# Complete Compressed Air System Audit Case Study - Southwestern Dairy Products Packaging Plant


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**March 7–11, 2017**

Las Vegas, Nevada, USA

# Compressed Air System Audit Case Study: Southwestern Dairy Products Packaging Plant

## Complete Compressed Air System Audit

- ✓ Supply and Demand-Side System Analysis
- ✓ Energy Savings
- ✓ Productivity
- ✓ Reliability Issues
- ✓ Future Projects for Continuous Improvement

AIR POWER USA
Independent and Brand Neutral

IFPE 2017

# Economics Outline – Current Situation

This facility currently spends an estimated $159,919 annually on energy to operate the compressed air system.

This figure is based on 11.5 cents per kWh, and operating 8,760 hours per year

The following projects will reduce the total cost by an estimated $81,877 or 51%

Additional savings estimated at $35,380 will be attained with heat recovery in steam use reduction.

Additional identified operating cost reductions:

| | |
|---|---|
| - oil and filter change reduction | $93,120 year |
| - elimination premature air end failure | + $13,000 year |
| Total: | $106,170 year |
| Total Cost Recovery: | $228,202 year |
| Total Budget Cost: | $220,000 |
| Simple pay back period: | 12 Months |

# Dairy Product Plant - Overview

## Compressed Air System Review: Executive Summary

| PROJECT | SAVINGS PROFILE | ENERGY AND OTHER SAVINGS | | | TOTAL PROJECT COST ($) |
|---|---|---|---|---|---|
| | | AVG kW | kWh | SAVINGS ($) | |
| **AIR COMPRESSOR SUPPLY** | | | | | |
| 1. Convert the 150-hp and 100-hp air-cooled units to water-cooled; flush system and add new type food grade lubricant to system | Savings taken with Project 2. | | | | $25,000 |
| Alternate: convert all four compressors to water cooled, as described for large units. | We recommend converting the primary 150-hp and 100-hp variable speed drive to water-cooled, but leave the 50-hp and 75-hp air-cooled in back up after ventilation problems are corrected. | | | | |

# Dairy Product Plant – Overview

| PROJECT | SAVINGS PROFILE | ENERGY AND OTHER SAVINGS | | | TOTAL PROJECT COST ($) |
|---|---|---|---|---|---|
| | | AVG kW | kWh | SAVINGS ($) | |
| **HEAT RECOVERY** | | | | | |
| 2. Add a new water / glycol cooling system sized for all four compressors with a duplex 7.5-hp pumping station, control valve and a trim cooler to allow pre-heating of process water for heat recovery (6,240 hrs./yr.) | Steam use savings 567,000 1,000 lbs./hour | N/A | N/A | $35,380/yr. ($10 hr. / 1,000 lbs. yr.) | $100,000 |
| 3. Reconfigure Compressor Room interconnecting piping; to eliminate “dead head” crossing tees and allow for proper operation of compressors. Install 3,000 gallon receiver. | 24 kW | 24 | 211,087 | $24,275 | $50,000 |
| 4. Replace current dryers with new oversized glycol based, full cycling refrigerated dryer (2,400 scfm) with mist eliminator | 9.8 kW | 9.8 | 85,844 | $9,851 | $31,514 |
| 5. Replace (2) electric timer drains with electric or pneumatic actuated no-loss drains | 6 cfm | 1.14 | 9,956 | $1,145 | $1,000 |
| 6. Implement recommended ventilation modification | This is not an energy savings measure, but will improve air quality and equipment reliability. (Potentially a phase two project to be revaluated after the other projects have been completed) | | | | TBD |

# Dairy Product Plant – Overview

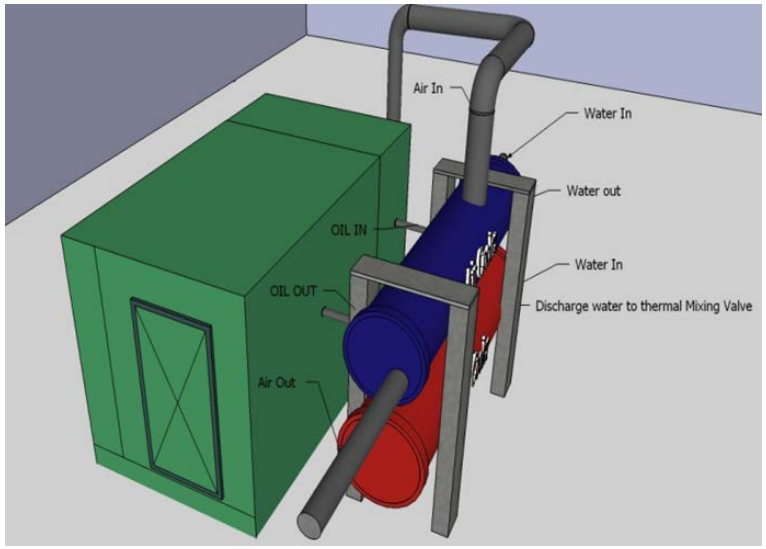
| PROJECT | SAVINGS PROFILE | ENERGY AND OTHER SAVINGS | | | TOTAL PROJECT COST ($) |
|---|---|---|---|---|---|
| | | AVG kW | kWh | SAVINGS ($) | |
| **DEMAND-SIDE SYSTEM** | | | | | |
| 7. Replace 17 open blows and add auto shut-off as listed. | 95 cfm | 18.01 | 157,774 | $18,144 | $1,700 |
| 8. Repair 53 identified and tagged leaks | 238 cfm | 26.35 | 164,484 | $26,546 | $4,000 |
| 9. Replace two air vibrators with electric | 14 cfm | 2.67 | 16,686 | $1,558 | $1,000 |
| 10. Add electronic stroke optimizer to AODD pump | 25 cfm | 4.74 | 41,521 | $4,775 | $2,000 |
| 11. Central control monitoring Quote | No projected energy savings for this project. Strictly recommended for operational optimization and risk avoidance. | | | | TBD |
| TOTAL | 567<br>1,000 lbs./hr.<br>378 cfm<br>33.8 kW | 86.71 kW | 687.352 kWh | $122,032 per year | $216,214 |

Potential Follow-up Projects:

- Optimization of the Palletizing, Case Erection and Vacuum System
- Optimization of the pulse jet collectors
- Cabinet coolers
- Vacuum generation optimization
- Lower system and compressor discharge pressure in “Dry Ingredients” Room

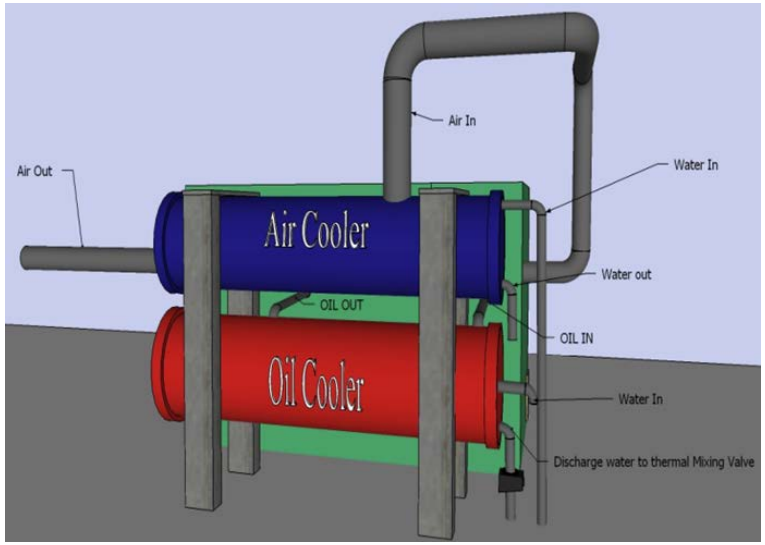
# Project #1 – Compressor Conversion

Convert the 150-hp and 100-hp air-cooled compressors to water-cooled, closed water/glycol with air-cooled heat exchanger and trim cooler.




Flush and service the Compressor Lubrication System and add new type food grade lubricant to system.

