HSB Equipment Efficiency Calculators

About These Calculators

Munich RE

1866

Hartford Steam Boiler

Table of Contents

BOILERS

GETTING STARTED

Some points on making the most of this calculator.

1. The boiler information page must be completed to unlock the savings pages.
2. A small amount of information is needed to complete these calculators. Gather this information before using the calculators to save time and give you more accurate results. This information includes:

    a) Boiler exit gas temperature
    b) Boiler excess air or excess oxygen level
    c) Fuel cost
    d) Hours of operation and average load

If you do not monitor exit gas temperature or excess air levels, this information can be found on the most recent maintenance information for your boiler. If you do not have this information, your service provider may. Fuel costs can be found on your most recent fuel bill.

BOILER EFFICIENCY INTRODUCTION

The boiler efficiency calculator was designed for natural gas and oil-fired commercial and industrial boilers. The calculator uses the input information to estimate a baseline boiler efficiency, yearly energy usage, fuel cost and carbon dioxide emissions. Potential efficiency and cost savings are then provided in the various modules.

EXCESS AIR

Excess air is the amount of air that is greater than the air required to completely burn the fuel. Excess air is determined by measuring the amount of oxygen in the exit gases. Some excess air is necessary to make sure the fuel is fully burned. Too much excess air creates an efficiency loss. The single largest boiler efficiency loss is the heat that exits the stack. The heat loss out of the stack is directly related to the quantity of gas that exits the stack. A reduction of 15% in excess air results in approximately a 1% increase in boiler efficiency. The lowest excess air possible is dependent upon the fuel being fired as well as the design of the furnace, combustion system and the operation of the control system. The boiler efficiency calculator module is based on an assumed minimum excess air of 10% for natural gas and 15% for No. 2 oil utilizing existing equipment. New burners or controls may provide further reduction. For larger installations, especially those that operate for longer periods of time at a low firing condition, new burners and controls with parallel control systems or an oxygen trim system may be worthy investments. This equipment will help optimize excess air over the load range and maintain these levels.

SCALE, SOOT CALCULATOR

For each 40° F reduction in exit gas temperature, boiler efficiency is increased by approximately 1%. Increases in boiler exit gas temperature indicate potential waterside (scale) or gas side (soot) fouling. Tracking exit gas temperature in a boiler log may identify potential tube fouling.

By taking corrective actions early, savings are enhanced and potential issues such as tube overheating can be avoided. There are several ways to reduce boiler exit gas temperature and improve efficiency.

1. SCALE - Scale on the waterside of the tubes acts as an insulator, reducing heat transfer to the water and efficiency. The boiler efficiency calculator estimates savings based on scale reduction in a firetube boiler using U.S. Department of Energy data. A qualified vendor or personnel should assess and remove scale as applicable. After scale removal, maintain proper water chemistry for the specific boiler type and pressure to minimize reoccurrence.
2. SOOT – Soot on the tubes also acts as an insulator, also reducing efficiency. The boiler efficiency calculator estimates savings based on soot removal using U.S. Department of Energy data. Soot is an indicator of incomplete combustion and a boiler tune up may eliminate the issue creating excess soot.

BOILER UPGRADE

1. "Boiler Replacement" - This calculator includes a module that can be used to develop cost savings estimates based on replacing an older boiler with a newer higher efficiency boiler utilizing the same fuel. This includes the new very high efficiency condensing boilers. Note that a new, higher efficiency boiler will save operating costs, but will also most likely reduce maintenance costs and improve reliability.
2. "Fuel Switch" - For boilers currently using No. 2 oil, significant cost savings are possible by converting to natural gas. The "Fuel Switch" calculation is based on reuse of the existing boiler. If a new higher efficiency boiler is installed, the calculated value will be conservative. Note that the savings from the "Boiler Replacement" calculation and the "Fuel Switch" calculation are not additive.
3. "Addition of an Economizer" - For steam boilers rated above 100 HP and 75 psig, the addition of a feedwater economizer to reduce exit gas temperature by recovering lost heat and increasing efficiency may result in an acceptable payback.

