Energy Efficient Injection Molding Operation

Babu Joseph
Edison

Vishu Shah
Consultek

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INJECTION MOLDING MACHINE EFFICIENCIES

By

Babu Joseph
Southern California Edison Company
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Machine Types

- HYDRAULIC MACHINES
  - FIXED VOLUME PUMPS
  - VARIABLE VOLUME PUMPS
  - VARIABLE SPEED PUMPS
- SEMIHYDRAULIC MACHINES
  - HYBRID MACHINES
  - PARTIAL ELECTRICS
- ALL ELECTRIC MACHINES

Energy Efficiency

- EFFICIENCY - KWH / KG OF POLYSTYRENE
- 1 KWH / KG = 45.4 KWH / 100 POUNDS

HYDRAULIC

	FIXED	V.V / V.S
KWH / KG	0.82 TO 1.25	0.45 TO 0.65

SEMIHYDRAULIC

	HYBRIDS / PARTIAL ELECTRICS
KWH / KG	0.4 TO 0.6

ALL ELECTRICS 0.2 KWH / KG

Machine Size and Production Rate

- **EFFICIENCY IMPROVES AS PRODUCTION RATE IMPROVES**

550 TON MACHINE: *(Milacron Data)*

Prod. Rate (POUNDS/HR)	HYDRAULIC	ALL ELE.
100	38 KWH/100 LBS 0.84 KWH/KG	16 KWH/100 LBS 0.35 KWH/KG
500	24 KWH/100 LBS 0.22 KWH/KG	10 KWH/100 LBS 0.53 KWH/KG

CONTROLLED STUDIES BY SCE

390 TON		240 TON	
HYD	**ALL ELE**	**HYD**	**ALL ELE**
39.6 KW	11.9 KW	18.7 KW	4.7 KW
465 GR/SH	465 GR/SH	173 GR/SH	173 GR/SH
105 LBS/HR	130 LBS/HR	50 LBS/HR	44 LBS/HR
0.83 KWH/KG	**0.199 KWH/KG**	**0.929 KWH/KG**	**0.21 KWH/KG**

KWH/KG

Preliminary Injection Molder Monitoring Results

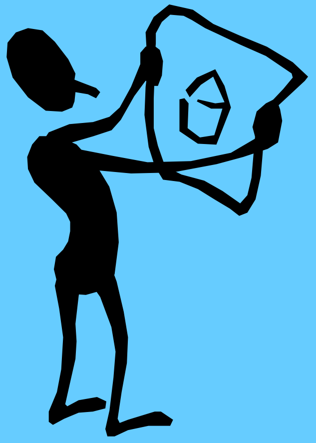
Machine	Type	SP Usage	Shot Wt (g)	Cycle Usage (Wh)	Cycle Time (Sec)	Capacity tons.	KW.	KWH/KG.
CB390	V V	0.63	660.5	416.3	42.56	390	35.21	0.63
CB500	V V	0.444	1658	736	55.86	500	47.43	0.444
F101	Std	1.22	56.7	68.32	11.0	170		
F102	Std	1.22	53.9	65.85	12.4	170		
F103	Std	0.97	79.4	77.31	12.9	200		
F114	V V	0.55	204.1	99.1	8.8			
F210	V V	0.51	187.1	95.46	15.5	350		
oil. ISG. 390 ME-1	Std ✓ fixed	0.83	465	385.10	35.0	390		
AE. 390 ME-2	AE	0.199	465	92.48	28.0	390		
Std. 220 NIM-1	Std fixed	0.929	173	161.2	31	220		
AE. 240 NIM-2	AE	0.21	173	141.4	27.2	240		
SP1	Std	0.91	25.0	22.8	22.6			
SP3	Std	1.04	52.0	54.3	37.2			
SP4	AE	39.54	3.0	119.8	125.0			
SP8	Std	1.72	9.0	15.4	15.7			
F301	Std	1.58	55.0	87.1	12.9			
F302	Std	1.60	47.0	75.2	12.9			
F312	Std	1.47	59.4	87.1	12.9			

All Electric Molding Machines

- Technology developed in early 1980 in Japan
- Introduced in USA by Milacron in 1985 at NPE
- Initially available in 50 to 150 tons sizes only
- Today up to 2000 ton all-electric machines available
- Term All-Electric implies use of servomotors on both clamp and injection end
- 10 to 20% higher in cost
- Over 30 machine manufacturers offer all-electric machines
- **#1 advantage…..Energy Savings**

All Electric Molding Machines

- Energy savings form 25% to 60%
- Repeatability, Accuracy, Consistency
- No hydraulic oil...clean
- No cooling water cost
- Quiet
- Low maintenance

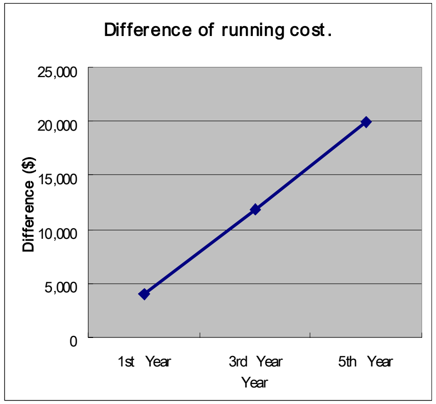


- Higher cost
- Torque related issues....Long Hold times...PVC
- Unscrewing molds?
- Core Pulls?

Energy Savings
5 yr extrapolation

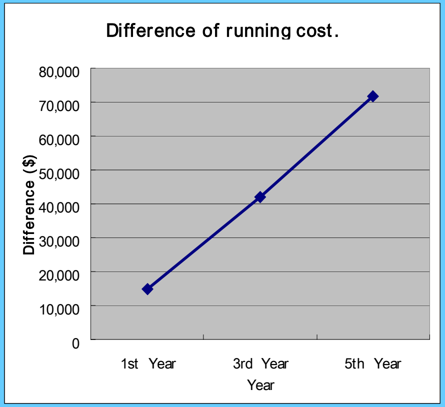
Comparison of Running Costs EC65 vs F60

MODEL	EC65	vs		
Molding Condition	Parts Connector	Weight(g) 17	Resin PBT	Cycle(s) 27
Electricity	Use kwh	Electricity Cost 1st Year	3rd Year	5th Year
Hyd.	6.0	4,303	12,908	21,514
All-Electric	1.4	1,004	3,012	5,020
Difference in Cost		3,299	9,896	16,494
Oil	Use gal	Oil Cost ($) 1st Year	3rd Year	5th Year
Hyd.	34	84	0	169
All-Electric	0	0	0	0
Difference in Cost		84	0	169
Oil Cooling Water	Use ton/day	Water cost ($) 1st Year	3rd Year	5th Year
Hyd.	36	648	1,944	3,240
All-Electric	0	0	0	0
Difference in Cost		648	1,944	3,240
Comparison		Total Difference in Cost($) 1st Year	3rd Year	5th Year
		4,031	11,840	19,902
Condition of	Running Time	Hours 24	Day 30	Month 12
	Oil	2.45	$/Gal	
	Water	0.05	$/Ton	
	Electricity	0.083	$/Kwh	



