Optimizing Centralized and Decentralized Vacuum Systems for Minimum Waste

Tim Dugan
Compression Engineering Corporation
Keynote Speakers

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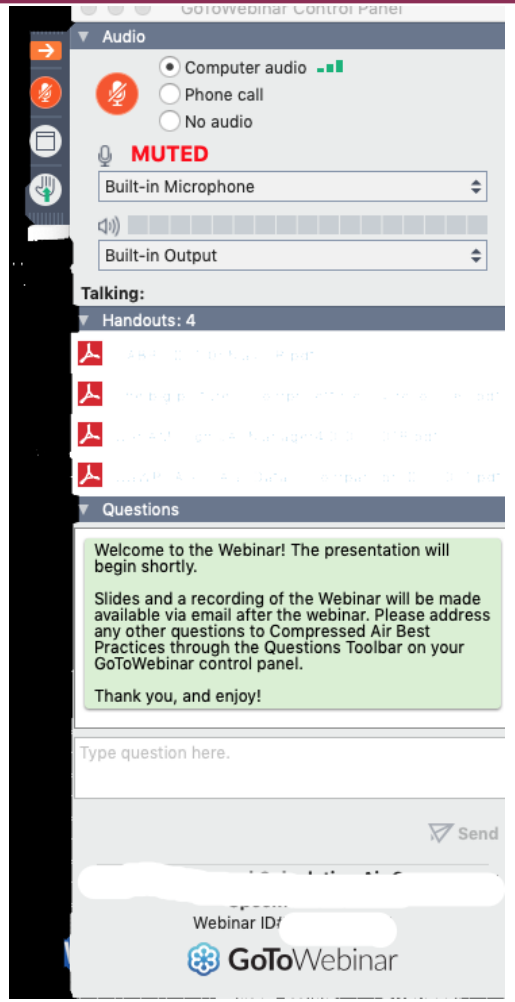
Q&A Format



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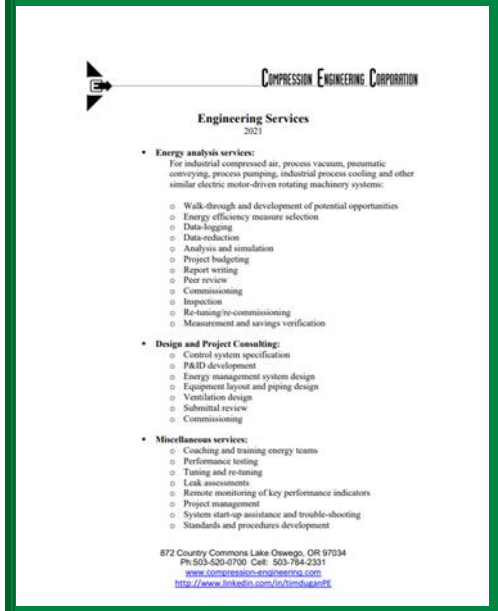

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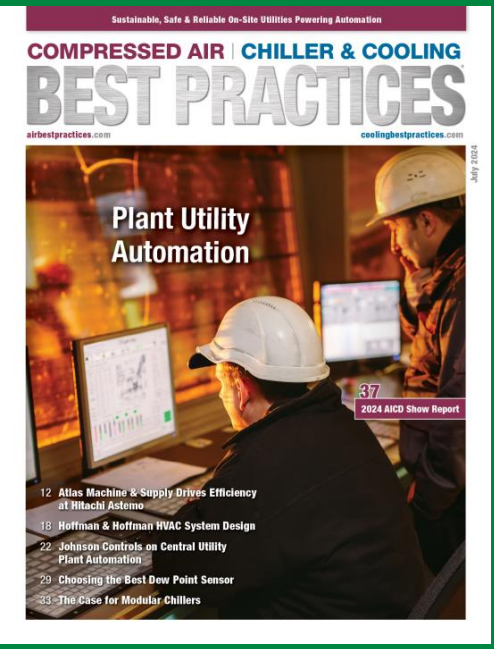

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All materials presented are educational. Each system is unique and must be evaluated on its own merits.

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Optimizing Centralized and Decentralized Vacuum Systems for Minimum Waste

Introduction

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About the Speaker

Tim Dugan
Compression Engineering Corporation

- President and Principal Engineer, Compression Engineering Corporation
- Over 36 years of experience in the industry
- 23 years of independent consulting experience

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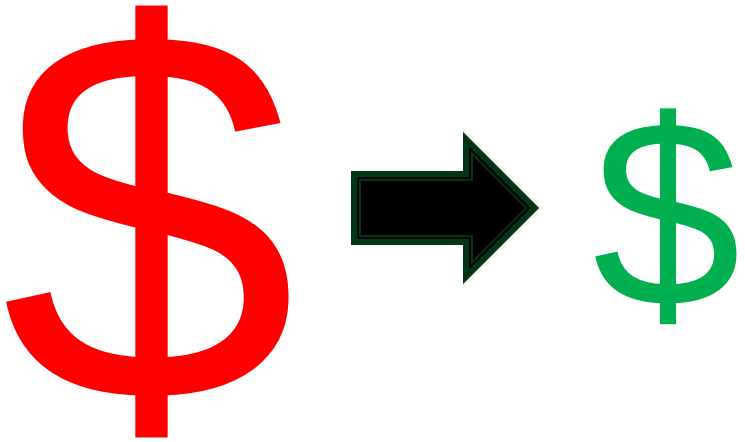
OUTLINE

