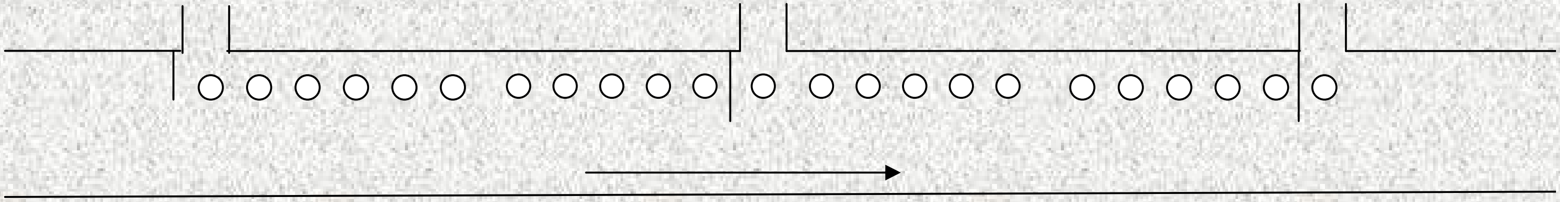
- Estimated Savings = $40,000 /yr

Preheat Continuous Load with Counter-flow Heat Exchange

Counter-flow Within Zones

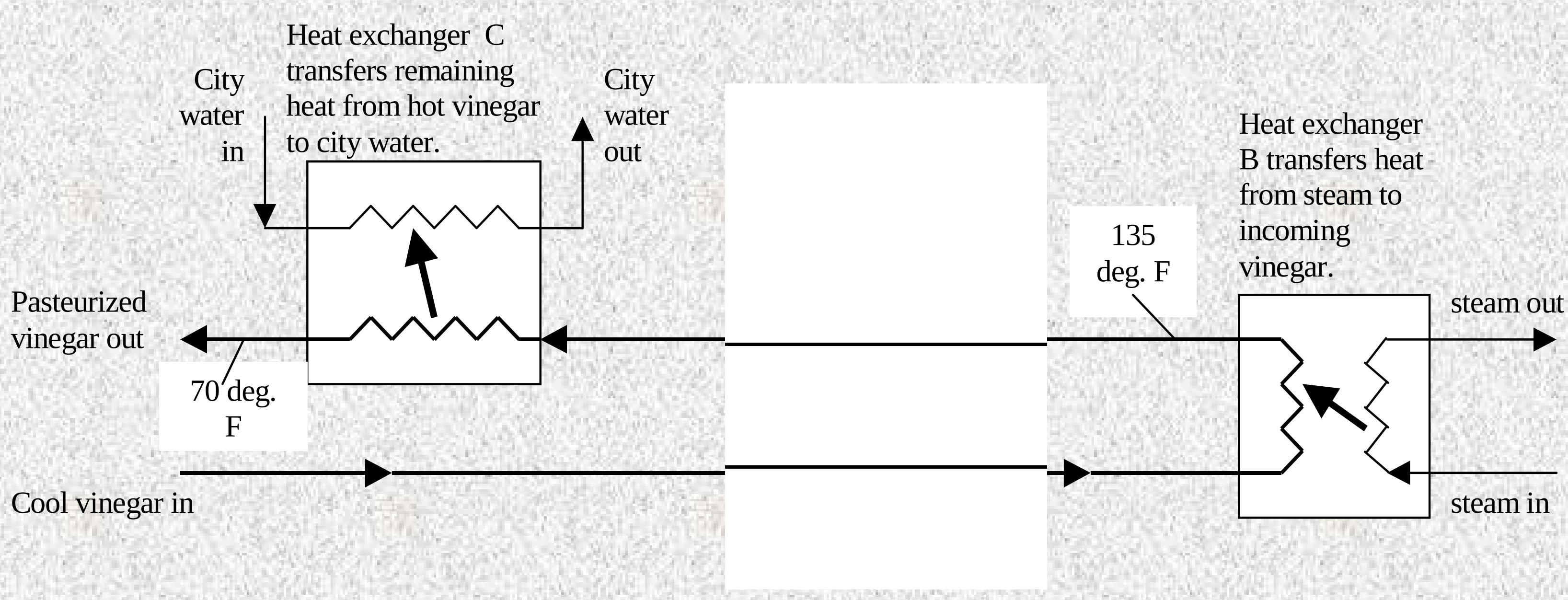


2 x (5 + 4 + 3 + 2 + 1) = 30 feet



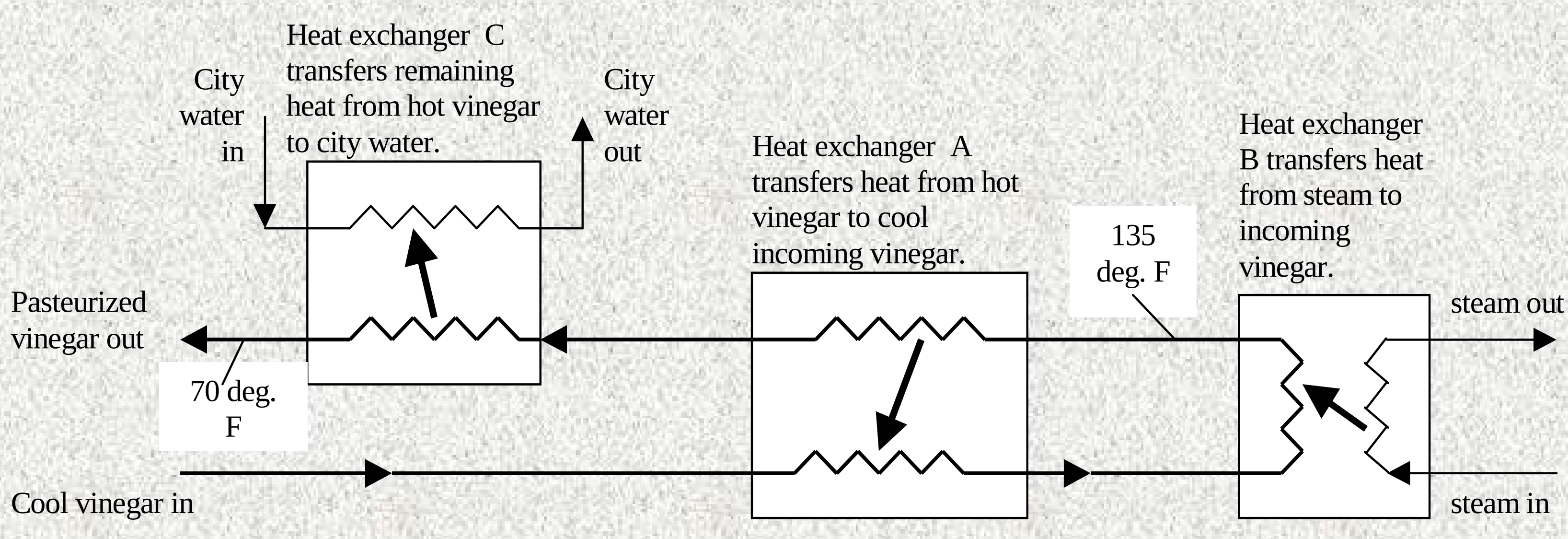
(10 + 9 + 8 + 7 + 6 + 5 + 4 + 3 + 2 + 1) = 55 feet

