Product Test Report

Introduction

The following report discusses the results from an analysis of the power and temperature data taken May 8, 2002 at Custom Molders, Inc., Henderson Facility. Included is an economic and environmental analysis that suggests that installing the PyroSil extruder insulation blankets can result in savings of nearly $45K annually, $33K first year. Due to power and air conditioning savings, the payback on each blanket is only 14 weeks. Additional benefits include better plant environment, better worker productivity, safer maintenance conditions, and lower maintenance on critical systems.

Background

Custom Molders, Inc., Henderson facility operates 15 plastic extruder lines of varying sizes. The barrels on these plastic extruders are metal with resistive heating bands around the outside of the barrel. While maintaining a 425°F plastic flow temperature, these barrels heat surrounding air to 360°F. With the air conditioning set to 75°F, the facility ambient temperature is near 95°F.

The high ambient temperature is very uncomfortable for workers. Studies have shown that high ambient temperatures can result in lower worker productivity. Other studies have also shown that machinery fatigues faster in environments approaching 40°C (104°F). Maintenance personnel must occasionally work on or near non-insulated barrels, with a surface temperature of 360°F, causing many safety concerns.

Energy lost to the environment from the heating bands is essentially consumed twice. Power consumed by the heating bands is increased to compensate for the heat lost to the environment. The facility cooling system must then work harder to reject the hotter air from the plant. Therefore, there are increased economic benefits in reducing the amount of heat lost to the facility environment. Reportedly, Custom Molders, Inc., has noticed both of these economic and facility benefits at their Durham facility where the extruder barrels are insulated using a ceramic blanket.

Mr. Ted Ford, of PE Products, a supplier of Custom Molders, Inc., identified the benefits of insulating extruder barrels through his company's experiences in industrial insulation over the past 5 years. He recommended that the Henderson facility try multi-layer silica based blankets instead of the ceramic based insulation being used at the Durham facility for their lower thermal conductivity, higher durability and accelerated return on investment.

As an independent testing facility, Advanced Energy was asked to test the silica blankets, or PyroSil, on an extruder at the Henderson facility to determine the economic and environmental benefits before further investment was made. Progress Energy, the facilities electric energy supplier, has sponsored this study as a service to help facilities in their service territory make informed energy decisions. Progress Energy will publish a case study on the use of multi-layer silica insulating blankets based on the results of this study.

Procedure & Observation

Extruder line F, a Toshiba IVGT, at the Henderson facility was used for all tests. First, the machine was tested without the insulation blankets. An ANSI K-type thermocouple was installed on the extruder barrel to monitor the surface temperature and amount of heat released to the facility environment. The thermocouple was read with a Fluke 51 K/J thermometer. Temperature readings were also taken with a Raytek infrared pyrometer. A Dranetz Power Platform 4300 using a task card 808 recorded energy consumption and demanded throughout both tests. With the extruder machine turned off at its main breaker, this unit was installed on the electric power feed between the machine's controls and the machine's main transformer. The Dranetz unit was set to record amps, volts, energy (kWh), and integrated demand (kW) over each 15-minute period.

This first, non-insulated test ran for 1.5-2 hours to ensure that there were at least four demand intervals of data from full production levels. The extruder line ran out of plastic at one point during the test, and the machine was set to idle in order to stay warm. This stop affected two data points, which were removed from analysis. The temperature of the barrel fluctuated during the tests based on the point in the extruding cycle. When plastic was ready to flow in the extruder barrel, the barrel emitted heat at 360°F, and when empty, the barrel was at 343°F.

