Estimating the Energy Savings Potential in Compressed Air Systems

Using the Efficiency Quotient Standard

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Executive Summary

Quincy Compressor has been awarded patent #7,519,505 for developing a standardized "Method and system for estimating the efficiency rating of a compressed air system." Never before has there been a way to quickly and effectively assess the cost to operate and the energy savings potential of a plant compressed air system. In a short one to two hour period someone familiar with the compressed air system, using the patented Quincy Efficiency Quotient Rating Worksheet, can quickly determine if there is significant energy savings potential with an attractive return on investment. There is typically a 20-30% savings opportunity that exists in most facilities that have a centralized plant air system with 50hp or more worth of compressors operating.

Business Challenge

Plant compressed air is expensive to produce and rising energy costs are driving industrial facilities to search for a method to estimate the energy savings potential in their plant compressed air system. Most compressed air users are not aware of and do not know how to properly estimate their current operating costs. This requires the expense of hiring a local auditor or compressed air consultant to come on-site and perform some type of assessment. There also exists no standardized report card or numerical rating method developed that represents the overall efficiency level of the system that can be used for comparison between facilities or for tracking progress over time.

Solution Description

Years of in the field experience from auditing hundreds of compressed air systems over a wide cross section of industries was drawn upon to identify the key principles driving the efficiency of a compressed air system. This led to developing the unbiased and technically sound questions targeting the supply and demand side of the air system along with an efficiency value assigned to each of the multiple choice answers to these questions.
The Efficiency Quotient (EQ) rating worksheet is a two page document. This worksheet determines the efficiency score for the air system, estimates the current operating cost and estimates the energy savings potential with an attractive return on investment. It consists of four sections: The supply side EQ rating, energy calculation, demand side EQ rating and the EQ summary. Separate scores are developed independently for the supply and demand EQ rating sections. These two numbers are then averaged to determine the overall system EQ rating (efficiency) score. In the energy calculations section the total energy consumption is estimated. This calculation takes into account the quantity and sizes of the compressors, dryers and the energy to cool the compressors is included in the estimated annual operating costs.

The EQ rating score is directly related to the savings potential in a compressed air system.

TABLE ONE

COST SAVINGS OPPORTUNITY

EQ Rating	50 hp system	100 hp system	500 hp system
85%	$ 4,973	$ 9,944	$ 49,722
75%	$ 7,458	$ 14,917	$ 74,584
65%	$ 11,187	$ 22,375	$ 111,875

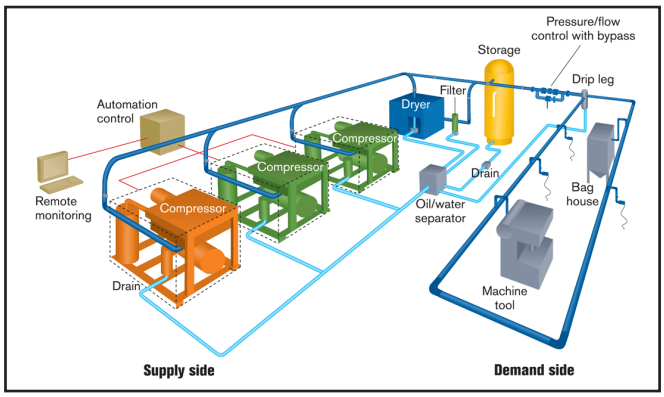
Note: Calculated @$0.07 /kWh.
See page 6 for more on the EQ Rating.

In Table 1 we can see how systems with a lower EQ rating are more expensive to operate and present a greater energy savings opportunity than those with a higher EQ rating.

We can also see that the EQ rating is a management tool for monitoring the efficiency of the air system over time. Air systems are very dynamic and changing almost daily in most facilities as new pieces of air using equipment are added and production equipment is modified. Periodic evaluations of the EQ rating will serve as a way to see if there is continuous improvement taking place or if the system is losing efficiency by comparing the current EQ rating to previous evaluations.