Counter-flow Heat Recovery



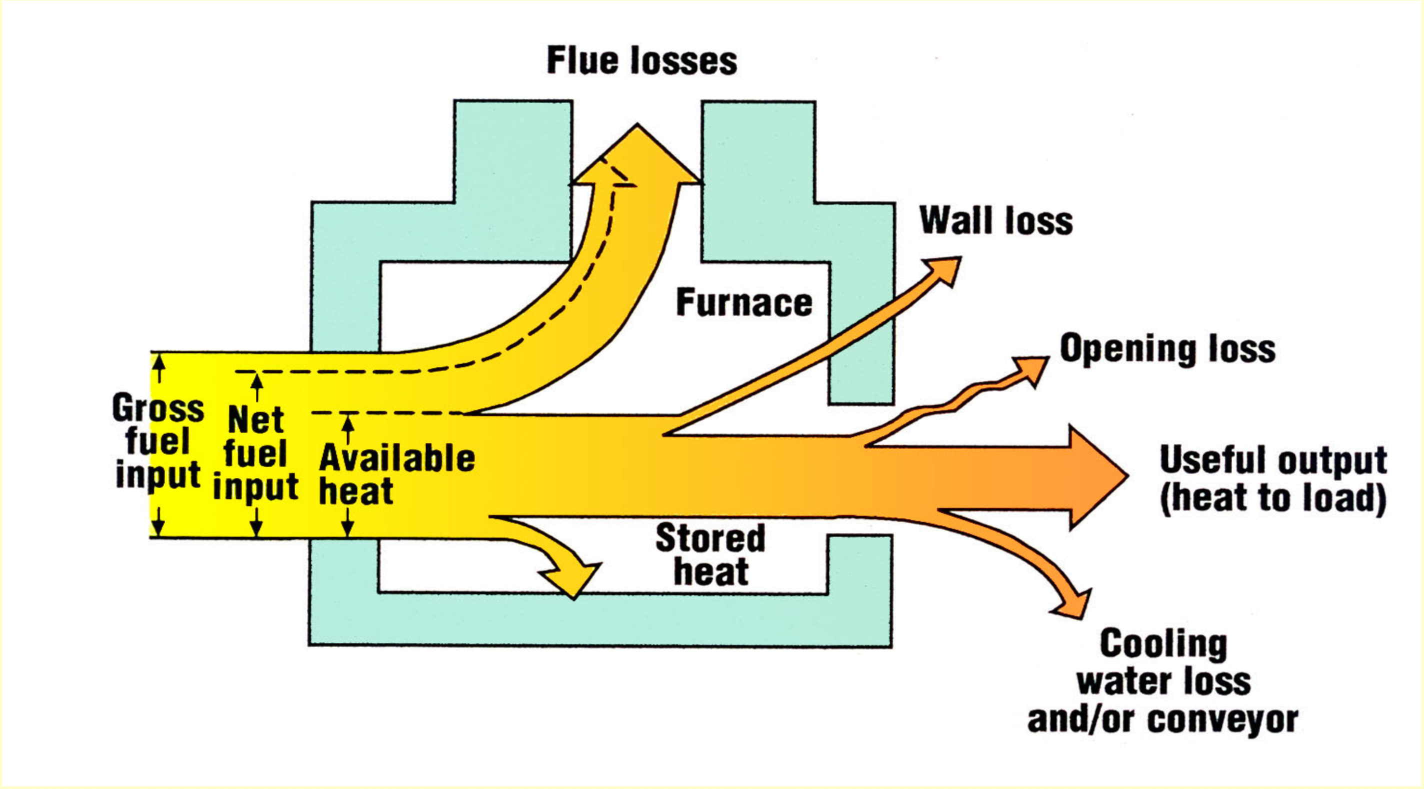
- Vinegar Pasteurization and Cooling

Counter-flow Heat Recovery



- Add Counter-flow heat exchanger
- Estimated Savings = $17,000 /yr

Heat Balance on Furnace



Natural Gas Combustion with Stoichiometric Air

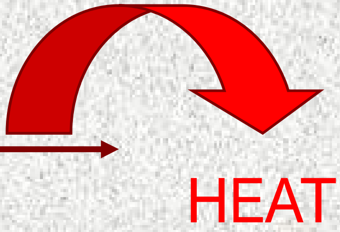
$$CH_4 + 2\,(O_2 + 3.8\,N_2) \longrightarrow CO_2 + 2\,H_2O + 7.6\,N_2$$