STEAM TRAPS

Leaking steam traps are common and can be one of the largest system losses in large steam systems. Repairing leaking traps can offer fast pay back. The steam trap calculator uses U.S. Department of Energy data to estimate the number of traps that may be leaking at any one time and the amount of lost steam and cost based on that estimate. The calculator savings estimate is based on the total number of traps in the system. According to the U.S. Department of Energy, between 15%-30% of steam traps in a system may be leaking if they have not been maintained for three to five years.

BOILER SYSTEM LOSSES

Plant operation plays a significant factor in overall efficiency. The boiler calculators are based on steady state calculations and do not take into account all variables. Before implementation of any scenario, a follow-up detailed analysis should be performed that considers all factors, including savings from decreased maintenance for example.

ELECTRICAL

TRANSFORMER EFFICIENCY -INTRODUCTION

An ordinary, old transformer is a very efficient device, compared to mechanical devices such as a boiler or turbines. Old distribution class transformers in use today have efficiencies in the low 90th percentile. While the difference in efficiency of an old transformer versus a modern high-efficiency model is only a few percentage points, it can save considerable energy, and significant operating costs.

Transformer efficiency can be expressed simply as: Power output / power input . The difference between input and output is the transformer losses. Losses in transformers can be divided into two categories: "load losses " and " no-load losses." Resistance of the windings dominates “load losses,” whereas hysteresis or “core losses” contribute to most of the “no-load loss.” Load losses are variable and directly proportional to the load on the transformer; but no-load losses are constant for each transformer design. The no-load loss can be significant, because transformers are usually always energized, and consuming some power, even when the load is “off.”

NEMA TP-1

With the passing of the Energy Act of 1992, the U.S. Department of Energy (DOE) first set guidelines for using more efficient electrical devices to reduce energy consumption. Then, in 1996, the National Electrical Manufacturers Association (NEMA) developed a voluntary comprehensive standard for higher efficiency transformers, known as “NEMA Standard TP-1,” Guide for Determining Energy Efficiency for Distribution Transformers. NEMA updated the standard in 2002 and received approval for inclusion of the TP-1 requirements into the DOE Energy Star program. The Energy Policy Act of 2005 (EPACT 2005) recognized and established NEMA TP-1 as the new national standard for low-voltage transformers, and requires that all low voltage dry-type distribution transformers, manufactured after 1/1/2007, must meet the Class I Efficiency Levels as specified by NEMA TP-1. Consequently, an ordinary general purpose dry type transformer made after 2007 meets the requirements of “TP-1.” The minimum Class I Efficiency Levels for dry type transformers with a 35% load are shown in Table 1.

Table 1 - Class I Efficiency levels (at 35% load)

Single Phase		Three Phase	
kVA	Efficiency (%)	kVA	Efficiency (%)
15	97.70%	15	97.00%
25	98.00%	30	97.50%
37.5	98.20%	45	97.70%
50	98.30%	75	98.00%
75	98.50%	112.5	98.20%
100	98.60%	150	98.30%
167	98.70%	225	98.50%
250	98.80%	300	98.60%
333	98.90%	500	98.70%
750	98.80%		
1000	98.90%		

NEMA PREMIUM EFFICIENCY

In 2010, NEMA introduced a new voluntary Premium Efficiency Transformer Program which goes above and beyond the requirements of NEMA TP-1. The new Premium Efficiency standard will help utilities, buildings owners, and industrial plants incorporate super high-efficiency electrical transformers into their operations. Most of the major dry type transformer manufacturers now offer Premium Efficiency transformers. The new “NEMA Premium Efficiency” transformer designation requires 30 percent fewer losses than existing NEMA TP-1 /DOE regulations for low-voltage dry-type distribution transformers. The Premium Efficiency Levels for dry type transformers with a 35% load are shown in Table 2:

Table 2 - Premium Efficiency Levels (at 35% load)

Single-phase		Three-phase	
kVA	Efficiency (%)	kVA	Efficiency (%)
15	98.39%	15	97.90%
25	98.60%	30	98.25%
37.5	98.74%	45	98.39%
50	98.81%	75	98.60%
75	98.95%	112.5	98.74%
100	99.02%	150	98.81%
167	99.09%	225	98.95%
250	99.16%	300	99.02%
333	99.23%	500	99.09%
750	99.16%		
1000	99.23%		

Is a Premium-Efficiency Transformer Worth the Cost?

