FILTER SPECIALTIES INC.

Energy Saving Specialists

ENERGY SAVING RETROFITTING:
Servo Hydraulic Pump Systems for Injection Molding Machines

------Injection Molding Machine ------
Permanent Magnet
Servo Hydraulic Pump Motor System

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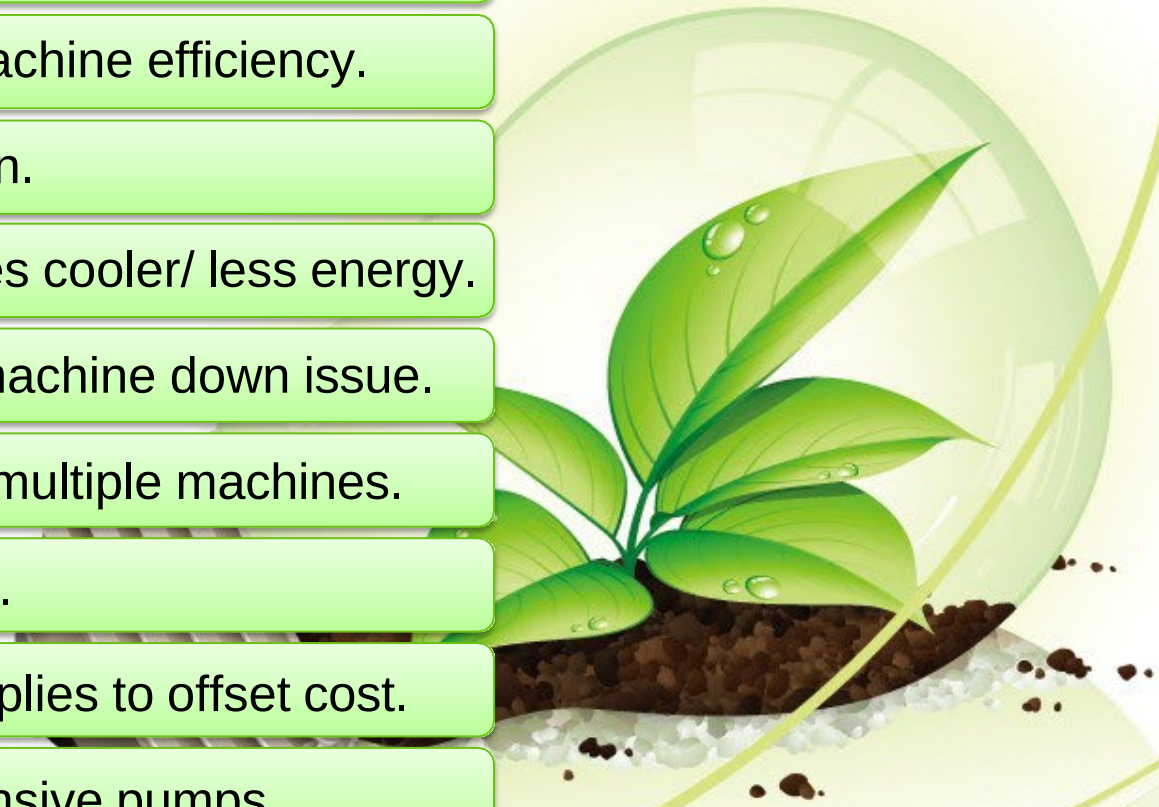
Why Retrofit

1. Typically greater than 50% energy reduction.
2. Improved cycle time & machine efficiency.
3. Significant noise reduction.
4. Hydraulic system operates cooler/ less energy.
5. Fast solution to resolve machine down issue.
6. Common spare parts on multiple machines.
7. Reduced carbon footprint.
8. Retrofit rebate usually applies to offset cost.
9. Replaces obsolete/ expensive pumps.



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1. Servo System Components
2. SUMITOMO Internal Gear Pump
3. Servo System: Comparison of Servo Pump vs Inverter with Fixed or Variable Pump
4. Servo System Advantage
5. Successful Case Examples

Injection molding machines with servo systems are the trend in todays market. Reconstruction of older machines with a retrofit servo hydraulic pump system is now a popular and profitable investment.

1. Servo System Components

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Permanent Magnet Servo Motor

Existing IMM Control System

VFD Servo Driver

Motor Speed Encoder

Precision Internal Gear Pump

Servo Drive Panel and Pump/Motor Assy.