HEAT

- Oxygen breaks CH_4 into CO_2 and H_2O
- Nitrogen doesn’t react
- Heat absorbed by products: CO_2, H_2O and N_2

Natural Gas Combustion with Too Much Excess Air

$$CH_4 + 3\ (O_2 + 3.8\ N_2) \longrightarrow$$



$$CO_2 + 2\ H_2O + 7.6\ N_2 + 0_2 + 3.8\ N_2$$

- With 'excess' air, heat absorbed by excess O_2 and N_2
- Lowers flame temperature, heat transfer and efficiency.

Natural Gas Combustion with 'Correct' Amount of Excess Air

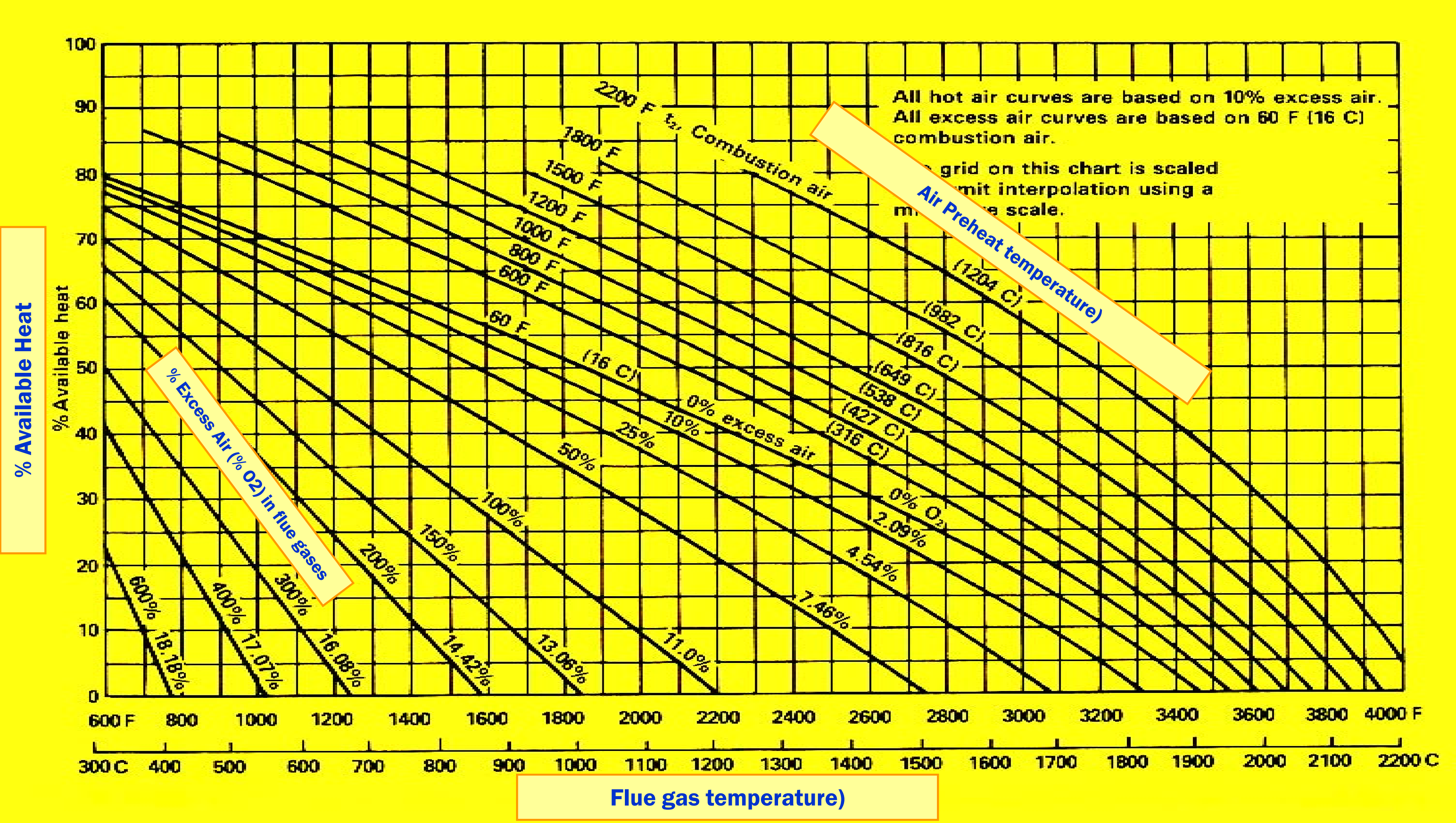
$$CH_4 + 2.2\ (O_2 + 3.8\ N_2) \longrightarrow$$

