Analysis Of Energy Uses And Opportunities To Reduce Consumption And Cost

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Abstract: This Energy Assessment study is the result of a process involving a significant effort by a team of people at the plant and the Facilities Engineering Energy assessment team from Round Lake. Other specialists within Global Facilities Engineering have reviewed the report and contributed their experience in evaluating some of the energy saving opportunities. The plant manufactures renal therapy bags along with IV nutrition products. The plant's major manufacturing equipment includes 5 filling lines, 11 mix tanks, 16 sterilization vessels and 5 Packaging lines. This study approach has identified potential energy and cost saving opportunities that conducted for compressed air system at the facility that are: Energy savings for implementing Lower Compressed Air Pressure and improve the compressors controls are 117,701kWh/year and $17,493.The savings for reducing the leak rate from 30% to 20% are 144,410kWh/year and $21,413/year. The estimated savings for installing these accessories in the packing robots are 26,850 kWh/year and $3,991/year. The estimated savings for Stop bleeds during cooling are 181,621kWh/year and $26,993/year.

1. Introduction

An energy assessment was conducted for compressed air system at the facility, which involved the facility's engineering, maintenance, production personnel and a small team from Facilities Engineering in Round Lake. The goal of the energy assessment was to account for the major energy uses at the facility and to identify opportunities to reduce energy consumption and its associated cost. [1] At the end of the site assessment a wrap up meeting was held with the facility staff to discuss the findings and provide a list of recommendations for the plant to start evaluating. We continued work evaluating the findings and recorded data to produce an amended list of energy saving opportunities listed in this report. Estimated project costs are also included where they are known. The Manufacturing VP's require compressed air system that have had an energy assessment done by our Team, to review the recommendations in the report and provide status updates on the progress of the recommendations until all projects are closed off or implemented.

2. Compressed Air System

Equip I.D.	Manufacturer	Model	Type (select)	Rated Flow	Rated pressure	Operating pressure
				CFM	PSIg	PSIg
Comp. # 1	Atlas	ZR3-BE	Screw - Load/No Load	658	125	110
Comp. # 2	Atlas	ZR4 C ARR	Screw - Load/No Load	1013	150	110
Comp. # 5	Atlas	Z250 VSD	Screw - VFD	496/ 1527	125	110
Air Dryer #1	Atlas	FD410	Refrigerated Non-Cycling	869	100	110
Air Dryer #2	Atlas	FD1000	Refrigerated Non-Cycling	2119	100	110
Air Dryer #5	Atlas	FD1000	Refrigerated Non-Cycling	2119	100	125

Table 1: *Equipment in the Compressed Air System*

The compressors run on their own set points, with the Compressor #5 (VSD) running as base-load machine, and the other 2 compressors doing some sort of trim function. During the site visit it was noted that all compressors had different pressure readings at the same moment; this creates a controls fight between the machines. The next diagram shows a simplified layout of the system.

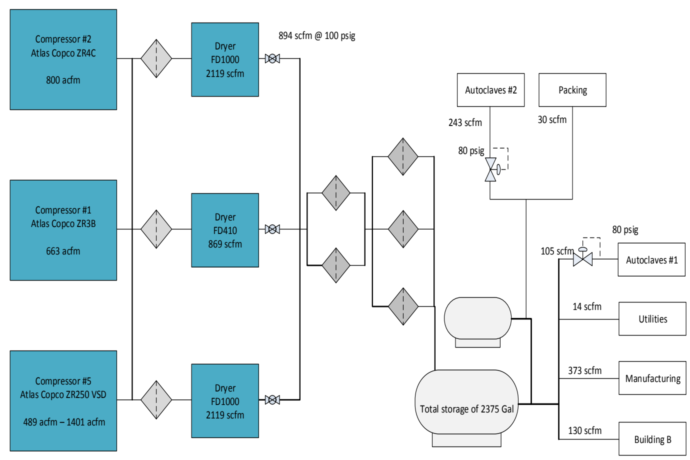


Figure 1: Typical compressed air Distribution System Configuration

As shown in the diagram, air from the compressors can flow to any of the dryers and then to the main filters bank with coalescing and primary filters. During the visit, the plant had humidity issues in the system, and 2 main issues were detected from the problem:

The valves after the dryers are manual, so if a dryer is turned off and the valve is not closed, humid air can pass through the dryers and to the filters which are not designed to dry the air. This situation happened when the issue occurred.

During the issue, the plant's dew point monitoring showed values of 27°F, which for the amount of humidity observed, the actual value had to be >45°F. This instrument has to be checked for effectivity.

3. Compressed Air Consumption

The plant monitors compressed air generation and consumption in the main pipes. The next graph shows the compressed air consumption based on the day of the week.