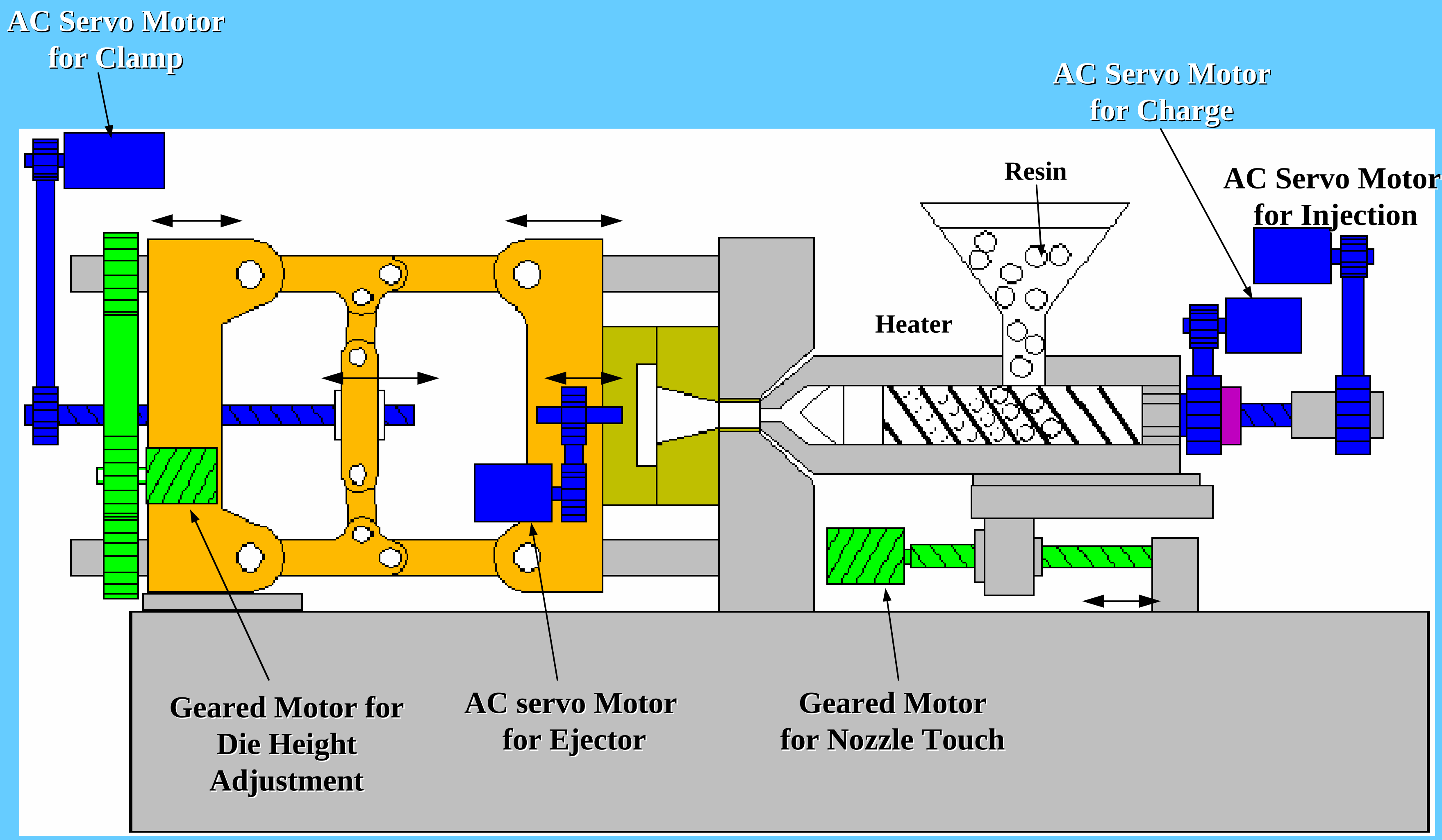
TOSHIBA MACHINE

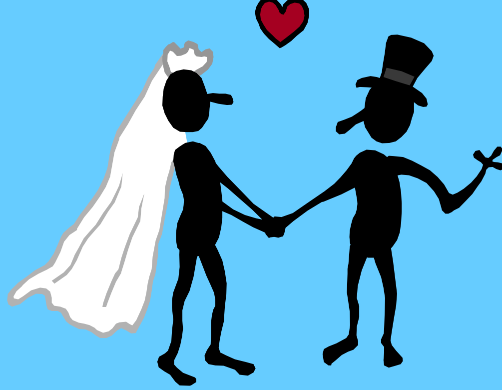
MODEL	EC390	vs	Hyd.390	
Molding Condition	Parts PC Cover	Weight(g) 232	Resin PC/ABS	Cycle(s) 51
Electricity	Use kwh	Electricity Cost 1st Year	3rd Year	5th Year
Hyd.	23.7	16,996	50,987	84,979
All-Electric	5.2	3,729	11,187	18,645
Difference in Cost		13,267	39,800	66,334
Oil	Use gal	Oil Cost ($) 1st Year	3rd Year	5th Year
Hyd.	317	778	0	1,556
All-Electric	0	0	0	0
Difference in Cost		778	0	1,556
Oil Cooling Water	Use ton/day	Water cost ($) 1st Year	3rd Year	5th Year
Hyd.	43	774	2,322	3,870
All-Electric	0	0	0	0
Difference in Cost		774	2,322	3,870
Comparison		Total Difference in Cost($) 1st Year	3rd Year	5th Year
		14,818	42,122	71,759
Condition of Simul	Running Time	Hours 24	Day 30	Month 12
	Oil	2.45	$/Gal	
	Water	0.05	$/Ton	
	Electricity	0.083	$/Kwh	