- When You Should Centralize
- Sample Centralization Audit
- When You Should Not Centralize
- Sample Decentralized Audit
- Waste Reduction in Centralized Systems
- Sample Sequencer Tuning Audit
- Waste Reduction in Non-centralized Systems
- Conclusions

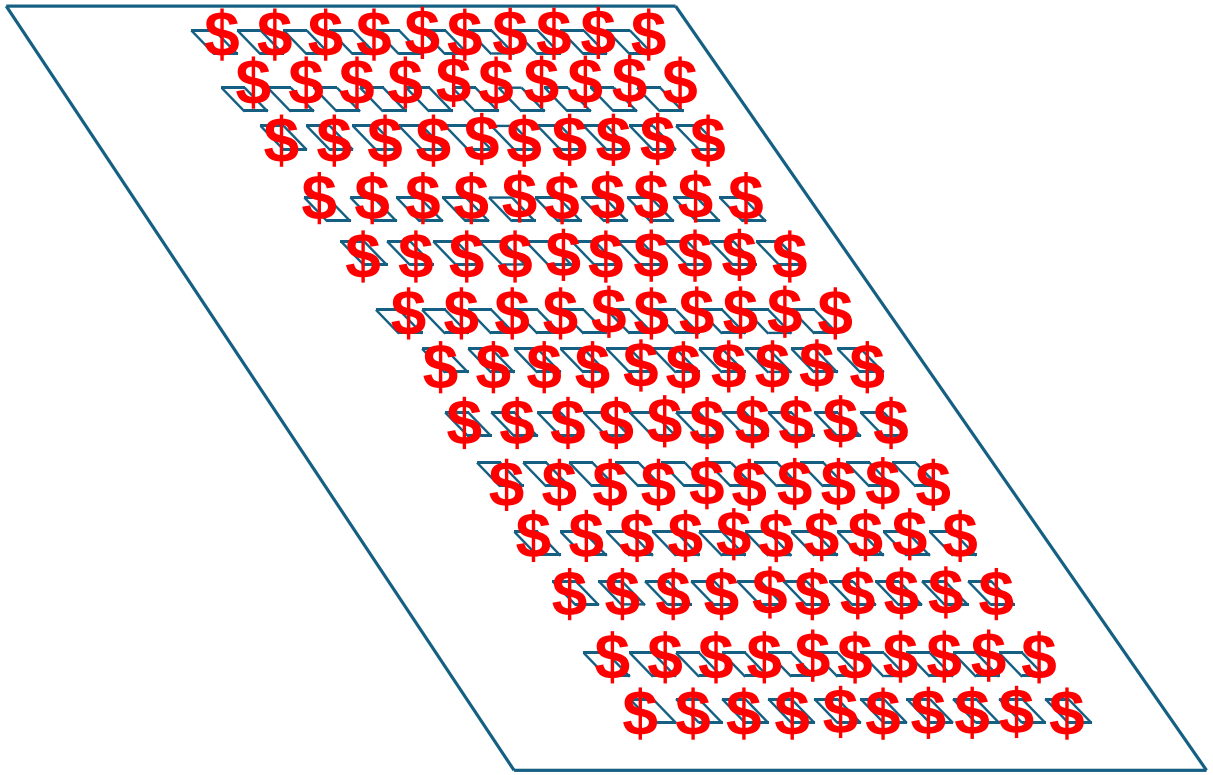
When Should You Centralize?

- All Processes Are Similar Vacuum Level
- Vacuum Pulls in Room Air, not Technical Gases
- Excessive Maintenance Costs of Many Distributed Vacuum Pumps
- Poor Reliability of Production Systems Due to Vacuum Pump Failures
- Uncontrolled Vacuum Levels
- Poor Efficiency Due to Excessive Non-production Run Time
- Air Quality or Noise in Clean Production Areas is a Problem

