Extruder Energy Study Results

November 4, 2016

Mr. Customer Name
Company Name
Street Address
City, State ZipCode

Overview of Study

The rising cost of energy is one of the largest challenges facing domestic plastic manufacturers today. For most plastic extrusion manufacturing facilities, approximately 1/3 of the energy consumed can be attributed to the extruder motors. Today, the majority of extruder machinery manufacturers are now installing alternating current (AC) vector motors and drives on their extruders instead of DC systems. There are multiple reasons that they are making this change, but the biggest reasons are lower costs and better performance of the AC alternative.

Although a DC motor can be as much as 90% efficient at full speed and full load, it becomes less efficient as it is reduced in both speed and load. Thus, the DC motor can have an efficiency reduction of 15% when it is operated at a lower speed and load. Measured efficiencies for an AC vector motor under the same reduced speed and load conditions have a typical reduction of 10% in efficiency. Actual measured efficiencies of your DC motor were taken using an AEMC Model 3945-B Power Quality Meter.

To determine the input power, we measure the input power going into the DC drive with the power quality meter. The output power were calculated from measurements taken with a clamp-on ammeter and a digital voltmeter of the armature voltage and current. From these readings percent speed and percent load can be determined when compared to the nameplate reading of the motor.

After the input power to the DC drive is measured and the output power is calculated, the total system efficiency for the DC drive and motor can be derived and the operational costs determined from actual utility records. These values are then compared to typical performance of an AC system providing the same output as the DC system measured using the same electrical costs.

Potential savings are determined from the following

EFFICIENCY

By design, DC motors are less efficient than AC, and several factors can worsen the situation, such as: poor brush and commutator maintenance, multiple motor rewinds, improper field settings or weak Silicon Controlled Rectifiers (SCR) in the DC drive. Efficiency is the primary delta in the power consumption when comparing DC to AC.

PEAK DEMAND

Because the power input to the AC system is less for the same output achieved by the DC system, the overall peak demand is also reduced. Peak demand charges from the utilities are always higher, and in effect a penalty for users during times where they are required to provide higher volumes to their entire base of customers. It should be noted that your peak demand charges are unusually high.

POWER FACTOR

Energy providers are very concerned about manufacturers operating with a good power factor and many penalize industrial manufacturers by adjusting their billing upward if it falls below 0.9 or 0.95. The reason they don't like poor power factors is that the current and power factor are inversely proportional. In other words, more current is required to do the same amount of work with a poor power factor. Therefore, the energy provider usually bills for kilowatt-hours (kWH) and peak kilowatts (kW) with and adjusted charge to the peak kW for a poor power factor.

SYSTEM MAINTENANCE

AC motors are maintenance-free other than the standard maintenance required for rotating machinery, namely bearings. For DC motors, regular brush replacement, turning of the commutator, and rewinds are necessary. The regular care of a DC motor over 10 years, often results in paying an equal amount as the original cost of the motor, making the motor twice the price.

AC SYSTEM COST

The ACPAK® extruder drive and motor price necessary for replacing the existing system are used in the Return on Investment (ROI) calculations. There are several things to consider in this evaluation. It is possible to mount the new drive in the existing cabinet for the CoEx, which has some savings, but it is not recommended for the larger drives as the heat characteristics are very different from the existing DC, meaning that in addition to the handling of very heavy drives (641lbs), the existing AC system will also need to be upgraded and negate any potential savings. It should also be noted that the ICT ACPAK® design caries a five-year warranty, which is an added incentive.

KEY VARIABLES

The actual cost per KWH play a significant role, in addition to the charges associated with Power Factor correction. The utility records provided allowed an averaging of what are typical charges associated with your facility and directly correlated to the consumption of each motor under normal load and speed measured during the study. Changes in utility costs, load or speed would impact the results significantly. It is for this reason we seek to measure systems under "normal" operating conditions, and ideally compare multiple bills from your provider. For this reason, it should be understood that increases in utility costs, will directly impact the ROI in a positive direction.

Items not considered for the Return on Investment (ROI)

CAPITALIZATION OF ASSETS

The decision to change technology typically hinges on either the resistance to spending outside the confines of a budgeted capital expense, or concerns of lost production. In regard to capitalization of the asset, when the AC extruder drive system is capitalized over 5 years, the consideration should be made if the annual savings exceeds the capitalized amount. Unless the ROI is greater than 5 years, this would be likely. Options for leasing the equipment is another option when capital budgets are unavailable.

