Industrial
Energy Efficiency
& Air Compression
Specialists

OPTIMIZATION

"There is always a best solution."

BPA Utility Forum
Controls Case Study - K-Ply

5-17-07

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Industrial Energy Efficiency & Air Compression Specialists

- **Who Are We?**
  - Compression Engineering Corporation is an independent energy-engineering consulting firm, specializing in industrial compressed air, pneumatic conveying, centrifugal pump, and other similar industrial machinery systems.
- **What Can We Do?**
  - energy analysis reports (“energy audits”)
  - preliminary concept layouts
  - equipment evaluations
  - detailed drawings, project consulting
  - measurement and verification.

Project Introduction

- **Facility Description:**
  - The facility is K-Ply, a privately held a plywood manufacturing facility in Port Angeles, WA. It has two lathes, a boiler, and finish end.
  - Recent organizational changes opened up the door to doing an EE project.
- **The project was managed by Donnie Edwards, K-Ply**
  - K-Ply took ownership of the project, and is still operating it exactly as started up in 2006.
- **The local utility contact is Bob Kajfasz, City of Port Angeles, WA**
  - Bob has been working with K-Ply for years to get them to do an efficiency project.
- **The BPA project engineer is Tony Koch**
  - Tony used the TSP process to contract with CEC to do a scoping audit and a detailed energy analysis.
- **The TSP contractor is Compression Engineering Corp.**
  - The compressed air specialist was Tim Dugan, PE
  - The project engineer was Steve Gazeley

Baseline

- **Four older single-stage oil-flooded rotary screw compressors, a total of 550 hp**
  - They all ran most of the time, independent of plant demand.
  - All compressors ran inlet modulated.
  - Piping distribution and drying needed to be upgraded.
  - One compressor was very old but still running.
  - Total system efficiency was about 59% of optimal.

Energy Efficiency Measures

- **EEM 1. Integrate and automate the entire system**.
  - This includes all necessary piping, controls and related dryers.

- **EEM 2. Segregate bag house system and reduce pressure**.
  - This includes a new small efficient compressor, receiver, and controls. It facilitates the reduction of pressure in the main system (since the bag house needs higher pressure).

- **EEM 3. Reduce compressed air flow.**
  - This is accomplished by reducing or eliminating inefficient air knife and blow-off demands, using efficient nozzles and small blowers.

Project Distinctives

- **All engineering was performed by one firm, CEC**
  - Initial scoping audit (TSP)
  - Detailed energy analysis (TSP)
  - CAD drawings, controls sequence development, vendor interface, project management assistance, start-up assistance, and maintenance documentation (on contract to K-Ply).
- **All compressors in the entire facility were automated**
  - This provided efficient and robust control for all possibly flow ranges and market conditions. It is running well right now, and through the recent turn-down in the Plywood market.

Project Contractors

- **One electrical contractor performed most tasks**:
  - All electrical installation
  - PLC panel building
  - PLC code development
  - Network installation
  - Tuning and start-up.
  - The contractor originally was LH Morris Electric. The key staff have now formed a new company, **The Automation Group** (TAG), and have recently started up another large compressed air controls and integration project at Stimson Lumber in Forest Grove OR.
- **Another contractor installed an "HMI"**
  - This allows local and remote data collection and key performance indicator tracking. This was **Industrial Automation Inc.** of Three Forks, MT.
- **Equipment was supplied by Rogers Machinery Co.**
- **Piping and equipment installation was done by HEMR Industrial Contractors of Coquille, OR**

Measurement and Verification

- Measurement and verification is embedded in the system.
  - This allows key performance indicators to be easily and continuously tracked. Four weeks of data were collected, 9/7/06 to 10/5/07, after the system was fully tuned.
- Trend data is based on actual power monitoring.
  - Power transducers are embedded in the system for all controlled compressors.
  - Spot reading were made for smaller constant loads.