Pressure Transducer

Brake Resistor

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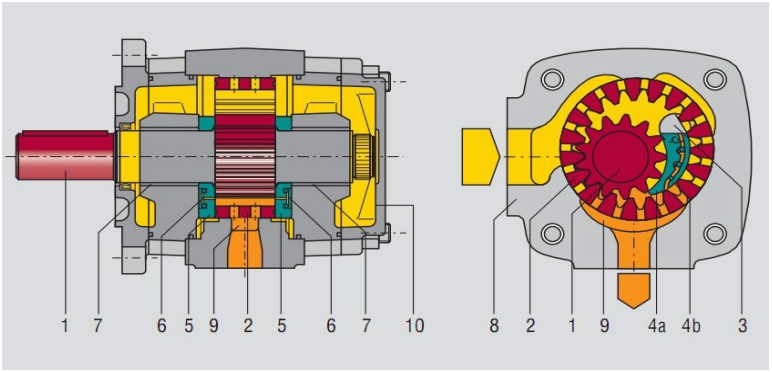
2. PUMP TYPES: *SUMITOMO / ECKERLE/ VOITH*

• ECKERLE, Germany

• VOITH, Germany

• SUMITOMO, Japan



Eckerle, Voith, Sumitomo design structure using a Compensated crescent

2. Internal Gear Pump Design Advantages

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Matching the original IMM pressure and flow is important. Consideration must be taken for improved IMM operational stability. A servo system with higher motor torque, pump flow and VFD power must be used to ensure the machine operation stability.

- *Positive displacement non-pulsing pressure output*
- *Only 3 moving parts (outer gear, inner gear, crescent piece)*
- *High Pressure and rotational speed capability*
- *Bi-direction ability*
- *High durability design for long life*
- *Excellent viscosity range variation capability*
- *Quiet operation*

3. Different Types of Pump Drive Systems

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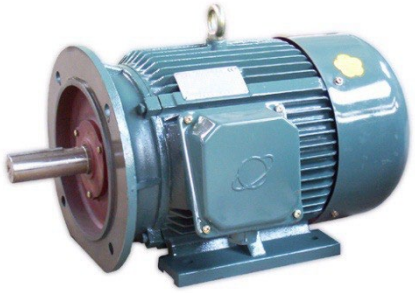
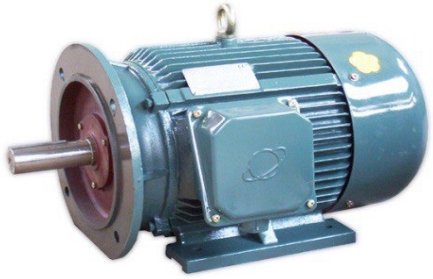
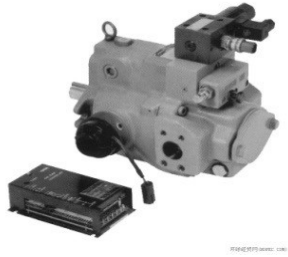
***AC** motor with*
Fixed Pump
constant rotation

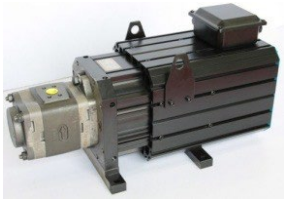


***AC** Motor with*
Proportional
Variable Pump
constant rotation





Servo Drive
With Gear Pump
only runs on demand



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3.1 Comparison *of Servo System vs. Fixed Pump Inverter System*

Item	Servo system	advantage	Fixed pump w/ Inverter	disadvantage
motor		Small size, low inertia, fast response, high efficiency, high overload tolerance.		Large size, high inertia, low speed response, low overload draw tolerance.
pump		High rotating speed, low leakage and pulsation, low speed and holding pressure stability.		If the rotating speed of the vane pump is lower than 600 rpm, oil flow volume is not consistent.
Pressure control		Digital control provides accurate pressure detection.		Analog control has slower response and the valve can wear and be blocked easily.
Speed control		Motor encoder has 1024 lines giving precision control of speed/ flow.		Inverter uses VFD to control motor speed resulting in low precision/ response time.
Braking device		External braking resistor provides rapid motor response.		No braking device results in low speed response at slow down.
Control system		Dual closed-loop control of pressure & flow results in precision & efficiency.		Open-loop Inverter results in low pressure & flow control precision.