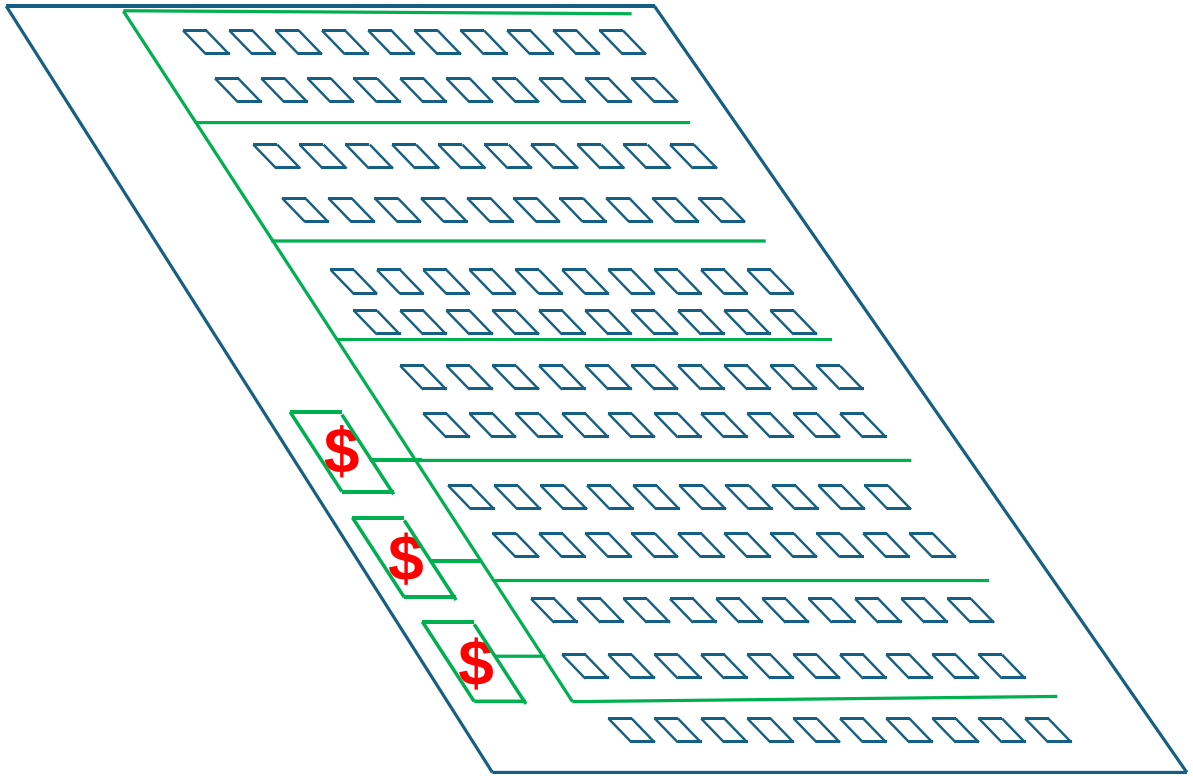


Sample Centralization Audit

- Packaging, 200 Pumps:



- Recommended 3 Pumps:



Sample Centralization Audit

- **Sources of Savings:**
- Far Fewer Pumps and Motors to Maintain, Lower Maintenance Costs & Spares
- Higher Process Productivity Due to Constant Vacuum
- Lower Air Consumption Due to Auto Shut-off Valves When Lines Down
- Lower Power Due to Sequencing & VFDs
- Better Vacuum Pump Efficiency

Sample Centralization Audit

DEPT	TOTAL BASELINE							IMPROVED					
	QTY	TOTAL AVG FLOW, SCFM	TOTAL MAX FLOW, SCFM	TOTAL AVG POWER, KW	AVG VACUUM, "HG	HRS/YR	ENERGY/ YR, KWH	TOTAL AVG FLOW, ICFM	TOTAL MAX FLOW, ICFM	TOTAL AVG POWER, KW	AVG VACUUM, "HG	HRS/YR	ENERGY/ YR, KWH
PC	49	425.0	782.2	63.9	12.86	6500	415,349	852.2				6500	
BCP	18	133.2	215.9	23.5	14.62	5327	125,043	267.1				5327	
TC1&2	45	359.1	597.9	58.7	15.34	6600	387,312	720.0				6600	
FCC	15	130.6	215.4	19.6	12.24	5300	103,674	261.8				5300	
FCP	32	283.6	549.3	41.7	13.55	6900	287,941	568.8				6900	
TC3	30	218.4	329.5	39.1	14.04	6000	234,734	438.1				6000	
CKF	12	87.4	131.8	15.6	14.04	2000	31,298	175.2				2000	
IDLE TIME								500.0 (LEAKS)				3242	
TOTAL	**201**	**1139**	**2822**	**181**	**13.81**		**1,585,351**	**2469**	**5659**	**112**	**15.0**	**6900**	**774,948**

6.292529 scfm/kW

1231.069 scfm avg

SAVINGS, KWH/YR:	810,403
SAVINGS, $/YR:	$ 36,468

NOTES:
AVERAGE FLOW IS WEIGHTED BY HOURS
CONCURRENT PEAK WILL NEVER REALLY HAPPEN

Sample Centralization Audit

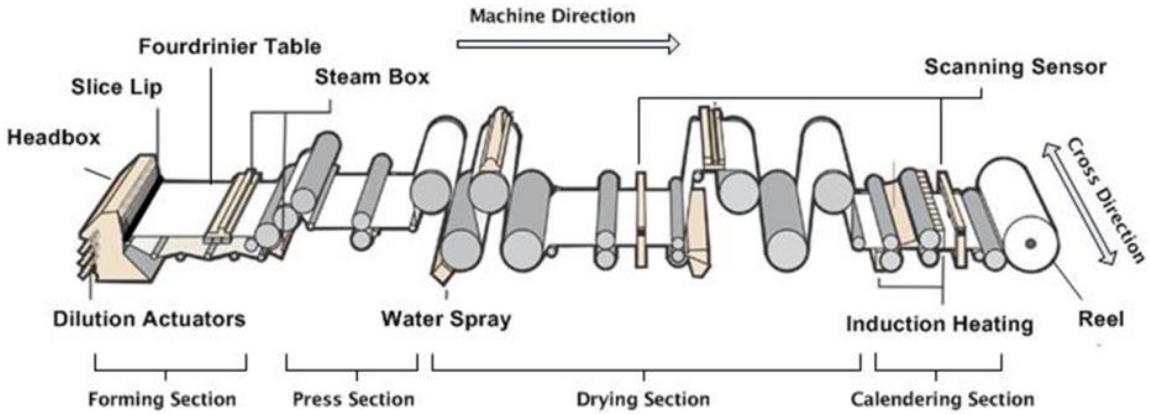
- **Complex Project:**
- Audit - Determine Total, Average and Min Flow at Vacuum
- Design – Piping
- Design – Valves and Controls
- Design – Automation
- Implementation – Clean Shift From Old to New

