RMG
Rex Materials Group

TCS

Temperature Control Solutions

Optimizing Plastics Production

Patent Protected throughout the Americans, Europe, Asia and Australia – US Patent 6,*486,445*

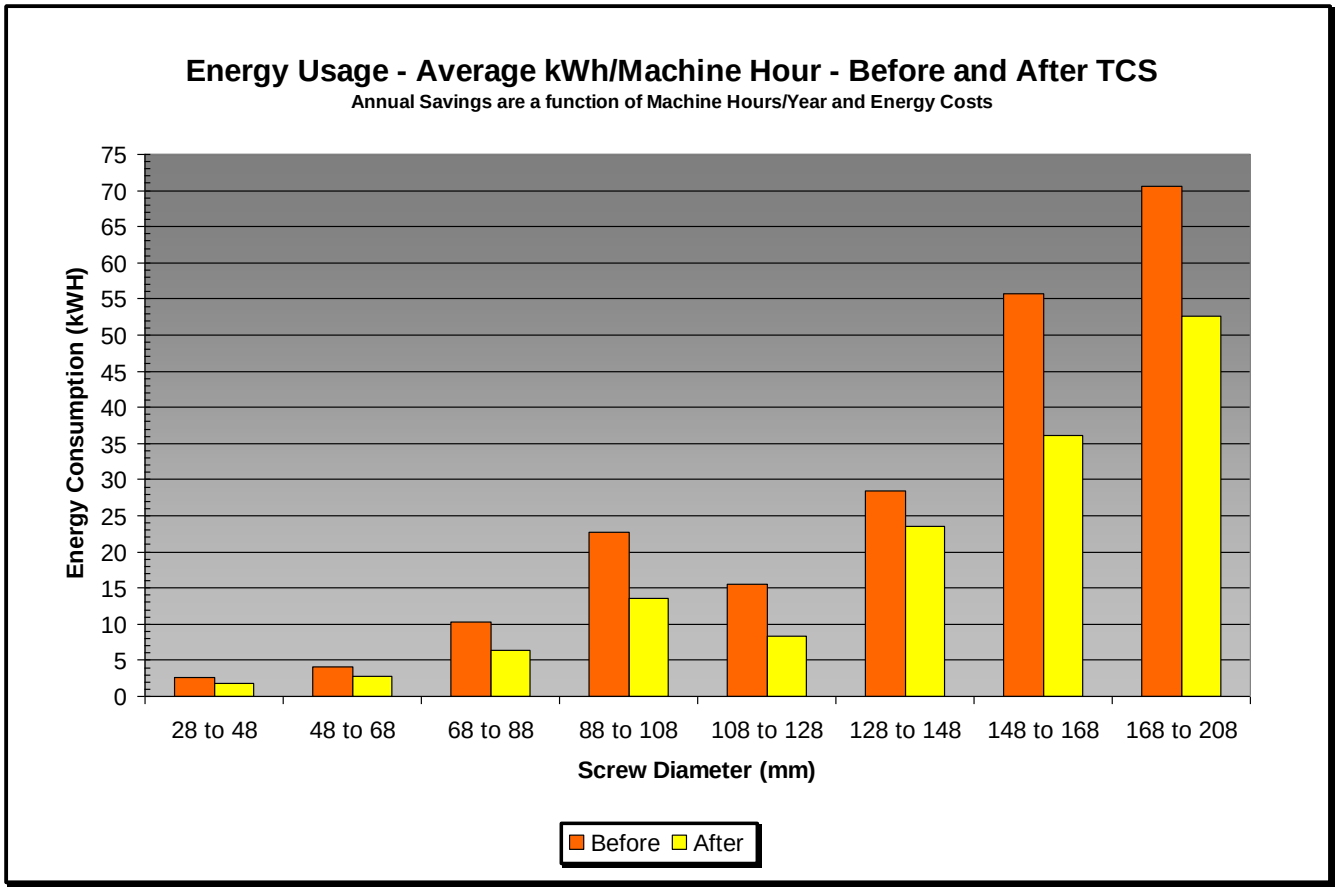
What Does it Do?

- Reduces Operating Cost by Decreasing Energy Consumption and Machine Down Time
  - Consistently Reduces Injection Molding Barrel Heating Energy use by an average of 40%
    - Energy Reduction up to 70% in some cases
  - Improves Machine Utilization with Faster Heat Up
  - Reduces Air Conditioning Load in Climate Controlled Spaces
  - Reduces Maintenance Downtime and Cost

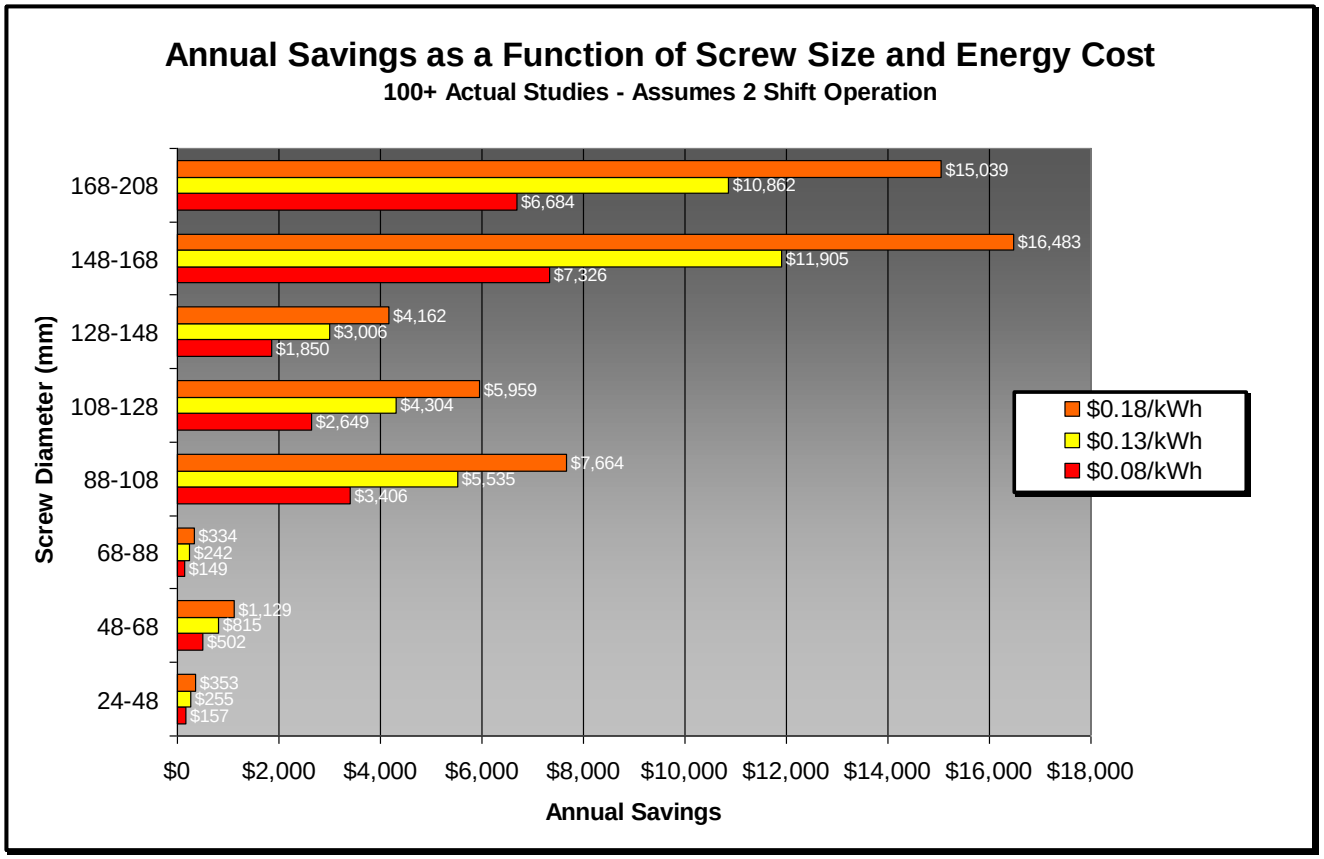
Additional Benefits

- Improves Product Consistency – Improves Quality
  - Reduces Melt Temperature Fluctuations providing a more Consistent Product
- Improves Worker Safety and Comfort
  - Removes Heat and Hot Surfaces from the Workplace
- Introduces Virtually No Operational Risk
  - Does Not Require Machine or Control System Modifications
- Introduces Virtually No Financial Risk
  - **Consistently Provides Return on Investment in less than (2) years**
    - ROI's as low as 1 Year in many Applications
    - Estimated ROI can be provided for specific machines/applications upon request