LOST PRODUCTION

Because various customer specific factors are involved in this calculation, and hourly poundage and material costs are outside the scope of this study, it is left to the customer to determine the actual cost of a planned replacement rather than an emergency replacement. ICT stocks pre-built extruder drive systems up to 500HP and can ship in as little as 24 hours for an additional 10%, or

within one week for 5%. Motor availability considerations should be made when contemplating this risk. ICT stocks the following motor configurations for emergency shipments: 100, 200, 300 and 500HP / 1750RPM / F1 conduit box, and a 150HP / 1750 RPM / F2 conduit box motor. Motors requiring an F2 configuration have a service fee and add one day to lead-time while motors with radial loading (roller bearings) or 1150 RPM are subject to manufacturer stock and may not be available for emergency delivery.

POTENTIAL RETURN FROM UTILITY PROVIDERS

Many customers have been able to recover a portion of conversion cost from their utility providers. ICT is willing to provide information to your provider upon request, or work over the phone to answer specific questions, but we do not pursue these rebates on your behalf.

Extruder Energy Savings Results

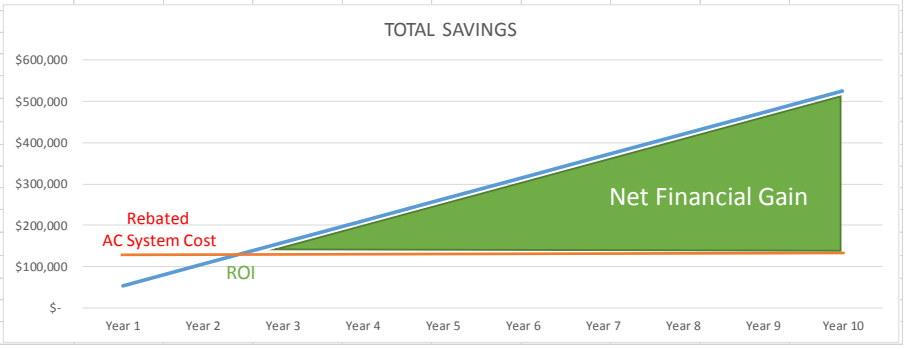
The following table summarizes the combined savings and quantifies your results. Your point of ROI for the conversion is at 3.53 years, with a 10 year rated component total savings around $360K – again, this does not include the cost associated with lost production or labor.

UTILITY SAVINGS	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Lifetime Total
Line 1 500HP	$ 10,200	$ 10,200	$ 10,200	$ 10,200	$ 10,200	$ 10,200	$ 10,200	$ 10,200	$ 10,200	$ 10,200	**$ 102,002**
Line 1 150HP	$ 3,801	$ 3,801	$ 3,801	$ 3,801	$ 3,801	$ 3,801	$ 3,801	$ 3,801	$ 3,801	$ 3,801	**$ 38,014**
Line 2 600HP	$ 13,775	$ 13,775	$ 13,775	$ 13,775	$ 13,775	$ 13,775	$ 13,775	$ 13,775	$ 13,775	$ 13,775	**$ 137,752**
MAINT SAVINGS											
Line 1 500HP	$ 8,494	$ 8,494	$ 8,494	$ 8,494	$ 8,494	$ 8,494	$ 8,494	$ 8,494	$ 8,494	$ 8,494	**$ 84,940**
Line 1 150HP	$ 7,767	$ 7,767	$ 7,767	$ 7,767	$ 7,767	$ 7,767	$ 7,767	$ 7,767	$ 7,767	$ 7,767	**$ 77,669**
Line 2 600HP	$ 8,494	$ 8,494	$ 8,494	$ 8,494	$ 8,494	$ 8,494	$ 8,494	$ 8,494	$ 8,494	$ 8,494	**$ 84,940**
TOTAL SAVINGS	**$ 52,532**	**$ 105,063**	**$ 157,595**	**$ 210,126**	**$ 262,658**	**$ 315,189**	**$ 367,721**	**$ 420,253**	**$ 472,784**	**$ 525,316**	**$ 525,316**

AC DRIVE & MOTOR	
Line 1 500HP	$ 65,930
Line 1 150HP	$ 31,938
Line 2 600HP	$ 65,930
HARDWARE COSTS	**$ 163,798**

UTILITY REBATE (est = 1 year)	
Line 1 500HP	$ 10,200
Line 1 150HP	$ 3,801
Line 2 600HP	$ 13,775
REBATE	**$ 27,777**

TOTALS	
AC Hardware ROI	**2.59**
Total Net Gain	**$ 389,294**



OBSERVATIONS / RECOMMENDATIONS

The two lines have identically rated gearboxes rated for a 600HP/1750RPM motor. Line 1 has a 500HP/1150RPM motor that produces approximately 450 ft-lbs more torque and exceeds the gearbox rating. Moreover, the 500HP/1150RPM is operating well below specifications and is not typically stocked, making the 600HP/1750RPM motor a reasonable choice for standardizing. The AC Drive is the same and does not change. The 150HP CoEx line was at capacity and we recommend upsizing this to a 200HP AC to allow more operational ceiling. The gearbox is rated at 250HP/1750RPM, so this should be easily within the mechanical specifications.