Non-energy Benefits

- **System Reliability**.
  - The baseline system had all four compressors running most of the time (an average of 89% run time). The optimized system had 1 spare 150 hp compressor available during peak production periods and one to two more during lower demand periods. In addition to providing automatic starting of the standby compressor during failure scenarios, the system facilitates preventive maintenance during production. All compressors were controlled by a management system that ran them at optimal energy consumption, with automatic back-up when a compressor failed or was shut down for maintenance. Operating at a lower system pressure also reduces wear and tear on all compressors, increasing their life.
- **Centralized Management of a Distributed System.**
  - From one location, maintenance staff can determine the status of all compressors, as well as the system reliability and efficiency as a whole.
- **Consistency of Pressure**.
  - The baseline system varied 14 psig in pressure from end to end of the facility, with the overall pressure varying from 63 to 103 psig throughout a production cycle. The optimized system maintained pressure throughout the facility within +/- 5 psig at all times.
- **Dry Air.**
  - The baseline system air was partly dried, using a deliquescent dryer for part of the system. The optimized system used refrigerated air dryers throughout.

Actual Savings

BASELINE

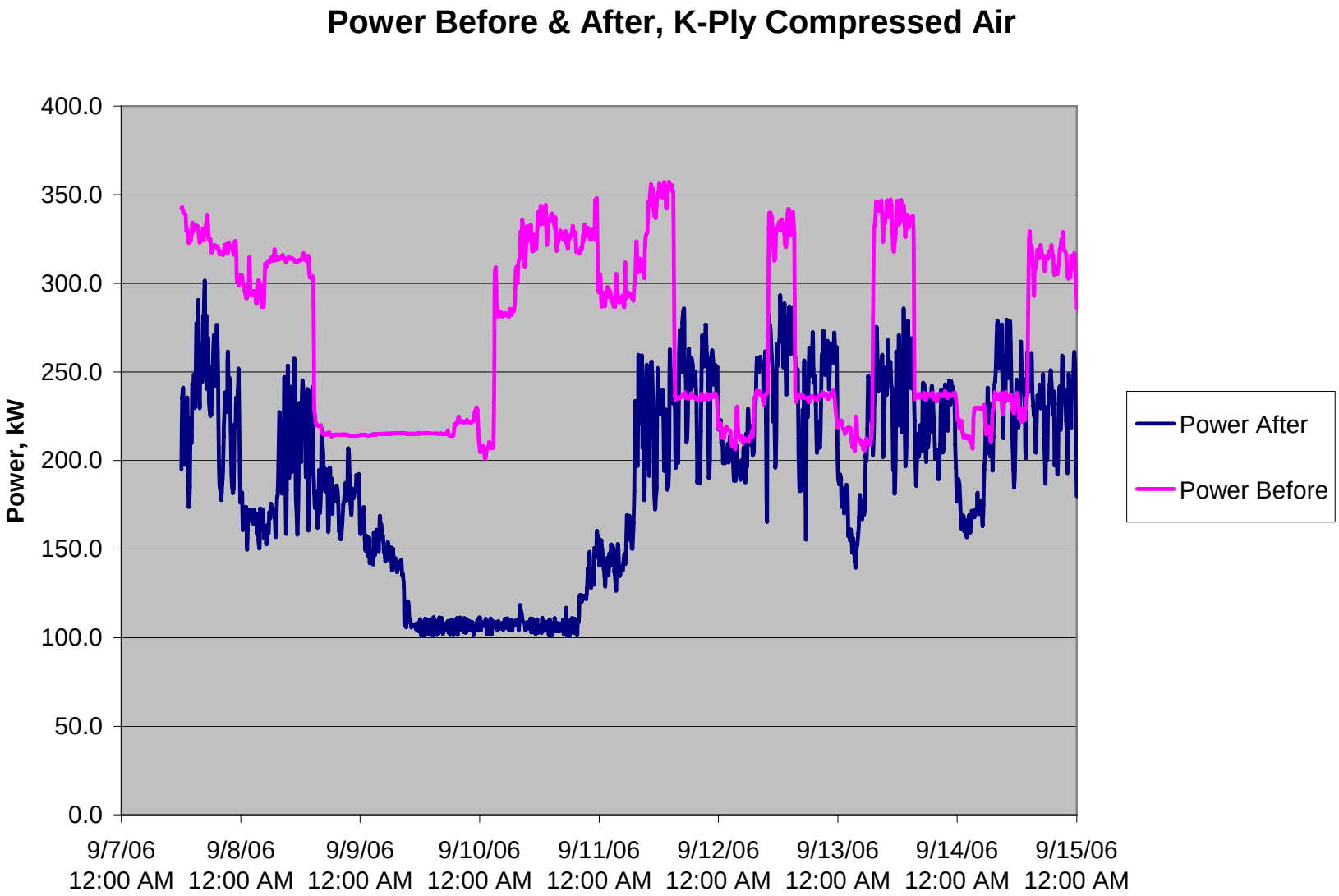
		FULL LOAD CAPACITY, (acfm)	AVERAGE FLOW, (acfm)	PEAK FLOW, (acfm)	AVERAGE PRESSURE, (psig)	AVERAGE POWER, (kW)	PEAK POWER, (kW)	ENERGY CONSUMPTION, (kWh/yr)	acfm/kW
COMPRESSOR	1 (QNW 740)	740	243	636	98.0	94.5	122.3	793,911	2.57
COMPRESSOR	2 (QNW 751)	750	280	686	94.2	77.4	122.3	649,964	3.62
COMPRESSOR	3 (QNW 650)	650	524	606	95.2	116.0	123.4	974,327	4.52
COMPRESSOR	4 (QNW 490)	490	172	452	86.2	57.1	86.7	479,854	3.01
TOTAL		**2630**	**1220**	**2124**	**93**	**345**	**359**	**2,898,056**	**3.54**