A premium-efficiency transformer costs more initially, but saves sufficient money over time to more than pay back the extra purchase cost. Premium-efficiency transformers usually have copper windings and cores made of low-loss silicon steel or amorphous steel. Copper windings have lower resistance per cross-sectional area than aluminum windings, and thus lower “load losses”. The transformer manufacturers have reduced the no-load losses (core losses) by improving the construction of the silicon steel, itself; using thinner lamination in the core, improving the cutting of the laminations; and improving the stacking or assembling of the laminations.

Cost Comparison of Standard versus Premium Efficiency Transformers

A proper cost comparison of a Premium Efficiency Transformer versus a standard “TP-1”transformer, must take into account not only the initial capital cost of the transformer, but also the cost of the energy losses. This can be done in one of two ways: 1) Calculate the annual energy savings, and compute a payback period; or 2) Calculate the savings over the life span of the transformer.

Annual Energy Savings

In our first example, Table 3, we examine the difference of the Load Losses and No-load Losses for a Premium Efficiency Transformer versus a standard “TP-1”transformer. In this example, both are 300 kVA 3-phase dry type units, 480 v to 208/120v. We recognize that transformer loads will vary throughout the day, but to keep this simple, we will assume the transformer’s average daily load is 75% of nameplate. Table 3 shows the additional initial cost of a Premium Efficiency versus a standard, and the annual payback. The “TP-1”transformer will pay for itself in as little as 5 years.

Table 3 - Annual Savings Payback Calculation

	Standard TP 1	**Premium-Efficiency**
Initial Cost (300kVA, 480/208-120, 3 □, Cu)	$28,300	$34,700
Initial Cost difference		$6400 higher
Efficiency	98.64%	99.02%
No-Load Loss	.75 kW	.33 kW
Load Loss at Full Load	4.8 kW	2.6 kW
Load Loss at 75% load	2.7 kW	1.46 kW
Total losses at 75% load	3.45 kW	1.79 kW
Energy Savings per hour(in kW)		1.66 kW
Annual kW Savings (8760 hours/year)		14,542 kW hrs

Benefits of Using Premium-Efficiency Copper-Wound Dry-Type Transformers

Electrical Energy Cost	Annual Cost Savings	Payback Period
5 ¢ /kWh	$727.08	($6400/ $727.08) = 8.8 years
7 ¢ /kWh	$1,017.91	($6400/ $1017.91) = 6.3 years

9 ¢ /kWh	$1,308.74	($6400/ $1308.74) = 4.9 years

Source data: GE BuyLog — Section 8: Transformers•

TOTAL LIFE COSTS

The total life cost (TLC) comparison takes into account the initial transformer cost and the cost to operate and maintain the transformer over its life. The TLC method not only includes the value of purchase price and future losses but it can also allow the user to adjust for tax rates, cost of borrowing money, different energy rates, etc. Since the formula includes the cost of losses which will occur in the future, the user can discount these future costs to equate them to present-day dollars.

As an example, we will compare the Total Life Cost of a Premium Efficient (copper-wound) 300 kVA transformer to a standard TP-1 transformer. To do this, we will need the no-load and load losses in watts from the manufacturer’s catalog. Having that data, the economic calculation can be performed, factoring in the present value of future losses. For this exercise, we will assume that electricity costs are 7¢ per kilowatt hour, and are steady for 15 years of estimated life, with no variation for time of day. The "discount rate" for relating future costs to present day dollars is assumed to be 6 % (the actual cost depends on the economy). Our transformer will be loaded to 75% of nameplate rating for 6,000 hours per year, and zero load for 2,760 hours per year. In order to keep this example very simple, we will not include salvage value, utility rate changes, taxes, inflation, carbon credits, maintenance costs and “goodwill” values.