TOSHIBA MACHINE

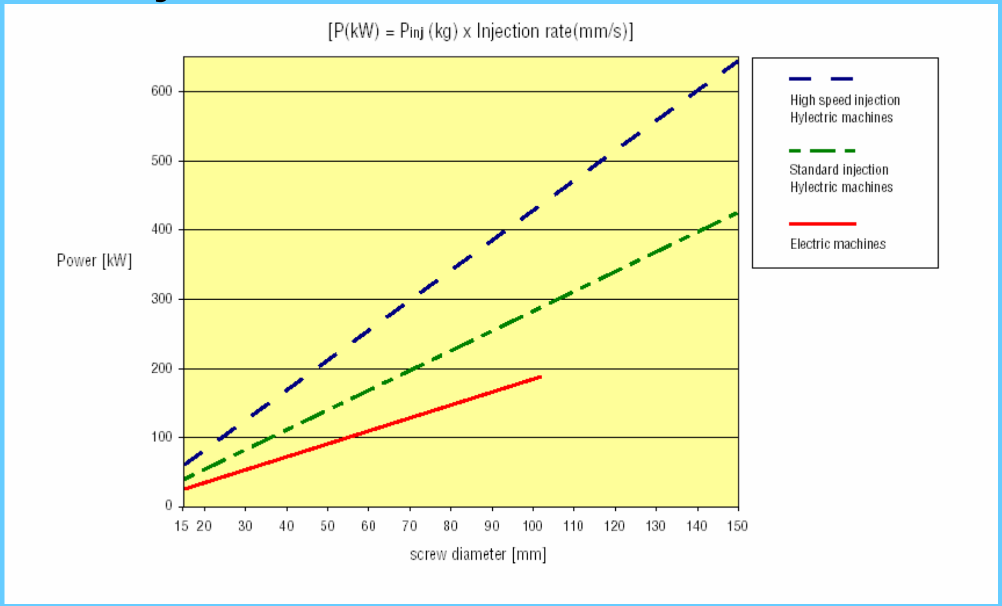
Basic Design of EC Machine





Hybrid Molding Machines

- Electric motor to drive the screw..hydraulic on clamp end
- Faster cycles (Clamp open and close speed)
- Faster Injection for thin walled parts
- Less power consumption than Hydraulic machines



Hylectric

Suppliers of electric and hybrid injection molding machines

Company	Electric	Hybrid
Arburg (860) 667-6500		x
Battenfeld (401) 823-0700	x	x
Demag Ergotech (440) 876-6455		x
Dima (562) 408-6899	x	x
Engel (519) 836-0220	x	
Ferromatik Milacron Europe (513) 458-8286	x	x
Ferromatik Milacron NA (513) 536-2351	x	x
Fortune/Victor (732) 214-0700	x	
Himaco (Brazil) +55 (51) 582-8000	x	
HPM (419) 946-0222		x
Husky (905) 951-5050		x
JSW (847) 427-1100	x	x
Kawaguchi (847) 520-5314	x	
Krauss-Maffei (859) 283-0200	x	x
Maruka/Toyo (630) 953-1707		x
Meiki (847) 439-4450	x	x
MHI/Mitsubishi (630) 693-4880	x	x
Mir (978) 537-4792		x
Netstal (978) 772-5100	x	
Negri Bossi (905) 761-0831	x	x
Niigata (630) 875-0202	x	
Nissei (714) 693-3000	x	x
Plastimatix (248) 478-2100	x	
Rutil (Italy) +39 (0331) 816711		x
Sandretto (724) 775-4255		x
Sodick (847) 759-6720		x
Sumitomo (770) 447-5430	x	
Toshiba (847) 709-7202	x	
Ube (734) 741-7000	x	
Van Dorn Demag (440) 876-8960	x	x
Welltec (219) 262-5007	x	
Woojin Selex (714) 521-5280		

Suppliers of electric and hybrid injection molding machines

Source: Plastics machinery & auxiliary magazine

Side by Side Comparison

	Electric	**Hybrid**	**Toggle /Hydraulic**
Energy	Best	Better	Good/Poor
Accuracy/Repeatability	Highest	High	Poor
Cleanliness	Excellent	OK	poor
Noise	Low	Medium	High
Maintenance	Low???	Medium	High
Use of existing molds	**Low adaptability**	Easy	Easy
Cost	High	Medium	Low

Energy savings With Variable Speed Drives

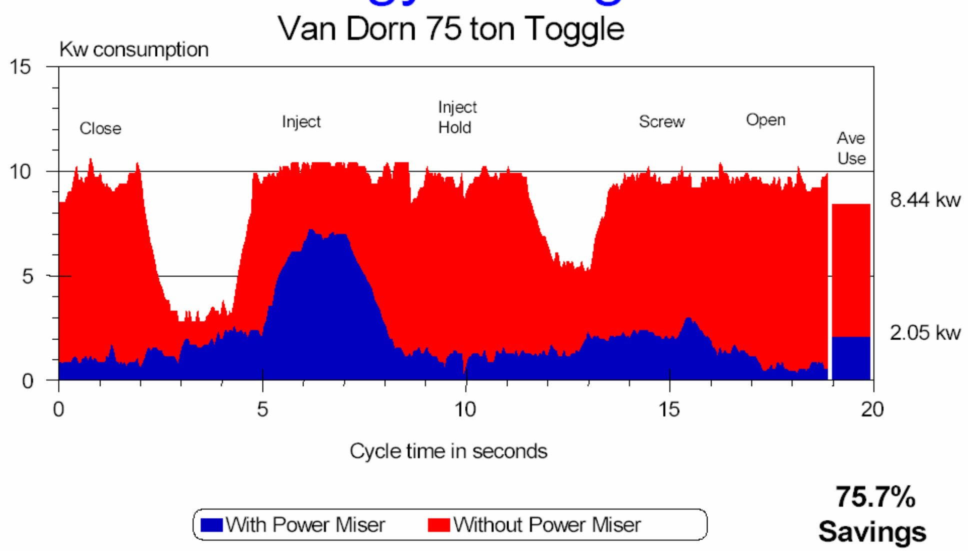
According to Plastics Technology, the **hydraulic pump-motor(s) account for 80%** of the total energy usage on an injection molding machine.