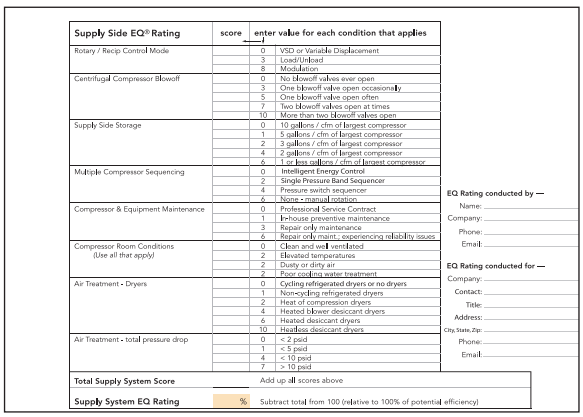
Larger corporations can use the EQ rating method as a way to fairly evaluate the energy savings potential of all of their facilities. The plants can then be prioritized for further evaluation so that capital is spent on those facilities with the greatest opportunity for energy savings. This approach has the side benefit of documenting the compressed air equipment at each facility and an estimate of the current operating costs.

Below is a diagram of the supply and demand side of a compressed air system.



As illustrated in this diagram, the supply side consists of the equipment in the compressors room(s). The demand side refers to the piping and the various end users of the air. Efficiency rating scores are determined for each part of the system. Then the overall system EQ or efficiency rating is then determined by combining these numbers.

Page one of the EQ rating worksheet is shown below and consists of eight questions.



Supply Side EQ® Rating	score	enter value for each condition that applies	
Rotary / Recip Control Mode		0	VSD or Variable Displacement
		3	Load/Unload
		8	Modulation
Centrifugal Compressor Blowoff		0	No blowoff valves ever open
		3	One blowoff valve open occasionally
		5	One blowoff valve open often
		7	Two blowoff valves open at times
		10	More than two blowoff valves open
Supply Side Storage		0	10 gallons / cfm of largest compressor
		1	5 gallons / cfm of largest compressor
		2	3 gallons / cfm of largest compressor
		4	2 gallons / cfm of largest compressor
		6	1 or less gallons / cfm of largest compressor
Multiple Compressor Sequencing		0	Intelligent Energy Control
		2	Single Pressure Band Sequencer
		4	Pressure switch sequencer
		6	None - manual rotation
Compressor & Equipment Maintenance		0	Professional Service Contract
		1	In-house preventive maintenance
		3	Repair only maintenance
		6	Repair only maint., experiencing reliability issues
Compressor Room Conditions (Use all that apply)		0	Clean and well ventilated
		2	Elevated temperatures
		2	Dusty or dirty air
		2	Poor cooling water treatment
Air Treatment - Dryers		0	Cycling refrigerated dryers or no dryers
		1	Non-cycling refrigerated dryers
		2	Heat of compression dryers
		4	Heated blower desiccant dryers
		6	Heated desiccant dryers
		10	Heatless desiccant dryers
Air Treatment - total pressure drop		0	< 2 psid
		1	< 5 psid
		4	< 10 psid
		7	> 10 psid
Total Supply System Score		Add up all scores above	
Supply System EQ Rating	%	Subtract total from 100 (relative to 100% of potential efficiency)	

EQ Rating conducted by —
Name:
Company:
Phone:
Email:

EQ Rating conducted for —
Company:
Contact:
Title:
Address:
City, State, Zip:
Phone:
Email:

A numerical value is assigned to each multiple choice answer. After these are selected they are totaled and subtracted from 100 to determine the supply side EQ rating. A score of 100 represents the perfect air system which is not economically practical to implement. It does however give us a basis for comparison and a standard against which we can determine if the system is improving or becoming less efficient.

Before leaving the compressor room we complete the energy calculation section.

Energy Calculations

compressors	*hp		kW
#1		x .746/.92	
#2		x .746/.92	
#3		x .746/.92	
#4		x .746/.92	
#5		x .746/.92	
#6		x .746/.92	
		compressor kW subtotal	
		***cooling kW subtotal	
		compressor + dryer + cooling = total kW	
		x operational hours per year	
		x $ per kW-Hr local rate	
		= Operating Costs Estimate	$

refrig dryers	cfm capacity	**divide by	kW
#1		200	
#2		200	
#3		200	
#4		200	
#5		200	
#6		200	
		dryer kW subtotal	

* enter nominal motor hp if on, leave blank if off
** divide by 60 for heated desiccant dryers
*** calculated as 3% of compressor kW

All of the compressors are listed and only those that typically operate are included in the calculation. Nominal values for the motor horsepower are used as some compressors are operating at full load which is typically 10-12% above the nominal motor horsepower rating while other compressors are trimming and using less than their nominal motor horsepower. Any dryers in the systems are also listed and the energy for cooling the compressors is also included. Both air cooled and water cooled compressors require additional energy to produce cooling of the air or the water.