For a series of equal payments (costs) over time, the present worth of future cost formula is:
PW = (1 + i)n - 1
i(1 + i)n where: i = discount rate, n = number of years

However, it is much easier to do this in a common spreadsheet tool. Using typical values for our 300 kVA transformer, from Table 3, shows:

	Standard TP-1	Premium Efficiency
Purchase Price	$28,300	$34,700
No Load Loss	.75 kW	.33 kW
Load Loss at 75%	2.7 kW	1.46 kW

Total life cost of standard TP-1 transformer :

Purchase price = $28,300

No load losses per year = .75 kW x 8760 hrs/yr x $0.07/kWh = $460

Present Value (P.V.) of no load losses for 15 yrs: = $4,467

Load losses (@75%) per year = 2.7 kW x 6000 h/y x $0.07/kWh = $1,512

Present Value. of load losses for 15 yrs. = $11,014

Total Life Cost of PREMIUM-Efficiency = $ 34,700 + $2045 + $5955 = $ 42,700

Total Life Cost Savings = $43,780– $ 42,700 = $1080

Or, the Premium Transformer will initially cost about 22% more ($6400) than a standard transformer, but the Premium Transformer will cost $1080 less than a standard transformer, over its life.

POWER FACTOR - THE BASICS OF POWER FACTOR

There are three types of power: Real power - Kilowatts (kW), reactive power - Kilo Volt Amperes Reactive (kVAR), and apparent or total power - Kilo Volt Amperes (kVA). Real power energizes work (running motors, lighting). It is measured by a residential electric meter. Reactive power is magnetic power used to setup magnetic fields in electric devices such as motors and transformers. kVA is the combination of kW and kVAR. Power factor(pf) is the ratio kW to kVA (kW / kVA). The lower the power factor(pf) the more total power(kVA) the utility has to supply for the same real power(kW).

1000 kW = 0.75 pf
1333 kVA

1000 kW = 0.95 pf
1052 kVA

A utility must size the generators, transformers and cables to support not just the amount of kW used but the total power, kVA, used. This results in larger more expensive equipment for the utility.

Residential and small businesses may be billed based on the amount of kW they use. For commercial and industrial customers, a utility may charge a penalty for a low power factor. The purpose of a power factor penalty is to encourage a customer to maintain a high power factor so the utility does not have to install the larger more expensive equipment.

Power factor correction capacitors are installed to raise a low power factor. The amount of power factor correction capacitors required depends on the current power factor, the target power factor and the electrical load on the system. The savings generated may be used to fund the installation of the power factor correction capacitors.

Utility rate structures vary widely across the United States. The following are examples of the most common billing practices. If a utility does not charge for a low power factor, this calculator is not applicable. A peak demand charge is different than a kWhr charge and the two cannot be interchanged.

Example - kVA peak demand billing

Original	Corrected
1000 kW	1000 kW
0.75 pf	0.95 pf
1333 kVA	1052 kVA
$5.00 per kVA	$5.00 per kVA
$6,666 monthly	$5,263 monthly

Monthly Savings $ 1,403
Yearly Savings $16,842

EXAMPLE - KVAR PEAK DEMAND BILLING

Original	Corrected
1000 kW	1000 kW
0.75 pf	0.95 pf
882 kVAR	329 kVAR
$5.00 per kVAR	$5.00 per kVAR
$4,409 monthly	$1,643 monthly

Monthly Savings $ 2,766
Yearly Savings $33,193

EXAMPLE - PF ADJUSTED KW PEAK DEMAND BILLING

Original	Corrected
1000 kW	1000 kW
0.75 pf	0.95 pf

1000* (0.95/0.75) = 1267 kW(billed)

$5.00 per kW	$5.00 per kW
$5,000 monthly $	6,335 monthly

Monthly Savings $ 1,335
Yearly Savings $16,020

ELECTRIC MOTORS –

VARIABLE FREQUENCY DRIVE, HIGH EFFICIENCY MOTORS

Variable frequency drives (VFDs), also known as variable speed drives or frequency drives, are devices used to match the speed of a motor to the demands of the load. This permits running the motor at the most efficient speed based on the load, which in turn, lowers the operating cost of the motor. To control the speed of the motor, the drive converts standard utility voltage, three phase or single phase, to a variable voltage and frequency output. The use of VFDs can result in a significant reduction in electrical power usage.