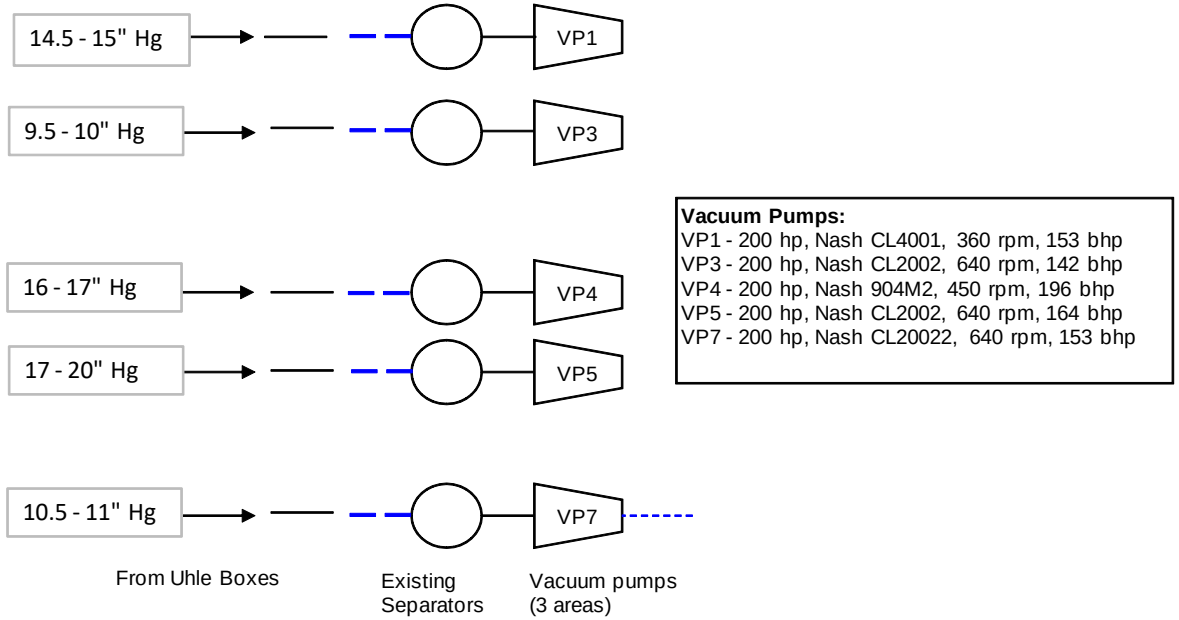
When You Should Not Centralize?

- Different Vacuum Levels
- Different Gases
- Integration Too Complex
- Production Equipment Local Vacuum Pumps Required (by OEM)

Sample Decentralization Audit

- Pulp and Paper:





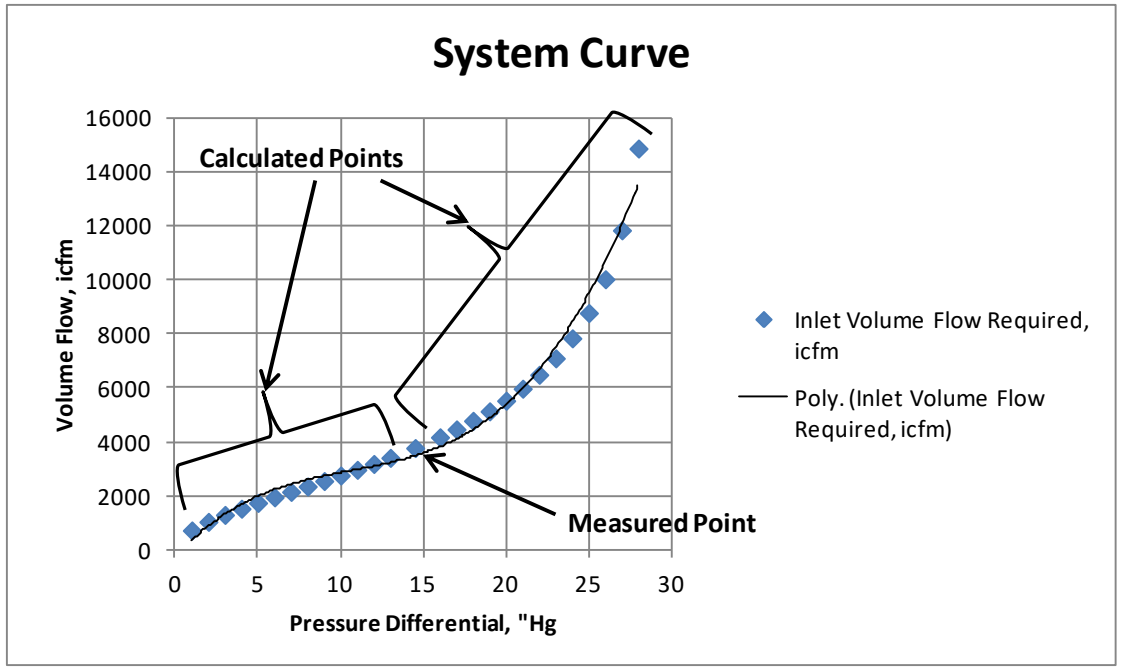
Vacuum Pumps:
VP1 - 200 hp, Nash CL4001, 360 rpm, 153 bhp
VP3 - 200 hp, Nash CL2002, 640 rpm, 142 bhp
VP4 - 200 hp, Nash 904M2, 450 rpm, 196 bhp
VP5 - 200 hp, Nash CL2002, 640 rpm, 164 bhp
VP7 - 200 hp, Nash CL20022, 640 rpm, 153 bhp