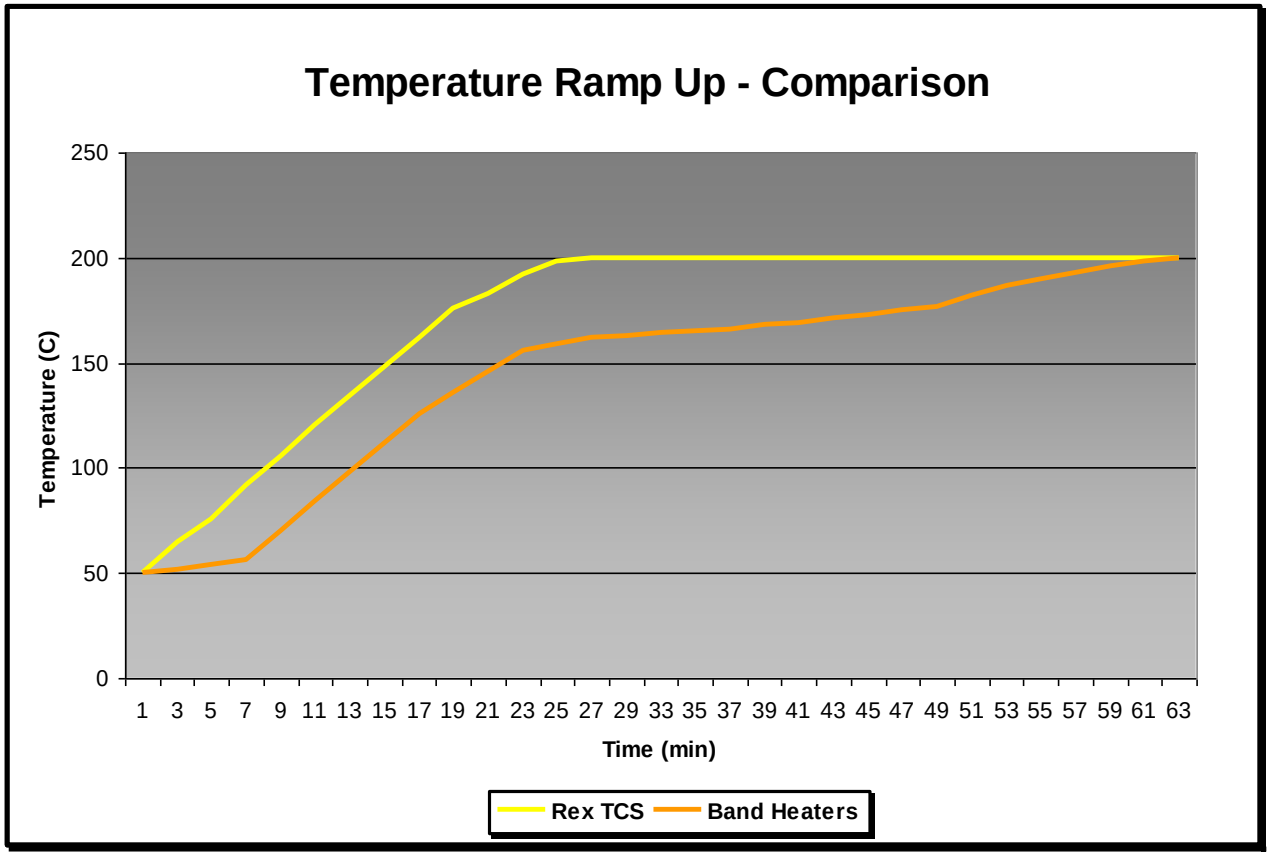
Consistently Reduces Operating Costs:
Average 40% Reduction



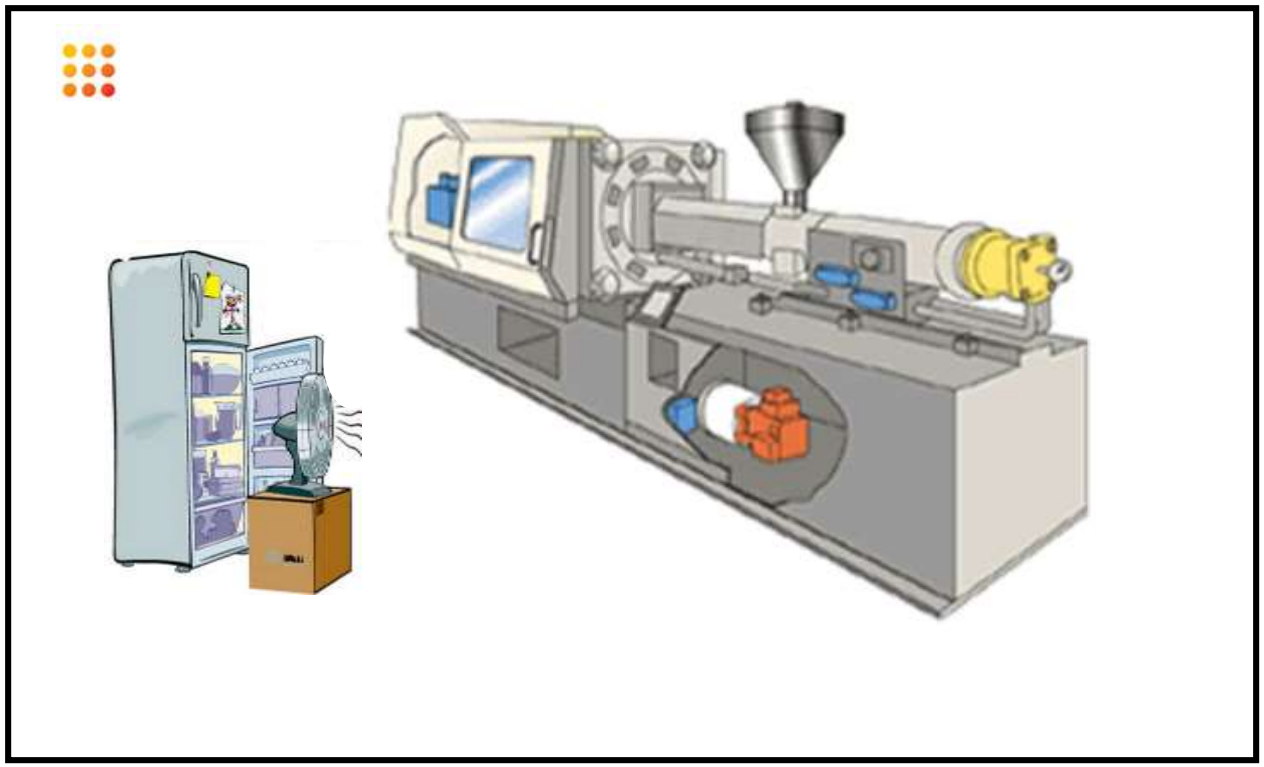
Low Financial Risk:
System Typically Pays for Itself in < 2 Years



Improves Machine Utilization:
Heats Up in Half the Time of Conventional Systems



Reduces Operating Costs:
Decreases Air Conditioning Load in Climate Controlled Spaces