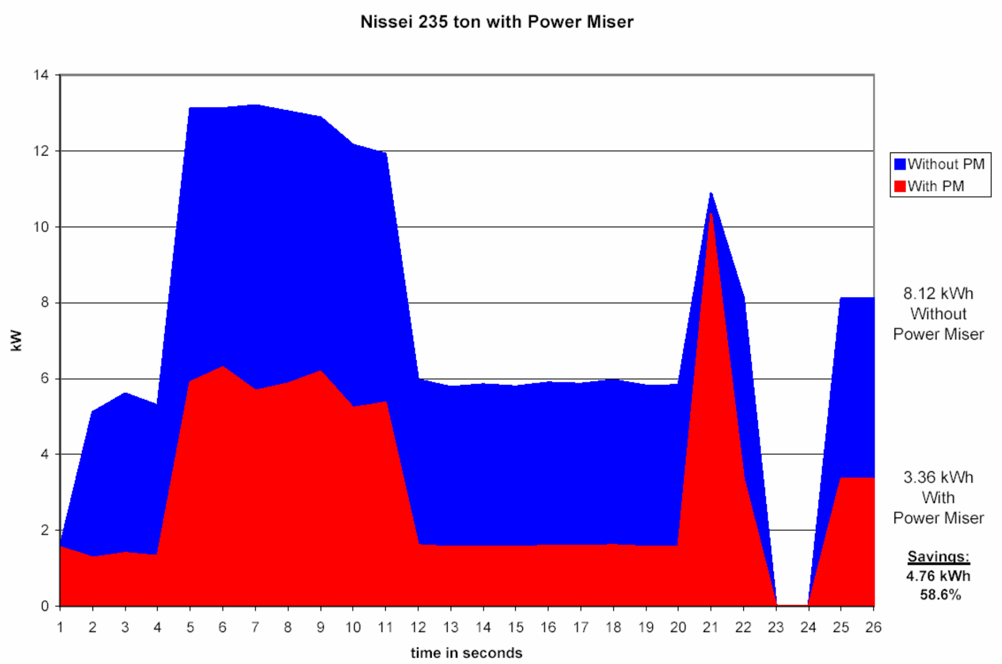
Even during periods of low hydraulic demand a maximum fixed-volume flow is produced. An example of the wasted energy at low demands is during the cooling stage of the cycle. During this cooling stage of the cycle, the motor(s) only need 20% rpm. **The fixed-speed system wastes considerable amounts of energy by making inefficient use of the hydraulic pump-motor(s).**

The motor conversion, from fixed-speed to variable-speed, enables the open loop injection molding process to be dependent on the demand for hydraulic fluid power. In return, there is a reduction in the use of kilowatt (kW) energy.

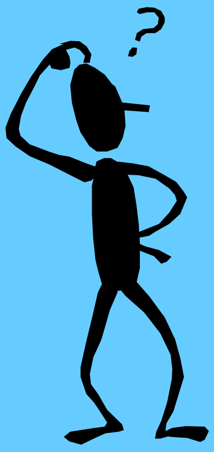
The basic concept of the system is simple: if the machine does not need the oil, don't pump it in the first place.

Energy Savings





When do VSD's Make Sense………..?



When AC drive systems are installed on the right machines, running the right jobs, the results can be tremendous

- Manufactures in areas with high electrical costs
- Long cooling times
- Large machines
- Older machines
- Jobs such as large PVC fittings

Identifying Opportunities

- Injection Molding Machines – Blow Molding Machines – Extruders
- Cooling Tower Fans – Tower & Chilled Water Pumps
- Air Compressors
- Mechanical control of process Speed, temperature or pressure.
- Varying system requirements based on production loading.

Source: Magnum, LLC

Machines with Built-in VSD ?

- Available as optional equipment
- Engel
- Van Dorn
- Dongshin

Energy savings with Auxiliary Equipment

Auxiliary equipment **account for 20% of the total energy** consumption

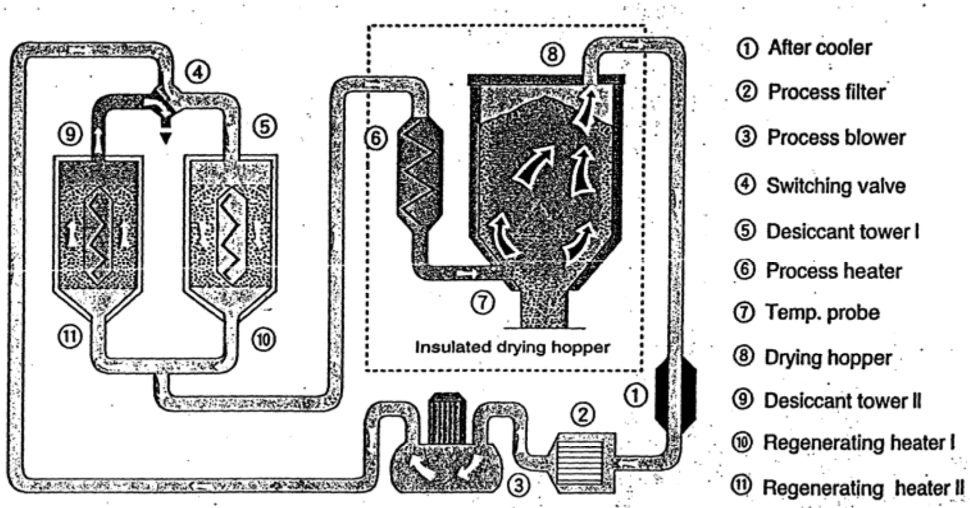
- Dryers
- Grinders
- Mold heaters
- Chillers
- Water Management

Material Drying

Energy consumption

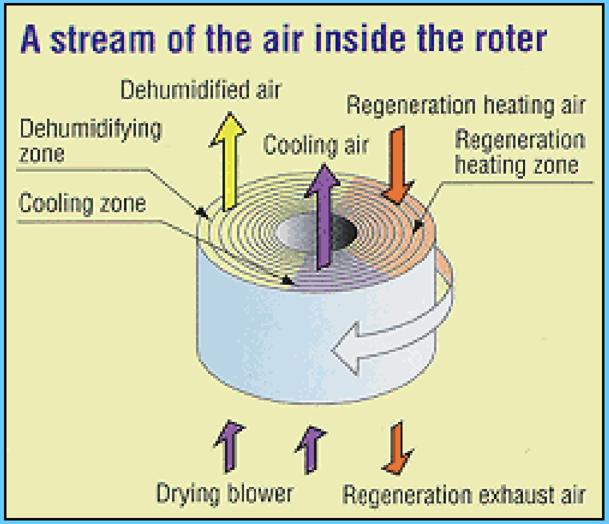
- Large electric heaters (Process & regeneration)
- Oversized blowers

