ROMAN MANUFACTURING INC.

Energy Savings Opportunities in Continuous Running Applications

White Paper

Stanley F. Rutkowski III
Mark B. Siehling
Robert S. Hofman
Donald B. DeCorte
9/19/2008

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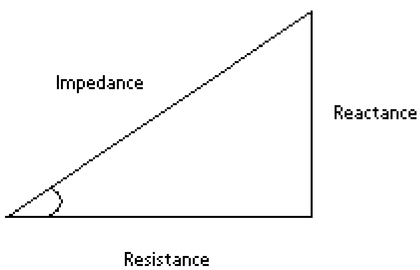
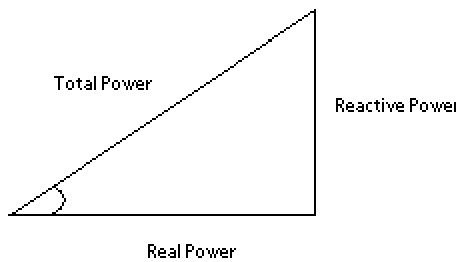
With the rising costs of electrical energy in the global marketplace, manufacturing industries are investigating the opportunity to reduce costs in their processing. During the times of low cost energy, little or no influence was given to electrical losses in a system as it had minimal impact on the operating cost of manufacturing a product. As the cost of electricity has risen, the impact of the operating cost has come to the forefront as an issue of competitiveness.

The cost of electricity is typically focused on five aspects of power:

1) Real Power (kW)
2) Power Factor
3) Peak Demand
4) Reactive Power (kVAR)
5) Total Power (kVA)





The easiest and single largest of the five aspects to put a monetary value to is the Real Power savings. A electric utility bill typically shows this cost in a set price in kilowatt hour (kWH). The other four aspects of the power are dependant on other factors in a facility, so this report will only focus on dollar savings (in $US) for the Real Power Savings.

In many industrial processing applications such as resistance heating, physically large air cooled transformer systems are installed. Systems incorporating air cooled transformers need to be kept in a stable temperature range and protected from dust or debris which could reduce heat dissipation. With this isolation, large and material intensive copper secondary circuits needed to be designed to accommodate the air cooled transformers.

With the use of a sealed water cooled transformer system, the limitations of the air cooled system are removed. The ambient temperature for the transformer now becomes the temperature of the inlet water. Also with any epoxy encapsulated transformer the vulnerability to contamination from dust or debris is removed. Typically other components in the electrical or mechanical system are already water cooled, so the impact of the water to the cooling system of the transformer is minimal. With the closer proximity of the transformer to the work piece, more electrically efficient and less material intensive secondary circuits can be employed in the system.

RoMan Manufacturing Incorporated has participated in eight case studies showing the electrical benefits of the water cooled transformer system. These studies were conducted on three continents with varying primary voltages and frequencies.

Case Studies #1 and #2

Position	Air Cooled System #1	Water Cooled System #1	Air Cooled System #2	Water Cooled System #2
Primary Current	140.21 A	50.5 A	128.42 A	49.0 A
Secondary Current	4,767 A	4,048 A	4,366 A	3,980 A
Reduction in Primary Current		89.71 A		79.42 A
Power Factor	0.47	0.65	0.50	0.67
Real Power	21.0 kW	12.5 kW	22.2 kW	12.0 kW
Cost of kW per Year	$10,117.80	$6,022.50	$10,695.96	$5,781.60
Savings in Real Power per Year*		$4,095.30		$4,914.36
Reactive Power	23.7 kVAR	6.7 kVAR	22.2 kVAR	5.9 kVAR
Total Power	31.7 kVA	14.2 kVA	31.4 kVA	13.4 kVA

* Price of kWH is $0.055 USD

In System #1

1) The Real Power is 59.5% of the existing application (12.5 / 21.0 X 100%). With the cost of $0.055 per kWH the savings would be $4,095.30 per year.

2) The Power Factor of the system will be increased by 38.3% ((0.65-0.47) / 0.47 x 100%).

3) The Peak Demand Current is 36.0% of the existing application (50.5 / 140.21 x 100%).

4) The Reactive Power is 28.3% of the existing application (6.7 / 23.7 x 100%).

5) The Total Power is 44.8% of the existing application (14.2 / 31.7 x 100%).

In System #2

1) The Real Power is 54.1% of the existing application (12.0 / 22.2 X 100%). With the cost of $0.055 per kWH the savings would be $4,914.36 per year.