Project cost: $25K



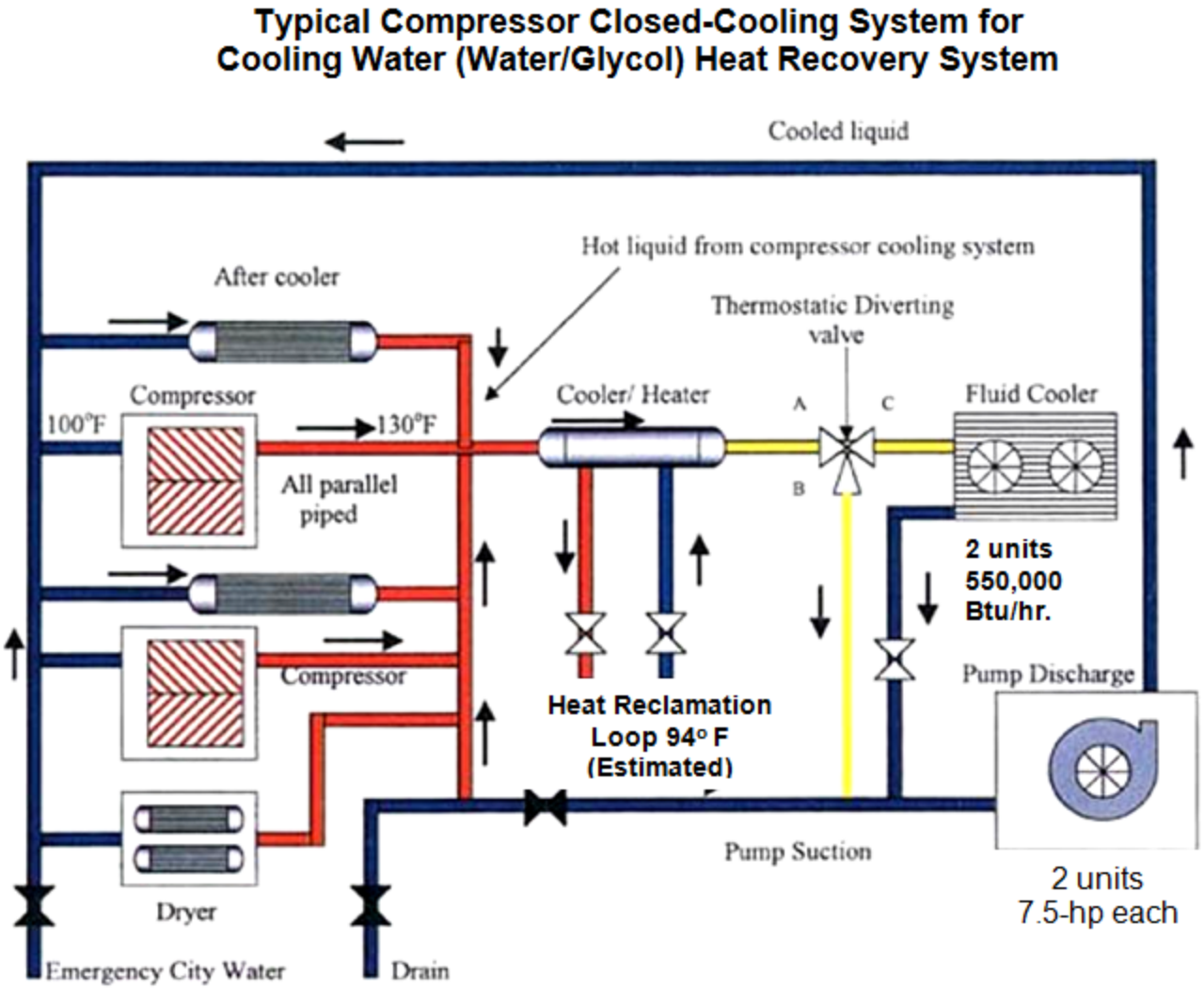
# Project #2 Closed Cooling – Trim & Heat Recovery

Add a new water / glycol cooling system sized for all four compressors with a duplex7.5-hp pumping station, control valve and a trim cooler to allow pre-heating of process water for heat recovery (6,240 hours year).

| | |
|---|---|
| Current heating cost of alternative heat source | $555K BTU year |
| Annual hours - equipment operation | 6,240 hours/year |
| Estimated annual heating cost being offset | $10.00 hour |
| | 1,000 lbs. / year |
| Estimated cost of steam (1,000 lbs.) | 567 lbs. / hours |
| Estimated annual heating cost being offset | $35,380 |
| Cost for heat recovery project (equipment and delivery) | $65,000 |
| Installation | $35,000 |

| Approximate BTU's Per Unit for Most Common Fuels | | |
|---|---|---|
| **Butane** | = | 103,000 Btu/gal |
| **Electricity** | = | 3413 Btu/kWh |
| **Firewood** | = | 20,960,000 Btu/cord |
| **Gasoline** | = | 125,000 Btu/gal |
| **Kerosene** | = | 135,000 Btu/gal |
| **Natural Gas** | = | 1,000 Btu/cu ft. |
| **#2 Oil** | = | 138,500 Btu/gal |
| **#6 Oil** | = | 150,000 Btu/gal |
| **Propane** | = | 91,500 Btu/gal |
| **Steam** | = | 970 Btu / hour / lbs. @ 212°F @ 14.7 psig |

# Project #2 Closed Cooling – Trim and Heat Recovery



# Project #2 Highlights

## Total cost: $100,000

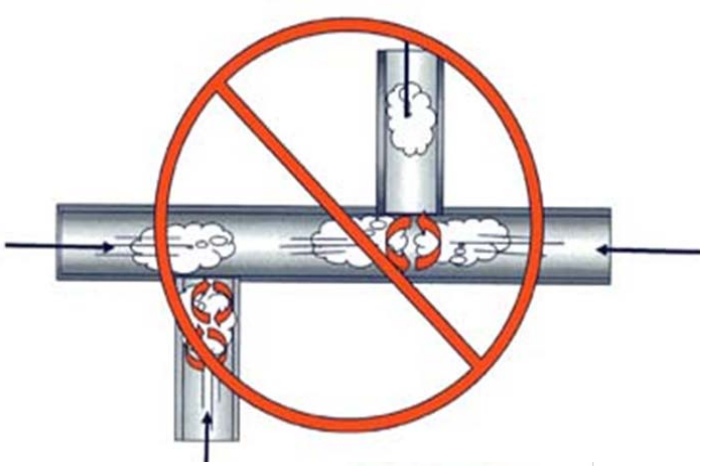
Energy and operating cost reductions:

- Heat Recovery steam: 567 lbs. / 1,000 lbs./hr. - $35,380/year
- Oil change and support $93,120/year operating cost reductions (historical data)
- Eliminate premature air end failure $13,000/year (historical data)
- Converting air to water will remove much of the heat load of the compressors

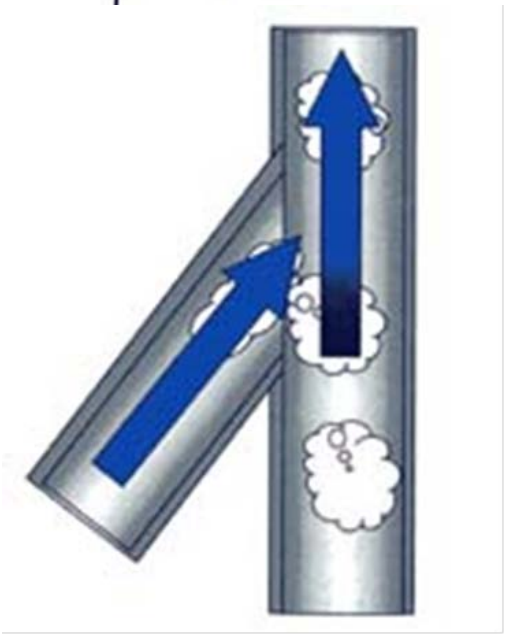
Critical Goals For Performance And Reliability
Compressor operating < 200°F
Entry temperature to dryer < 100°F

# Project #3 – Compressor Room Piping

Reconfigure the Compressor Room interconnecting piping; eliminating “dead heads” and “crossing T’s” to allow for proper operation of the compressors.