HEAT

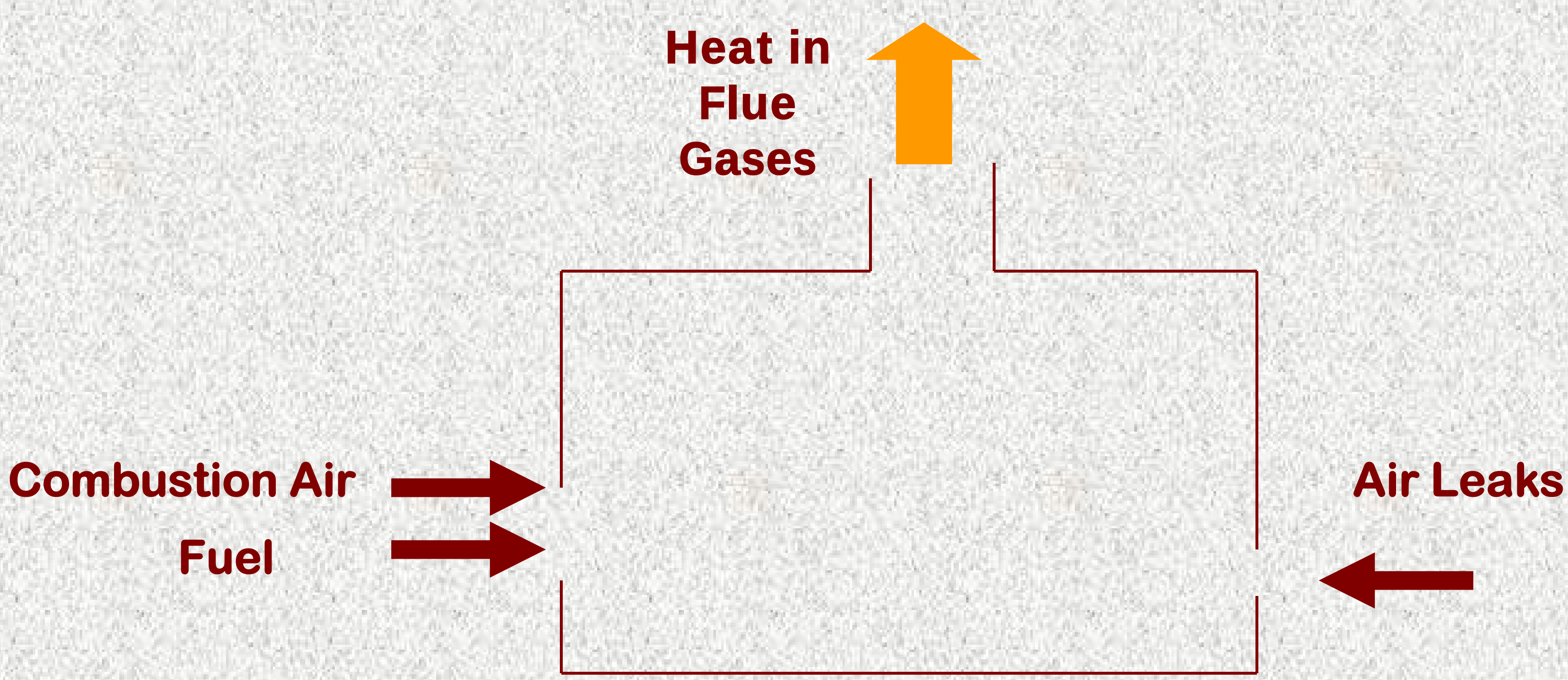
$$CO_2 + 2\ H_2O + 7.6\ N_2 + 0.4\ 0_2 + 0.8\ N_2$$