2) The Power Factor of the station is increased by 34.0% ((0.67-0.50) / 0.50 x 100%).

3) The Peak Demand Current is 38.2% of the existing application (49.0 / 128.42 x 100%).

4) The Reactive Power is 26.6% of the existing application (5.9 / 22.2 x 100%).

5) The Total Power is 42.7% of the existing application (13.4 / 31.4 x 100%).

The installed base for each of the two systems is 200 units. With a total conversion to the water cooled system in the facility the power saving per year in Real Power alone would be $1,801,932.00 (200 x $4095.30 + 200 x $4914.36).

Case Study #3

Position	Air Cooled System	Water Cooled System
Primary Current	106.4 A	92.6 A
Secondary Current	5,000 A	5,000 A
Reduction in Primary Current		13.8 A
Power Factor	0.79	0.89
Real Power	40.3 kW	39.5 kW
Cost of kW per Year	$35,302.80	$34,602.00
Savings in Real Power per Year*1		$700.80
Reactive Power	10.7 kVAR	4.9 kVAR
Total Power	41.7 kVA	39.8 kVA

*1 Price of kWH is $0.10 USD

1) The Real Power is 98.0% of the existing application (39.5 / 40.3 X 100%). With the cost of $0.10 per kWH the savings would be $700.80 per year.

2) The Power Factor of the station is increased by 12.7% ((0.89-0.79) / 0.79 x 100%).

3) The Peak Demand Current is 87.0% of the existing application (92.6 / 106.4 x 100%).

4) The Reactive Power is 45.8% of the existing application (4.9 / 10.7 x 100%).

5) The Total Power is 95.4% of the existing application (39.8 / 41.7 x 100%).

The installed base for each of the two systems is 62 units. With a total conversion to the water cooled system in the facility the power saving per year in Real Power alone would be $43,449.60 (62 x $700.80).

Case Study #4

Position	Air Cooled System	Water Cooled System
Primary Current	90.0 A	84.0 A
Secondary Current	4,950 A	4,947 A
Reduction in Primary Current		6.0 A
Power Factor	0.86	0.92
Real Power	29.4 kW	29.4 kW
Cost of kW per Year	$15,452.64	$15,452.64
Savings in Real Power per Year*2		$0.00
Reactive Power	4.8 kVAR	2.6 kVAR
Total Power	29.8 kVA	29.5 kVA

*2 Price of kWH is $0.06 USD

1) The Real Power is 100.0% of the existing application (29.4 / 29.4 X 100%). With the cost of $0.06 per kWH the savings would be $0.00 per year.

2) The Power Factor of the station is increased by 7.0% ((0.92-0.86) / 0.86 x 100%).

3) The Peak Demand Current is 87.0% of the existing application (84.0 / 90.0 x 100%).

4) The Reactive Power is 93.3% of the existing application (4.9 / 10.7 x 100%).

5) The Total Power is 99.0% of the existing application (29.5 / 29.8 x 100%).

The installed base for each of the two systems is 74 units. With a total conversion to the water cooled system in the facility the power saving per year in Real Power alone would be $0.00. In this application, the increase of the power factor attributed more of the total power to the real power in the application, resulting in no dollar savings in kWH while showing savings in the other aspects of the system. Each application needs to be assessed for its savings potential as not all applications allow for savings in power.

Case Study #5

Position	Air Cooled System	Water Cooled System
Primary Current	85.1 A	73.3 A
Secondary Current	5,280 A	5,280 A
Reduction in Primary Current		11.8 A
Power Factor	0.75	0.84
Real Power	23.0 kW	22.1 kW
Cost of kW per Year	$11,081.40	$10,647.78
Savings in Real Power per Year*3		$433.62
Reactive Power	7.7 kVAR	4.2 kVAR
Total Power	24.3 kVA	22.5 kVA

*3 Price of kWH is $0.055 USD

1) The Real Power is 96.1% of the existing application (22.1 / 23.0 X 100%). With the cost of $0.055 per kWH the savings would be $433.62 per year.

2) The Power Factor of the station is increased by 12.0% ((0.84-0.75) / 0.75 x 100%).

3) The Peak Demand Current is 86.1% of the existing application (73.3 / 85.1 x 100%).

4) The Reactive Power is 54.5% of the existing application (4.2 / 7.7 x 100%).

5) The Total Power is 92.6% of the existing application (22.5 / 24.3 x 100%).