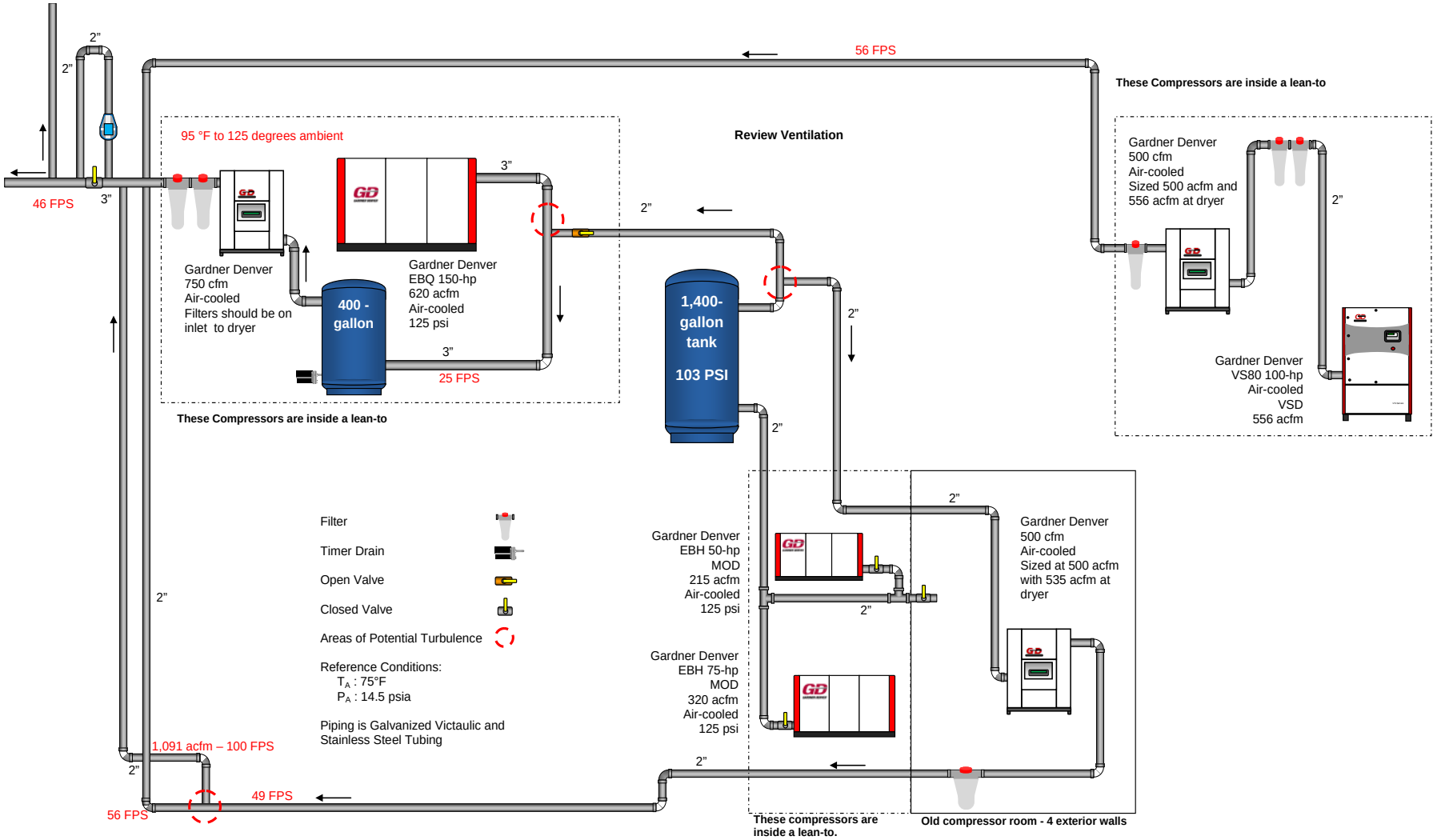


Piping should be upsized to maintain a 20 fps velocity.

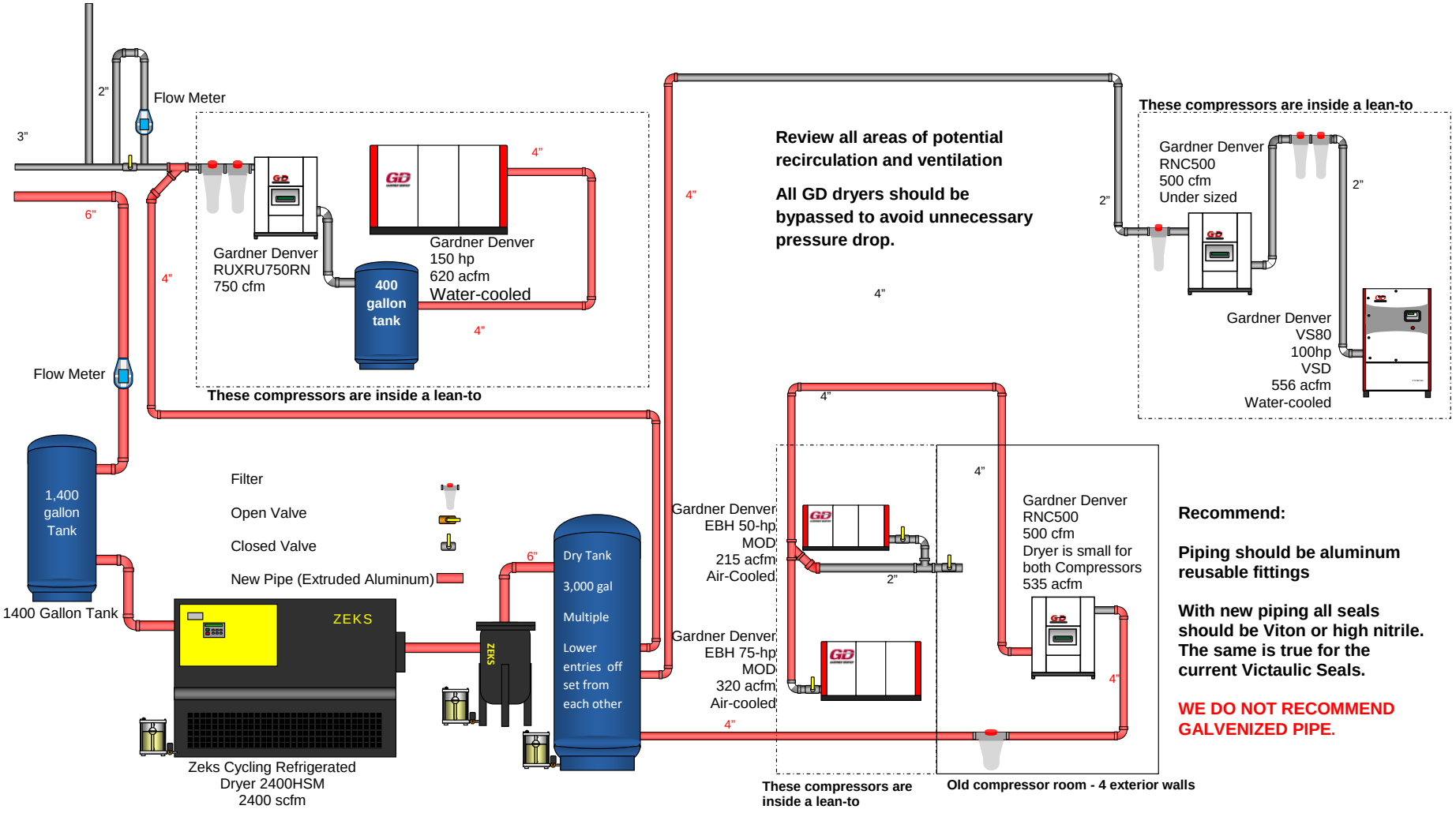


| | |
|---|---|
| Project energy savings | $24,275 year |
| Project cost | $50,000 year |

# Current Compressed Air System



# Reconfigured Compressed Air System




**Recommend:**

**Piping should be aluminum reusable fittings**

**With new piping all seals should be Viton or high nitrile. The same is true for the current Victaulic Seals.**

**WE DO NOT RECOMMEND GALVENIZED PIPE.**

# Project #4 – Compressed Air Dryers

Replace current dryers with new, oversized glycol based full cycling refrigerated dryers (2,400 scfm) with mist eliminators.