APPLICATIONS OF VFDS

For energy savings, VFDs are typically used to replace mechanical control systems of centrifugal pumps and blowers. They are used in applications in which the flow of water or air is controlled. Examples include: Exhaust fans, supply fans, water recirculation pumps and other systems that use dampers or values to control flow, pressure or temperature in a system.

THE BASICS OF ELECTRIC MOTOR EFFICIENCY

Motor efficiency is a measure of how efficiently a motor converts electrical power into mechanical power. The higher the efficiency of a motor, the lower the electrical usage for that motor. Motor- driven systems such as fans and pumps can constitute up to 70% of the electrical usage in industrial and commercial facilities. In heavy industrial facilities it may be above 70%.

Motor efficiency depends on many factors: The design and material used in a motor, the maintenance level of a motor, and the installation and connection of the motor to the load.

STEPS TO INCREASE MOTOR EFFICIENCY

1. Match the motor size to the load. Motors operate near peak efficiency at 75% to 110%, of their rated load.
2. Ensure the power supplied to the motor is within manufacturer's recommendations.
3. Ensure the motor is clean and properly ventilated.
4. Ensure the bearings are lubricated with the proper amount and type of grease.
5. Ensure the motor is properly installed, aligned and connected to the load.

VAMPIRE LOADS

This calculator uses energy consumption data for common household items from a variety of sources including www.energystar.gov and Lawrence Berkley National Laboratories. Source: http://standby.lbl.gov/summary-table.html

The data provided lists the energy used by the device in several modes of operation. In use, on - but not in use, stand by, and plugged in, but off.

LIGHTING UPGRADES

Upgrading the lighting in your office or home can be one of the simplest and most cost-effective upgrades. Commercial and residential buildings account for almost 40% of the total energy used in the United States each year. Home lighting accounts for more than 10% of the energy used each year and in commercial buildings it is almost double that.

This calculator provides a very simple way to estimate the energy saved by replacing older inefficient lighting fixtures with newer technology. One thing to consider when upgrading your lighting is the cost of maintenance. For example, some LED lights may last 20 years or more, which can significantly reduce the overall cost of ownership. Cost of ownership is not included with the calculator.

MECHANICAL EQUIPMENT

COMPRESSOR

GETTING STARTED

1. The compressor information page must be completed to unlock the savings pages.
2. There is a small amount of information needed to run these calculators.

a) Motor horsepower (Hp) and rated efficiency
b) The load factor (average power use in amps)/(peak demand amps at the busiest time of day)
c) Hours of operation
d) Electrical utility rate and monthly demand charges (from utility bills)
e) Utilization factor (ratio of compressor nameplate motor requirements to installed motor Hp). This information is found on the motor and compressor nameplates. As an example, a compressor that requires 45 Hp and is fitted with a standard-sized 50 Hp motor, has a utilization factor of 0.90 (45 Hp compressor required / 50 Hp motor rating).

COOLER INLET AIR

Cool air is denser than warm air and takes less energy to compress to a given pressure. Providing lower temperature outside or conditioned air at the compressor intake will reduce energy use. This can often be accomplished by adding new ductwork to an outside intake or a cool air intake point.

LEAK CALCULATOR

Energy is lost from leaks in the piping systems. Air leaks are found in most plants without regular leak prevention programs. Leakage rates of 20% to 30% are common. The most common sources of air losses are:

Couplings, hoses, tubes and fittings

Pressure regulators

Open condensate traps and shut-off valves

Pipe joints, disconnects and thread leakage

Open orifice spray systems in manufacturing operations.

REDUCTION IN AIR PRESSURE

Most plant equipment can run on lower pressure than standard (100-110 psi) compressor operating setpoints. Reducing the air compressor operating pressure to a set point closer to the maximum device requirements can be accomplished if air supply piping is adequately sized. If air supply piping is not adequately sized, adding parallel or "looped" piping may reduce pressure drops with minimal costs.

