



COMPRESSED AIR AUDIT

APPLICATION

Compressed Air Audit for reducing energy consumption and proper sizing of compressors.

BACKGROUND

Compressed air is widely recognized as industries fourth utility. It is the only utility the end-user has the sole responsibility to produce and maintain in-house. Compressed air is a very costly utility; it is not “free”. Developing an understanding of the dynamics of a compressed air system (CAS) is advantageous to the end user for two main reasons.

First, a CAS is inherently inefficient. Due to heat loss during the heat of compression, only approximately 10% of the input energy is usable energy at the point of use. Therefore, significant opportunities exist to reduce the input energy consumed to meet the compressed air demand, sometimes in the neighborhood of 35-40%.

Secondly, the CAS can be a source of numerous problems that bring about added costs, product rejection and unnecessary downtime due to the erratic and inefficient performance of the CAS.

It is with these facts in mind that industry owners, managers and engineers must recognize that industrial compressed air systems can represent the most insidious form of industrial waste in a plant, and therefore, offer great opportunities for efficiency improvements and increasing the bottom line.

REQUIREMENT

No two compressed air systems are identical. A CAS is dynamic. The operation, response and performance are different due to the constantly changing conditions, equipment and demands. To better understand the dynamics of a CAS, and create useful data needed in accomplishing some goals discussed above, a thorough compressed air audit must be performed.

During an air audit, several sensors are installed at key locations to monitor the system. The objective is to collect data that can be used to create “profiles”. The three main profiles created during an audit are flow, power and pressure.

Compressed air systems are split into two main parts; the supply-side, most commonly referred to as the compressor room or powerhouse, and the demand-side, the main plant or production area. The bulk of the monitoring during an audit is performed on the supply-side where a system might consist of several air compressors, air dryers and pieces of ancillary equipment. To properly monitor a CAS, anywhere from 4 to 36 points or more must be monitored simultaneously. The data then needs to be logged or “stored” over

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time in an efficient and reliable manner. This data is later downloaded to a PC for post-audit data processing. In summary, to properly monitor a CAS during a through audit can be quite a challenge in data logging.

SOLUTION

The Logic Beach HyperLogger HL-1 data logger has been configured and programmed into a data acquisition system suitable for monitoring compressed air systems. The versatility and expansion capabilities of the Logic Beach HyperLogger HL-1 have made this an excellent choice when working with the simplest or most complex air systems.

As mentioned previously, there are no two systems alike. Every audit performed is different in regards to the equipment, layout, scope and the overall objective. The sensors used in the data acquisition process are; pressure transducers, current transformers, kW meters and various types of flow meters, among others. Therefore, the data acquisition system must be easily configurable in the field to monitor and log the data from this list of sensors.

The Logic Beach HyperLogger HL-1 data logger, coupled with the HyperWare software, makes a great package that allows the user to easily interface with these various types and quantities of sensors while in the field. The HyperWare software also allows the user to view the data in real-time, as well as store for post-audit download, processing and evaluation.

The Logic Beach HL-1 data logger is a wonderful example of a versatile, rugged and dependable data logger that has exceeded the compressed air auditor's needs.

SAMPLE AUDIT

The equipment used to collect data during an audit, or any evaluation for that matter, is very critical. The old adage applies here; garbage in garbage out. To this point we have mentioned several times the importance of a high quality data logger like the Logic Beach HyperLogger HL-1. It is equally important to use sensors that are of high accuracy and quality. Sensors should be chosen that have an accuracy of $\pm 1\%$ or better.

To perform a basic audit, it is necessary to interface these high quality sensors; a pressure transducer, current transformer, or power monitor, a mass flow meter and a temperature sensor. This is easily accomplished with the Logic Beach HL-1 data logger. The preferred sensors are 4-20mA and can be excited from an isolated dc power loop, or sensor excitation can be supplied from the logger itself. Once the loop is created, the sensors are wired to the logger Port of choice with the internal dip switches configured for current input on the 20mADC scale. The logger is then ready for the Program Net to be built utilizing the HyperWare software. The following Program Net is simplified NET utilizing a CASE Index develop by Southern California Edison (explain later) and just a few of the powerful programming Icons available in HyperWare from Logic Beach.