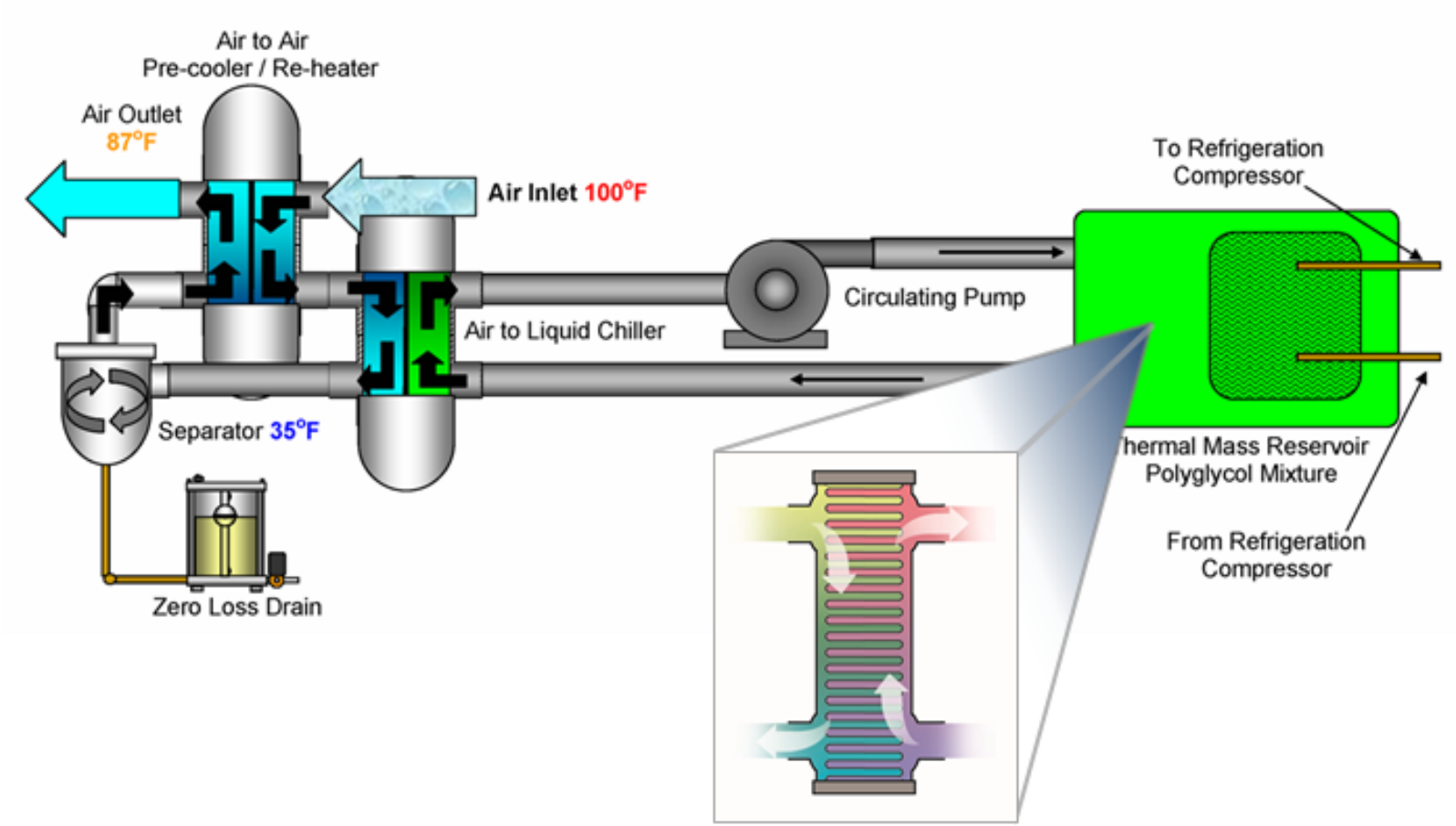
| Manufacturer | Gardner Denver | Gardner Denver | Gardner Denver | **Replacement Zeks** |
|---|---|---|---|---|
| Model | RVXRD750 | RNC500 | RSD800 | **2400 HSM** |
| Unit Type | Non-Cycling | Non-Cycling | Non-Cycling | **Heat Sink Cycling** |
| Rated Flow @ 100ºF / 100 psig / 100 scfm | 750 | 500 | 800 | **2,400** |
| Full Load Heater kW (or Refrigerated kW) | 4.2 | 2.68 | 4.2 | **9.9** |
| Total Full Load kW | 4.2 | 2.68 | 4.2 | **9.9** |
| % Load w/ Dew Point Demand Control or Cycling Regeneration | 100% | 100% | 100% | **15%** |
| Net Electric Demand (kW) | 4.2 | 2.68 | 4.2 | **1.3** |
| Total Annual Operating Cost ($) | $4,231 | $2,699 | $4,231 | **$1,310** |

| | |
|---|---|
| Annual electric energy cost of current dryers | $11,161 year |
| Annual electric energy cost of proposed dryer | $1,310 year |
| Annual cost savings with new proposed dryer | $9,851 year |
| Equip. cost for proposed dryer | $31,614 (Installation included with Project #2) |

Note: If the compressor and new dryer remain air-cooled, a larger multiplex 3,250 scfm unit may be needed.

# Heatsink Cycling Refrigerated Dryer

## How It Works



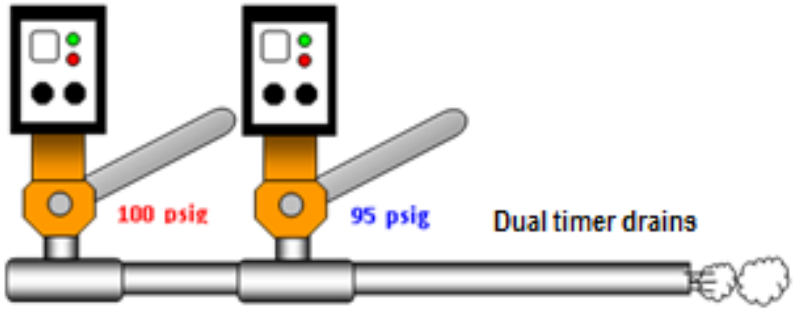
# Project #5 – Condensate Drains

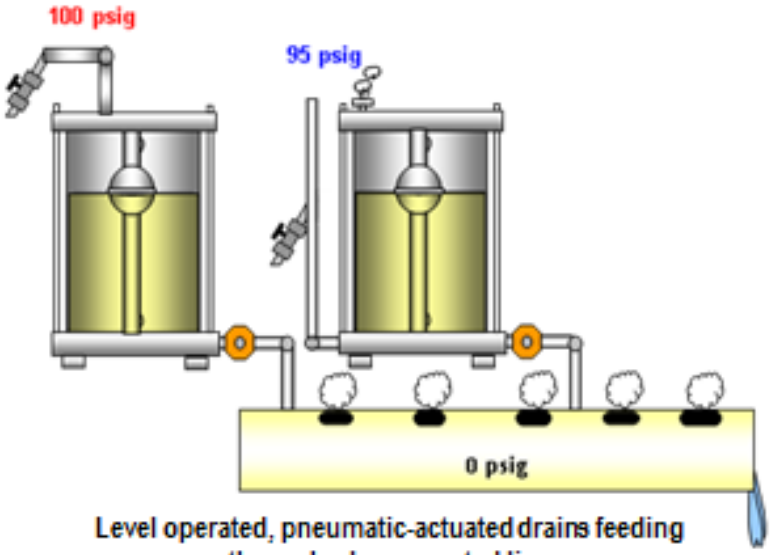
Replace timer drains with electric-or pneumatic-actuated no-loss drains.

Savings: 6 cfm

Project savings: $1,145 yr.

Project cost: $1,000




Level operated, pneumatic-actuated drains feeding through a large, vented line

# Project #7 – Open Blows & Auto Shut-offs

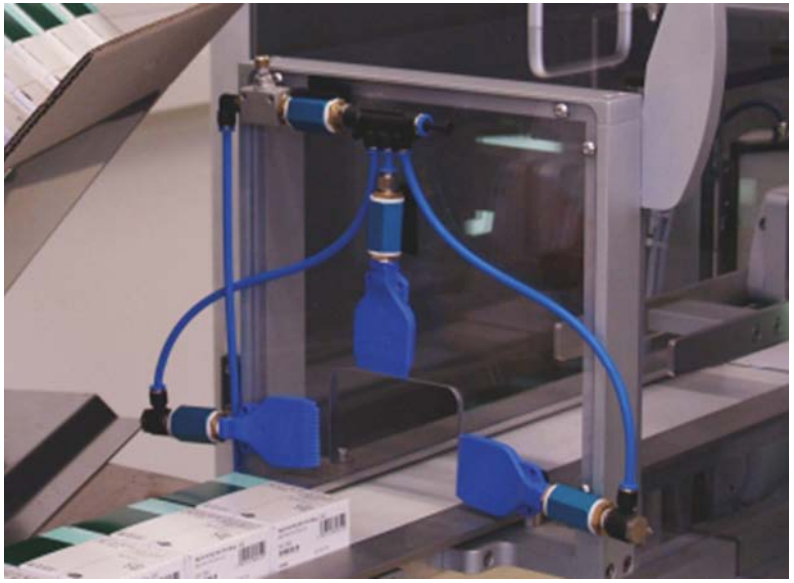
Replace all identified open blows and add auto shut-offs where applicable.

| | |
|---|---|
| Total number of applications | 17 open blows/units |
| Compressed HP air currently used | 180 scfm (10-11 scfm each) |
| Compressed HP air used after installation of Venturi nozzles | 1 scfm each (17 scfm total) |
| Value of air reduction | $111.31 scfm/year (163 scfm) |
| Total electric energy cost recovery by installing Venturi nozzles | $18,144 year |
| Project cost with installation | $1,700 |

Note: Add automatic shut-off to area when applicable.

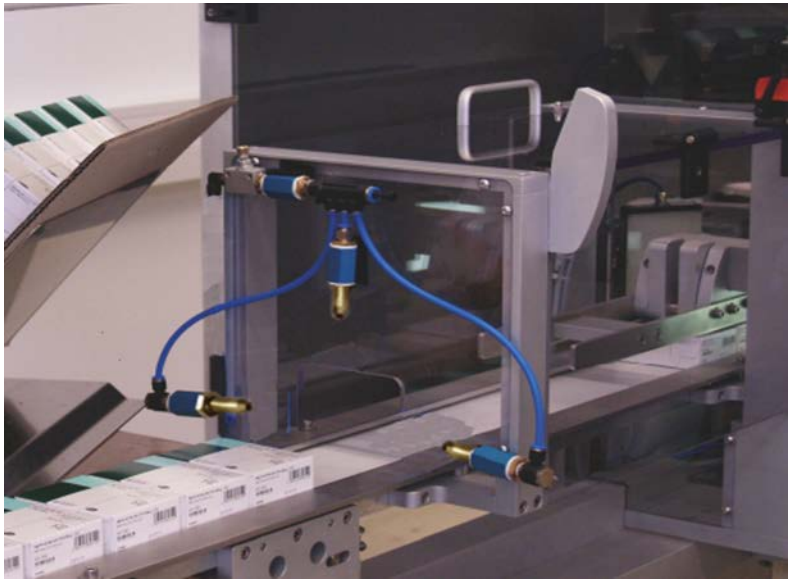
# Project #7- Examples

Pictured below are examples of project implementations that resulted in a lower CFM use and delivery of more air to the individual process. Nozzles used have a 25:1 amplification.