- About 10% 'excess' air, insures complete combustion
- 10% excess air = 2% O_2 in exhaust gasses

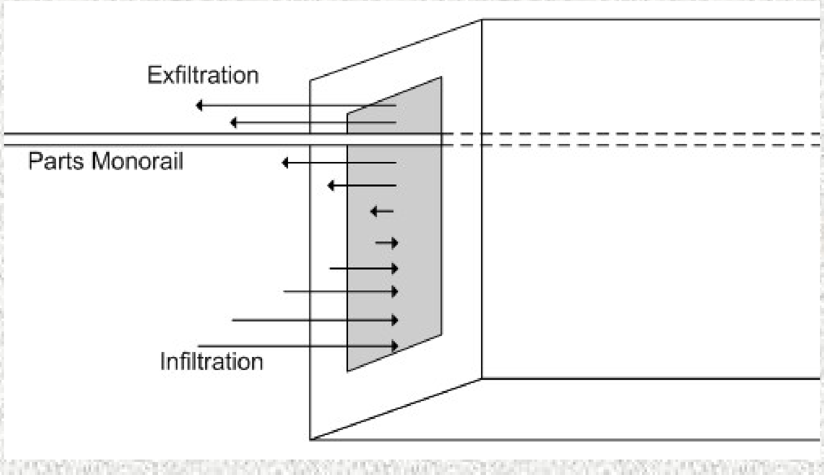
Fraction Heat Available to Furnace (Combustion Efficiency)