We then move on to the demand side portion of the system. By walking around the facility we can look for and identify those applications and situations that are wasting compressed air.

Demand Side EQ® Rating	score	enter value for each condition that applies	
Artificial Demand/ Header Pressure		1	<80 psig plant header pressure
		3	80-90 psig plant header pressure
		5	90-100 psig plant header pressure
		8	>100 psig plant header pressure
Open Blowing Applications		0	No compressed air blowing or use low pressure blowers only
		2	Minimal blowing applications using engineered nozzles
		5	Some compressed air blowing using tubing or pipe manifolds
		8	Significant use of comp air blowing on product or equipment
Inappropriate or Inefficient Uses (Use all that apply)		0	No inappropriate or inefficient uses identified
		2	Vacuum generators and venturis driven by compressed air
		2	Sparging, mixing of liquids with compressed air
		2	Vibrators or agitators powered by compressed air
		2	Other: diaphragm pumps, filter presses
		4	Large or multiple pulse type baghouses or dust collector
		5	Conveying of material with compressed air (not blowers)
		7	Significant use of air <45 psig but compressed to >90 psig
Leak Management		1	Aggressive leak repair program including ultrasonic scanning
		3	Semi or annual leak repair effort
		5	No leak management but do repair large or obvious leaks
		7	Minimal effort on leak repairs
Idle Production Equipment		0	Automatic shutoff of air to idle production equipment
		2	Manual shutoff of air to idle production equipment
		4	No shutoff of air to idle production equipment
Condensate Drain Losses		0	All demand style drains well maintained
		2	Mix of demand and solenoid drains
		4	Timed solenoid drains
		6	Partially open valves or drain bypasses
Total Demand Side Score		Add up all scores above	
Demand Side EQ Rating	%	Subtract total from 100 (relative to 100% of potential efficiency)	

The final section is the EQ Summary. Here we first calculate the overall EQ rating score by averaging the supply and demand side scores. We then use this score to look up the energy savings potential percentage from the table shown on the worksheet. By using the operating cost estimate calculated earlier with this savings % we can then determine the estimated annual $ of energy savings potential for the compressed air system.

Efficiency Quotient Summary

Supply Side EQ Rating	%		
Demand Side EQ Rating	%		
(Demand EQ + Supply EQ) / 2	%	System EQ Rating	
System EQ Rating of	>95%	5%	Opportunities exist, but Return On Investment may be limited
	>90%	10%	Operating cost reductions of 5-10% exist, providing an attractive ROI
	>85%	20%	Operating cost reductions of 15-20% exist, providing an attractive ROI
	>80%	25%	Operating cost reductions of 20-25% exist, providing an attractive ROI
	>75%	30%	Operating cost reductions of 25-30% exist, providing an attractive ROI
	>70%	35%	Operating cost reductions of 30-40% exist, providing an attractive ROI
	>65%	45%	Operating cost reductions of >40% exist, providing an attractive ROI
OPERATING COSTS ESTIMATE (From Energy Calculations Worksheet)	$		
Cost reduction opportunity based on EQ Rating	%	(copy in reduction opportunity based on system EQ rating)	
Cost Reduction Opportunity	$	ROI payback required _____ years Project funding available $ _____	

Once the opportunity for energy savings has been estimated the Quincy EQ Analysis is a low cost way to confirm the actual operating costs, determine the actual energy savings potential and develop an action plan for implementation to capture the opportunity.

Implementation

The EQ rating worksheet estimates the overall efficiency of the compressor system and is available for download at no cost to conduct your own walk-through at www.quincycompressor.com/auditing/eq-efficiency-quotient or your local Quincy distributor can be contacted www.quincycompressor.com/sales-services-locator and can come on-site to provide this professional service free- of-charge. An EQ App is also available in the itunes store (https://itunes.apple.com/us/app/eq-energy-efficiency-analyzer/id492166290?ls=1&mt=8). The app tool is a calculation "worksheet" that provides an estimate of overall operating costs, system efficiency level and potential savings from having a complete EQ analysis performed.

Summary

By using the unbiased and technically sound EQ Rating Worksheet any corporation can quickly and cost effectively estimate the energy savings potential that exists in their compressed air system. It can be performed in-house or with the assistance of an outside professional at no cost.

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Printed in the U.S.A. (EQ Whitepaper-001 03/13)