Blue dispersion nozzles using about 10-11 scfm

50 scfm to process



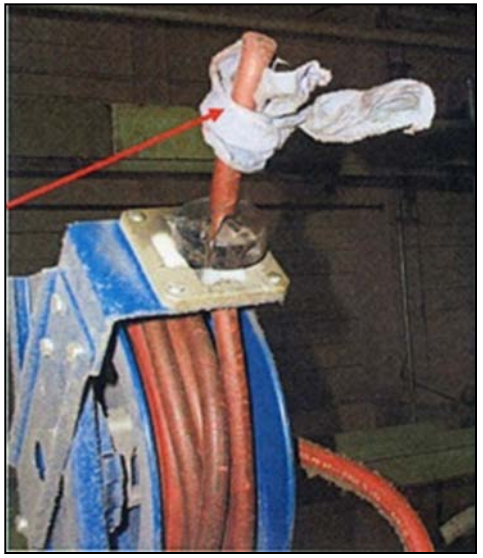
Replace with (3) 48002 AiRTX Venturi-driven micro nozzles using 1 cfm each at 40 psi.

75 scfm at process

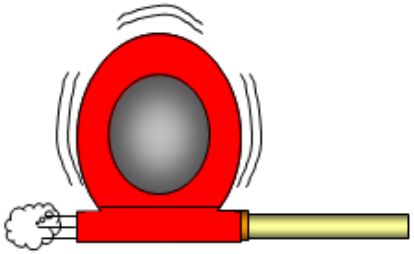
# Project #8 – Compressed Air Leaks

Repair all identified and tagged compressed air leaks. Implementation of a company-wide leak management program is an effective step to key “best practices” and energy saving solutions.

| | |
|---|---|
| Total compressed air leaks identified: | 53 |
| Total SCFM of leaks | 238 scfm |
| Cost to repair leaks | $4,000 |
| Recoverable annual energy savings | $26,546 yr. |



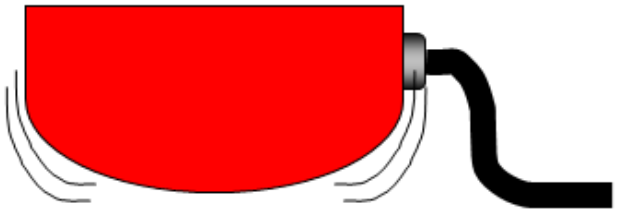
# Project #9 – Air Vibrators vs. Electric Vibrators



Air Vibrator

Currently uses: 7 cfm at 80 psig

Annual cost = 1.5 kW X $.05 /kWh X 8,760 hours = $657.00 year



Electric Vibrator

Proposed usage: .25 kW

Annual cost = .25 kW x $.05 /kWh x 8,760 hours = $109.00 year

Air vibrators are primarily used to keep product or packaging moving and/or separated, e.g. keeping product lids separate prior to sealing. If a plant employs air vibrators that use about 7 cfm each they will require approximately 2.5-hp or more to produce the same as a similar electric vibrator - which might use about 0.25-hp input energy. Air vibrators can almost always be replaced with electric except in foundry sand mold operations.

Total project savings = $1,558

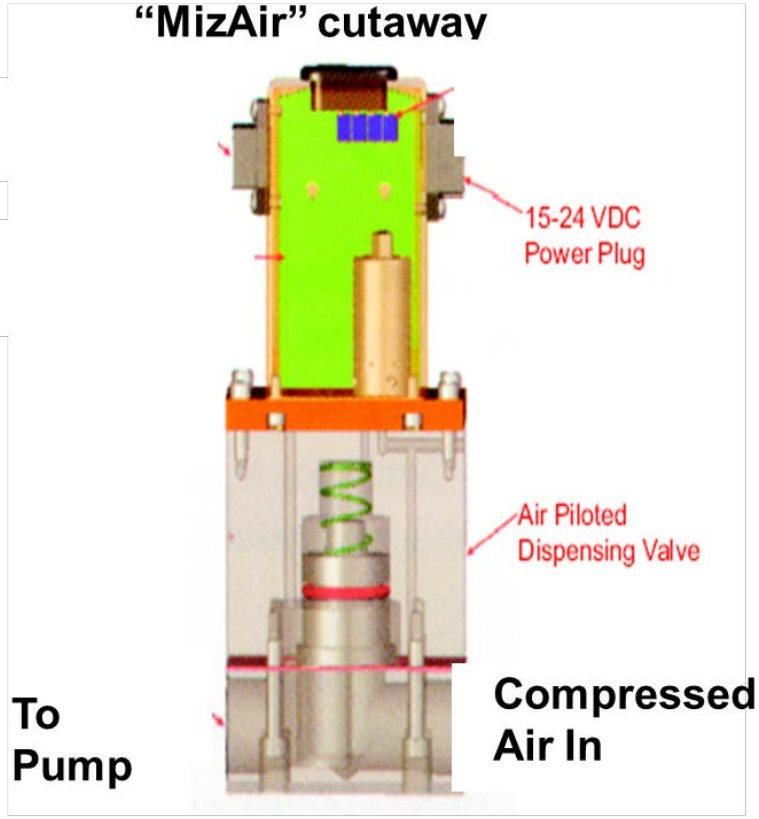
Total project cost = $1,000

# Project #10 – AODD Pump Electronic Stroke Control

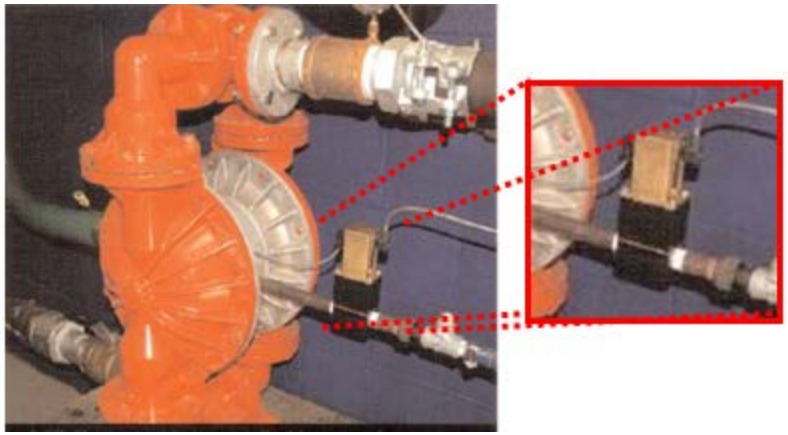
Add electronic-optimized stroke control, pneumatic-operated or 24v DC to all applicable diaphragm (AODD) pumps.

Total project cost savings: $4,775

Total project cost: $ 2,000







# Equipment Reliability Issues

Addressing supply-side equipment reliability issues. The following are concerns identified during the compressed air system audit.

- Short compressor oil life
- Compressor airend failure
- Frequently fouled coolers
- Wet compressed air during summer months
- High operating temperatures

ALL OF THESE ARE RELATED!