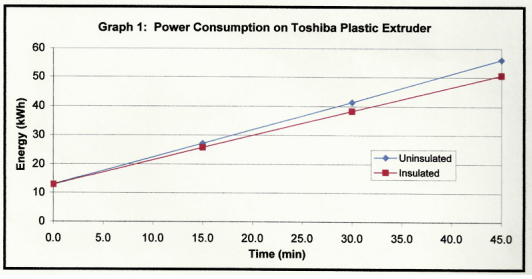
Then, the extruder machine was disabled and the blankets installed. Five blankets were

installed along the 78-inch length of the machine. Advanced Energy's ANSI K-type thermocouple remained underneath the blankets to monitor barrel temperature, and the Raytek was exclusively used to monitor the outer temperature of the blankets. After the control rewiring needed with the blanket insulation, the machine was re-engaged and began another 1.5 hours of normal production. Very notably, the barrel temperature remained a constant 408°F throughout the insulated portion of the test. The outside of the blankets displayed no more than 130°F as seen with the infrared pyrometer, and no more than 165°F at the seams of 5 blankets.

Results & Recommendations

Analysis of test extruder:From each test, non-insulated and insulated, there were four data points where production was constant and had comparable rates. Each data point represents the average of 15 minutes of power data. These four data points were used for all power consumption analysis.

The first power consumption analysis compared the average demand over the four good data points. The average of these four points was 56.059-kW for the non-insulated test, and 50.671-kW for the insulated test. This shows a demand reduction of 5.388-kW on this machine during the test. The four data points were consistent with each other, having a standard deviation of less than 2-kW. This indicates that the non-insulated machine is drawing less power than the insulated machine. The linear trend and lower energy consumption of the insulated machine are illustrated in Graph 1 (below).



The second power consumption analysis compared the energy, or power consumption over the applicable data points. This analysis included an economic analysis using the average cost per kilowatt-hour and typical demand charges are determined by the facility's electric power reports

of a 12-month period from May 2001 to April 2002. Based on these reports the facility consumed 6,578 MWh in the past year at a cost of $340,600. The kW demand charge is typically based on around 1200 kW of load. The average cost of electricity for this facility over the past year was 5.18¢/kWh. In a one-hour period, the non-insulated plastic extruder consumed 56.07 kWh over one hour at normal operating load at a cost of $2.90. The insulated plastic extruder consumed 50.68 kWh over a similar period at a cost of $2.63. Therefore, in machine operation costs, the silicon insulation saves 27¢ per hour. In a 3 shift, 7 day week operation this insulated extruder barrel translates to a cost savings of $2,435 annually at the tested production rate; in a 5 day per week operation, energy cost savings are $1,740. Energy savings are further compared in Table 1.

Savings Breakdown of Extruder Machine °F

(Based on data data acquired May 8, 2002)

Non-Insulated

Insulated

Energy Consumption	56.066 kWh per hour	50.684 kWh
Electric Rate	$0.052/kWh	

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Electric Cost per Hour Operation	$2.914	$2.625
Annual Operating Weeks	52	52
Operating Days Per Week	7	7
Operating Hours Per Day	24	24
Annual Operating Hours	8736	8736
Annual Operating Electric Costs	$25,471.26	$22,935.77
Annual Savings with Insulation		**$2,435.49**
Energy Saved Per Hour		5.382 kWh
HVAC Savings Per Hour		$0.04596

Annual HVAC Savings	**$401.50**
Total Savings	**$2,836.99**
Cost of Insulating Blankets	**$743.06**
Simple Payback	**14 Weeks**

The 5.38-kWh energy saved in machine operation by the insulation should also be considered as heat directly saved from entering the facility. Therefore, as a result of the insulation, there are additional savings on plant cooling from the insulated extruder. There is an estimated additional 4.8¢ in savings each hour due to lowered cooling costs while the plant cooling is operating. This was calculated assuming a recent model chiller system with .6 kW/ton of cooling. Also, without this heat energy being released to the environment, the facility will feel considerably more comfortable. Saving for a 24-hour, seven-day operation are $400, as shown in Table 1.