AFTER EEM1-3, MEASURED & VERIFIED

		FULL LOAD CAPACITY, (acfm)	AVERAGE FLOW, (acfm)	PEAK FLOW, (acfm)	AVERAGE PRESSURE, (psig)	AVERAGE POWER, (kW)	PEAK POWER, (kW)	ENERGY CONSUMPTION, (kWh/yr)	acfm/kW
Main System									
COMPRESSOR	1 (QNW 740)	740	275	740	85	55.1	136.2	462,588	4.99
COMPRESSOR	2 (QNW 751)	750	267	750	85	48.1	127.8	403,872	5.55
COMPRESSOR	3 (QNW 650)	650	0	0	85	0.0	0.0	-	
COMPRESSOR	4 (QNW 490)	490	491	500	85	79.4	76.7	666,792	6.19
BLOWER	New 15-hp Blower					3.3	9.9	27,720	
DRYERS	500 & 800 SCFM	1300				4.9	6.7	41,295	
Baghouse									
COMPRESSOR	5 (New 30hp)	126	101	126	115	23.5	28.1	197,400	4.30
TOTAL		**2756**	**1134**	**2099**	**85**	**214**	**369**	**1,799,667**	**5.29**

SAVINGS, EEM1-3, MEASURED & VERIFIED

		FLOW REDUCTION (acfm)		PRESSURE REDUCTION (psig)	AVERAGE POWER REDUCTION (kW)	PEAK POWER REDUCTION (kW)	ENERGY SAVINGS (kWh)	
TOTAL		**86**		**9**	**131**	**-9**	**1,098,389**	**$37,020.60 per year**


Power Before & After, K-Ply Compressed Air
Power, kW
400.0
350.0
300.0
250.0
200.0
150.0
100.0
50.0
0.0
9/7/06 12:00 AM
9/8/06 12:00 AM
9/9/06 12:00 AM
9/10/06 12:00 AM
9/11/06 12:00 AM
9/12/06 12:00 AM
9/13/06 12:00 AM
9/14/06 12:00 AM
9/15/06 12:00 AM
Power After
Power Before