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3.2 Comparison of *servo system vs variable pump with Inverter*

Item	Servo system	advantage	variable pump with inverter	disadvantage
motor		Small size, low inertia, fast response, high efficiency, high overload tolerance.		Large size, high inertia, low speed response, low overload draw tolerance.
pump		High rotating speed, low leakage and pulsation, low speed and holding pressure stability.		Response capability of the variable pump is poor, the electric motor is in operation all the time.
Pressure control		Digital control provides accurate pressure detection.		Low control precision and the proportional valve is easy blocked
Speed control		Motor encoder has 1024 lines giving precision control of speed/ flow.		Proportional valve control of pump swash plate creates a speed response delay.
Braking device		External braking resistor provides rapid motor response.		No braking device results in low speed response at slow down.
Control system		With dual closed-loop control, precision, efficiency		Open-loop inverter results in low pressure and flow control precision.

4. Servo System Advantages

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Excellent energy savings

High performance stability

Long service life

High energy efficiency

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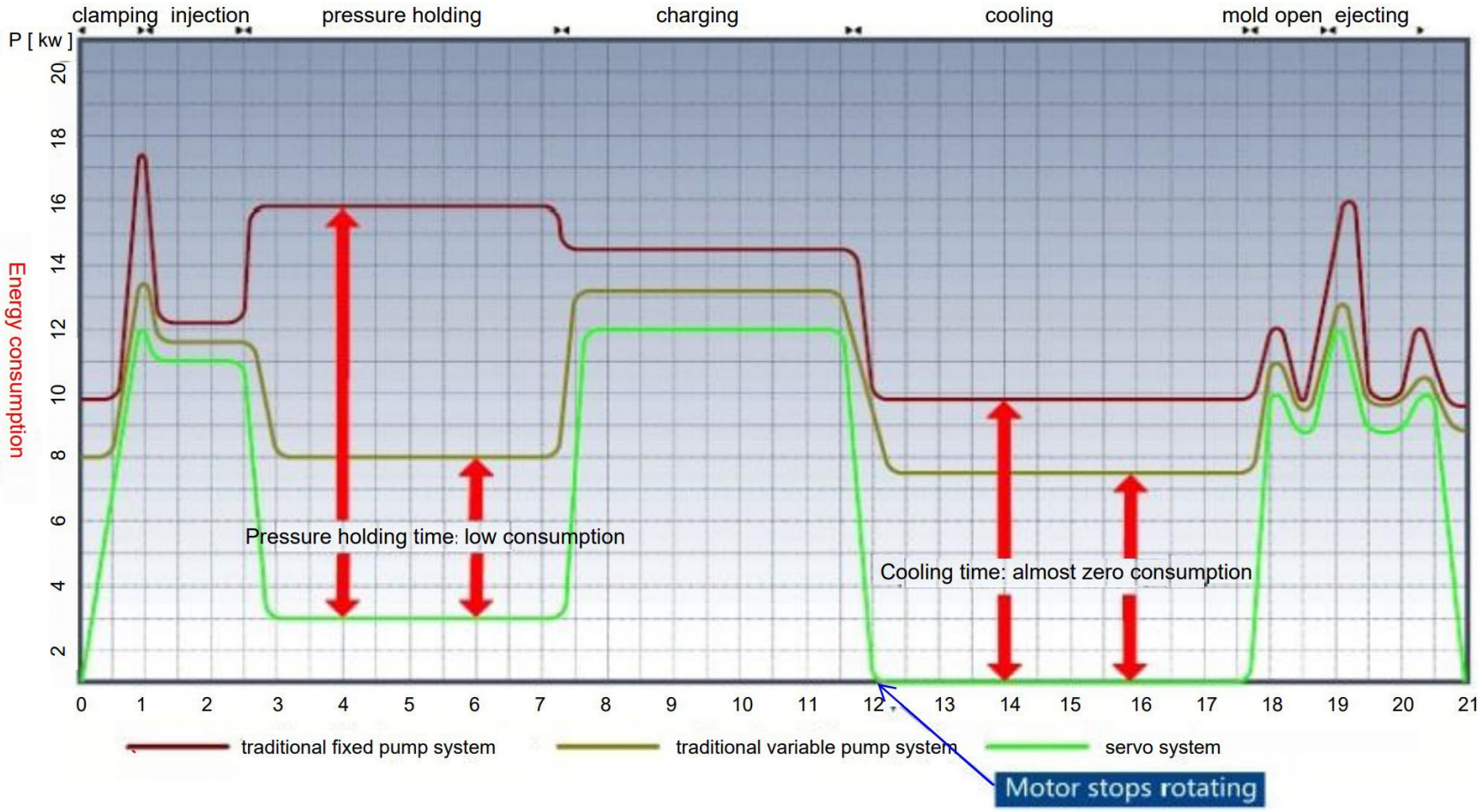
4.1 *Curve comparison of power system energy consumption*

Considering different product cycle times, any IMM retrofitted with the servo hydraulic pump system could save a maximum 85% power in comparison to standard systems.