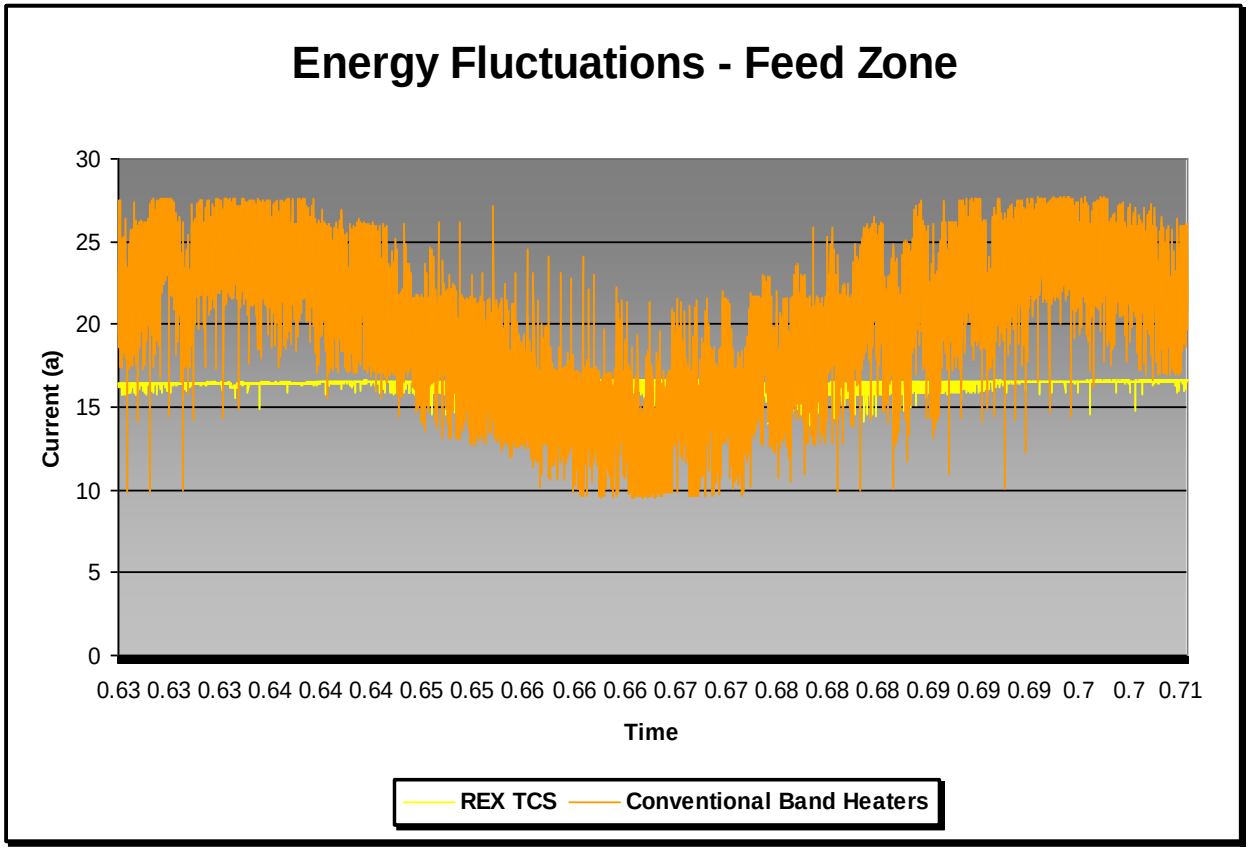


All Excess Energy
put Into the Molding process must be Removed by the AC System

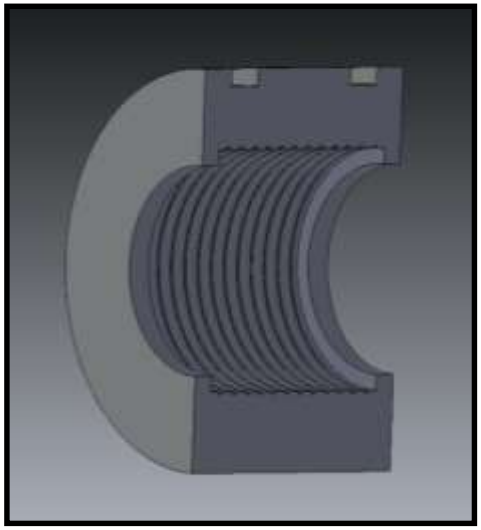
Essentially, you pay for the Energy Twice – Once to put it in and Again to Remove it.

In Non-Controlled Spaces, during summer Months, the Excess Energy creates a Less-Comfortable Work Environment for Staff

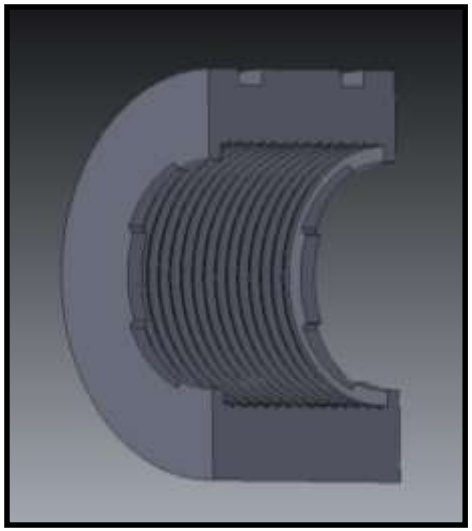
Improves Quality:
Quicker Response Time
Minimizes Temperature Fluctuation



Rapid Cool Option

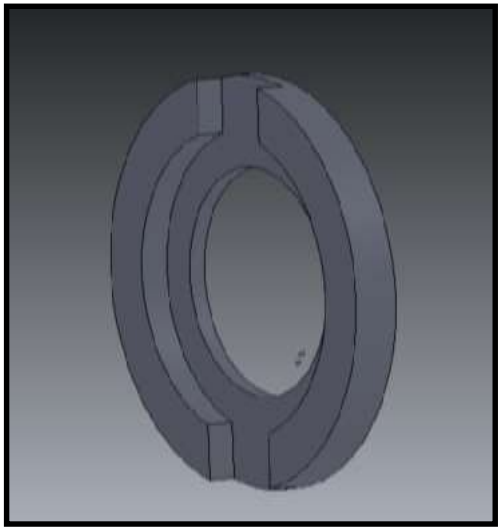


Standard Design



Channeled Design

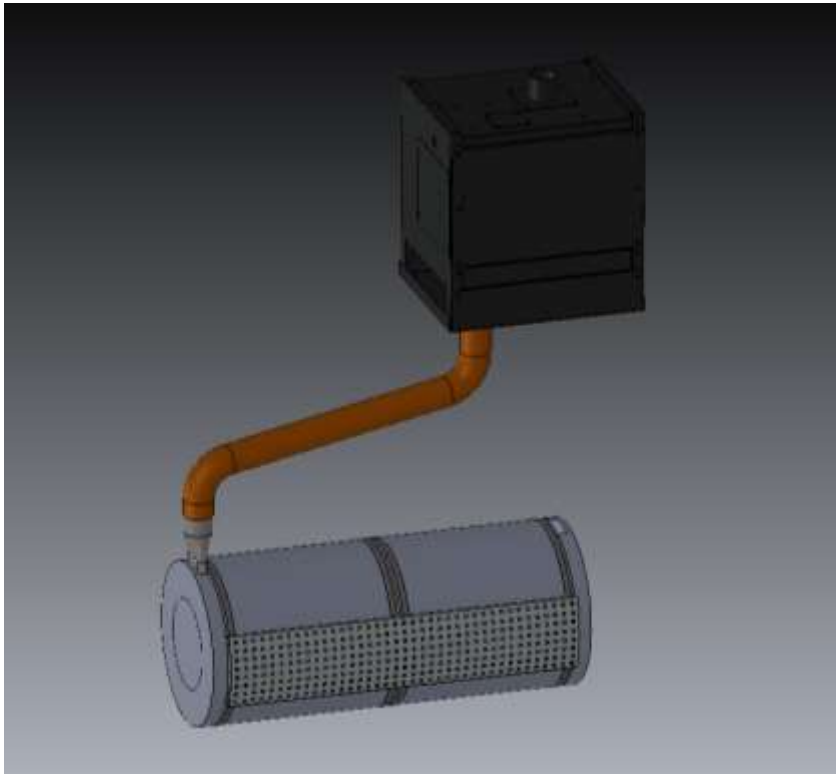
Allows Air to Flow Entire Length of TCS, Adjacent to Barrel

