Conveyor Optimization

Process & Energy Efficiency Delivered

Author: Greg K. Elliott

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Project Description

Application: Ready Mix Concrete Plant "Feed Belt"

36" width, 55' length
15 degree incline
aggregate feed belt
325 feet per second
285 tons per hour
40 HP 60 AMP Heavy Duty Motor

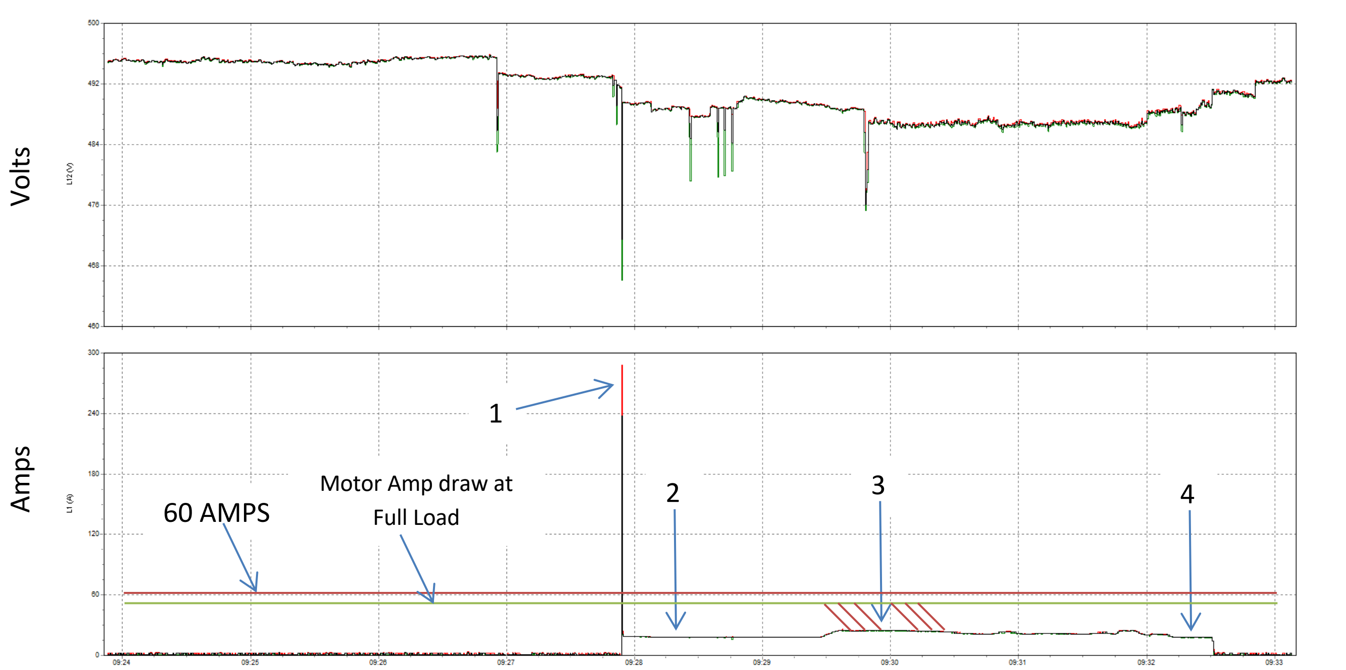
Application Details

This was part of a material handling optimization and energy efficiency project for a Mid-Atlantic ready mixed concrete producer. This particular application is one of the most common throughout the industry regardless of size, type, age or country. This is the optimization of what is commonly referred to as the "feed" or "batch" belt; the belt that delivers weighed aggregate from the scale to either the mixer in a wet plant or the truck in a dry plant. The plant in question is a dry plant.

IPS experts on-site first performed a thorough site review before installing power meter data logger on the relevant circuits to be studied. After observing multiple cycles of the feed belt in operation the following observations and metering where recorded:

- conveyor runs from as little as 23 seconds to as much as 55 seconds empty while material is being weighed
- conveyor design encourages spillage off the tail pulley and off the sides past the skirting if belt is properly loaded
- conveyor at "full load" is not fully loaded to designed capacity
- design deficiencies require manual loading of conveyor which increases the likelihood of error or under loading
- conveyor speed has been increased to reduce tail and skirt spillage resulting in under-loading
- increased conveyor speed has resulted in altered target point of material and increased impact wear and resulting maintenance costs
- conveyor runs for no less than 20 seconds empty after the last material has been discharged

The following is a sample load cycle reading from the metering taken. Metering was done for one week in addition to that done under observation. The chart below represents a typical 8 yard batch. All anomalies and exceptions have been identified and eliminated.