The specific motor measurements and individual ROI values are on the following page.

Utility Constants	$/KWH	$/Peak KW
	$ 0.044	$ 22.100

MEASURED VALUES

Line 1: 500HP/1150 RPM: 450V input

Operation Time	50 Weeks/Yr; 7 Days/Wk; 24 Hrs/Day		
Load	46%	55%	Speed
Line 14 300HP	DC	AC	Change
System Efficiency	107.67%	90.68%	-18.74%
Input Amps	275	96.8	-184.09%
I2R Losses in KW	0.8	0.1	-700.00%
Power Factor	36.41%	82.00%	55.60%
Total KW Required	77.8	61.78	-25.93%
Total KVA Required	213.7	75.34	-183.65%
KW Annual Cost	$27,186.75	$21,411.85	-26.97%
Peak KW Charge	$20,833.12	$16,407.83	-26.97%
Total Annualized Utility Savings			**$ 10,200.19**

Maintenance Savings		
Brushes	$ 1,100	
Turning Commutator (every 2yrs)	$ 5,879	
Rewind Armature (every 4 yrs)	$ 17,816	
Annualized Maintenance Costs		**$ 8,494.00**
Total Savings from Transition		**$ 18,694.19**

New AC System Costs		
ACP-600-500	ACPAK	$ 41,626.15
IDDRPM445006	RPMAC Motor	$ 24,304.25
Total Cost of New System		$ 65,930.40
Utility Rebate (est @ 1 yr savings)		
		$ 10,200.19
System ROI without DC Motor Failure		**2.98 yrs**

Line 1: 150HP/1750 RPM

Operation Time	50 Weeks/Yr; 7 Days/Wk; 24 Hrs/Day		
Load	100%	49%	Speed
300HP	DC	AC	Change
System Efficiency	78.21%	93.68%	16.51%
Input Amps	208	75.8	-174.41%
I2R Losses in KW	0.4	0.1	-300.00%
Power Factor	36.22%	90.00%	59.76%
Total KW Required	63.1	57.26	-10.20%
Total KVA Required	174.2	63.62	-173.81%
KW Annual Cost	$21,987.38	$19,835.22	-10.85%
Peak KW Charge	$16,848.86	$15,199.66	-10.85%
Total Annualized Utility Savings			**$ 3,801.36**

Maintenance Savings		
Brushes	$ 700	
Turning Commutator (every 2yrs)	$ 2,651	
Rewind Armature (every 4 yrs)	$ 7,760	
Annualized Maintenance Costs		**$ 7,766.85**
Total Savings from Transition		**$ 11,568.21**

New AC System Costs		
ACP-250-200	ACPAK	$ 21,240.00
IDDRPM282004	RPMAC Motor	$ 10,697.54
Total Cost of New System		$ 31,937.54
Utility Rebate (est @ 1 yr savings)		
		$ 3,801.36
System ROI without DC Motor Failure		**2.43 yrs**

Line 2: 600HP/1750 RPM: 475V input

Operation Time	50 Weeks/Yr; 7 Days/Wk; 24 Hrs/Day		
Load	84%	49%	Speed
300HP	DC	AC	Change
System Efficiency	82.74%	93.68%	11.68%
Input Amps	660	249.1	-164.95%
I2R Losses in KW	4.4	0.6	-633.33%
Power Factor	37.32%	90.00%	58.53%
Total KW Required	203	184.2	-10.21%
Total KVA Required	544	204.67	-165.79%
KW Annual Cost	$71,761.76	$63,962.86	-12.19%
Peak KW Charge	$54,990.81	$49,014.53	-12.19%
Total Annualized Utility Savings			**$ 13,775.18**

Maintenance Savings		
Brushes	$ 110	
Turning Commutator (every 2yrs)	$ 5,879	
Rewind Armature (every 4 yrs)	$ 17,816	
Annualized Maintenance Costs		**$ 8,494.00**
Total Savings from Transition		**$ 22,269.18**

New AC System Costs		
ACP-600-500	ACPAK	$ 41,626.15
IDDRPM406004R1	RPMAC Motor	$ 24,304.25
Total Cost of New System		$ 65,930.40
Utility Rebate (est @ 1 yr savings)		
		$ 13,775.18
System ROI without DC Motor Failure		**2.34 yrs**