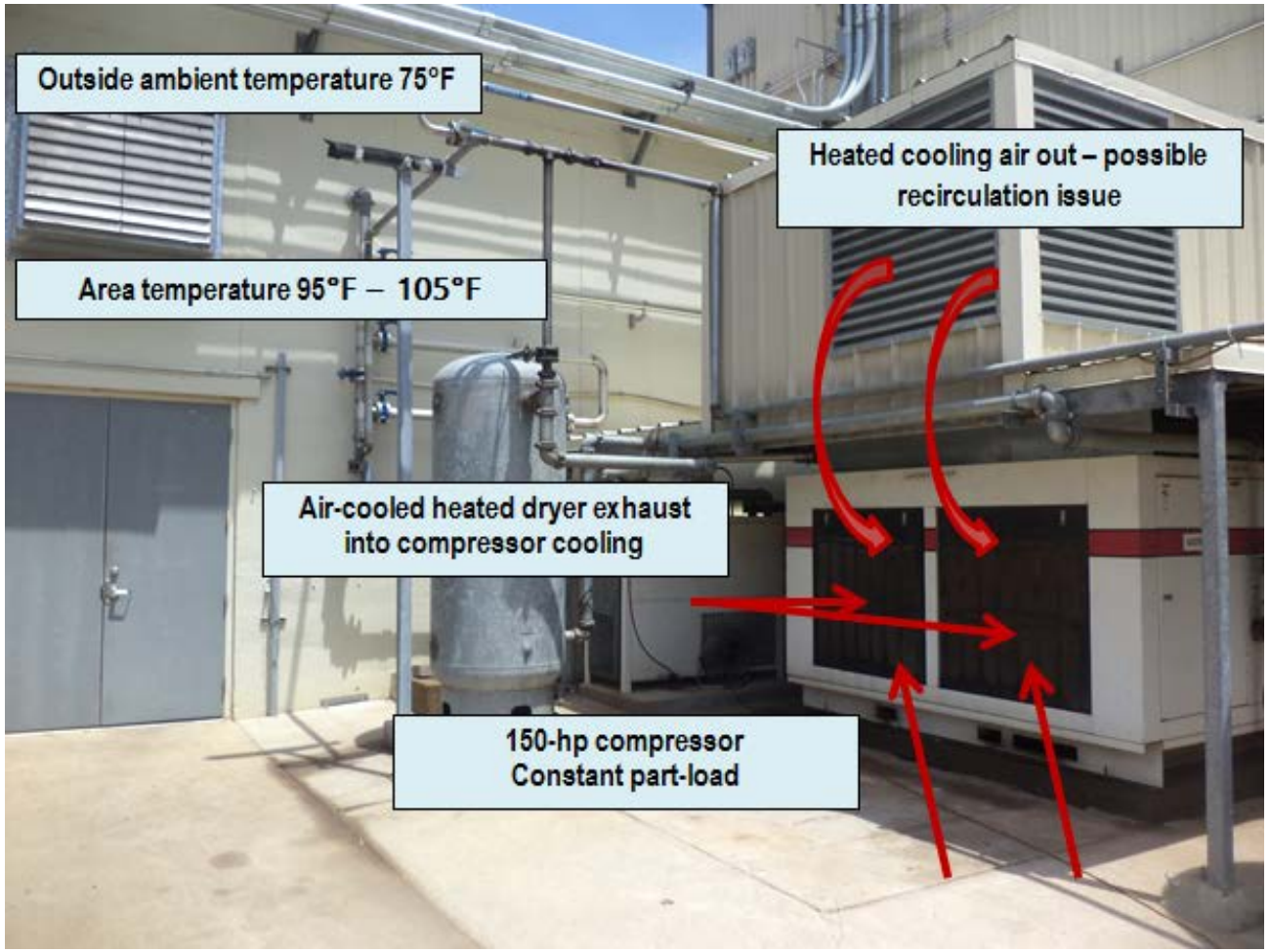
# Project #6 – Ventilation Modification

This project recommendation is not a energy savings measure but it will improve air quality and equipment reliability. This project should be evaluated after all other project recommendations have been implemented. Modifications made as required.

# Project #6 – Ventilation Modification

Air quality and equipment reliability issue.

Evaluate and modify after all other projects are implemented.



# Equipment Reliability Issues

## Root Cause of Food Grade Lubricant / Coolant Oil Short Life

- Frequently running too hot shortens the oil life
- Air-cooled compressors combined with high ambient temperatures
  - Oil cooler is too hot – varnish exacerbates
  - Thermostatic controls fouls, etc.
  - Aftercooler too hot – dryer pressure dewpoint (PDP) to 75-80°F / Production area is air conditioned at 70°F

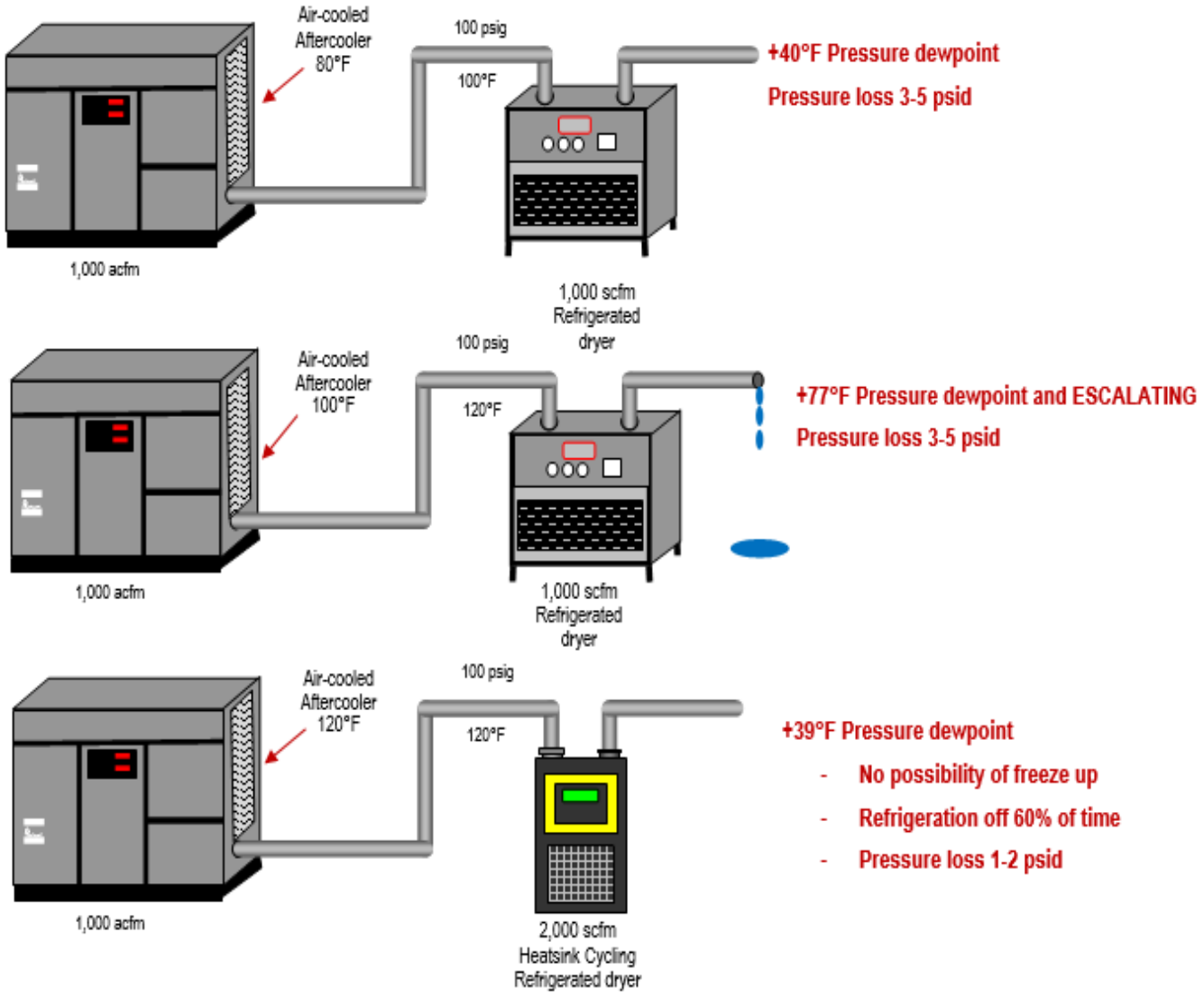
# Equipment Reliability Issues

## Two-pronged Program

- Convert air-cooled 150-hp and 100-hp variable speed drive compressors from air-cooled to water-cooled, with air-cooled multi-fan, closed coolant cooling system, and trim cooler – set for heat recovery
- Clean, flush and repair all units and refill with “new” HI food grade PAD with enhanced additive package with ESTERS

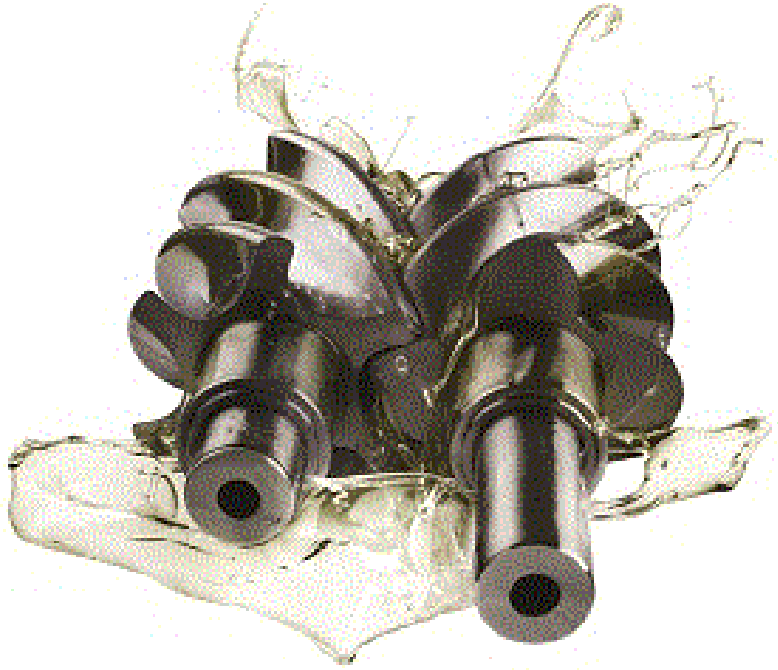
# Equipment Reliability Issues

Refrigerated dryers work okay – except in hot weather



# Troubleshooting

Proper Lubricant / Coolant Selection



# Standard PAO Food Grade

- PAO Without "new" FDA HI approved enhancement additive packaging including Ester
- Currently lasting less than 1,000 hours
- Compressor running hot which increasingly makes the situation works (>200°F)
- Hard varnish left in the compressor, coolers, etc. – contributes to high operating temperatures
- Air-cooled units
- Ventilation is an issue
- High ambient temperatures