Sample Decentralization Audit

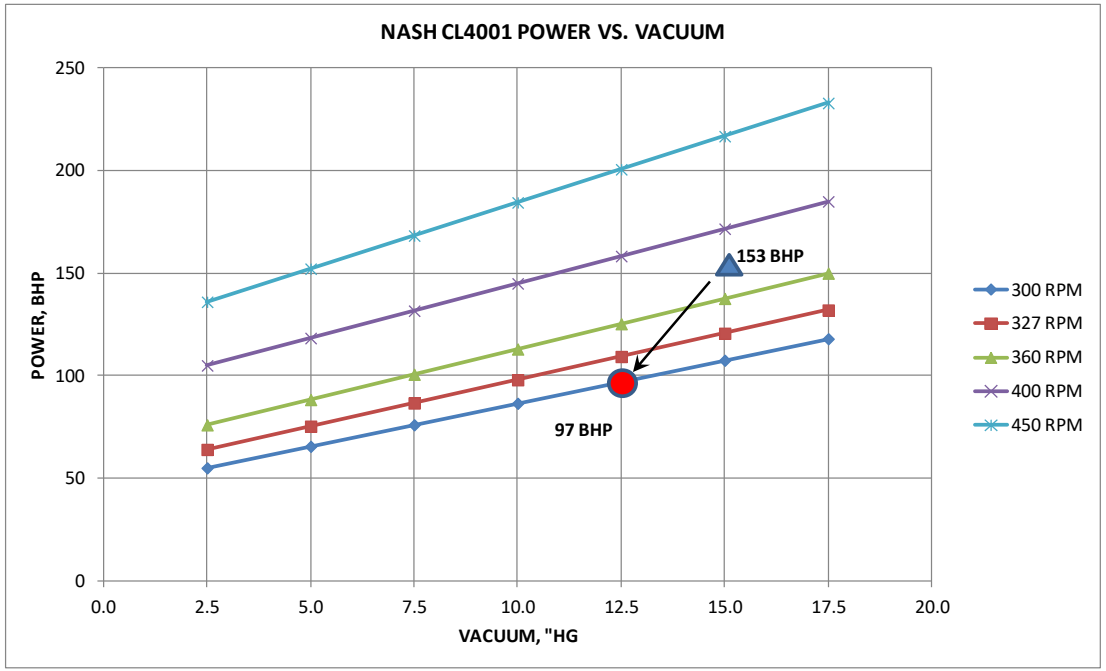
- Solution – Install Independent VFDs, Set at Different Vacuum Levels
- Benefits:
- Reduced Flow (Artificial Demand)
- Reduced Power
- Better Control for Each Subsystem

Sample Decentralization Audit

- Reduced Flow:



- Reduced Power:



Sample Decentralization Audit

MEASURED BASELINE

	VACUUM PUMP MODEL NO.	NOMINAL MOTOR SIZE, HP	FULL LOAD CAPACITY AT OPERATING POINT, CURVE, ICFM	DE-RATED CAPACITY AT OPERATING POINT, ICFM	AVERAGE FLOW, ICFM	AVERAGE VACUUM, "HG	AVERAGE ABS PRESSURE, MBAR	AVERAGE FLOW, SCFM	AVERAGE POWER, KW	PEAK POWER, KW	OPERATING HOURS	SPECIFIC EFFICIENCY, ICFM/KW	ENERGY CONSUMPTION, KWH/YR
VACUUM PUMP #1	CL4001	200	3780	3289	3078	14.5	383	1584	112	120	6257	27.4	703,441
VACUUM PUMP #4	904M2	200	5414	5143	5126	16.8	305	2247	153	154	6257	33.5	958,128
VACUUM PUMP #3	CL2002	150	2200	1848	1848	9.7	547	1250	111	111	6257	16.6	695,434
VACUUM PUMP #5	CL2002	200	2200	1848	1842	18.6	243	694	129	129	6257	14.3	804,882
VACUUM PUMP #7	CL2002	200	2200	1848	1811	10.9	506	1152	118	120	6257	15.4	736,335
TOTAL				**13976**	**13705**	**14.1**	**397**	**6927**	**623**	**634**	**6257**	**22.0**	**3,898,220**