Application of findings to full facility: Analysis of the test extruder, as detailed above, is favorable to applying insulation throughout the Custom Molders, Inc., Henderson facility. Assuming each plastic extruder operates the same per square foot, or emits the same amount of heat to the plastic and to the environment, as the test machine, certain numbers can be assumed and then used to analyze all extruder machines at the facility. The heat exchange surface, or outermost surface area of the extruder barrel, is used as a normalizing factor. From facility measures, the test extruder has a barrel surface area of 15.833-ft ^{2}. Dividing all savings and blanket surface area by the surface area of the barrel gives the constants in Figure 3, which will be assumed throughout the facility.

From facility measurements, the total barrel surface area of all 15 extruder machines is 255.035-ft^2. Using the constants from Table 2, this gives more than $44K in savings annually and a simple payback of only 14 weeks on insulation blankets. A detailed breakdown of savings is shown in Table 3, below. A first year cash flow is depicted in Graph 2, next page, showing the 14-week payback.

Table 2: Assumptions made based on

data from extruder machine °F

Surface Area (SA) of extruder barrel 15.833 ft^2

Annual Operational Savings $2,350.86

Annual HVAC Savings $401.50

Area of Insulating Blankets 19.097 ft^2

Cost of Insulating Blankets $743.06

Operational Savings Per SqFt barrel SA $148.48

HVAC Savings Per SqFt barrel SA $25.36

SqFt Blankets Per SqFt barrel SA 1.206

Cost of Blankets Per SqFt blankets $38.91

Table 3: Projections for Insulating all 15

Extruder Barrels at Custom Molders, Inc., Henderson

Total Facility Barrel SA 255.035 ft^2

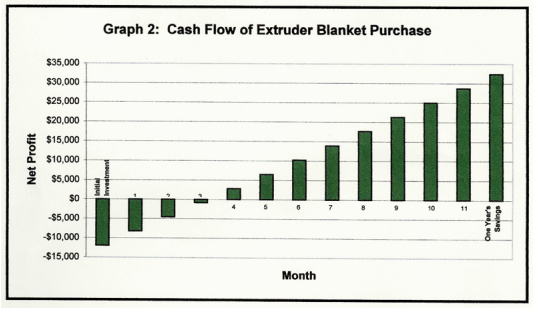
Estimated Annual Extruder Savings $37,908.55

Total Annual HVAC Savings$6,467.20

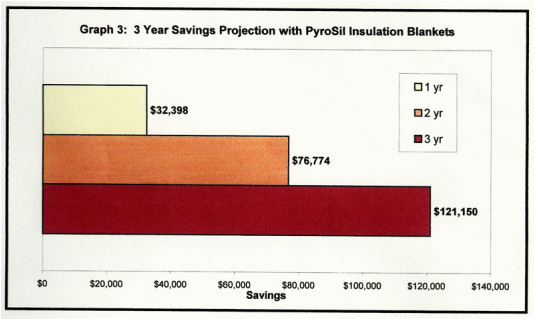
Total Annual Savings $44,375.75

Total Cost of Insulating Blankets $11,977.34

Simple Payback 14 Weeks



Looking at the investment of the PyroSil blankets over three years; the initial investment cost is 9% of the total savings after 3 years. The savings each year for the first three years is depicted below in Graph 3.



Conclusion

At current production rates, Custom Molders, Inc. should achieve a 14-week payback by insulating the extruder barrels with the blankets used in this study. This translates to a total facility reduction in energy costs of 13%. When the heat is no longer emitted from the barrels, the facility ambient temperature will be significantly more comfortable and able to be controlled effectively with the current HVAC system. With a more comfortable working environment, worker productivity and morale should increase. Also, critical machines and systems will not fatigue as often, reducing down time. Finally, as machines are maintained, personnel will be able to perform maintenance around cooler barrels. These insulation blankets have more than just economic advantages and will greatly benefit Custom Molders, Inc., Henderson facility.

Thank you for your interest in energy efficient technologies. If you have any further questions regarding other energy savings measures available through Progress Energy please contact Bob Donaldson at (919) 546-7900. For all inquiries regarding this study please feel free to contact Ewan Pritchard at (919) 857-9028 or epritcha@advancedenergy.org .