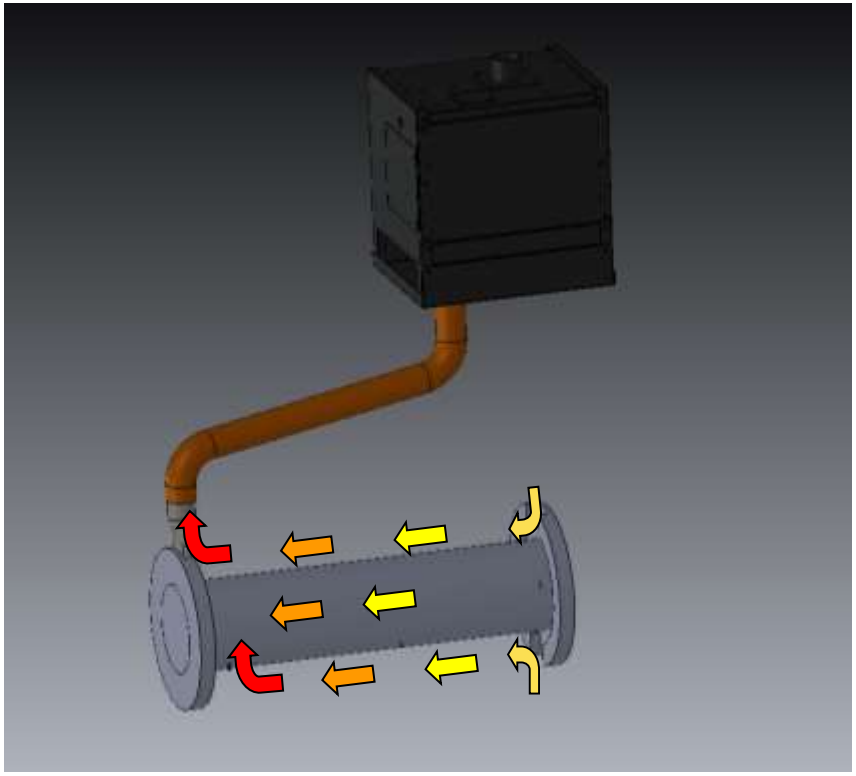


Cooling Ring

Allows Air to Flow Into and to be Pulled Out of System

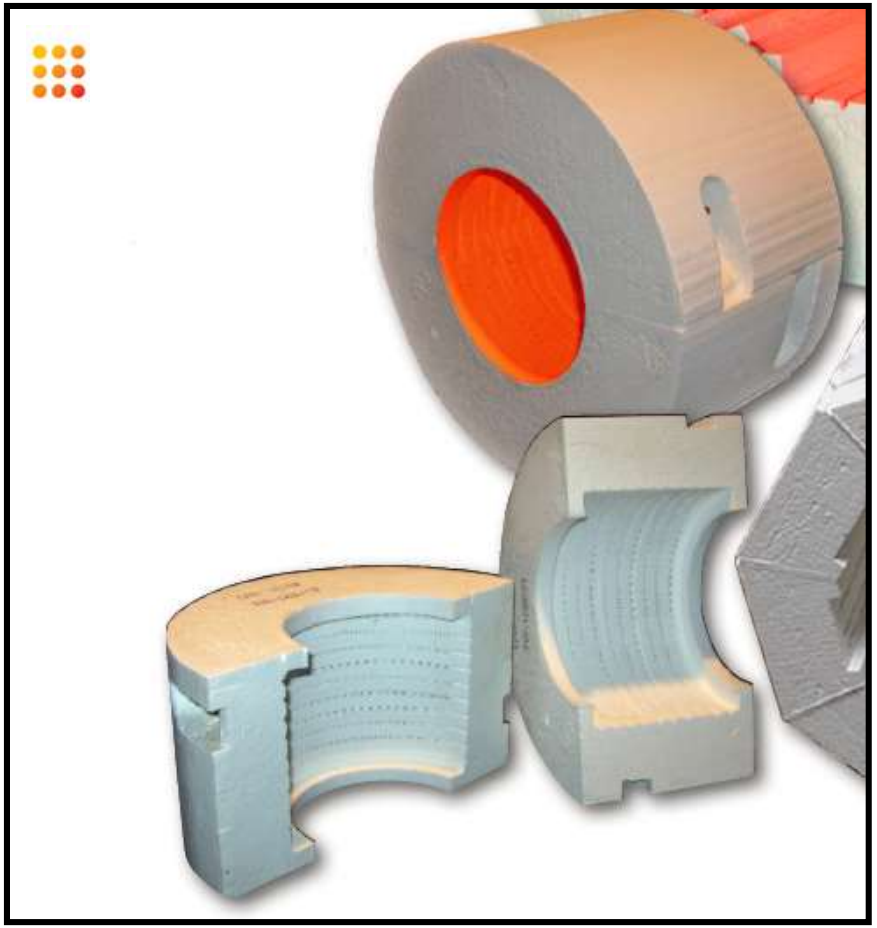
"Cooling Rings" and Channeled TCS Sections allow Air to be pulled through the system, directly over the Barrel, and exhausted as necessary, to speed cooling for Material Changes or to Remove Residual Heat upon Shut-Down





Improves Workplace Safety

Exterior is "Touch Temperature"

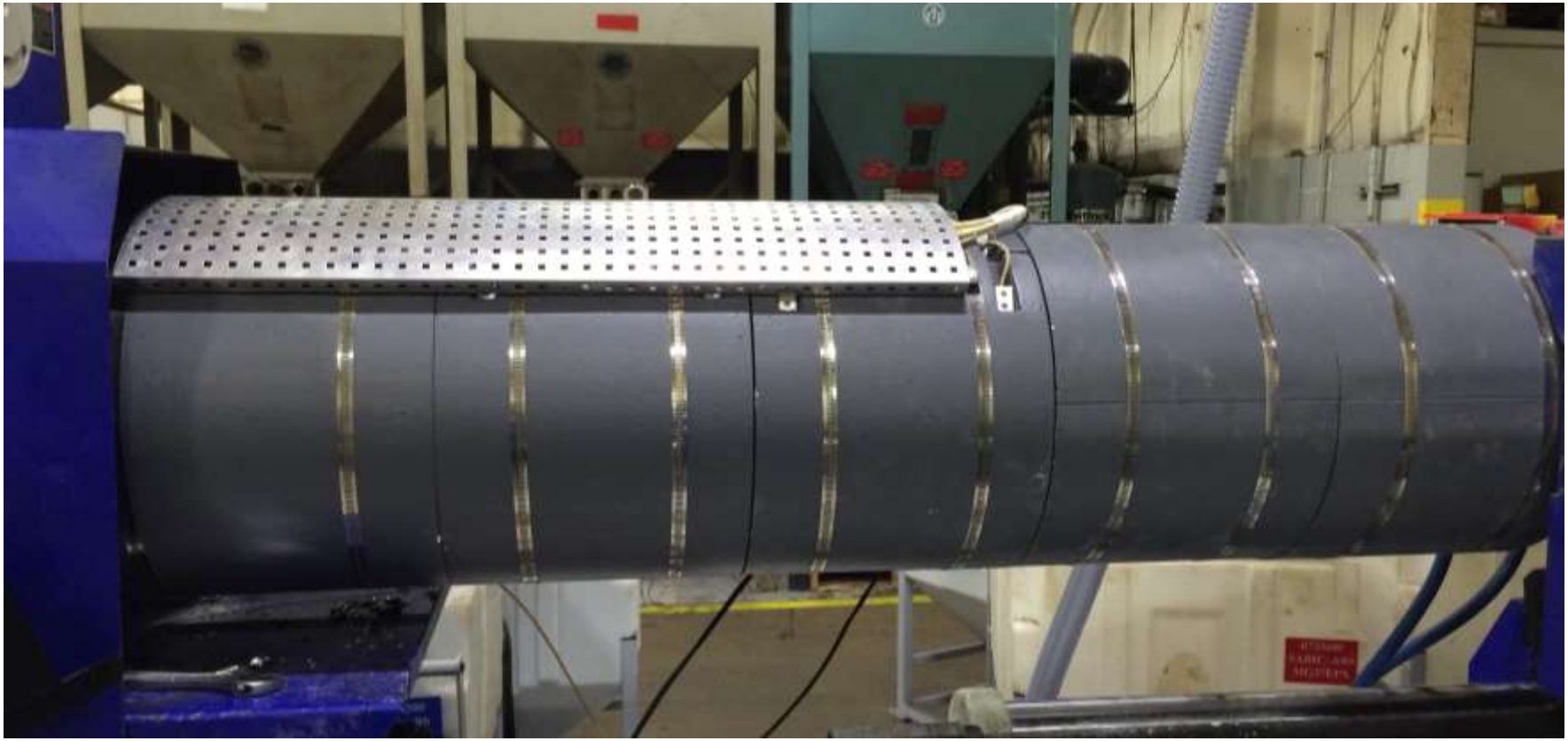


Introduces Very Little Risk

- TCS Employs Existing Controls
  - No Controller Changes
    - SSR's, Fuses, Contacts
  - Existing Wiring is Typically Employed
- Easy Installation
  - Few Resources Required for Installation /Training
- Easily Removed for Barrel Maintenance
- Low Cost
  - ROI typically < 2 Years