Synthetic

| | | | |
|---|---|---|---|
| • Superior Protection synthetic lubricant<br>• Increased machine operating efficiencies<br>• Formulated for excellent condensate oil/water separation | • Exceptional thermal stability<br>• Completely demulsible<br>• Long life at high temperature | • Food grade extended life lubricant<br>• Minimizes maintenance and downtime<br>• Improved lubrication at high and low temperatures | • Long life, polyolester synthetic lubricant<br>• Non-hazardous, BIO-degradable, demulsible<br>• Maximum operating efficiencies realized |
| AEON 9000SP is a Superior Protection PAO (polyalphaolefin)/ MFSE (multi-functional synthetic ester) blend formulated with proven additive components. The result is superior thermal and oxidative stability.<br>AEON 9000SP is ideal for applications which require extended operating intervals. It is formulated for demulsibility and optimum viscosity over the compressors entire operating temperature range.<br>Lab life and multiple field applications have proven AEON 9000SP to provide superior service life, while minimizing oil carry over and unit maintenanc | AEON 9000TH is a polyalophaolefin (PAO)/MFSE synthetic ester custom blend formulation for proven performance.<br>AEON 9000TH is an extended life lubricant for rotary screw compressors with oil injection operating under harsh service conditions with high compressor temperatures. It is ideal for rotary screw air compressor applications where oil is exposed to high operating temperatures needed to prevent condensation in high humidity applications. This lubricant may not be appropriate in applications with low ambient temperatures. | AEON 6000 Food Grade is a PAO (polyaphaolefin) blend, authorized by the USDA as an H-1 approved lubricant for use in federally inspected meat and poultry plants. It complies with FDA 21CFR 178.3570—lubricants for incidental food contact.<br>AEON 6000 Food Grade is an extended life lubricant formulated to reduce maintenance intervals and extend compressor life. | AEON BIO is a custom blended polyolester (POE), long life synthetic lubricant, readily bio-degradable according to CEC Test L-33-T-82.<br>AEON BIO is especially advantageous in applications where it is exposed to elevated temperatures for extended periods of time. AEON BIO resists forming sludge and varnish even under these extreme conditions.<br>AEON BIO is formulated to be recyclable with standard mineral oil recycling systems and technology. Also, none of the ingredients are found on OSHA's list (29CFR 1910.1200) of hazardous materials. |

# Effect of High Operating Temperatures

High discharge air temperatures may shorten the life of the any oil, even some synthetics, as follows:

| Discharge air temperature | Probable oil change interval |
|---|---|
| 85° to 96°C (185° - 205°F) | 4,000 hours* |
| > 102°C (>215°F) | 3,000 hours* |
| > 107°C (>225°F) | 1,000 hours* |
| > 113°C (>235°F) | ? hours* |

*Confirm by measuring the total acid number (T.A.N.) of the used oil. T.A.N. value of > 2.0 mg KOH/g is indicative that an oil is breaking down or has broken down.

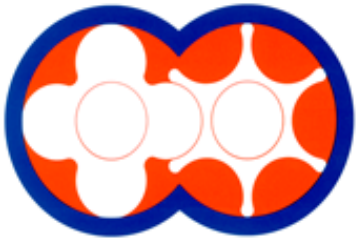
# Troubleshooting

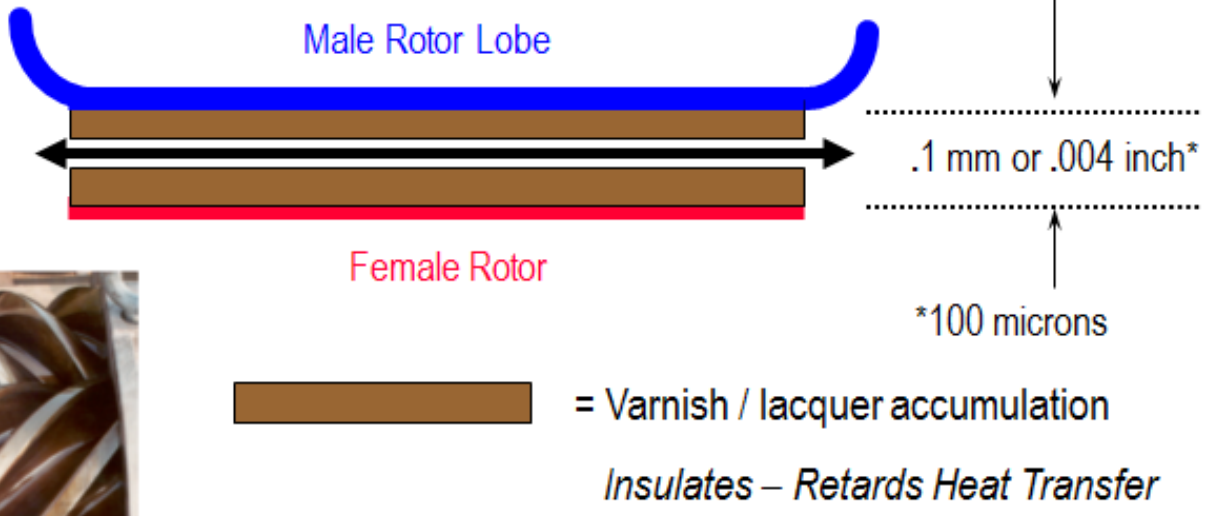
## What causes a compressor to run hot?

- Dirty compressor due to varnish build-up
- Air intake near or downwind of diesel or natural gas engine exhaust fumes / gases
- Air intake near another air-cooled compressor's aftercooler exhaust fan / air-cooled dryer
- Limited ventilation in the Compressor Room
- High altitude
- High ambient temperatures
- Stuck thermostat valve
- Dirty coolers

# Troubleshooting

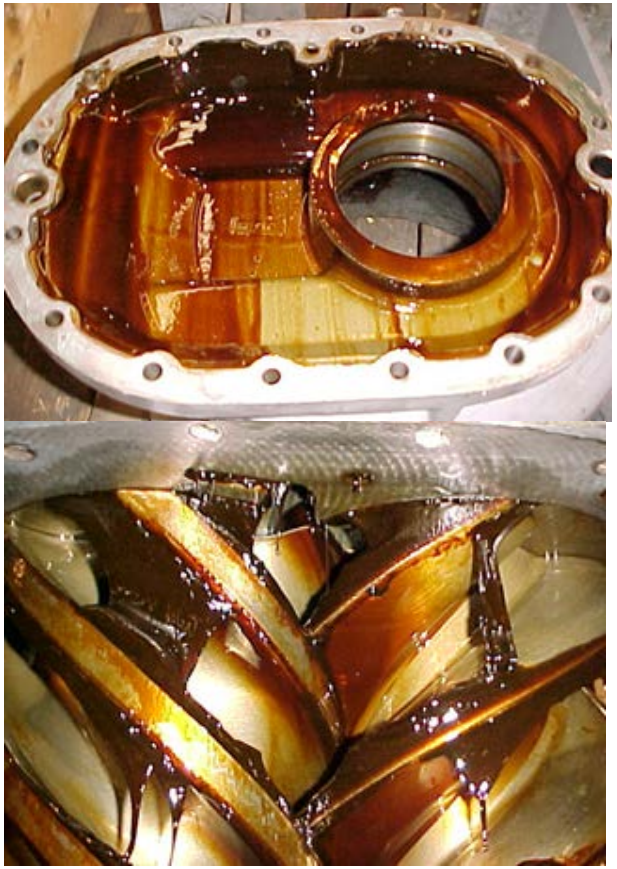
Heat-of-compression removal is affected by varnish build-up






# Troubleshooting

Over-extended run of coolant / lubricant



# Troubleshooting

## Other Cautions: Potential High Water Content Oil

- The lower the operating temperature, the longer the lubricant will last. But operating at **discharge temperatures too cool** and/or below the operating oil pressure will cause water to accumulate in the lubricant forming emulsions, causing corrosion, wear, and lowering viscosity. This will not only reduce oil life, but will also significantly affect bearing and oil separator life.