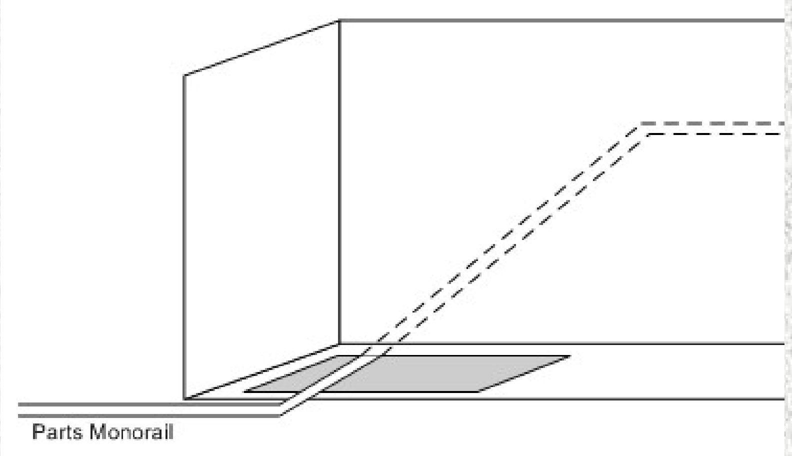


Minimize Air Leakage Into Furnaces



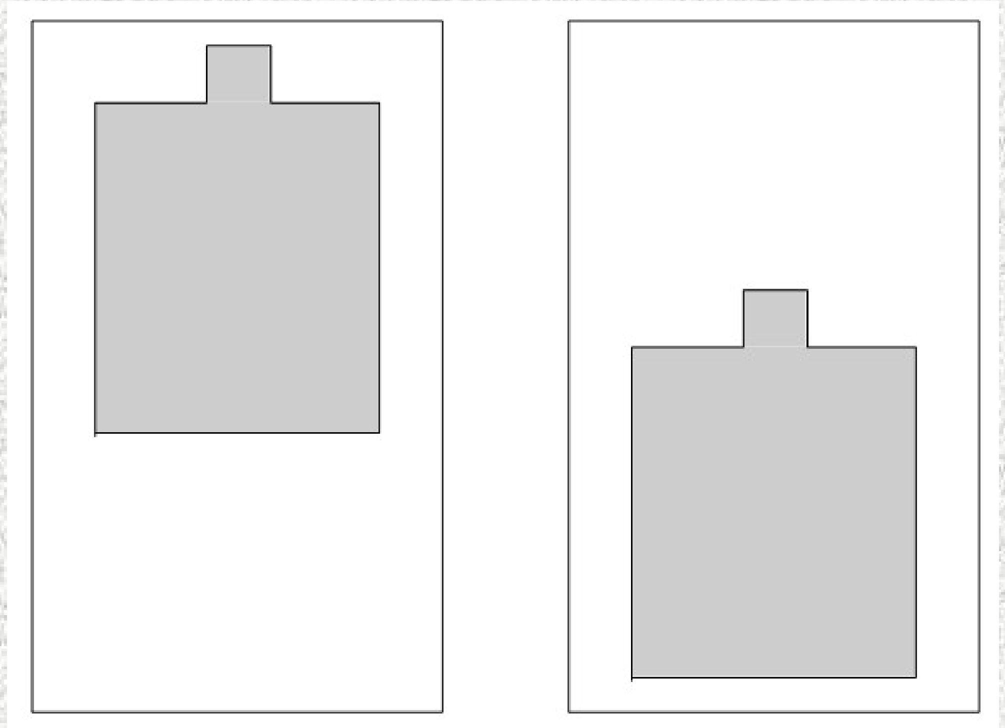
Managing Infiltration





Move Opening to Oven Floor

Managing Infiltration



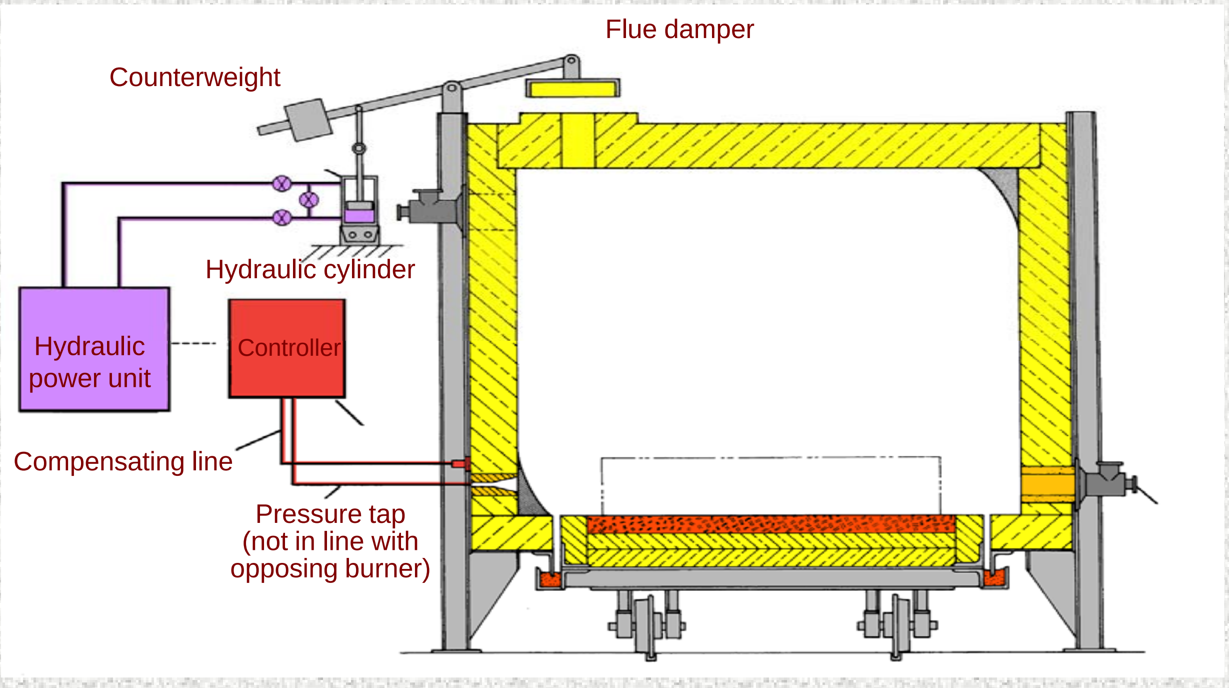
Lowering Openings

Seal Furnace Openings

Openings

- Usually enable air leakage into furnace
- Always enable radiation loss