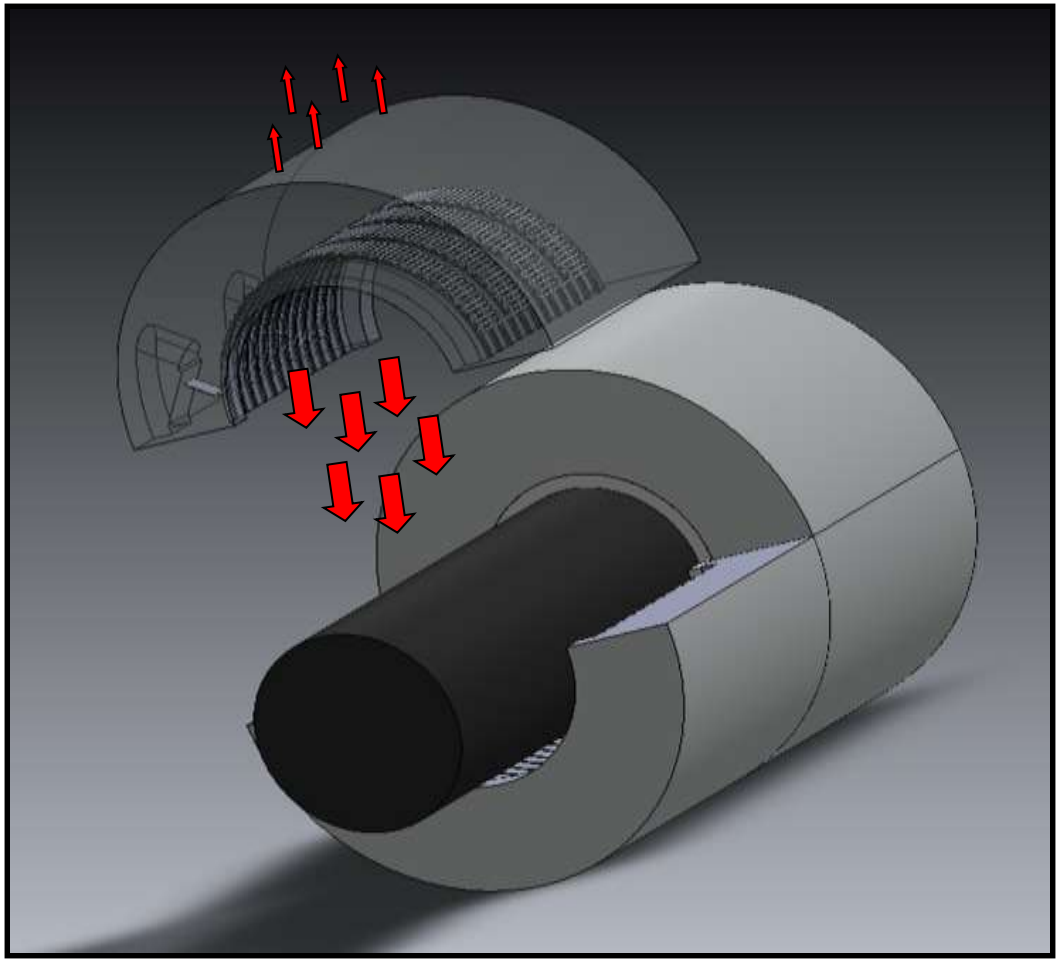
Multiple Benefits – No Risk

- Reduced Energy Consumption
- Improves Product Consistency/Quality
- Improves Machine Utilization
- Improves Worker Safety and Comfort
- No Operational Risk
- No Financial Risk



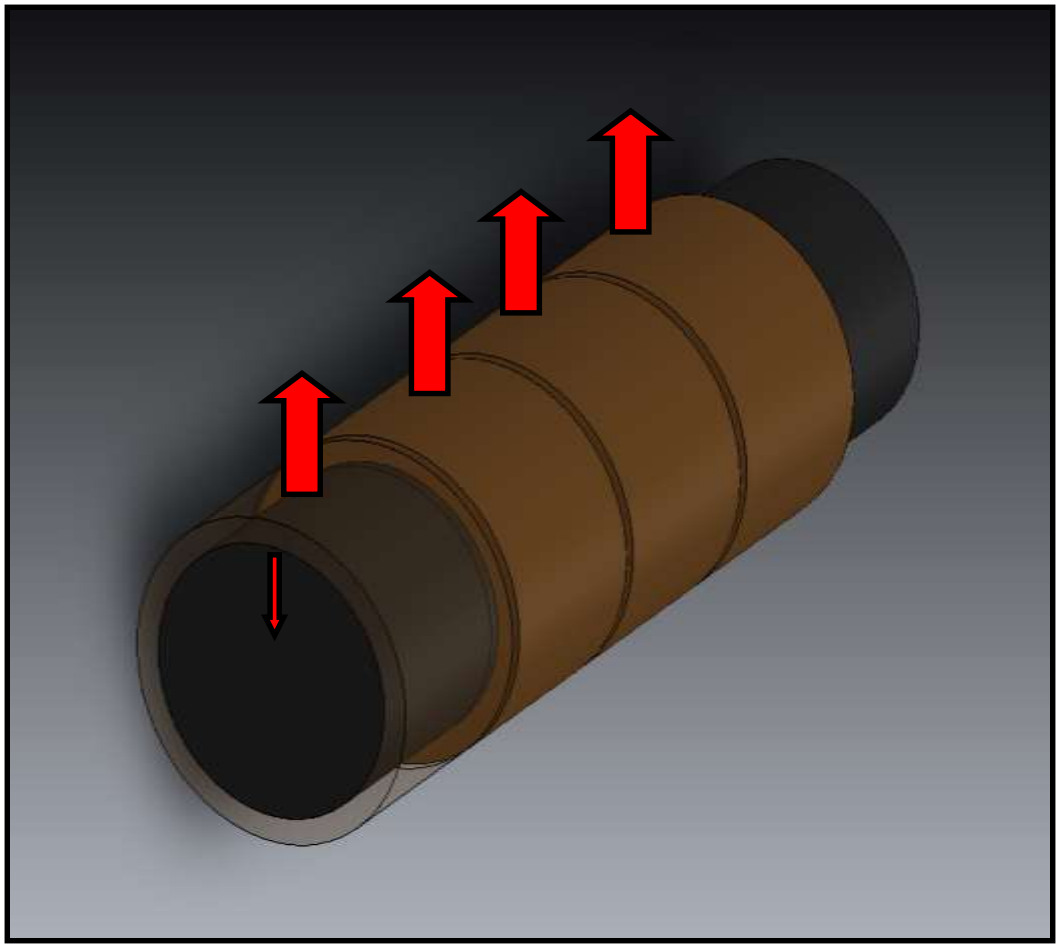
How Does it Work?

- Heat, like Electricity or Water, always takes the path of Least Resistance
- TCS Radiant Heaters directs heat into the Barrel, and Hence into the Melt, rather than to the Surrounding Environment
- This is because the thermal resistance of TCS is greater than that of the Barrel and Melt



The Thermal Resistance of TCS, to the Exterior (Surrounding Air), is much Higher (>300%) than the Thermal Resistance of the Melt

As such, the majority of the Heat Energy from TCS (>80%) will be directed into the Melt rather than into the Surrounding Air



Alternatively, the Thermal Resistance of the Melt is Much Greater Than that of the Surrounding Air on Systems employing Band Heaters

As such, the majority of Heat Energy generated by Heater Bands will be directed to the Surrounding Air, rather than to the Melt

A key factor in determining the direction of heat flow is the Temperature differential between two objects.

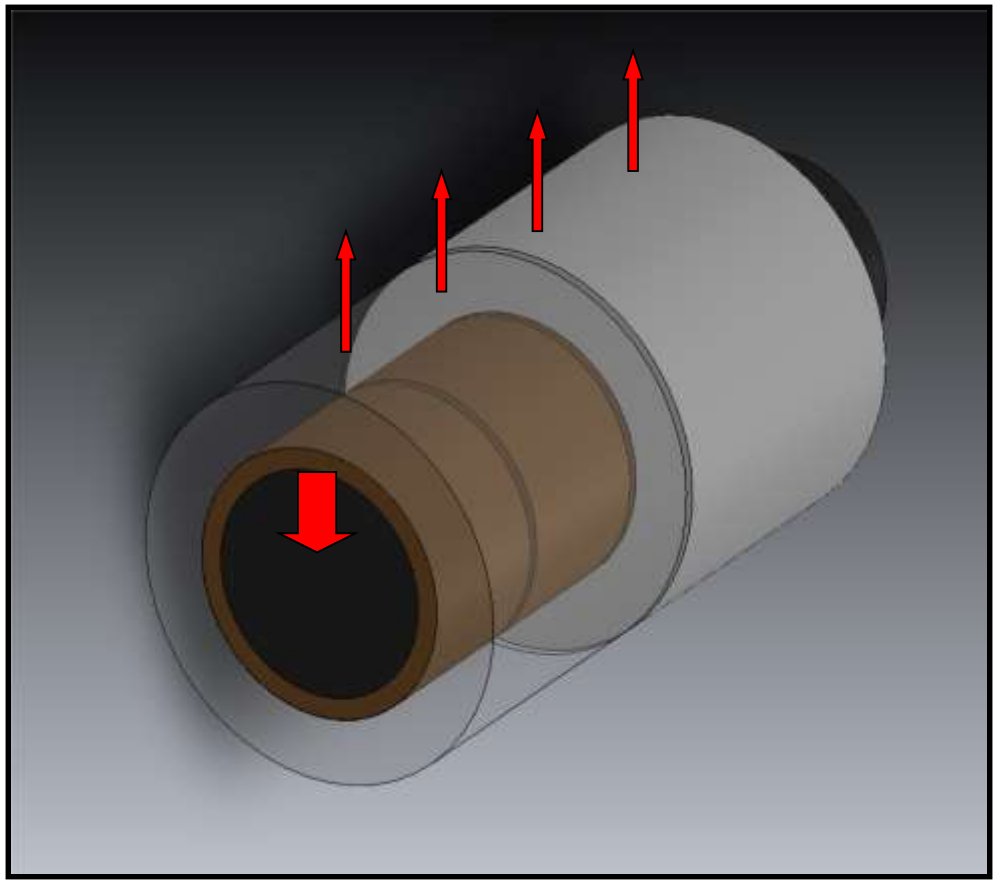
The temperature difference between the heater band and the surrounding air is much greater than between the heater band and the barrel, thus energy to the driven to the surrounding air rather than to the Melt.