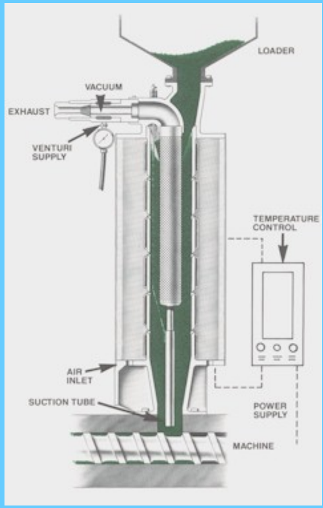
The Dehumidifying Principle



Energy Savings Measures

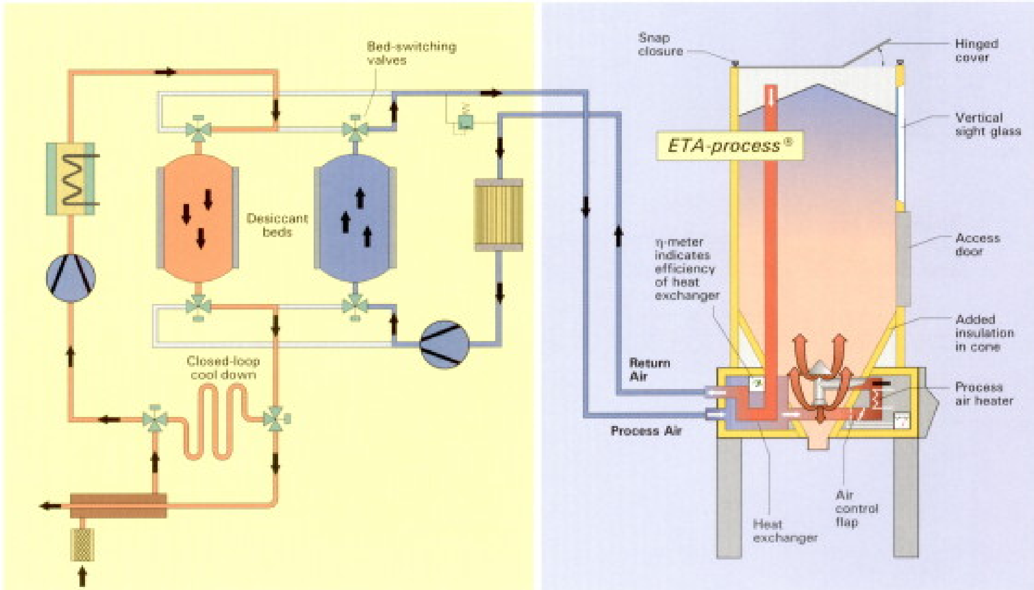
- Use of hot return air for desiccant regeneration
  - Example…Moton Luxor line of Dryers
- Use of sensors and controls
  - Lower drying temperature when not in use
- Honeycomb rotary bed
  - Crystallized molecular sieves baked on to drying wheel
  - Efficient moisture absorption
  - Low air pressure (smaller bower)
  - Faster drying time
  - No dust
- Low pressure dryer (Vacuum dryer)
  - At low pressure boiling point drops to 133° F
  - Low temperature and vacuum removes moisture faster
- Compressed air – no desiccant dryer
  - Uses hot and compressed air to remove moisture
  - No regeneration heaters





Cactus dryer

LUXOR Drying with ETA-process® Bins – Efficiency and Economy



Exceptional Drying Accuracy, Efficiency, and Reliability
The LUXOR dryer's twin desiccant design, with closed-loop cool down and dew-point controlled bed switching, delivers consistently low (-40 F) dew points.

LUXOR's stationary desiccant beds mean fewer moving parts and higher reliability.

Motan's touch screen controller provides the operator with the ultimate in operating and troubleshooting diagnostics. Add to this the positive-seating bed-switching valves and stationary desiccant beds and you have the industry's most maintainable dryer.

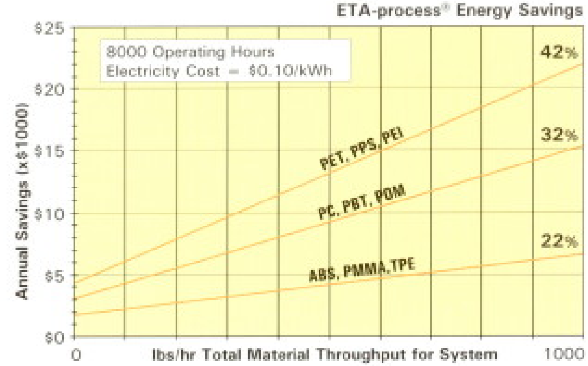
ATN
Drying for too long at high temperatures may lead to thermal degradation with some plastics. The MOTAN patented ATN function monitors the material throughput against the drying time and lowers the drying temperature to prevent damage during low throughput situations. This saves heat energy and keeps the material dry until the throughput rises. The ATN system senses when production resumes, and will automatically ramp temperatures up to provide efficient modulation of process temperatures, based on material usage.

Motan's ETA-process® Reduces Operating Costs
The patented ETA-process® was developed by Motan to gain maximum utilization of the heat developed in drying.

The ETA-process® heat recovery system uses the exhausted heat from the drying bin to preheat the process air coming from the dryer. Less energy is used to increase the temperature of the process air, resulting in significant reductions in operating costs (see chart below).

An additional advantage is the preliminary heat reduction of the air returning to the dry-air generator, thereby in most cases eliminating the need for an after-cooler.

