TurboTrac Systems
Energy transmissons ahead of the curve.™

Business Case

Introduction

Turbo Trac USA

PROJECT NAME: Paper Mill Energy Savings
Customer Name: Card Board Paper Mill

BUSINESS CASE A1 – PAPER MILL ROLL STAND ENERGY SAVINGS PROJECT

06/15/2011

The US is projected to have a major energy shortfall in the amount we consume versus the amount we produce over the next several years. This shortfall will result in a deviation from our normal manufacturing processes, in terms of hours of operation and the number of pieces of equipment that can operate at any one time. One industry greatly impacted is the Paper Mill industry, as large amounts of energy are required to manufacture the paper and card board that we depend on every day.

This case study focuses on a large mill that produces various grades of corrugated container and box board that needs a solution that would decrease energy consumption. The Turbo Trac, Infinitely Variable Transmission (IVT) was selected for its energy savings capability and variable speed control ability. One of the roll stands at the mill was selected as an opportunity to reduce energy cost. This particular roll was driven by a 50 HP motor, Variable Frequency Drive (VFD) and 6:1 gearbox. The Turbo Trac IVT replaced both the gearbox and VFD in this application. The roll stand is operated 24 hours per day, 365 days per year and the customer is currently paying $ 0.07 per kWh. Five different cardboard materials are processed during the year at varying durations of time. Any one cardboard type is processed at the mill a per cent of time over the course of the year, as identified as per cent of usage in the table below. The cardboard weight varieties and application parameters at this roll stand are identified below.

By implementing the IVT into their system the user eliminated a gear box and variable frequency drive. The annual energy savings on this one roll stand alone was over $5,500. There are 10 additional roll stands at this paper mill. Therefore this same type of saving extrapolated over the 10 roll stands would yield an annual energy savings of over $50,000.

ROLL STAND OPERATION PARAMETERS

Production Grade	Machine Speed (fpm)	Roll Rpm	Motor RPM	Load	Use (%)
33#	2150	342.36	2105.15	40%	10
35#	2100	334.39	2056.19	40%	35
42#	1900	302.55	1860.37	40%	26
45#	1500	238.85	1468.71	40%	19
57#	1400	222.93	1370.80	40%	10

Factors impacting the application

It is important for customers to realize that individual equipment efficiency is important, however the efficiency of the system tells the real story in terms of how energy effective the application. Equipment efficiency deceases as the operation point deviates from the rated operation parameters. In industrial applications most equipment is not operating at its rated speed and load. Therefore the resulting efficiency is less than they had hoped. Additionally when taking system efficiency into account, the desired end result may be less than you had anticipated. Therefore in this business case we look at the following factors to clearly uncover the impact on the system efficiency.

1. Individual Unit Efficiency
2. Current System Efficiency
3. IVT System Efficiency
4. Annual Operation Cost

Individual Unit Efficiency

Each unit in the system actual efficiency is computed versus the unit efficiency at the rated operating conditions. The bottom line is that an AC motor is quite efficient at rated speed and voltage, but the losses build as a percentage of output as speed is

reduced. The power factor enters the efficiency equation and the control losses add in as well. The following unit efficiency tables illustrate that point.

Motor and VFD Efficiency (example grade 35# card board)

	Percent Load	RPM	Efficiency
Motor and VFD Rated Parameters	90 %	1800	95.5%
Motor Actual Operation Parameters	40%	2056	89% *
VFD Actual Operation Parameters	40 %	2056	90% *

Reference (*) See appendix A for Rooks and Wallace data on motor and VDF efficiency at various speeds.