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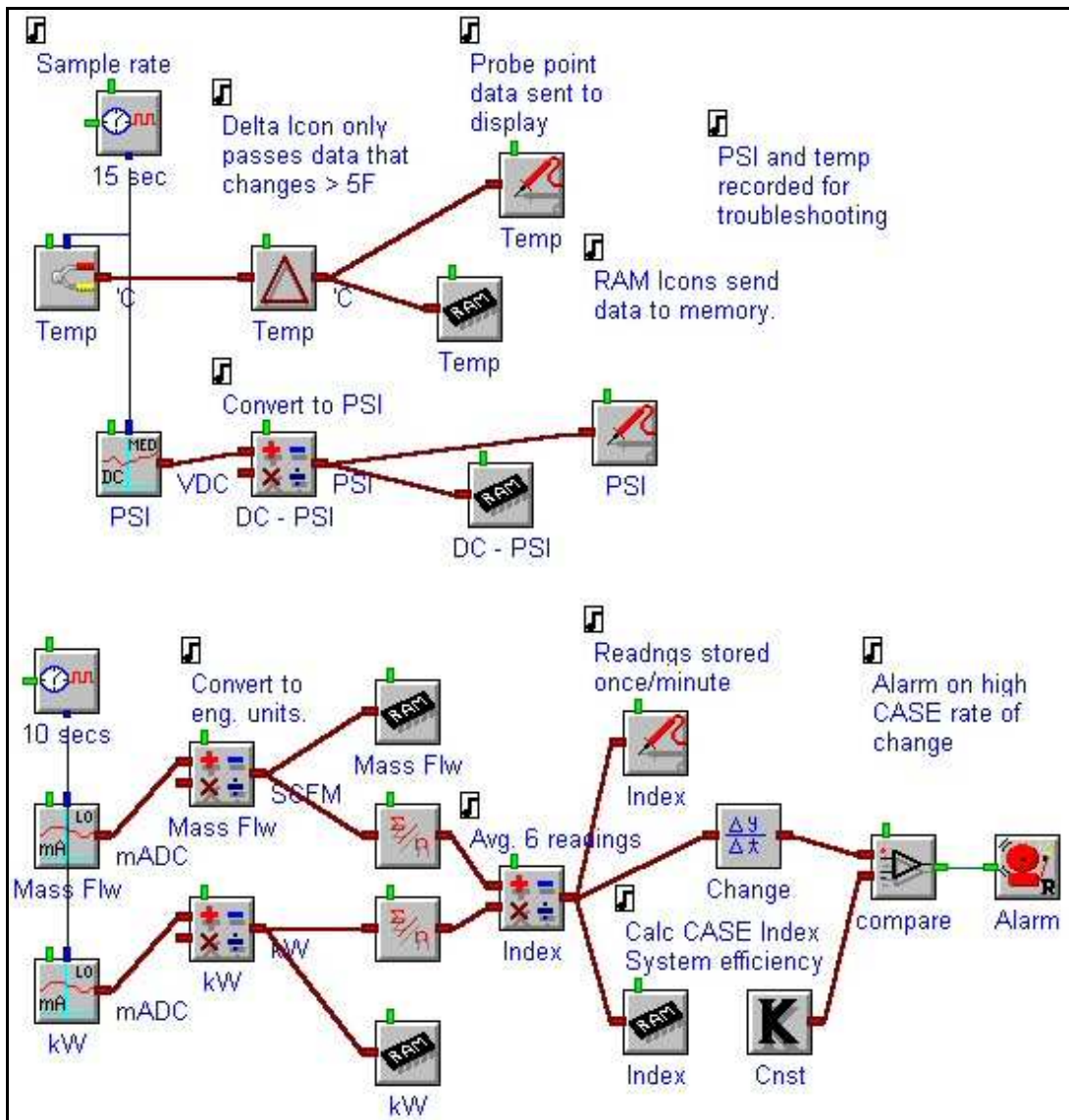


Figure 1

Figure 1 is a sample of a basic audit Program Net as created in HyperWare the software used for Logic Beach data logging instruments. HyperWare is a graphical, icon-based, program designed for ease-of-use and simplicity. See more [here](#). The appropriate Input Icons are first chosen that represent each sensor wired to the logger Port, and the corresponding channels. The Sample Rate Clock Icon is selected and should be set for a rate of 6 to 15 second interval. This interval works well to capture changes that happen rapidly within an air system, large demands that occur within a small time frame.

