COMPRESSORS

OBJECTIVES

You will:

- Understand how a utility charges for refrigeration system energy and power.
- Understand the importance of reducing compressor lift.
- Understand efficient compressor capacity control strategies.
- Identify opportunities to reduce compressor energy usage.
- Estimate energy savings from compressor opportunities.

INPLT TRAINERS

Steve Koski, PE
Principal Engineer
Cascade Energy, Inc.
steve.koski@cascadeenergy.com

Tom Simenc, PE
Project Engineer
Cascade Energy, Inc.
tom.simenc@cascadeenergy.com

UTILITY BILL ENERGY BASICS EXERCISE

Purpose: To develop knowledge, comfort and proficiency with:

- energy units and calculations
- how refrigeration system power and energy are charged on a utility bill
- the relationship between energy and refrigeration system equipment

In the winter of 2015, a food processor in Fake City, Alabama received the electric bill shown below.

ACME ELECTRIC

February, 2015

Account ID	0004 1234-56789 8
Billing Dates	1/27/2015- 2/28/2015 33 days of service
Usage	490,793 kWh

Invoice Number	**123456789**
Current Charges	**$29,760.80**
Due By	**3/15/15**

Meter # ABC123456, Schedule 81 Secondary

Service Descriptions

Basic Charge	560.00
System Charge	593.85
Off-Peak Usage of 195,446 kWh x $0.0335	6,547.44
On-Peak Usage of 295,347 kWh x $0.0504	14,885.49
Demand Charge of 932 kW x $1.9500	1,817.40
Transmission Charge of 932 kW x$0.910	848.12
Distribution Facility Capacity Charge of 1,017 kW x $2.0600	2,095.02
	$27,347.32

Taxes and Adjustments

City Tax (1.5%)	410.21
Public Purpose Charge (3%)	820.42
108 Regulatory Adjustments	29.47
115 Energy Efficiency Funding	1,153.38
	$2,413.48

Period Ending	Avg. Daily Temp °F	Avg. kWh Per Day	Avg. Cost Per Day
This Year	45.6	14,872.5	$901.84
Last Year	46.2	15,020.9	$910.84

ACTIVITY SHEET – ENERGY BASICS EXERCISE

a. How many kilowatt-hours of electricity did this facility use during this billing cycle?

b. How much cheaper is their off-peak rate than their on-peak rate?

The plant runs one of its four 400 hp compressors at full capacity all winter, drawing 250 kW.

c. How many kWh does the compressor use on a winter day?

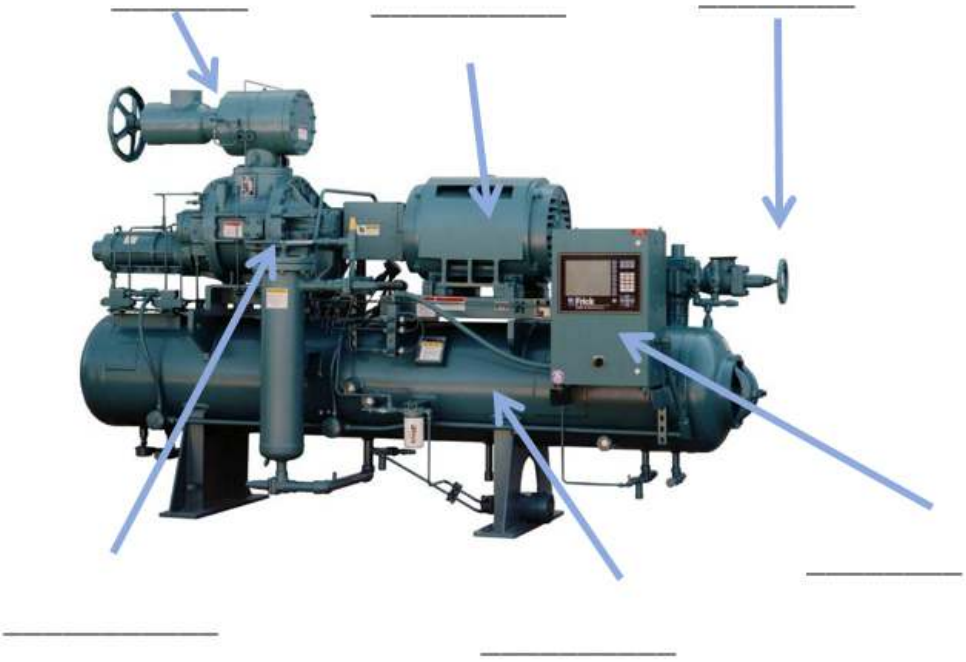
d. What % of the total demand charge does the compressor make up?

e. What is the bulk rate energy price for this bill?

FUNDAMENTALS OF REFRIGERATION

What percent energy is used by each system component?

COMPRESSOR COMPONENTS



What are the key energy issues for screw compressors?

1.

2.

3.

4.

5.

COMPRESSOR LIFT EXERCISES – SAMPLE SYSTEM

1. Given a facility with 3,000,000 kWh/year total compressor use, increase the suction pressure from 3 psig to 6 psig on a low-temp system.

   a) What % compressor energy will we save?

   b) How many kWh will we save?

   c) Assuming a utility rate of $0.10/kWh, what is the cost savings?