TCS Delivers 250% more Heat to the Melt and 75% less Heat to Surrounding Air than Traditional Band Heaters

- TCS
  - Heat Flow to Melt: 1376 BTU/ft-ft-hr
  - Heat Flow to Surround Environment: 349 BTU/ft-ft-hr
- Traditional Band Heaters
  - Heat Flow to Melt: 454 BTU/ft-ft-hr
  - Heat Flow to Surrounding Environment: 1402 BTU/ft-ft-hr

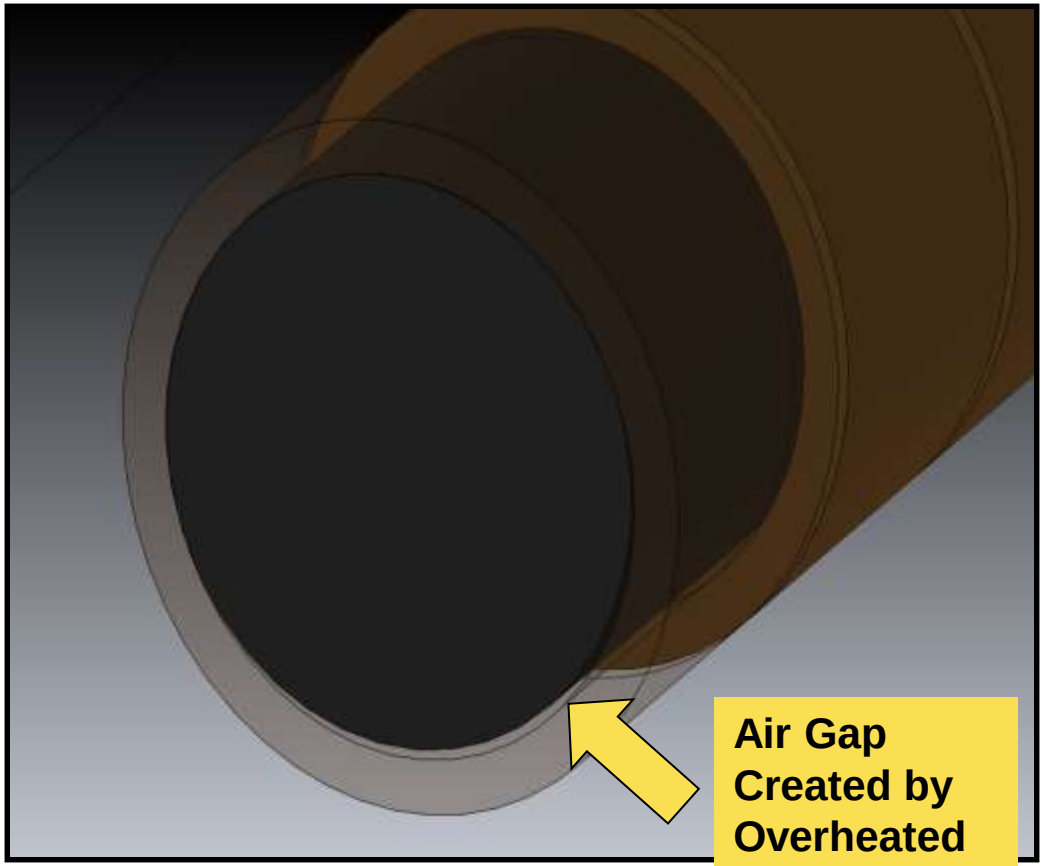
Analytical Report with full assumptions available upon request

Heat Flow Calculations completed on Planar Surface with Single Direction Heat Flow



Placing Blankets over Traditional Band Heaters is beneficial, however the higher thermal conductivity of these blankets, and the Band Heater's reliance on conduction heat transfer, reduces the benefit, compared to TCS

Additionally, Blankets cause Heaters to run hotter than usual, creating a higher probability of premature Heater Failure



Additionally, as the temperature of the heater bands rise, thermal expansion of the metal causes them to lose contact with the barrel and create an air gap between the barrel and the heater

A small gap (0.0625”) can double the thermal resistance to the melt, further driving Heat Energy to the Surrounding Air, reducing the potential energy saving benefits of the Blankets and causing premature Heater Failure

Implementation

- Document Current System using Template Provided:
  - Barrel Length and Diameter
  - Thermocouple Locations
  - Number of Zones
  - Number of Band Heaters
  - Voltage/Power of Band Heaters
  - Structural Interference

TCS Quote Request - Injection Molding Machines - Remit to TCS_Technical_Service@rexmaterials.com

Machine Information

Manufacturer:_____

Machine Model:_____

Barrel Diameter (mm):_____

Barrel Length (mm):_____

Supply Voltage:_____

Cooling Required:_____

Return on Investment

Energy Costs ($/kWhr): _____

NOTE: Energy Cost Should include Taxes, Transmission Costs and Riders)

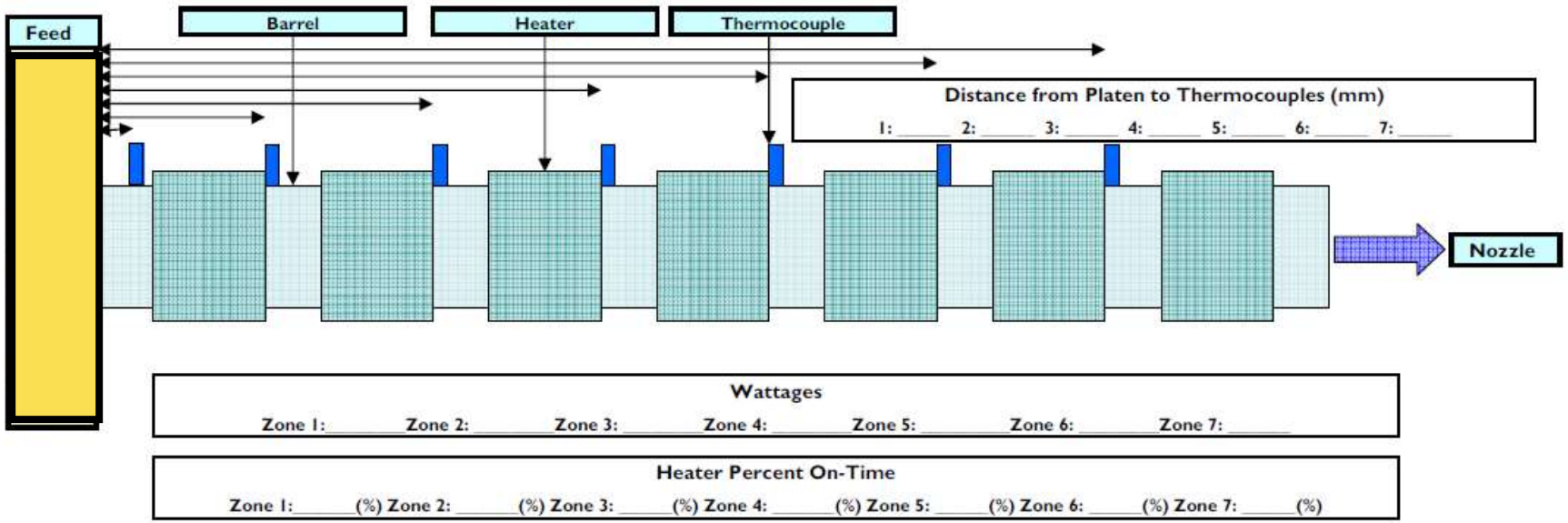
Hours of Operation per Week:_____

Is Machine in Air Conditioned Space?_____

If Yes, Months per Year AC employed?_____

Place Business Card Here and Populate all White Boxes with Data

Detailed Barrel Drawing, with Machine Interference, is Required Prior to Final Design. Information Below is for Quoting Purpose – Form Assumes (7) Zones – Denote Appropriate Number of Zones on Sketch