ETA-process® Energy Savings



Energy Savings Measures

- Natural Gas dryers

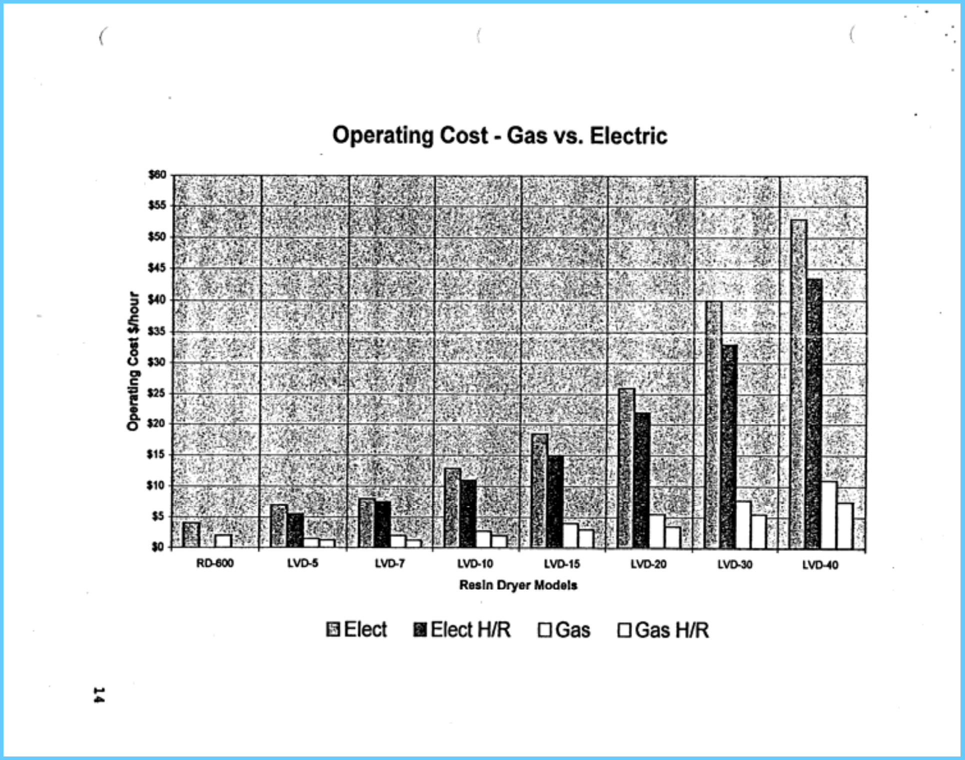
  Use of Natural gas for process heat

  and regeneration

- Insulated Hoppers and Hoses

  Study shows loss of 1 to 15 °F per foot of hose

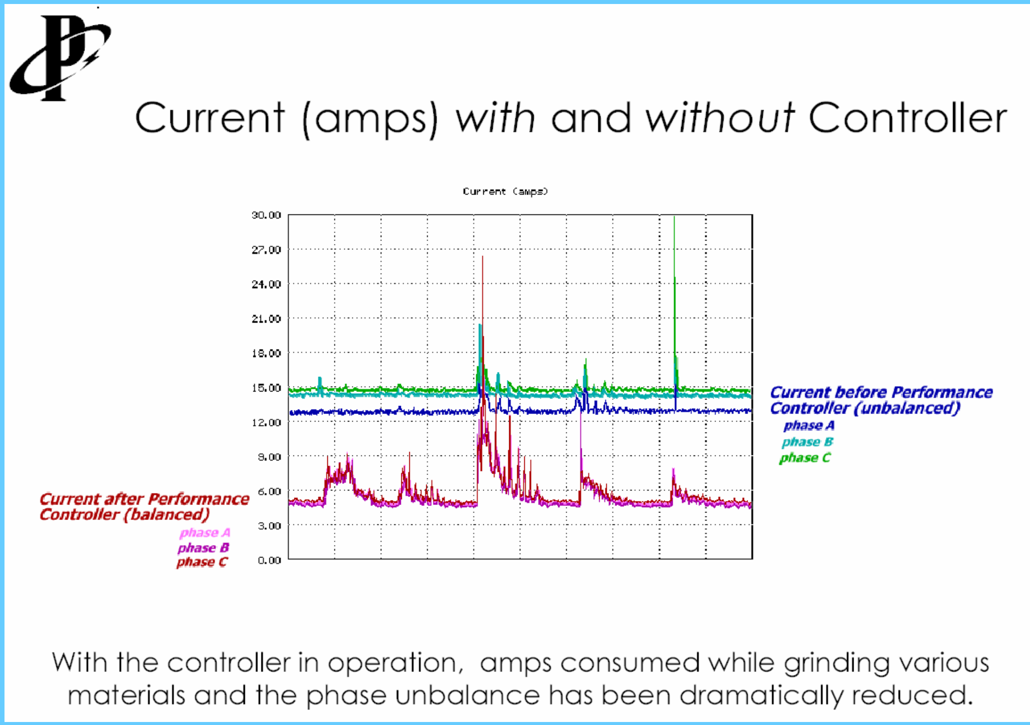
- Central Drying
- Use of sensor to switch beds
- Infrared drying with cool air
- Microwave drying
- Electromagnetic heating



Source: Regency Sales/Pneu-Con

Granulators

- Shut-down method (Watt Wattcher From IMS co.)
- Voltage reduction method (Performance Controller\MPG)
- RPM reduction

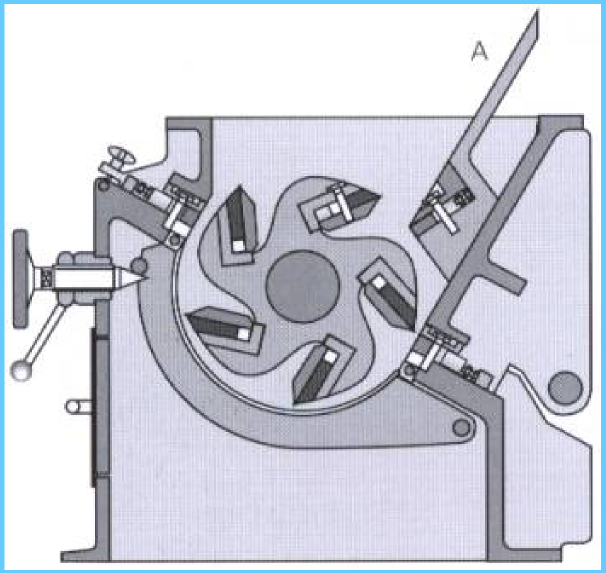


50% reduction in Power consumption

Energy efficient Granulators

- Low RPM granulators
- Low RPM 2 stage screenless granulators (Bi-Cutter)
    - 10 x 13 grinder using 1 HP motor at 15/45 RPM
- Grinders equipped with energy efficient motors
- Grinders equipped with carbon steel blades