AFTER EEM 2

	VACUUM PUMP MODEL NO.	NOMINAL MOTOR SIZE, HP	FULL LOAD CAPACITY AT OPERATING POINT, CURVE, ICFM	DE-RATED CAPACITY AT OPERATING POINT, ICFM	AVERAGE FLOW, ICFM	AVERAGE VACUUM, "HG	AVERAGE ABS PRESSURE, MBAR	AVERAGE FLOW, SCFM	AVERAGE POWER, KW	PEAK POWER, KW	OPERATING HOURS	SPECIFIC EFFICIENCY, ICFM/KW	ENERGY CONSUMPTION, KWH/YR
ALL VACUUM PUMPS COMBINED IN ONE SYSTEM:													
VACUUM PUMP #1 (BASE-LOAD)	CL4001	200	3900	3393	3215	17.0	299	1098	132	132	6257	24.4	826,073
VACUUM PUMP #4 (BASE-LOAD)	904M2	200	5355	5087	5128	12.0	299	1751	153	154	6257	33.4	960,106
VAC PUMP #3 (TRIM)	CL2002	150	2200	1848	1749	10.0	299	597	108	114	6257	16.1	677,749
VAC PUMP #5 (TRIM)	CL2002	200	2200	1848	1001	15.0	299	342	72	133	6257	13.9	450,752
VAC PUMP #7 (TRIM)	CL2002	200	2200	1848	7	9.0	299	3	0	31	6257	14.9	3,102
TOTAL				**14024**	**11100**	**13.5**	**299**	**3791**	**466**	**564.0**	**6257**	**23.8**	**2,917,781**

EEM 2 SAVINGS

				FULL LOAD CAPACITY INCREASE, ICFM	AVERAGE FLOW REDUCTION, SCFM	AVERAGE VACUUM REDUCTION, "HG	ABS PRESSURE REDUCTION, MBAR	AVG FLOW REDUCTION, SCFM	AVERAGE POWER SAVINGS, KW	PEAK DEMAND SAVINGS, KW	OPERATING HOURS DIFFERENCE	SPECIFIC EFFICIENCY IMPROVEMENT, %	ENERGY SAVINGS, KWH/YR
TOTAL				**48**	**2605**	**1**	**98**	**3136**	**157**	**70**	**0**	**8%**	**980,438**

Centralized System Sequencer Tuning Audit

- **Recommendations for Already Centralized Systems:**
- Install Auto Shut-off Valves on Production Machines to Minimize False Loads
- Install Vacuum Sequencer
- Improve Piping if Pressure Drop is >2”Hg
- Increase Storage if Needed (Calculation Needed)
- Sometimes Install New VFD Vacuum Pump(s) if Economics Justify. Audit Needed for Size
- Consider VFD Retrofit(s) If Sufficient Turn-down

Waste Reduction In Centralized Systems

- **Recommendations for Already Centralized Systems:**
- Install Auto Shut-off Valves on Production Machines to Minimize False Loads
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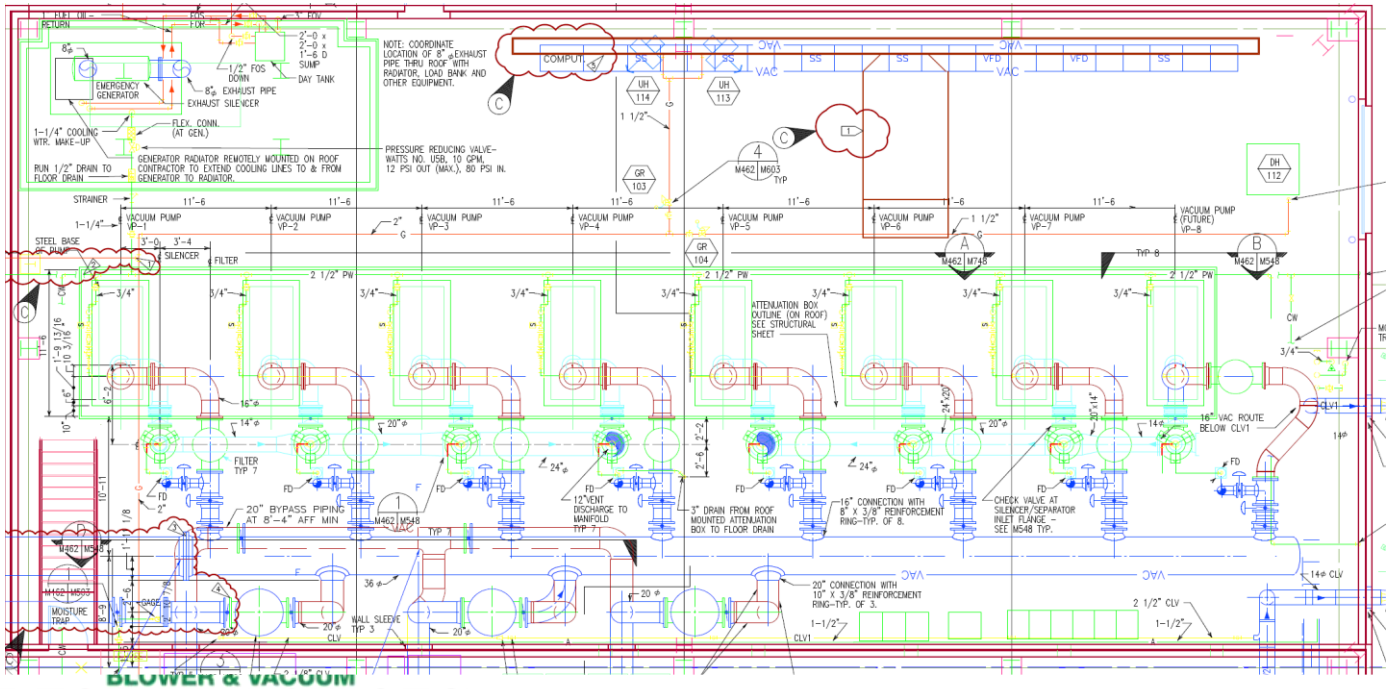
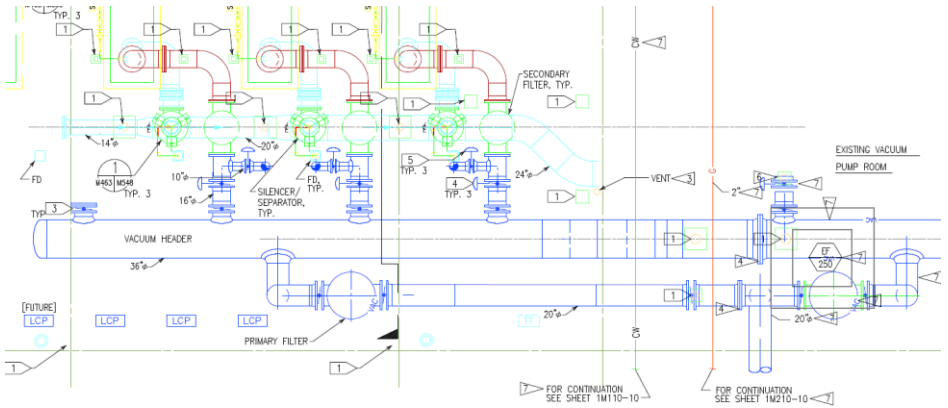
- Sometimes Install New VFD Vacuum Pump(s) if Economics Justify. Audit Needed for Size
- Consider VFD Retrofit(s) If Sufficient Turn-down