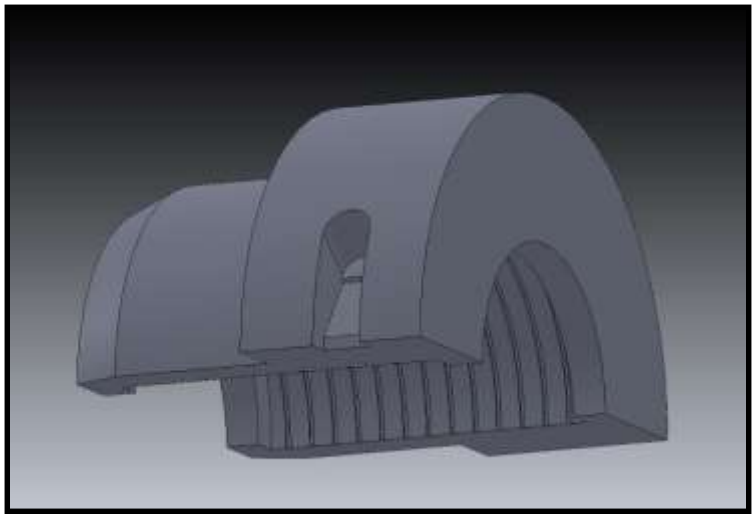
NOTE: Barrel Supports & Any Interference Within 83mm of Barrel Must be Added to Above Sketch; Dimensions (widths) of Barrel Supports and other Interference are Required

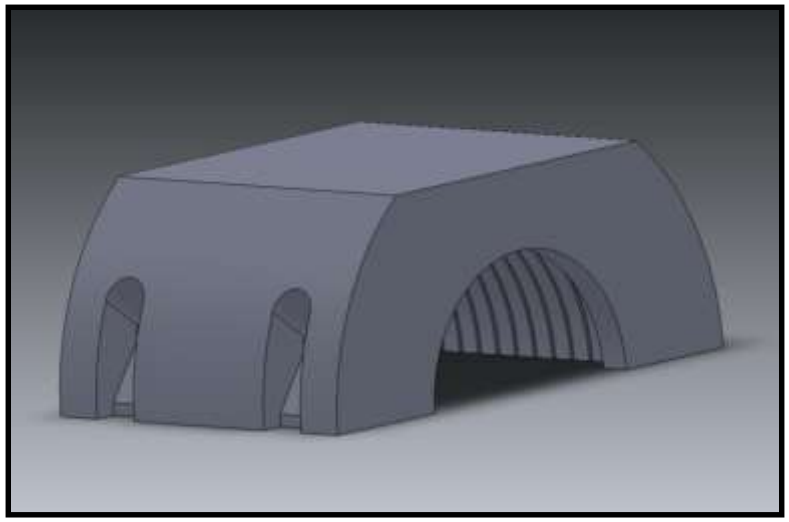
Design TCS System

- TCS Team will Engineer Machine-Specific System
  - Heating Elements designed to match Voltage and provide 80% Power (Wattage)
    - TCS Requires less power to achieve desired processing results due to its energy efficiency over standard band heaters
  - Geometrically Fit the Application while minimize the number of TCS Sections
    - Provides a Simple, Cost-Effective Design
      - Typically 1 TCS Section will replace multiple Band Heaters
    - Custom Beveled or Reduced OD Parts available
- TCS Design includes support hardware such as jumper wires, cable trays and retaining rings
  - Does not include Thermo-couple extensions

Custom Geometries are Available

Reduced Diameter - Beveled

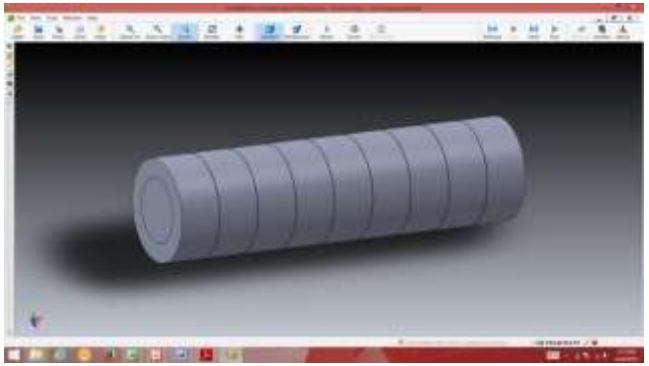


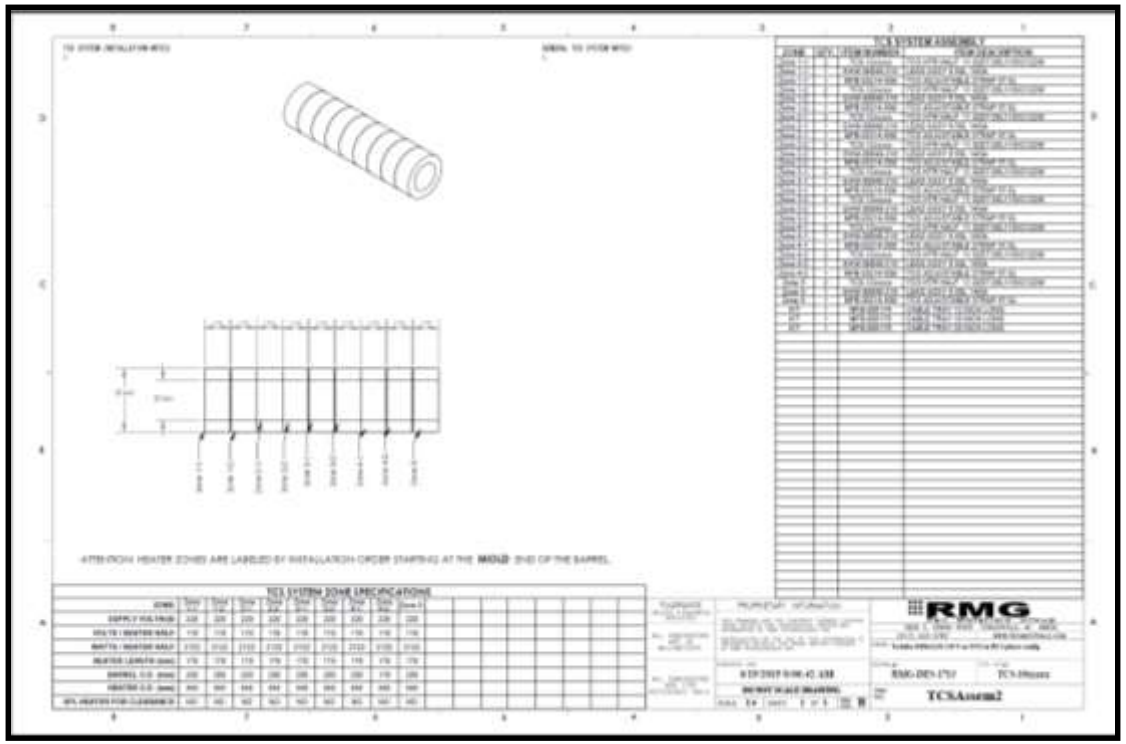


- TCS can be machined to approximately half the standard thickness to address fit challenges
- Thermal efficiency is greatly reduced with reduced diameter parts

Design Input

Automatically Generates Kit Installation Drawing, BOM and Heater Specifications





Return on Investment

- Considers (4) Factors:
  - Reduced Energy Consumption by Barrel Heating Elements
  - Reduced Air Conditioning Load (in Climate Controlled Spaces)
  - Improved Machine Utilization due to Rapid Heat Up and Cool Down
  - Reduced Maintenance Cost (Time and Parts)
- Input includes:
  - Band Heater Power Rating
  - Heater Band On-Time Percentage
  - Electricity Cost
  - Hours of Operations
  - Heat Up/Cool Down Occasions/Year and Duration (hrs)
- **Government Incentives can Improve ROI**
  - http://energy.gov/eere/femp/energy-incentive-programs

Return on Investment Calculation

Populate Light Blue Cells

TCS - Return on Investment

RMG Rex Materials Group

Energy Savings and Machine Run Time

Light blue boxes must be populated for calculation

Customer Name:

Location:

Machine Manufacturer:

Machine Size:

Approximate Barrel Size - Diameter/Length:

Material Type:

Product Type (Packaging, Medical, etc.):

Machine Serial Number:

Quote Number and/or TCS Primary Point of Contact:

TCS System Cost ($)	Power Company Incentives ($)
$ 4,250.00	$ 250.00

Total Annual Saving (%)	Return on Investment (yrs)
$ 3,800.35	1.05

General Facility/Machine Parameters

Energy Cost per kW-Hr ($)	Machine Charge-Out Rate ($/hr)	Hours per day	Days per week	Weeks per year	Approximate Cost - Heater Bands ($)
$ 0.12	$ 65.00	10	7	48	$ 1,320.00

Note: Electricity Cost must include taxes, riders and transmission costs in addition to base rate

Note: Cost of Heater Bands is provided as a reference point and is not employed in ROI Calculation

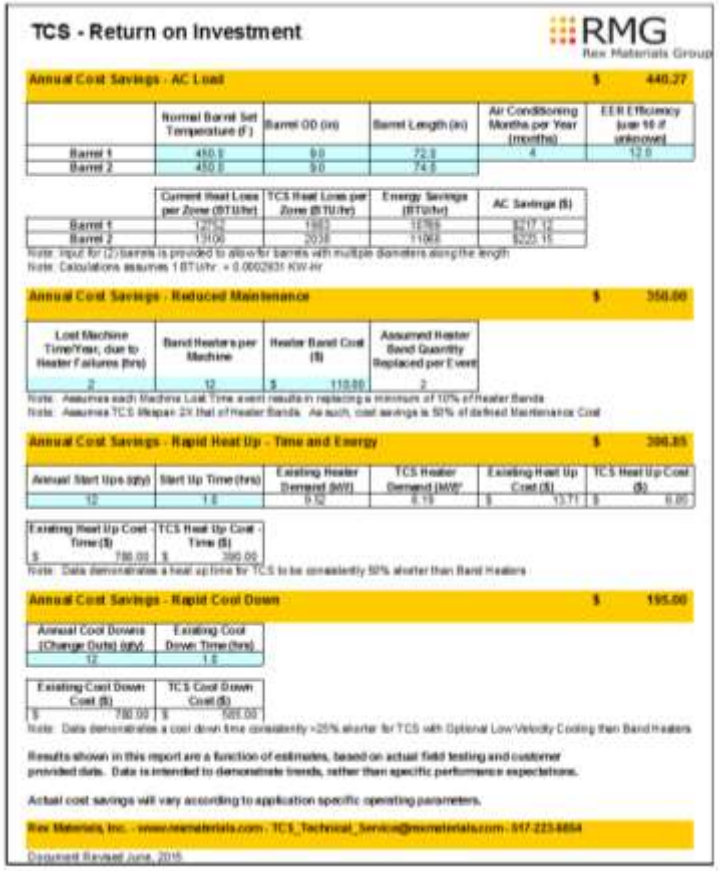
Note: Cost of Heater Bands is calculated from data provided below

Annual Cost Savings - Barrel Heater Energy Consumption $ 2,418.23

	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5
Heater Power (kW)	6.0	6.0	6.0	6.0	0
On Time (%)	70%	45%	30%	25%	0%
Avg. Power (KW-hr)	3.4	2.7	2.0	1.4	0.0

	Zone 6	Zone 7	Zone 8	Zone 9	Total
Heater Power (kW)	0	0	0	0	
On Time (%)	0%	0%	0%	0%	
Avg. Power (KW-hr)	0.0	0.0	0.0	0.0	9.52

Estimated % Savings with TCS	Total Power Consumption - Band Heaters (KW-hr)	Total Power Consumption - TCS (kW-hr)	Power Reduction (kW-hr)
35%	9.52	6.19	3.33



TCS - Return on Investment

RMG Rex Materials Group

Annual Cost Savings - AC Load $ 440.27

	Normal Barrel Set Temperature (F)	Barrel OD (in)	Barrel Length (in)	Air Conditioning Months per Year (months)	EER Efficiency (use 10 if unknown)
Barrel 1	450.0	9.0	72.0	4	12.0
Barrel 2	450.0	9.0	74.5		

	Current Heat Loss per Zone (BTU/hr)	TCS Heat Loss per Zone (BTU/hr)	Energy Savings (BTU/hr)	AC Savings ($)
Barrel 1	12754	1963	10789	$ 317.12
Barrel 2	13106	2038	11068	$ 325.15

Note: Input for (2) barrels is provided to allow for barrels with multiple diameters along the length

Note: Calculations assumes 1 BTU/hr. = 0.0002931 KW-Hr

Annual Cost Savings - Reduced Maintenance $ 350.00

Lost Machine Time/Year, due to Heater Failures (hrs)	Band Heaters per Machine	Heater Band Cost ($)	Assumed Heater Band Quantity Replaced per Event
2	12	$ 110.00	2

Note: Assumes each Machine Lost Time event results in replacing a minimum of 10% of Heater Bands

Note: Assumes TCS lifespan 2X that of Heater Bands. As such, cost savings is 50% of defined Maintenance Cost

Annual Cost Savings - Rapid Heat Up - Time and Energy $ 300.85

Annual Start Ups (qty)	Start Up Time (hrs)	Existing Heater Demand (kW)	TCS Heater Demand (kW)*	Existing Heat Up Cost ($)	TCS Heat Up Cost ($)
12	1.0	9.52	6.19	$ 13.71	$ 8.91

Existing Heat Up Cost - Time ($)	TCS Heat Up Cost - Time ($)
$ 780.00	$ 390.00

Note: Data demonstrates a heat up time for TCS to be consistently 50% shorter than Band Heaters

Annual Cost Savings - Rapid Cool Down $ 195.00

Annual Cool Downs (Change Outs) (qty)	Existing Cool Down Time (hrs)
12	1.0

Existing Cool Down Cost ($)	TCS Cool Down Cost ($)
$ 780.00	$ 585.00

Note: Data demonstrates a cool down time consistently >25% shorter for TCS with Optional Low Velocity Cooling than Band Heaters

Results shown in this report are a function of estimates, based on actual field testing and customer provided data. Data is intended to demonstrate trends, rather than specific performance expectations.

Actual cost savings will vary according to application specific operating parameters.

Rex Materials, Inc. - www.rexmaterials.com - TCS_Technical_Service@rexmaterials.com - 847-223-5854

Document Revised June, 2015

NFPA 79 – Electrical Standard for Industrial Machinery "Finger Test"

- Per section 6.2.3 - Direct Contact from Outside an Enclosure
  - *In the absence of a rated enclosure, the determination of suitability of an enclosure as protection from electrical shock shall be determined by using a test finger as described in Figure 6.2.3. The test finger shall be applied, with only minimal force, in every opening in the enclosure after removal of all parts of the enclosure that are capable of being removed without the use of a tool. The test finger shall not encounter live parts in any direction.*
- TCS Terminal design allows installed system to conform to this requirement
- **Proper installation is required**

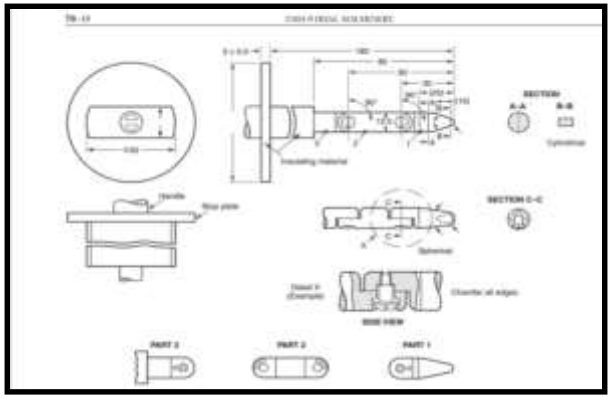


Figure 6.2.3

CE Certified

- TCS is aligned and certified to the CE Low Voltage Directive
  - Defines the Essential Requirements for Parts of this Nature, in this Application
- (3) Harmonizing Specification were determined to be Applicable:
  - IEC 60519-1, Safety in Electroheat Installations Part 1
  - IEC 60519-1, Safety in Electroheat Installations Part 2
  - ISO 13732-1, Ergonomics of the Thermal Environment Methods for the Assessment of Human Responses to Contact with Surfaces Part 1
- RMG employed Third Party testing (Intertek Testing Services) to Certify TCS, though Self Certification is acceptable for Low Risk parts of this nature
- Certification or Full Report is Available Upon Request

Machines Fitted with TCS

Summary

- TCS Offers Immediate Operating Cost Reductions with Very Low Risk
- Secondary Benefits Include:
  - Improved Consistency/Quality
  - Reduced Maintenance
  - Better Working Environment (Safety and Temperature) for Staff