Additional Resources

1. The US DOE Energy Management Portal: https://save-energy-now.org
2. The US DOE Compressed Air site:
http://www1.eere.energy.gov/industry/bestpractices/compressed_air.html
3. The US DOE Compressed Air Tip Sheets:
http://www1.eere.energy.gov/industry/bestpractices/tip_sheets_compressed_air.html
4. The Compressed Air Challenge: http://www.compressedairchallenge.org/

DRIVE BELTS CALCULATORS – NOTCHED AND SYNCHRONOUS

A notched belt reduces slip and allows the belt to bend around sheaves with less energy loss. Reduction in motor speed and efficiency occurs when a standard V-belt slips within the groove of the sheave. Efficiency improvements have been found to range up to 3%.

Friction between the standard V-belt and sheave generates heat within the belt, resulting in an energy loss and shortened belt life. Notched V-belts can last twice as long as standard V-belts but have shorter lives in abrasive environments where contaminants can become trapped between the belt and the sheave.

Notched V-belts may be used with existing V-belt pulleys but typically cost 20-30% more

In general, the additional cost of the notched V-belts will be offset by a longer lifetime, so there is no cost associated with installing notched V-belts to replace old belts when they wear out, yielding an immediate payback.

Synchronous belts require the installation of new, fixed diameter (non adjustable) sheaves which will reduce energy use more than notched belt replacement alone. The additional cost for synchronous sheaves is approximately 25% more than V-belt sheaves. This can have as little as a six-month pay back.

A 70% load factor is included in this computation (% of time in use)

VARIABLE SPEED DRIVE CALCULATOR FOR PUMPS - EXISTING FLOW CONTROLS; LISTED FROM LEAST EFFICIENT TO MOST EFFICIENT

1. Bypass/Recirculation Valve: Recirculates flow from pump discharge back to pump inlet.
2. Throttling valve: Restricting valve usually found downstream of the pump outlet
3. Mechanical Torque convertor: This is essentially a pair of overlapping centrifugal pumps with separate shafts immersed in an oil bath. The input shaft and pump fits inside the output pump and shaft
4. Eddy Current Clutch: An eddy current drive consists of a fixed speed motor and an eddy current clutch. The clutch contains a fixed speed rotor and an adjustable speed rotor separated by a small air gap.

NOTES

Flow controls 1 and 2 are the most common.

Torque convertors are rare. This could be specialty process control equipment requiring expert review to implement changes.

Eddy current clutches are an early design method of electric speed control.

High pump loading; vs. Low Pump Loading - The "low load" duty cycle offers greater variable frequency drives energy savings potential than the "high load", because it is further from the design point.(full load).

HEATING, VENTILATION AND AIR CONDITIONING

HVAC - DEFINITIONS:

Three energy efficiency ratings are commonly used in air conditioning and refrigeration. The three are not identical even though they are all ratios of power to power.

Energy Efficiency Ratio (EER):
This is the nameplate information provided by the manufacturer for equipment operating at "Standard Conditions" for systems larger than five tons.

Standard conditions are:

OUTDOOR : 95°F dry bulb temperature and 75°F wet bulb temperature.

INDOOR: Air to be cooled of 80°F dry bulb, and 67°F wet bulb temperatures

Integrated Efficiency Ratio (IER)

This a calculated value from EER testing data by an American National Standards Institute (ANSI) standard to predict part load performance of the same equipment calculated above with nameplate EER data. Using this calculator allows small commercial customers to see an efficiency number which is closely akin to a seasonal energy efficiency ratio (see below), which they may be familiar with from residential installations. This number is a weighted average of equipment operated at 100%, 75%, 50% and 25% of full load and different dry bulb and wet bulb conditions.

SEER - Seasonal Energy Efficiency Ratio

SEER ratings provide an estimated energy use profile developed by the Environmental Protection Agency and is used for homeowners and small business air conditioner efficiency. It is largely meant to provide comparative information for energy savings available when the consumer upgrades the air conditioner or heat pump they currently own. The estimated use is based on some average historical data of the amount of BTUs per season, divided by the amount of electricity used per season. The SEER numbers are very closely related to the IEER numbers and could be used interchangeably with small margins of error.