2. Given the same facility, reduce the condensing pressure from 110 psig to 100 psig half of the year?

   d) What % compressor energy will we save?

   e) How many kWh will we save?

   f) Assuming a utility rate of $0.10/kWh, what is the cost savings?

COMPRESSOR LIFT REDUCTION EXERCISE – YOUR SYSTEM

1. What is your current suction pressure setpoint (pick a suction system)?

2. What is the maximum allowable suction pressure for this system (use evaporator/fluid cooler design TD or estimated TD)?

3. What is limiting the system from operating at the maximum allowable suction pressure?

4. How much energy savings could be available for increasing suction pressure? (% or kWh) Show your energy calculations.

COMPRESSOR LIFT REDUCTION EXERCISE CONTINUED

5. What is your current minimum condensing pressure setpoint?

6. What is the minimum allowable condensing pressure for your system?

7. What is limiting the system from operating at the minimum allowable condensing pressure during periods of cool weather?

8. How much energy savings could be available for decreasing condensing pressure during cool weather? (% or kWh) Show your energy calculations.

ANSWER SHEETS

ACTIVITY SHEET – ENERGY BASICS EXERCISE

a. How many kilowatt-hours of electricity did this facility use during this billing cycle? (January/Feb 2015) 490,793 kWh

b. How much cheaper is their off-peak rate than their on-peak rate? $0.0504 - $0.0355 = $0.0169

c. How many kWh does the compressor use on average every day? 250 kW x 24 hrs = 6,000 kWh

d. What % of the total demand charge does the compressor make up? 250 kW / 932 kW = 27%

FUNDAMENTALS OF REFRIGERATION

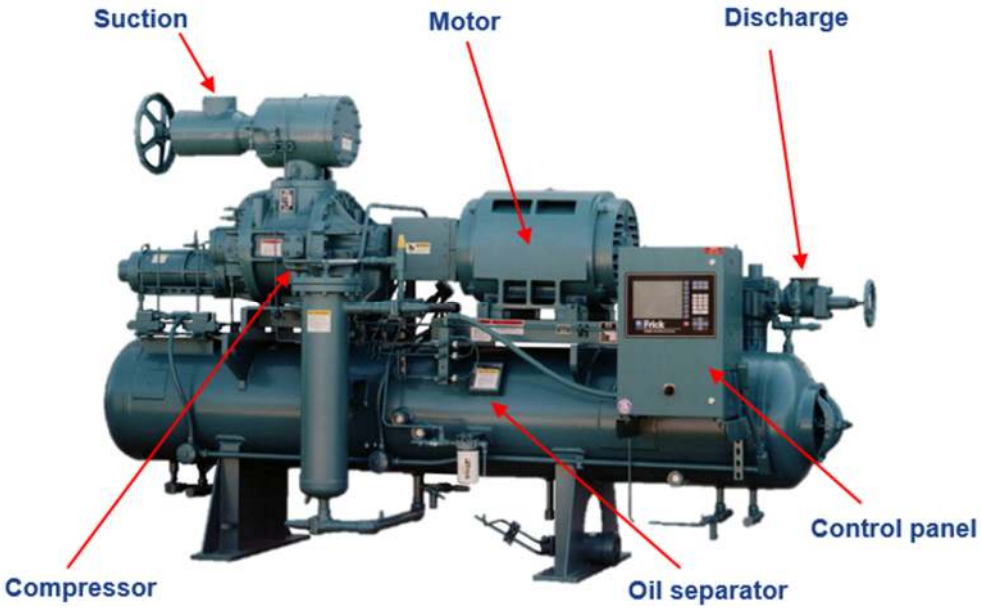
What percent energy is used by each system component?

Typically: 60-75% compressors, 10-20% evaporators, 5-15% condensers, 0% expansion valves

_____   _____

_____   _____

COMPRESSOR COMPONENTS



What are the key energy issues for screw compressors?

1. Lift
2. Capacity Control
3. Volume Ratio
4. Compressor Cooling
5. Economizing

COMPRESSOR LIFT EXERCISES

Given a facility with 3,000,000 kWh/year total compressor use. Increase the suction pressure from 3 psig to 6 psig on a low-temp system.

a) What % compressor energy will we save? 3 psig = -24°F, 6 psig = -15°F, 6°F change x 2% = 12%
b) How many kWh will we save? 3,000,000 x 12% = 360,000 kWh
c) Assuming a utility rate of $0.10/kWh, what is the cost savings? 360,000 kWh x $0.10 = $36,000

Same facility, reduce the condensing pressure from 110 psig to 100 psig half of the year.

d) What % compressor energy will we save? 110 psig = 68°F, 100 psig = 63°F, 5°F change x 1.5% = 7.5%
e) How many kWh will we save? 3,000,000 x 7.5% / 2 = 112,500 kWh
f) Assuming a utility rate of $0.10/kWh, what is the cost savings? 112,500 kWh x $0.10 = $11,2500