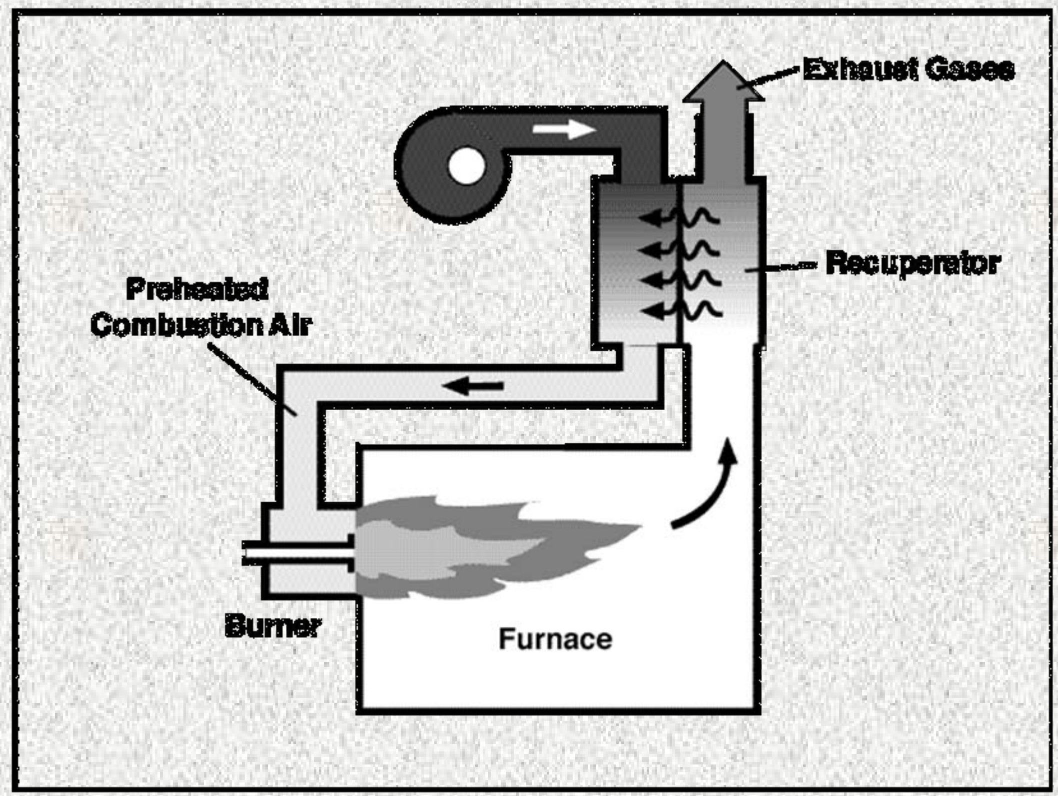
Use Draft Control to Balance Pressure



Cover Charge Wells

- 2 ft x 4 ft open charge well radiates and convects heat
- Cover charge well with mineral fiber insulation 75% of time
- Savings = $1,500 /yr

Preheat Combustion Air with Recuperator



Preheat Combustion Air with Tube–in-Tube Heat Exchanger