To use the SEER calculator, you will need to estimate the energy use from a prior year:

1) Review your utility bills to see last year’s month by month electrical consumption. Air conditioners will be responsible for a large part of your electrical bill in the summer months. The difference between the summer months and an equivalent number of winter months will provide an estimated cooling cost.

2) Estimate the number of summer months (or part of) air conditioning was running and:

Add up the electrical cost of Summer months	$ XXXX
Add up the electrical cost of equal amount of Winter months	$ XXXX

Subtract Winter total from Summer months = $ Approximate air conditioning seasonal cost

Rule of Thumb - Based on old equipment and typical costs, for each 1,000 square foot of living space, the seasonal total should be in a range of $200 for Chicago and $500 for Dallas.

ENERGY AND POWER - KNOW THE DIFFERENCE

Energy and power are related and often confused. To help explain the difference, picture the Hoover Dam:

Energy - The height of the water above the electric turbines is the potential energy available.

Power - The flow rate, (gallons per minute) through the turbines, generates the power from the turbine. Power is a function of both flow and potential energy.

1. British thermal Units (BTU)s; are a measure of ENERGY.

2. AC equipment is rated in BTU's per hour or Tons. BTU's per hour are a measure of POWER. A Ton is defined by the amount of heat required to melt 2,000 pounds of ice in a 24 hour period, this again is a POWER rating. Tons are not used in these ratings. If tons are listed as the capacity, they must be multiplied by 12,000 to convert to BTU per hour for use in the ratios.

3. Watts are a measure of electric POWER. This is an energy (joule) per time (seconds) rating.

4. Energy efficiency ratios are a measure of BTUs per hour to electrical Watts. This is a ratio of Power to Power.

INSULATION EFFICIENCY CALCULATORS

Exposed piping and ductwork have high levels of radiant losses. This calculator estimates the amount of energy required to make up for these radiant losses. If the piping or ductwork are located in a ventilated area, the losses (and therefore potential savings) are even greater. The savings are based on the installation of 90% efficient insulation.

VARIABLE SPEED DRIVE CALCULATORS FOR FANS

Fans are often oversized to account for unknowns in the system design and provide for the maximum foreseeable cooling load. A damper controls the flow rate and can be installed at the fan inlets and or or outlets. At each load point, the control damper(s) will adjust open area to produce the required flow. The pressure drop across the partially closed control damper is an energy loss. Powering the fan with a Variable Frequency Drive allows the fan to produce only enough pressure to provide the required flow, resulting in significant energy savings.

Speed control using Variable Frequency Drives is efficient because horsepower (Hp) is a cubed function of flow. As an example, if a 10,000 cfm fan such as that used in a 25 ton air conditioner only needs 7500 cfm most of the time, installing a variable drive would reduce Hp and energy use by 42% = (7500/10,000) ^3 during the off peak loads.

Some fans have better ability to run at lower speeds and still have the pressure required to deliver the air. This is where the backwardly inclined fan is best due to its high pressure capabilities.

Backwardly Inclined Fans: Chances are you will find many of these in your facility, and these have the largest potential savings with the installation of VFD controls.

1. Most common commercial HVAC fans 5 Hp to 800 Hp
2. Efficiency up to 85 %
3. High pressure capability
4. Worst efficiency when dampened for flow control

Forward Curved Fans: These are commonly used in small inexpensive systems

1. Common in residential and small commercial (<15 Hp)
2. Efficiency range up to 65% efficiency
3. Low pressure capability and low cost
4. Damper control has little efficiency loss (low pressure already)

Eddy current drive fans have been used for quite some time and provide reasonably efficient speed control and energy usage.

Fan Type; Listed from least efficient to most efficient

1. Outlet damper, backwardly inclined & airfoil fans
2. Inlet damper box
3. Inlet guide vane, backwardly inclined & airfoil fans
4. Outlet damper, forward curved fans

5. Eddy current drives: An eddy current drive consists of a fixed speed motor and an eddy current clutch. The clutch contains a fixed speed rotor and an adjustable speed rotor separated by a small air gap.
6. Inlet guide vane, forward curved fans.

Note that the "Low Fan Loading" cycle offers greater variable frequency drive energy savings potential than the "High Load", because it is further from the design point (full load).