Use/Purchase Optimum Sized Compressor (Arc 2.4226)

(The analysis below was extracted from one of the assessment reports by the Clemson University Industrial Assessment Center (IAC). This is only an example recommendation and hence, not all the background information and sources for numbers are included here.)

Est. Electric Consumption Savings	= ***370,440 kWh/yr***
Est. Electric Consumption Cost Savings	= ***$14,447 /yr***
Est. Implementation Cost	= ***$39,883***
Simple Payback Period	= ***33 months***

Recommended Action:
It is recommended to change the existing 150 hp single speed modulation mode air compressor to a 50 hp variable frequency driven air compressor (VFD). VFDs have a lower energy requirement for the same amount of work done.

Background:
The plant uses compressed air for pneumatic machines. The requirement for air is 150 cfm. The plant currently uses a 150 hp motor at 90 hp to serve this purpose in modulating mode. This is not the optimal size of the compressor required for this purpose. Generally, 1 hp in a compressor can generate up to 5 CFM of air. This means a 30 hp functioning compressor is enough to meet the company requirements. We suggest a 50 hp variable frequency drive to be run at 30 hp. Variable frequency driven compressors will have higher part load efficiency than modulating compressors, meaning they will use less energy at fractional loads than modulating compressors.

Anticipated Savings:
Generally, the power consumed by a compressor in its functioning is calculated as the product of voltage, ampere, and the hours of usage of the compressor.

The plant currently runs a 150 hp compressor at 460V/176A/0.84 power factor.

The power consumed by this compressor is given by:

$$\textit{Power consumed} = 460 \times 176 \times 0.84 = 68kW$$

The power consumed by the recommended 50 hp is given by the following calculation [2]:

$$\textbf{Fractional capacity (FC) = Running capacity/Rated capacity = 30hp/50hp = 0.60}$$

$$\text{Fractional power during production (FP)} = FC * (1-FP0) + FP0$$

$$= 0.6\,(1-0.1) + 0.1 = 0.64$$

$$\textbf{Power consumed} = 50\text{ hp} \times 0.746\text{ kW/hp} \times 0.64 = 23.9\text{ kW}$$

FP0 is the fractional power at no load which for variable frequency drives is typically 0.1.

The estimated unit electricity consumption saving for every hour can be determined as follows:

Unit Electricity consumption savings (UECS) = 68 kWh – 23.9 kWh = 44.1kWh

The annual electricity consumption saving for the compressor can be calculated as the product of kW saved and the hours of operation of the unit.

Electrical consumption saving (ECS) = UECS × Operation hours

= **44.1kWh × 8400/yr**

Electrical consumption saving (ECS = 370,440 kWh/yr

Finally, the estimated annual electric consumption cost savings can be determined based on the unit electricity consumption charge as

Electric consumption cost savings (ECCS) = ECS × ($0.039/kWh)

= 370,440 kWh/yr × (0.039)

Electric consumption cost savings (ECCS) = $14,447.16/yr

Implementation Cost:
The facility already has the support structure in place to run a compressor, such as air lines, hoses, valves, etc. The installation cost of the new compressor will only involve the replacement of the old compressor. The installation cost is estimated to be 7-11% of the cost of a compressor. We are using 10% as the higher approximate for our calculations. The cost of the new Variable Drive Compressor is $36,258.04. The installation cost is approximately $3,625.80, which brings the total implementation cost to $39,883.84.

Implementation cost (IC) = ($36,258.04) + (10% × $36,258.04)

Implementation cost (IC) = $39,883.84

Simple Payback Period:
The simple payback period (SPP) is the time required to pass before the estimated total cost savings equal the estimated implementation cost, and is calculated by:

$$SPP = \frac{IC}{TCS} \times 12\ months/yr$$

$$SPP = \frac{\$39{,}884}{\$14{,}447} \times 12\ months/yr$$

SPP = 33.12 months

References:

1. Schmidt, Chris, and J. Kelly Kissock. "Power characteristics of industrial air compressors." (2003).