The installed base for each of the two systems is 80 units. With a total conversion to the water cooled system in the facility the power saving per year in Real Power alone would be $34,689.60 (80 x 433.62).

Case Study #6

Position	Air Cooled System	Water Cooled System
Primary Current	53.0 A	35.8 A
Secondary Current	2,915 A	3,043 A
Reduction in Primary Current		17.2 A
Power Factor	0.90	0.93
Real Power	17.2 kW	12.0 kW
Cost of kW per Year	$8,286.96	$5,781.60
Savings in Real Power per Year*4		$2,505.36
Reactive Power	1.9 kVAR	0.9 kVAR
Total Power	17.3 kVA	12.0 kVA

*4 Price of kWH is $0.055 USD

1) The Real Power is 69.8% of the existing application (12.0 / 17.2 X 100%). With the cost of $0.055 per kWH the savings would be $2,505.36 per year.

2) The Power Factor of the station is increased by 3.3% ((0.93-0.90) / 0.90 x 100%).

3) The Peak Demand Current is 67.5% of the existing application (35.8 / 53.0 x 100%).

4) The Reactive Power is 47.4% of the existing application (0.9 / 1.9 x 100%).

5) The Total Power is 69.3% of the existing application (12.0 / 17.3 x 100%).

The installed base for each of the two systems is 40 units. With a total conversion to the water cooled system in the facility the power saving per year in Real Power alone would be $100,214.40 (40 x 2,505.36).

Case Study #7

Position	Air Cooled System	Water Cooled System
Primary Current	17.7 A	10.6 A
Secondary Current	1,700 A	1,700 A
Reduction in Primary Current		6.0 A
Power Factor	0.52	0.70
Real Power	4.4 kW	3.5 kW
Cost of kW per Year	$1927.20	$1533.00
Savings in Real Power per Year*5		$394.20
Reactive Power	4.1 kVAR	1.5 kVAR
Total Power	6.0 kVA	3.8 kVA

*5 Price of kWH is $0.05 USD

1) The Real Power is 79.5% of the existing application (3.5 / 4.4 X 100%). With the cost of $0.05 per kWH the savings would be $394.20 per year.

2) The Power Factor of the station is increased by 34.6% ((0.70-0.52) / 0.52 x 100%).

3) The Peak Demand Current is 59.9% of the existing application (10.6 / 17.7 x 100%).

4) The Reactive Power is 36.6% of the existing application (1.5 / 4.1 x 100%).

5) The Total Power is 63.3% of the existing application (3.8 / 6.0 x 100%).

The installed base for each of the two systems is 48 units. With a total conversion to the water cooled system in the facility the power saving per year in Real Power alone would be $18,921.60 (48 x $394.20).

Case Study #8

Position	Air Cooled System	Water Cooled System
Primary Current	70.0 A	58.3 A
Secondary Current	3,500 A	3,500 A
Reduction in Primary Current		11.7 A
Power Factor	0.77	0.88
Real Power	20.4 kW	19.4 kW
Cost of kW per Year	$11,615.76	$11,046.36
Savings in Real Power per Year*6		$569.40
Reactive Power	6.1 kVAR	2.6 kVAR
Total Power	21.3 kVA	19.5 kVA

*6 Price of kWH is $0.065 USD

1) The Real Power is 95.1% of the existing application (19.4 / 20.4 X 100%). With the cost of $0.065 per kWH the savings would be $569.40 per year.

2) The Power Factor of the station is increased by 14.3% ((0.88-0.77) / 0.77 x 100%).

3) The Peak Demand Current is 83.3% of the existing application (58.3 / 70.0 x 100%).

4) The Reactive Power is 42.6% of the existing application (2.6 / 6.1 x 100%).

5) The Total Power is 91.5% of the existing application (19.5 / 21.3 x 100%).

The installed base for each of the two systems is 65 units. With a total conversion to the water cooled system in the facility the power saving per year in Real Power alone would be $37,011.00 (65 x $569.40).

Conclusion:

In eight industrial studies, we have demonstrated annual power savings between $394.20 and $4,914.36 in kWH per transformer system used in the application. In one case study no real power savings could be demonstrated. There are savings in the other four aspects of the power system in each of the case studies as well, but the dollar savings are more difficult to calculate with the information provided by the power companies. Other savings can be shown in the reduction of secondary copper in the systems, lower maintenance costs and the reduction of space needed to house the water cooled system in the facility. With one of the case studies shown in this report, the customer was able to add significant output to the facility with no additions to the power system or square footage in the facility by the savings created by the water cooled system.