The following observations and confirmations were made:

1. excessive Amp draw on hard start for unloaded conveyor
2. belt running empty creates motor low load, low PF condition for 1:32 minutes of 4:25 minute cycle
3. belt in "full load" condition based on the process controls is never loaded to design capacity and is never above 50 % motor load and very low PF as a result
4. belt is running empty for an extended time at the end of the cycle after the material has discharged

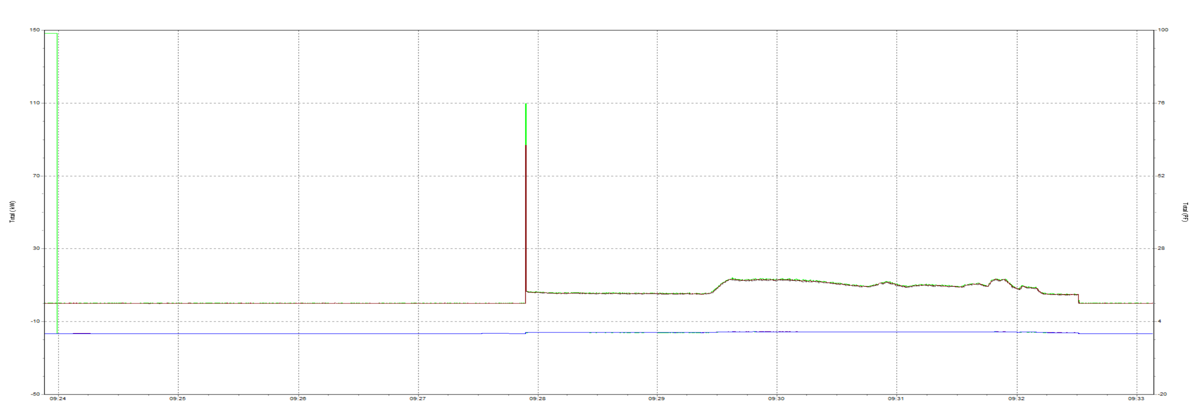
5. Active Power and Power Factor readings are horribly low:

Root Cause Analysis and Corrective Action Plan

The energy efficiency impacts of the design, automation and process inefficiencies can be measured and quantified with great detail. One means of evaluation used on this project was to enter the data into a motor analysis program that allows the collected data to be compared with potential values from an optimized solution. This provides a comparison of annual cost to operate the conveyor before and after optimization. With this data we can calculate the actual cost of corrective action as compared to energy saving to determine the ROI.

In this case the corrective action steps were quite simple and low-cost.

Issue	Root Cause	Corrective Action	Cost
Excessive Amp draw on start up	empending motor failure, bleed from adjacent circuit and undue resistance from conveyor design	replace motor, correct ciruit bleed and reduce belt tension by re-spacing idlers from pulley	$5,150.00
Empty Belt causing low load conditions after start-up	manuel operation	Automation- the controls already existed within the batching software but were not being properly utilized	$0
low load on motor and low PF during aggregate conveying	excessive belt speed, belt loading design flaw	replace skirt system to eliminate spillage of fully loaded belt, re-shieve motor to reduce speed	$1,575.00
			$6,725.00



Motor Savings Analysis - Replace Existing

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INPUTS

Motor Characteristics

	Existing Motor		Premium-Efficiency Motor	
Description:			WEG Electric Motors - NEMA Premium - IEEE-841 - NEMA Design B	
Size (HP) / Speed (RPM) (Poles):	40.0 HP	1800 RPM	40.0 HP	1800 RPM
Enclosure / Voltage (Volts):	TEFC	460 Volts	TEFC	460 Volts
Load (%):	65.0		65.0	
Efficiency (%):	42.0		94.7	
Full load RPM:	0 RPM		0 RPM	
Centrifugal load:	False			
Old Motor Efficiency Loss (%):	0			

Costs/Use

	Existing Motor	Premium-Efficiency Motor	Utility Data	
Dealer discount (%):	N/A	35	Energy price ($/kWh):	0.0907
Purchase price ($):	N/A	3,050	Demand charge ($/kW/mo.):	4.48
Installation cost ($):	N/A	2,100	Power factor (%):	N/A
Motor rebate ($):	N/A	0	Rebate program:	<None>
Peak months:	12	12	Simple payback criteria, yrs:	10
Hours use/yr:	2100	1225		