Sample Centralized System Tuning Audit

- **(11) 300hp Positive Displacement Vac Blowers, on a “Sequencer”**
- Vacuum Level Wandered From 24”Hg to 5”Hg
- (38) CNC Tables, Much Wasted Bypass Air





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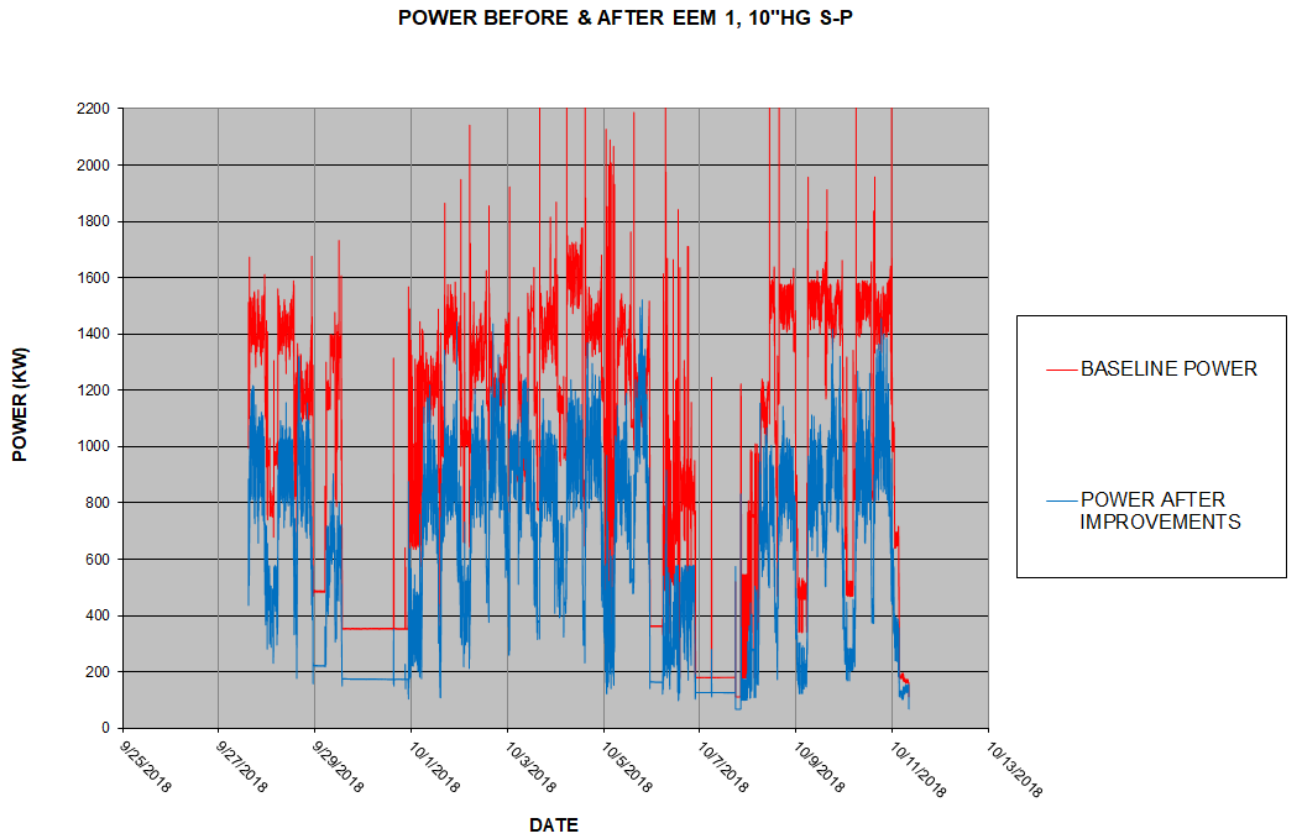
Sample Centralized System Tuning Audit