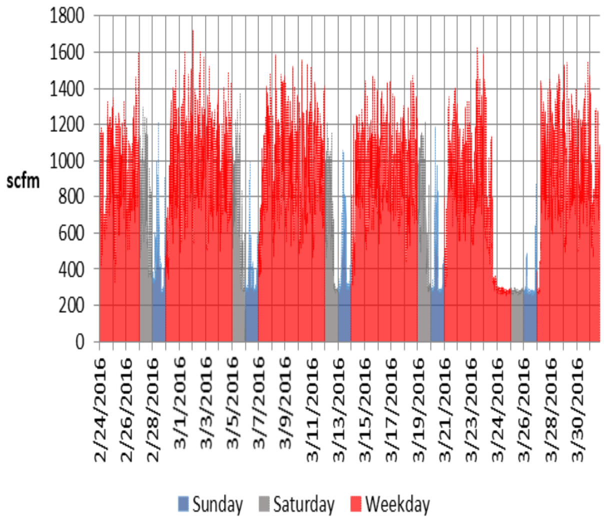


Figure 2: Typical compressed air Consumption

As seen on the graph, the airflow is higher during the week, getting to lower levels during the weekend. The next table shows the compressed air profile for the plant.

	Weekday	Sat.	Sun.	
Average Flow	894	602	401	scfm
Minimum Flow	253	255	254	scfm
Maximum Flow	1721	1377	1216	scfm
Average Power	220	141	92	kW
Consumption	1,294,318	165,461	109,871	kWh/year
Efficiency	4.06	4.28	4.38	scfm/kW

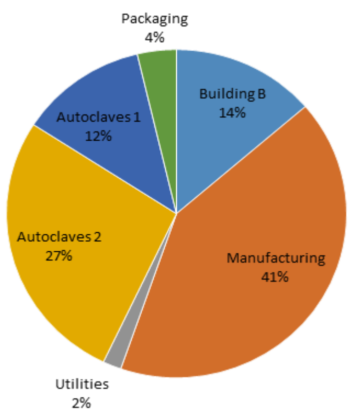
Table 2: Compressed Air Profile for the Plant

Currently, because of piping distance, the users in Building B are the most critical in the plant; they are the ones to first sense a fluctuation in the system's pressure. The minimum pressure that this area requires is 85 psig, but when other areas like sterilization have consumption peaks, the pressure can get lower than that. The following table shows the average airflow for the different area.

Average Flow per Area (scfm)

Area	Max. Flow	Week days	Sat	Sun
Building B	277	130	65	33
Manuf.	473	373	247	166
Utilities	14	14	14	14
Autoclaves 2	690	243	170	95
Autoclaves 1	690	105	77	65
Packaging	43	30	29	29
Total		894	602	401

Table 3: Average Airflow for Different Area



4. Leak Management

The plant recently bought an ultrasonic leak detector, and is starting a leak detection program. Current leak level is 30%, and it is calculated based on the flows recorded for 3/25/2016 that the plant was shut down, but the compressors were running. The following table shows the leak flow per area.

Area	Leak Flow (scfm)	Leak Rate
Building B	23	18%
Manufacturing	114	31%
Autoclaves 2	52	8%
Autoclaves 1	52	7%
Packaging	27	62%
Total	267	30%

Table 4: Leak Flow per Area

5. Compressors Controls

Compressors run by suing their own pressure set points. The following graph shows the % Power on a normal day.

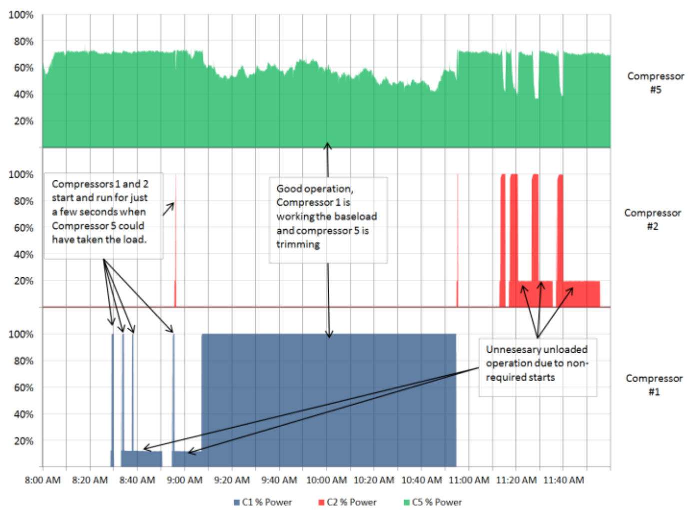


Figure 3: Compressor Run % Power

As shown in the graph, between 9:10 a.m. and 10:55 a.m. (also from 1:30 pm to 3:30 p.m., but is not shown in the graph) that the compressed air demand is high and the compressors ran in a good way; Compressor #1 as base load and Compressor #5 (VSD) as trim machine. Also, from 3:00 a.m. to 8:30 a.m. that the demand is the lowest; the system operates correctly because Compressor #5 runs by itself. The issue occurs the rest of the day when the demand is such that creates conflicts between the compressors controls. The consequences from these conflicts are mainly false starts from Compressors #1 and #2 that result in unnecessary unloaded operation.