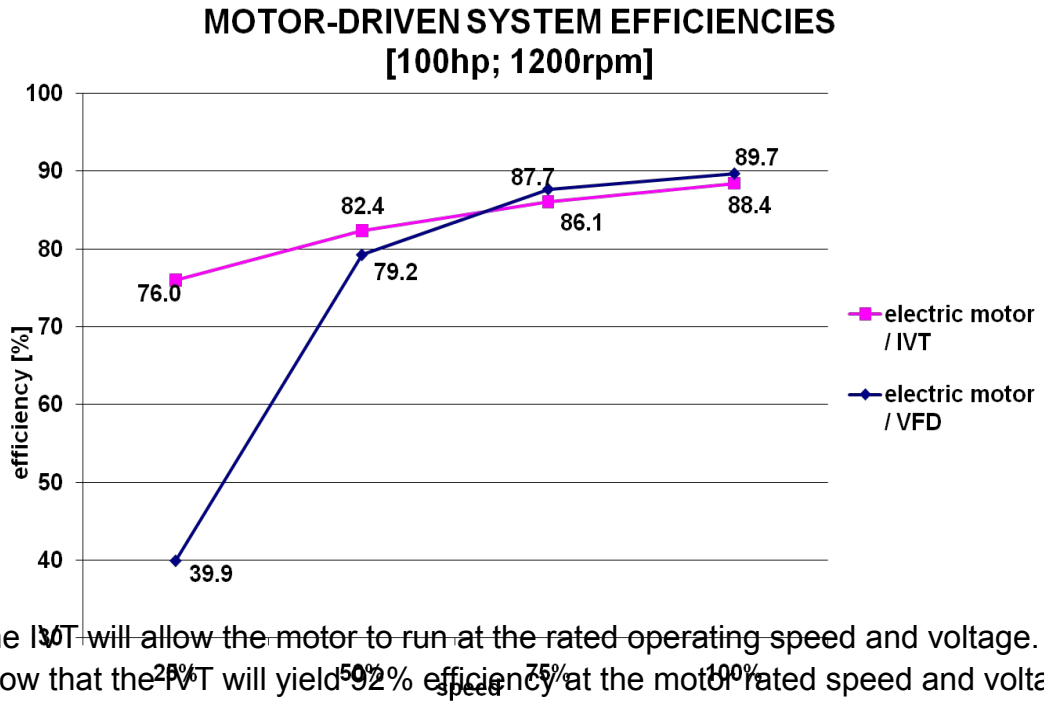
Gearbox Efficiency (example grade 35# card board)

	Percent Load	RPM	Efficiency
Gearbox Rated Parameters	90%	285	97%
Actual Operation Parameters	40%	334.39	93%

Current System Efficiency (example: product grade 35#)

Current System efficiency = 74% (motor eff. * VSD eff. * gearbox eff.)

IVT Efficiency



The IVT will allow the motor to run at the rated operating speed and voltage. We know that the IVT will yield 92% efficiency at the motor rated speed and voltage. Therefore the combined motor and IVT efficiency is 87%.

IVT System efficiency = 87% (motor eff. * IVT eff.)

Annual Operating Cost Calculation

Annual operating cost is calculated as shown in the formula below. We can use this formula to determine the cost to operate the current system at the specified operation parameters as well as the IVT plus motor system.

$$\text{Cost} = \frac{\text{Rate X Connected HP X 0.746 x Hours Run}}{\text{Motor eff. X Gearbox eff. X VSD eff.}}$$

Where:

Cost = Annual Utility Cost

Rate= Local cost of power

Connected HP = # of operating drives x HP

Hours Run = Hours per day x # of operating days per year

The denominator of this equation changes when you only have the IVT and motor in the system.

Annual Operating Cost Summary

Production Grade	Current System efficiency	IVT System efficiency	Current Utility Cost	IVT Utility Cost	Energy Savings
33#	71%	89%	$4752	$3802	$950
35#	74%	88%	$15,889	$13,613	$2276
42#	78%	87%	$11,689	$10,480	$1209
45#	78%	85%	$8120	$7519	$600
57#	71%	84%	$4752	$4028	$724
Annual Savings					$5759

1. Additional Benefits

- Elimination of mature out-dated technology (VFD and Gearbox)
- Elimination of single point of highest failure (VFD)
- Allows motor to operate at fixed speed (not over speed which degrades windings)
- Overall reduced maintenance cost
- The Energy Independence and Security Act (EISA) went into effect December 19, 2010, and has far reaching implications for many industries. – the EISA addresses raising the efficiency of industrial electric motors.

2. Expected Benefits

Benefit	Benefit measurement
Energy Savings	Reduction in energy cost for the year.
Less Equipment Downtime	Reduction in maintenance cost.
Less Inventory	Reduction in inventory holding cost

Appendix A

Efficiency of Motors at Operating Speeds

Rated HP at 60 HZ Speed	25%	50%	75%	100%
50	79.2%	84.5%	94.1%	94.9%
100	79.2%	87%	93.7%	96%
200	78.2%	86%	93.8%	96.4%

Efficiency is based on 80% load
Source: Energy Efficiency of Variable Speed Drive Systems, Rooks and Wallace

VFD Efficiency as a function of Percentage of Full Operating Speed

VFD HP Rating	25%	50%	75%	100%
10	35.3%	79%	83%	92.4%
25	35.6%	79%	90.3%	93.5%
50	43.3%	83.5%	92.1%	94.4%
100	54.8%	89%	95%	96.6%
200	61.2%	91.3%	96.1%	97.3%

Efficiency is based on 80% of rated HP
Source: Energy Efficiency of Variable Speed Drive Systems, Rooks and Wallace