- **Savings:**
- Reduced Bypass Air via Repairing Valves
- Reduced Excess Air via Better Vacuum Control
- Better Vacuum Pump Efficiency
- Higher Reliability at Lower Vacuum Level on Nights & Weekends
- 40% Savings, $200k/yr Electricity Alone



Conclusions

- Centralized:
  - Centralized Is Best When Vac Level is Similar and All Air
  - Centralized Should Include Auto Shut-off Valves, Sequencing, and Sometimes VFDs
  - Existing Centralized Systems Can Be Optimized By Better Bypass Flow Reduction and Sequencing
- Decentralized:
  - De-centralized Is Best When Vac Levels Are Different Or Not All Air
  - Decentralized Should Also Include Auto Shut-off Valves and Sometimes VFD
  - Existing Decentralized Systems Can Be Optimized By Better Bypass Flow Reduction and Optimal (Lower) Set Points

About the Speaker

Weston Benton
Kaishan

- Product Channel Manager – Vacuum & Low Pressure, Kaishan
- 8 years in the vacuum industry
- Bachelor's in Mechanical Engineering, University of South Alabama

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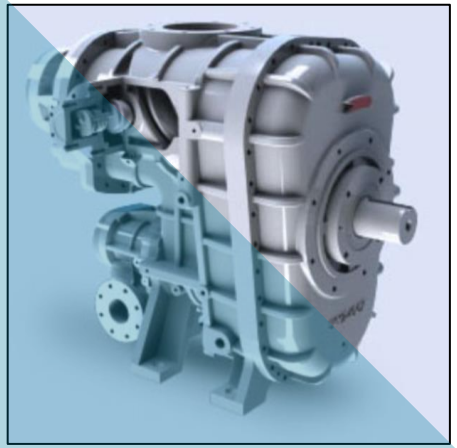

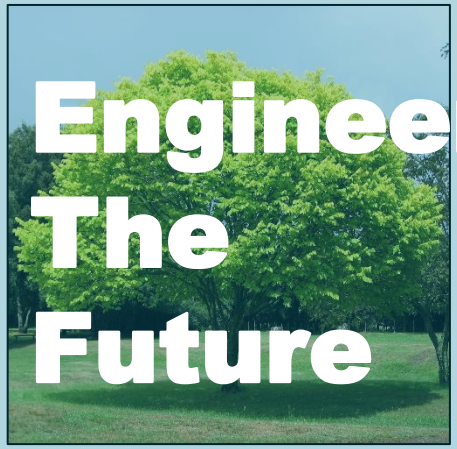

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Centralizing Your Vacuum System

Weston Benton

Kaishan Compressor USA

Centralizing Your Vacuum System

- Agenda
  - Point of use vs centralizing
  - Save energy
  - Lower maintenance
  - Less downtime
  - Challenges
  - Take away

Point of use vs Centralizing

- Point of use
  - Smaller vacuum pump at each demand
  - Pumps are directly connected to one application/demand
  - Natural result of gradual expansion
- Centralizing
  - Larger pump that provides vacuum for most/all vacuum demands
  - Piping network runs from pump to each demand
  - Deliberate result of forethought and planning

Centralized Saves Energy

- More efficient technology
  - Some technologies are just more efficient than others

Technology	ACFM/HP
Single stage Liquid Ring	13.58
Dry Rotary Vane	13.62
Lubricated Rotary Vane	15.85
Fixed Speed Screw	15.89
Traditional VSD Screw	26.38
VSD Screw with VDP	29.70

- Utilization Factor
  - Not all processes run at the same time.

Lower Maintenance

- Maintain all vacuum pumps at once
  - By alternating pumps in a redundant system
    - ✓ *Under common control balanced running hours makes maintaining entire system at once easy and practical.*
  - During planned downtime
- Eliminate constant maintenance on many small pumps
  - Smaller rotary vane pumps require frequent maintenance that can sometimes cost a significant percentage of a new pump
  - Increased uptime for your production
- Single point of filtration to maintain, better protecting the pumps
  - Single point of inspection for maintenance eliminates depending on machine operators to monitor filtration status.

Less Downtime

- Easier to properly maintain one machine
  - With one maintenance schedule to coordinate, instead of 15, the system is better taken care of and is more reliable.

- Easier to have a fully redundant backup
  - Impractical to have backup at all points of use
  - One backup in centralized systems
    - ✓ *Balanced running hours*
    - ✓ *Automatic handoff*

Centralizing Your Vacuum System

- Challenges
  - Capital expenditure
    - ✓ *Equipment and filtration*
    - ✓ *Proper installation / space*
  - Piping system
    - ✓ *Not as expensive as compressed air piping*
    - ✓ *Can use PVC pipe*

Centralizing Your Vacuum System

- Take away
  - A centralized redundant system is often the best configuration for energy efficiency, ease of maintenance, and reliability of your vacuum system.

Centralizing Your Vacuum System

- Conclusions
  - Every application is different
  - Every system is different
  - Every installation is different
  - Work with an expert who knows what they are doing.
  - I'll be glad to help you with your analysis – contact me.

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Please submit your answer in the upcoming poll

When should you consider centralizing your vacuum system?

A
- When vacuum levels vary for each process

B
- When maintenance costs for distributed pumps are high

C
- When vacuum pulls in technical gases

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Q&A

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Thank you for attending!

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