RESULTS - SAVINGS

	Existing Motor	Premium-Efficiency Motor	Energy Savings	
Differential cost ($):		5,150	Energy (kWh/yr):	71,880
Energy use (kWh/yr):	96980	25100	Demand (kW):	25.7
Energy cost ($/yr):	8,796	2,277	Energy savings ($/yr):	6,519
Demand charge ($/yr):	2,483	1,102	Demand savings ($/yr):	1,381
Greenhouse Gas Emissions Reduction			Total savings ($/yr):	7,901
State:	Virginia	tonnes CO2/yr:: 37.81	Simple payback (yrs):	0.7

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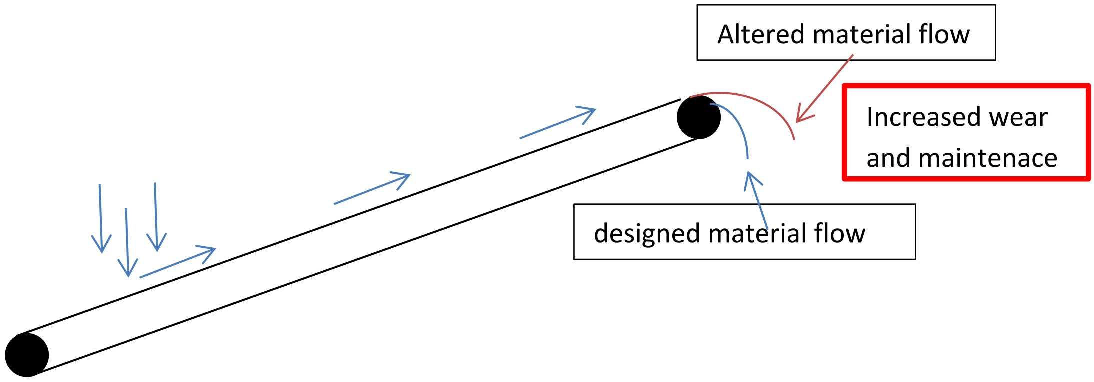
With a cost of $6,725.00 for customer performed improvements and annual savings of $7,901.00 the ROI is just over seven months. The savings comes as a result of each of the above stated corrective actions. Replacing the motor with a new NEMA Premium grade motor was important as were the design and speed changes. However the single largest impact on energy cost comes from the reduction of run time hours at a higher Power Factor. By eliminating the no load conditions – the belt running empty- and the low load conditions – belt running partially loaded with only 1:45 seconds of full load conditions the run time hours were reduced from 2,100 to 1,225 annually.

In addition to reduced energy cost, the reduction in consumption also reduces the plant CO_2 emissions by more than 37 tons. See the Motor Analyser results on the next page.

In addition to the electric utility savings the client reported additional savings of over $16,000 USD per year in maintenance labor and materials. By increasing the speed of the conveyor the material pitch was altered and created a new impact point that caused undue wear and material deflection slowing down and impeding the material flow. The corrective action implemented (returning the belt to the designed speed and material pitch) eliminated this problem permanently.



Conclusion

The proper application of process knowledge and power monitoring can result in root cause determination and corrective action planning that is executable and verifiable. In this case an investment of less than $7,000.00 on one conveyor resulted in a ROI of approximately 7 months with and annual ***electric utility*** savings of nearly $8,000.00 per year with no extra maintenance costs. This means that the $7,000.00 created a $39,505.00 savings over five years at the current cost of energy and current rate of consumption. As volume increases and the cost of energy rises the savings will likely be over $50,000.00 in five years.

In addition to the electric utility savings and the elimination of $16,000 USD per year in maintenance cost there is the value of increased productivity. Since the time to batch was reduced from 4:25 seconds to under 2 minutes (1:55 average) the customer has ***increased productivity*** of over 200%. Operating the plant 50% less time per batch means increased asset life for conveyors and all their components. Additionally, there has been a significant decrease in compressed air production and dust collection run time also equating to reduce energy cost and enhance asset life. Thereby process optimisation has created savings outside of energy cost that have a greater impact on overall plant reliability and profitability. This makes energy savings an exclamation on otherwise greater advantages of process efficiency.

Considering all benefits, the total savings over a 5-year period will exceed $150,000.00 USD. The total investment in auditing, planning, development of Recommended Corrective Action (RCA) and implementation on ALL plant systems (not just this conveyor) was approximately $35,000.00 USD. The ROI was slightly over one year with $150,000.00 USD savings over 5 years at 2011 energy costs and production rates. As energy cost continue to rise and production increases the total savings will increase as well.