The top portion of the Program monitor and record air temperature and pressure. These are largely used as a check if the Flow and Power move in a drastic irregular manner. The Pressure (PSI) signal is converted from a process signal to engineering units in the Math Icon. (4th order polynomials are easily handles here).

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Temperature from a thermocouple does not require signal conversion and may be recording or processed directly from the Input Icon.

The lower portion of the Program Net represents the two 4-20mA signals from the Mass Flow Meter and the Power (kW) sensor. After applying a Math Icon to convert the process signals to engineering units each program channel then flows in parallel to Averaging Icons and then to a Math Icon where the CASE Index is calculated. A Rate of Change Icon monitors the CASE Index fluctuation over time and if the rate of change is greater than the anticipated constant (Constant Icon) and alarm is triggered.

The data logger Memory Icon allows the data to be stored within the internal memory of the logger. This data can be accessed at anytime on a laptop computer via a serial connection, and of course eventually downloaded in full to a desktop PC for post-audit processing and detailed evaluation. The Probe Point Icons allows the user to view the data in real-time through the serial connection. This is very convenient while the auditor is still in the field and is certainly necessary to ensure the sensors are set up, scaled and sensing properly.

POST-AUDIT EVALUATION

The post-audit evaluations of the data collected and report generation is equally important as the data collection itself. There are several values that need to be extrapolated to create a useful report. Basic information includes the minimum, maximum and average flow, and power and pressure values. These values can be calculated through the HyperWare Program Net using the icons available, however, with different shifts of operation and several other contributing factors, it is best to extrapolate these values manually so the auditor does not miss any event in the air system that is of value to the end user. Knowing the exact time of day, peak flow, duration and power consumed are just some of the useful points of information the auditor needs to extrapolate, examine and derive possible solutions to improve the system.

Other useful values are the scfm/kW ratio. An air system utilizing positive displacement rotary-screw air compressors, operating at 100% rated full load and 100psig, should have a 100% dynamic efficiency close to 5 scfm/kW. A system that has room for improvement will be operating in the 2 to 3 scfm/kW ratio range for instance. Power consumed to produce the scfm required is critical and is at the crux of most air system audits.

Southern California Edison (SCE) developed a metric to measure compressed air system performance and to compare its performance to other compressed air system installations. The method involves monitoring and recording flow, energy consumption of the system, temperature and pressure of the air. A ratio results from this inputs which is named CASE (Compressed Air Supply Efficiency) Index and is the ratio of air supplied in standard cubic feet per minute divided by the power in kWh. The ratio may vary between 0 and 320 with a SCE recommended target of 200 or above for averaged system period. Below 200 systems may be oversized, reservoirs undersized, and/or individual machines operating ineffectively creating unnecessary air loss and power consumption.

Most compressor manufactures, distributors and independent auditors have created their own post-audit evaluations programs. These programs take the raw data, extrapolate the values desired, and allow the auditor to then pour over the data to model potential solutions to problems and help create the most efficient

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Application Note

air system possible. Needless to say, these programs are not made available to the public for obvious reasons.

To date, the most widely accepted evaluations program made available to the public is the AIRMaster+ software program. This is a software package developed in part by the U.S. DOE to help the end user maximize the efficiency and performance of their compressed air system through improved operations and maintenance (O&M) practices, usually the main goal of a compressed air audit. AIRMaster+ provides comprehensive information on assessing compressed air systems, including modeling and evaluating energy efficiency. For more information on downloading this program, and locating a qualified specialist to assist you in identifying system improvement opportunities, please visit the link provided below.

<http://www1.eere.energy.gov/industry/bestpractices/software.html#air>

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