Bi-Cutter by Size Reduction Specialist



SMS granulators with deflection wedge & 3 bed knives

Mold Heaters

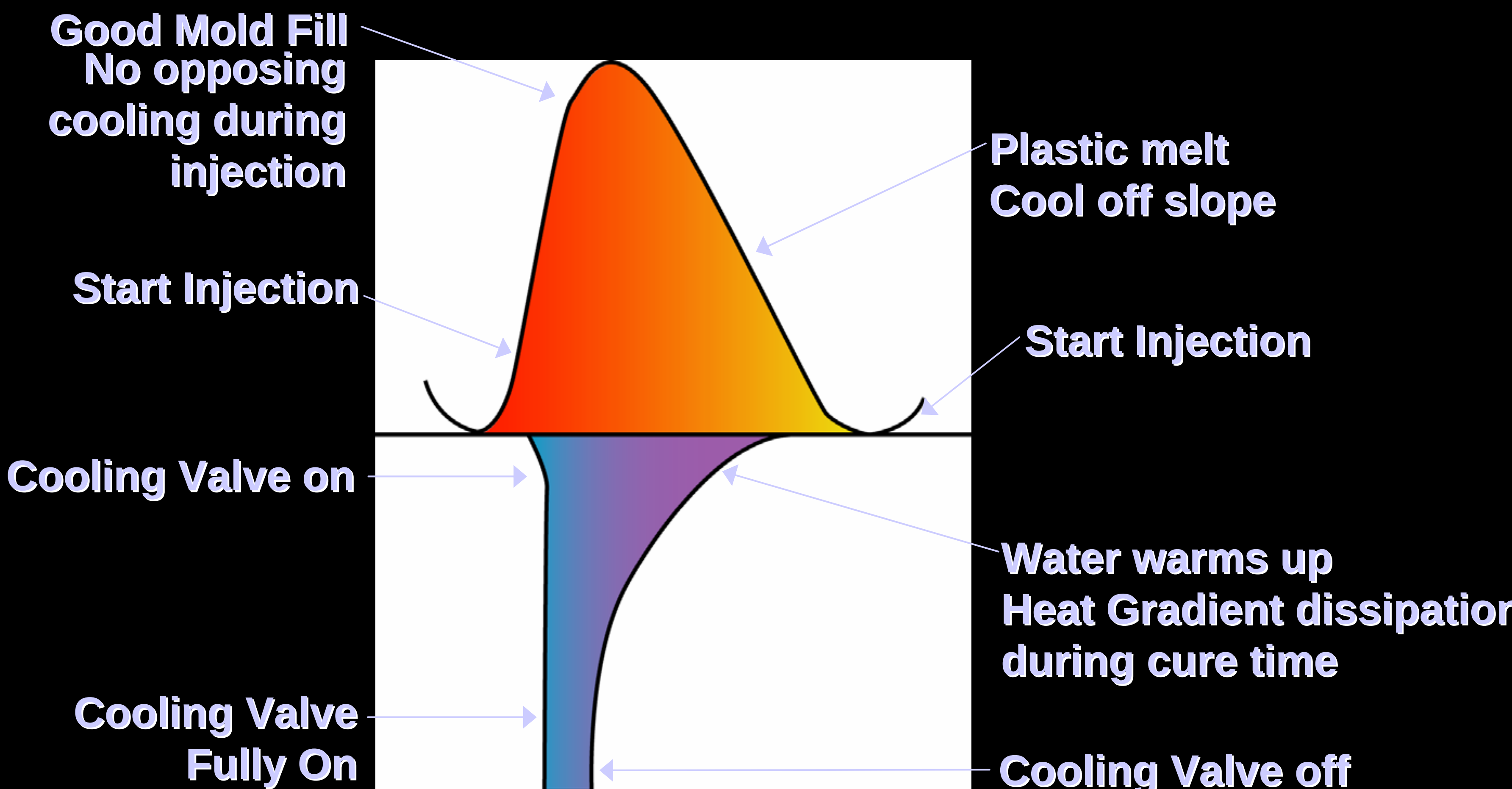
- Energy efficient motors
- Pulse cooling technology

Thermolators add heat to control the mold

PulseCooling removes heat to control the mold

Energy savings from reduction or elimination of thermolators

Pulse Cooling dynamics



Chillers

- High efficiency scroll compressors Vs. traditional semi-hermatic
- Winter cooler…use of cool outside air
- Power consumption in direct proportion to cooling load
- Variable speed drive

Energy savings from proper Water Management

Points to Consider at the Machine

Is the supply pressure adequate (50 psi min)

Is the return pressure at least 40 psi less than the supply

Adequate pipe sizing for the number of machines in service

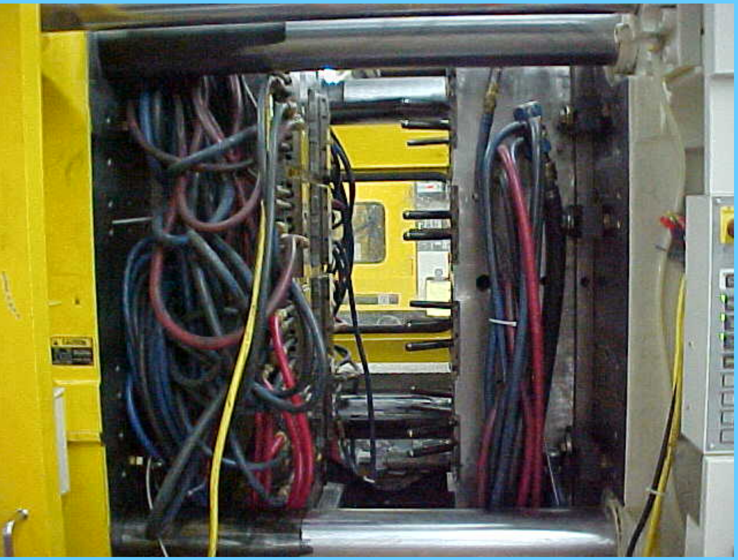
Is the GPM flow adequate to cool the molds properly

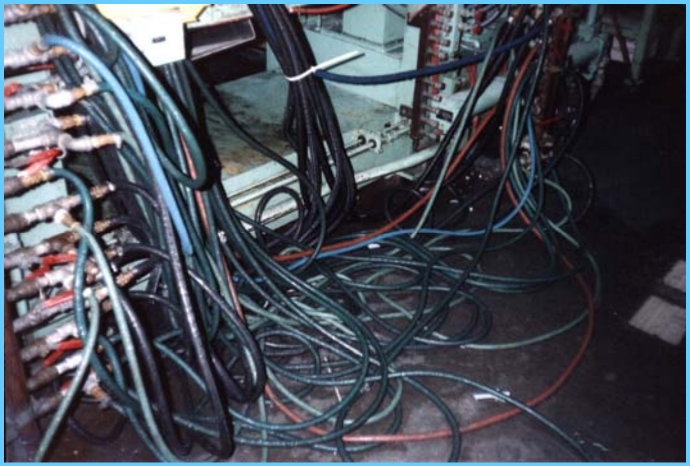
Is there an adequate number of valves on each manifold

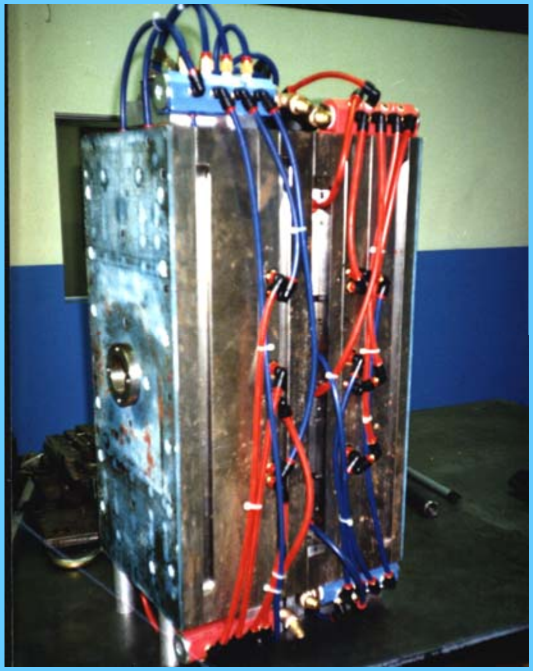
Are the supply/return manifolds in close proximity to the mold