6. Compressed Air System Recommendations

6.1. Lower Compressed Air Pressure and improve the Compressors Controls

This recommendation is to be done in 2 parts:
Improve controls: Currently each compressor is controlled by its own set points which are based on the pressure read by each compressor sensor. The issue is that because of calibration issues, each sensor reads different pressure levels at one time, causing the system to work inefficiently. To fix this, it's recommended to install a master controller (Atlas Copco and EnergAir [15] are companies that manufacture controls that will comply with all requirements), and control the machines based on the pressure in the tank. The following are the minimum requirements for this controller:
Must be able to control a VFD compressor.
Must be able to select the most efficient combination of machines based on system operation.
Must control all compressors based on 1 pressure band. The pressure control signal should come from the main compressed air receiver.
Must reduce or eliminate fix compressors unloaded operation.
Lower the pressure: Before lowering the pressure, the steam demand system recommendation to reduce Boiler pressure by controlling the sterilizer's startups and the compressors master controller must be operational. After those 2 items are completed, it is recommended to start lowering the pressure 2 psig every 2 or 3 days to 100 psig. A lower pressure in the system will reduce leakage, non-regulated demand, and power required by the compressors.
Energy savings for implementing this recommendation are 117,701kWh/year and $17,493.

6.2. Reduce Leak rate by implementing a leak detection, repair and verification program

Was taken during holiday. The savings reflected here only account for a 10% reduction (20% system losses), but in reality the plant needs to at least reduce from 30% to 10%.To do this a leak detection, repair and verification program has to be put in place. The plant already has an ultrasonic detector, which is the required equipment to do the task. The recommended program is run by UE Systems. A basic leak reduction program should have:
Leak detection: Routine detection of the areas using flow meters and/or an ultrasonic leak detector. Detected leaks have to be documented and marked (tagged) for correction [10] .
Leak fix: Fix all tagged leaks in a timely manner.
Verify fix: All leaks that were fixed need to be verified. If the leaks are in a process machine, when verifying, the machine has to be re-checked for leaks.
Frequency review: The frequency of leak detection for specific areas have to be determined based on the documented leak findings. By doing this appropriately, the facility leak rate will improve progressively in time.
The savings for reducing the leak rate from 30% to 20% are 144,410kWh/year and $21,413/year.

6.3. Install Proportional Regulators in the Ventures in the Packing Machines

The vacuum used by the packing machines and robots is generated by using a venture pump (compressed air driven). To reduce the amount of compressed air in this application, it is recommended to use a proportional regulator that will control the compressed air usage based on the vacuum level in the vacuum cups.

Figure 4: a venture pump (compressed air driven)

Also, in the robots, they handle different size of boxes, so sometimes (when the box is small) several cups will by pulling vacuum, when there's no need for it. In this case, it is recommended to change the type of cup to one that has a check valve in it. This valve will close if there's no vacuum required. The following images show both of the recommended products:

Check valve for the suction cups Proportional pressure regulators

Figure 5: check valve & pressure regulator

Both solutions are supplied by Piab, [14] which is the same brand of vacuum accessories that the plant currently uses; it is recommended for the plant to have Piab go and do some application recommendations in other processes in the facility.
The estimated savings for installing these accessories in the packing robots are 26,850 kWh/year and $3,991/year

6.4. Stop bleeds during cooling

Currently the autoclaves maintain an open flow of air in the bleeder valves during the cooling stage of the cycle. This is not needed, and so other plants like Cuernavaca, Cali and Sao Paulo have validated that the cycle doesn't get affected by eliminating this bleed of air. The sterilizer's bleeds in already have the control valves, so the next step is to activate the controls to close the valves when the cooling cycle begins and validate the change.
The estimated savings for implementing this recommendation are 181,621kWh/year and $26,993/year.

7. CONCLUSION :

This Energy Assessment Report is the result of a process involving a significant effort by a team of people at the Plant and the Facilities Engineering Energy assessment team from Round Lake. Other specialists within Global Facilities Engineering have reviewed the report and contributed their experience in evaluating some of the energy saving opportunities.
This team approach has identified potential energy and cost saving opportunities that are
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Some of the projects may need project cost adjustment depending on local costs that may or may not improve the ROI. Other projects may have an interaction with each other and the savings and costs could change.

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