- The thermostatic bypass valve may need to be set or changed so as to maintain the proper operating temperature, both low and high, with the proper new water-cooled heat exchanger.

# Troubleshooting: Oil Analysis

## An Effective Oil Analysis Interpretation Program

### Oil Analysis Program

The in-house Summit laboratory, with the R&D support from their international partner Klüber Lubication, is one of the international leaders in providing their customers high quality data and technical support. The Summit lab continues to grow in the range of lab test performed and they are continually updating diagnostic equipment. Summit guarantees quality oil analysis with strict accordance to ISO 9001:2000 registered procedures. Summit lab analysis assists in preventing the end user from experiencing equipment failure and expensive downtime. Customer support is a primary focus for the Summit laboratory staff. They are dedicated to improving existing products and the research and development of new lubricants for specific applications.

Summit is internationally known for their expertise in manufacturing synthetic lubricants. They support their synthetic products with Free Oil Analysis to confirm the extended life of synthetic lubricants versus petroleum based lubricants. Summit provides their customers with a free testing kit to use in drawing samples for oil analysis and evaluation. Oil analysis will aid in increasing equipment life and oil change intervals.

Through thorough and detailed oil testing Summit lab technicians can help in discovering equipment problems in the early stages to prevent costly down time and repairs. Summit provides the customer with an oil analysis report, data interpretation and recommended actions that should be taken. For new users of Summit synthetic lubricants the Summit lab can help with compatibility issues and recommend to the customer the Summit synthetic product to be used for replacement.

You receive an added value by using Summit lubricants. Summit Industrial Products provides free oil analysis for anyone using their synthetic lubricants. This is a normal charge by most companies of $10 to $30 a sample depending on the scope of the test. For a small fee, Summit provides a TAN (Total Acid Number) Test Kit for the evaluation of an in use lubricant for possible replacement. There are two reasons to conduct routine oil analysis: to assess the condition of the used lubricant and to assess the condition of the equipment. The benefits of assessing oil condition include the savings in oil purchasing, lowering the cost for oil disposal and to reduce the downtime and labor cost associated with oil changes and repair. Periodic oil analysis can aid you in effectively controlling equipment wear by noting contaminates to detect active equipment wear. When you sample for lubricant condition you save money with extended oil change intervals, and reduce downtime by increasing equipment reliability.

Summit continues to commit to laboratory expansion and product development. They recognize the value of their laboratory for customer support and product development. For more information about the abilities of the Summit laboratory, call 1.800.749.5823.

- Most important - High Ambient + High Humidity = The worst of both worlds
- Interpret for reliability not necessarily maximum oil life
- When analysis or operation indicates “varnish” starting – partial mix flushes before oil change will often help control

# Troubleshooting: Oil Analysis

Key Variables to Watch:

- pH – contaminated air
- Total Acid Number (T.A.N.) coolant life remaining
- Viscosity
- Contamination – other lubricant
- Wear metals – DR Ferrography

# Troubleshooting: Oil Analysis

## Used Oil Condemning Limits

- Viscosity
  - 10% increase
  - 10% decrease
- Viscosity stabilization for gas compressors
- T.A.N: 2 mg KOH/gram above new oil
- H2O: Any amount above 0.1% (1,000 ppm) by volume

# Troubleshooting: Oil Analysis Report

## Baselines and Report Interpretation

# Oil Analysis Report

| Maintenance Recommendations for Lab No._ABC0113501_ | Unit No. 1 |
|---|---|
| | End User: |
| ????????? | Location: |
| | Component: Rotary Screw Air Compressor |
| Baseline | Make & Model: QSI 200 |
| | Oil Capacity: |
| | Oil Type: Summit Supra Coolant |

ELEMENTAL CONCENTRATIONS IN PARTS PER MILLION (PPM) BY WEIGHT

| LAB. NO. | Ag | Al | B | Ba | Ca | Cd | Cr | Cu | Fe | Mg | Mn | Mo | Na | Ni | P | Pb | Sb | Si | Sn | Ti | V | Zn | Sample Drawn |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Baseline | 0 | 0 | 0 | 253 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 31 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| Actual | 0 | 1 | 10 | 186 | 11 | 0 | 1 | 4 | 1 | 1 | 0 | 0 | 46 | 0 | 127 | 0 | 0 | 0 | 1 | 0 | 0 | 135 | |

| SAMPLE INFORMATION | | | PHYSICAL TEST RESULTS | | | | |
|---|---|---|---|---|---|---|---|
| LAB. NO. | MI/HR UNIT | MI/HR OIL | KV100 | KV40 | TAN | H2O% | |
| Baseline | N/G | N/G | 9.38 | 55.38 | 0.11 | < 0.1% | |
| Actual | 40896 | 5635 | 9.08 | 59.81 | 3.48 | <0.1% | |

| | | | |
|---|---|---|---|
| Ag = Silver | Al = Aluminum | B = Boron | KV40 = Kinematic Viscosity @ 40°C |
| Ba = Barium | Ca = Calcium | Cd = Cadmium | KV100 = Kinematic Viscosity @ 100°C |
| Cr = Chromium | Cu = Copper | Fe = Iron | TAN = Total Acid Number mg KOH/1g |
| Mg = Magnesium | Mn = Manganese | Mo = Molybdenum | N/G = Not Given or Provided |
| Na = Sodium | Ni = Nickel | P = Phosphorus | |
| Pb = Lead | Sb = Antimony | Si = Silicon | |
| Sn = Tin | Ti = Titanium | V = Vanadium | |
| Zn = Zinc | | | |

# Oil Analysis Report

| | |
|---|---|
| **Maintenance Recommendations for Lab No._ABC 0113501__** | Unit No. 1 |
| | End User: [redacted] |
| Barium content has dropped. Viscosity & TAN are high. | Location: Costa Rica |
| Boron & Calcium are slightly elevated. | Component: Rotary Screw Air Compressor |
| Phosphorus, Sodium & Zinc are high. Possible mixed fluid. | Make & Model: QSI 200 |
| Recommend changing oil due to high TAN. | Oil Capacity: |
| | Oil Type: Summit Supra Coolant |
| | |
| Possible wear metals | |

**ELEMENTAL CONCENTRATIONS IN PARTS PER MILLION (PPM) BY WEIGHT**

| LAB. NO. | Ag | Al | B | Ba | Ca | Cd | Cr | Cu | Fe | Mg | Mn | Mo | Na | Ni | P | Pb | Sb | Si | Sn | Ti | V | Zn | Sample Drawn |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Baseline | 0 | 0 | 0 | 253 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 31 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| Actual | 0 | 1 | 10 | 186 | 11 | 0 | 1 | 4 | 1 | 1 | 0 | 0 | 46 | 0 | 127 | 0 | 0 | 0 | 1 | 0 | 0 | 135 | |

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| **Mg = Magnesium** | **Mn = Manganese** | **Mo = Molybdenum** | **N/G = Not Given or Provided** |
| **Na = Sodium** | **Ni = Nickel** | **P = Phosphorus** | |
| **Pb = Lead** | **Sb = Antimony** | **Si = Silicon** | |
| **Sn = Tin** | **Ti = Titanium** | **V = Vanadium** | |
| **Zn = Zinc** | | | |

# Oil Analysis Report

| Maintenance Recommendations for Lab No._____ | Unit No. |
|---|---|
| ?????? | End User: |
| Bearing wear, high water and dirt levels. | Location: |
| | Component: Rotary Screw Air Compressor |
| | Make & Model: Atlas Copco GA-75 |
| | Oil Capacity: |
| | Oil Type: Summit SH-46 |

**ELEMENTAL CONCENTRATIONS IN PARTS PER MILLION (PPM) BY WEIGHT**

| LAB. NO. | Ag | Al | B | Ba | Ca | Cd | Cr | Cu | Fe | Mg | Mn | Mo | Na | Ni | P | Pb | Sb | Si | Sn | Ti | V | Zn | Sample Draw n |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Baseline | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 474 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| Actual | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 45 | 0 | 0 | 0 | 0 | 0 | 462 | 0 | 0 | 15 | 0 | 0 | 0 | 0 | |

| SAMPLE INFORMATION | | | PHYSICAL TEST RESULTS | | | | |
|---|---|---|---|---|---|---|---|
| LAB. NO. | MI/HR UNIT | MI/HR OIL | KV100 | KV40 | TAN | H2O% | |
| Baseline | N/G | N/G | 7.11 | 43.36 | 0.17 | < 0.1% | |
| Actual | | 1000 | 7 | 40 | 0.2 | 3.12% | |

| | | | |
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# Summary

## Compressed Air System Audit Case Study: Southwestern Dairy Products Packaging Plant

Complete Compressed Air System Audit

- ✓ Supply and Demand-Side System Analysis
- ✓ Energy Savings
- ✓ Productivity
- ✓ Reliability Issues
- ✓ Future Projects for Continuous Improvement

# Thank you for the opportunity to present!

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