Are the valves properly sized

Source: Pulse cooling-West

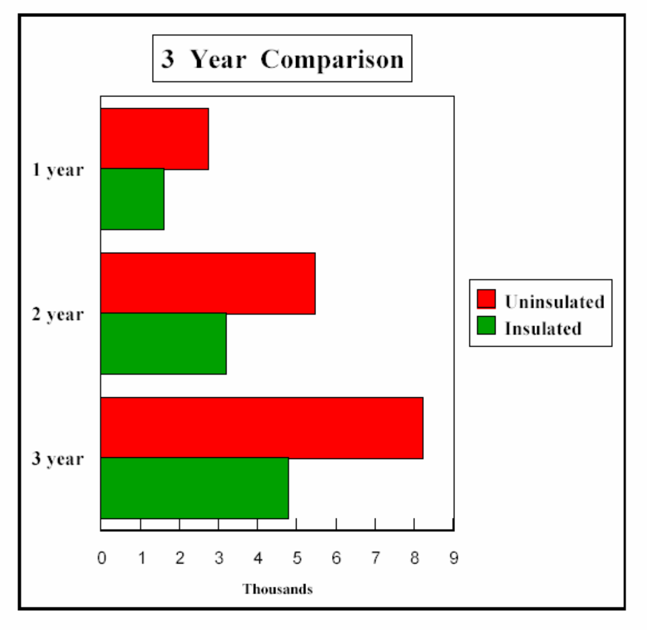






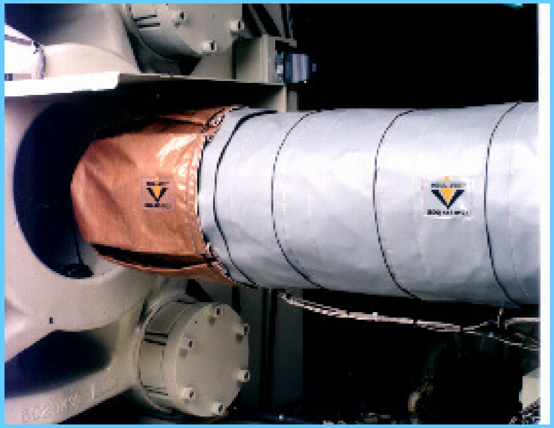
Insulation Blankets

30% energy savings



- Fast Start up
- Even Heat Profile
- Personnel Protection
- Extended Heater Band Life

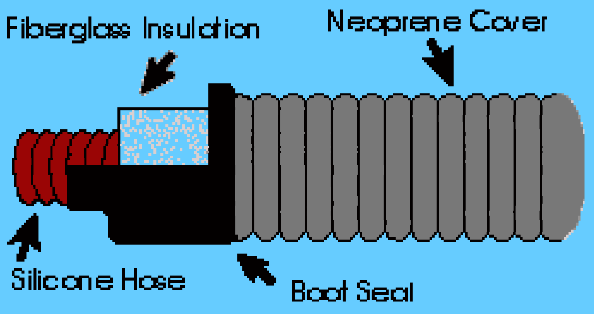
200 Ton Milacron



Drool protection Disk or cover

Common Sense Approach

- Hot Runners Molds
- Long hold times……Gate freeze studies
- Multiple ejection
- Parts on the floor
- Material on the floor
- Insulated Dryer hoppers
- Leaky Dryer and air Hose
- Oil leaks
- End of jobs….turn off power



Where to find more information?

http://www.fasti.at

http://www.energysolutionscenter.org/PlasticsSuite/www/chillers/chillers.htm

http://www.cometauxiliary.com/article7.html

http://www.imscompany.com/default.htm

http://www.unitherm.com/coolnews/cn-002.htm

http://www.insul-vest.com/purge-away.htm

http://www.oekutec.de/ird-oekutec-de/presse-e-kunstst1.htm

http://www.maguire.com/products/dryers.htm

http://www.powerefficiencycorp.com/home/welcome.shtml

http://www.srscorp.com

http://www.pneu-con.com/

http://www.matsuiamerica.com/

http://www.magnumllc.com

http://www.pma-magazine.com/articles/2002/September/01

http://www.pma-magazine.com/articles/2002/November/4

http://www.pma-magazine.com/articles/2002/March/02

http://www.plasticstechnology.com/articles/200110cu4.html

http://www.immnet.com/articles?article=602

http://www.immnet.com/articles?article=581

http://www.immnet.com/articles?article=478

Where to find more information?

www.motan.com

www.pulsecooling.com

www.dri-air.com

www.novatec.com

http://www.powermiser.com/

Energy Incentives

- SPC program …..Old Vs. New
- Express Efficiency….Motors, Lighting etc.
- Savings by Design…..New additions, New Plants

Standard Performance Contract

A Southern California Edison 2003 Energy Efficiency Incentive Program

PROPOSED

2003 SPC
GENERAL DESCRIPTION

- **Pay-for-Performance**
  - Participant installs energy-efficient equipment resulting in energy [kWh] savings
  - SCE pays a flat cents-per-kWh-saved incentive
- **Applicant**
  - Customer may self-sponsor, or
  - A 3rd Party may apply on behalf of customer

2003 SPC COMPARISONS TO EE

- **Incentive Basis**
  - SPC: Cents per kWh saved
  - EE: Dollars per “widget” installed
- **Installation of Equipment**
  - SPC: After application is approved
  - EE: Prior to application submission
- **Eligible Measures**
  - SPC: General list of measures
  - EE: Specific list of measures

2003 SPC
PROGRAM ELIGIBILITY

- **Customer**
  - Business Customers in SCE service territory
  - Pays PGC or DSM surcharge on utility bill
- **Measures**
  - Retrofits or replacements only
  - In general, eligible if: useful life > 5 years, energy savings can be estimated, and tools are required to install the measure
- **Express Efficiency Eligibility**
  - Projects eligible under SCE 2003 Express Efficiency program are not eligible for SPC

2003 SPC
INCENTIVE LEVELS

- **Lighting Measures**
  - 5 cents per kWh saved
- **AC & Refrigeration Measures**
  - 14 cents per kWh saved
- **Motors & Other Equipment**
  - 8 cents per kWh saved
- **Total Funding Available for Incentives**
  - $10.8 million
  - 30% [$3.24MM] limit for lighting incentives

2003 SPC TIMELINES

- **Anticipated Implementation Date: 2nd qtr 2003**
  - Program Manual and forms will be available upon implementation
  - CD may be ordered via website
  - Website: www.scespc.com
- **Application Submittal Deadline 12/31/03**
- **Project Installation Deadline 6/1/04**

2003 SPC RESOURCES

- **Website** **www.scespc.com**
- **Your SCE Account Representative**
- **Phone**
  - – General questions: 800-736-4777
  - – Technical questions: 626-302-1724
- **E-mail**
  - – SPC@sce.com

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