Project Schedule

K-PLY

COMPRESSED AIR PROJECT

SCHEDULE

UPDATED 05/22/06

TASK	CONTRACTOR	START	END	X	FEB '06				MAR '06				APR '06			
					6-Feb	13-Feb	20-Feb	27-Feb	6-Mar	13-Mar	20-Mar	27-Mar	3-Apr	10-Apr	17-Apr	24-Apr
ENGINEERING																
PRELIM ENGINEERING	COMPRESSION ENGR (CEC)	02/20/06	02/28/06	X												
MECHANICAL INSTALLATION DRAWINGS	CEC	02/27/06	03/31/06	X												
ELECTRICAL SPECIFICATION	CEC	03/06/06	03/31/06	X												
FINES BLOWER ENGINEERING	CEC	04/03/06	04/07/06	X												
MECHANICAL SPECIFICATION	CEC	02/20/06	04/07/06	X												
CONTRACTOR PROPOSALS	KPLY	04/03/06	04/14/06	X												
CONTRACTOR SELECTION	KPLY	04/17/06	04/30/06	X												
FINAL CONSTRUCTION ESTIMATE	CEC	04/24/06	04/30/06	X												
NOZZLE & AIR KNIFE SELECTION	CEC	04/17/06	05/12/06	X												
SUBMITTALS: EQUIP'T & ELEC DRAWINGS	LH MORRIS	05/01/06	05/15/06													
REVIEW SUBCONTRACTOR PROPOSALS	CEC	05/15/06	05/22/06	X												
RELEASE FOR CONSTRUCTION	KPLY	05/22/06	06/01/06													
CLOSE OUT DOCUMENTATION	CEC	10/23/06	11/10/06													
EQUIPMENT / PROCUREMENT		**START**	**END**													
CONTROLS	LH MORRIS	05/01/06	07/14/06													
COMPRESSOR, DRYERS, TANK & ACCESSORIES	ROGERS MACHINERY CO.	05/01/06	07/14/06													
NOZZLES & AIR KNIVES	KPLY	05/01/06	07/14/06													
CONSTRUCTION		**START**	**END**													
FINES BLOWER INSTALLATION	KPLY	06/01/06	07/14/06													
490 PAD & ENCLOSURE CONSTRUCTION	KPLY	06/01/06	07/14/06													
PIPING	TBD - MECH CONTRACTOR	07/17/06	08/18/06													
COMPRESSOR, DRYER & TANK INSTALLATION	TBD - MECH CONTRACTOR	07/17/06	08/18/06													
FINES BLOWER DUCTING	SUPERIOR SYSTEMS	07/17/06	08/18/06													
WIRING	LH MORRIS	06/19/06	08/18/06													
LOAD / UNLOAD UPGRADES	ROGERS MACHINERY CO.	07/17/06	07/19/06													
COMPRESSOR INTERFACES	LH MORRIS	08/21/06	09/04/06													
TUNING AND COMMISSIONING		**START**	**END**													
EQUIPMENT START-UP	TBD	09/05/06	09/05/06													
COMPRESSOR CONTROLS INTEGRATION	LH MORRIS	09/11/06	09/19/06													
TESTING & TUNIG	KPLY & CEC	09/25/06	10/20/06													
M&V & REPORT	CEC	10/23/06	11/10/06													

COMPRESSED AIR PROJECT

SCHEDULE

UPDATED

TASK	MAY '06				JUN '06				JUL '06				AUG '06			
	1-May	8-May	15-May	22-May	5-Jun	12-Jun	19-Jun	26-Jun	3-Jul	10-Jul	17-Jul	24-Jul	7-Aug	14-Aug	21-Aug	28-Aug
ENGINEERING																
PRELIM ENGINEERING																
MECHANICAL INSTALLATION DRAWINGS																
ELECTRICAL SPECIFICATION																
FINES BLOWER ENGINEERING																
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CONTRACTOR PROPOSALS																
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LOAD / UNLOAD UPGRADES																
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EQUIPMENT START-UP																
COMPRESSOR CONTROLS INTEGRATION																
TESTING & TUNIG																
M&V & REPORT																

COMPRESSED AIR PROJECT

SCHEDULE

UPDATED

TASK	SEP '06				OCT '06			
	4-Sep	11-Sep	18-Sep	25-Sep	2-Oct	9-Oct	16-Oct	23-Oct
ENGINEERING								
PRELIM ENGINEERING								
MECHANICAL INSTALLATION DRAWINGS								
ELECTRICAL SPECIFICATION								
FINES BLOWER ENGINEERING								
MECHANICAL SPECIFICATION								
CONTRACTOR PROPOSALS								
CONTRACTOR SELECTION								
FINAL CONSTRUCTION ESTIMATE								
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