*Zero energy consumption during cooling
*Low energy consumption during hold pressure
*Low energy consumption during other functions



4. 2 System response curve comparison

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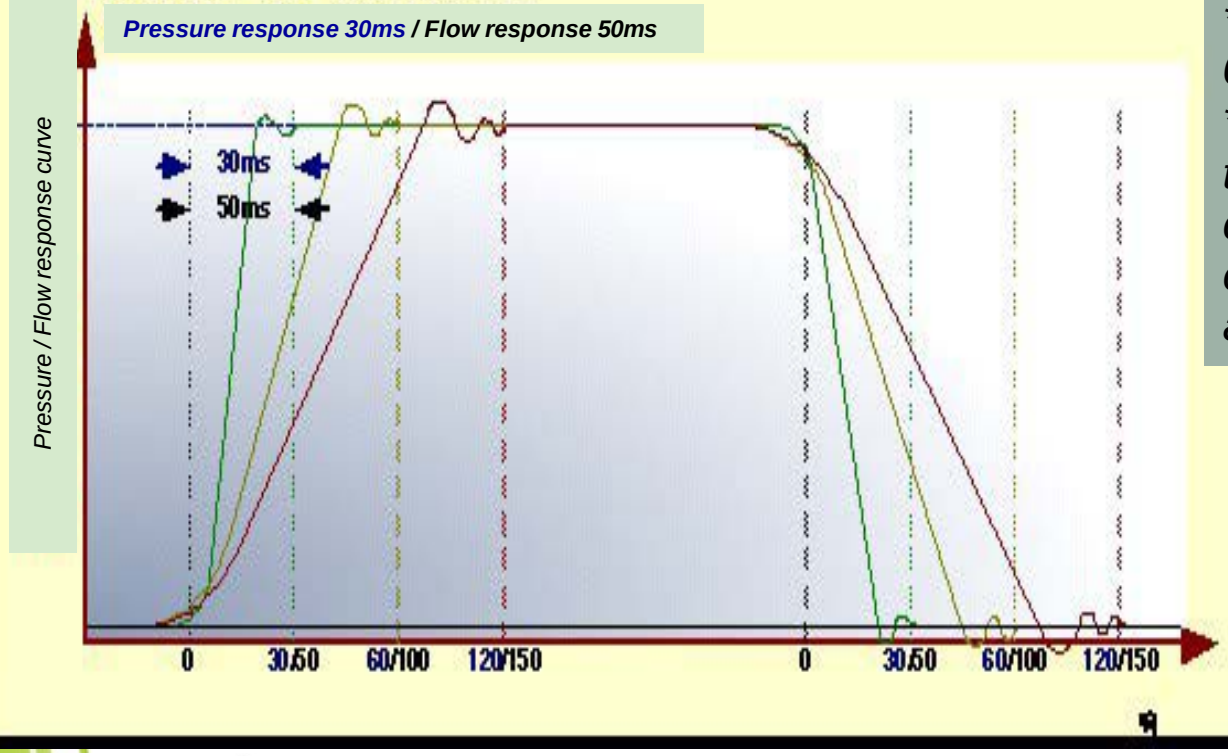
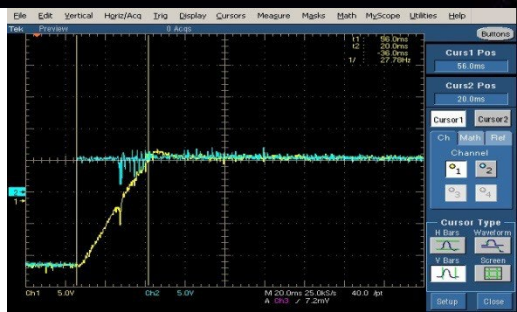


*Servo pump pressure response 0~max pressure output 0.03s
*Servo pump flow response 0~ max flow output 0.05s
*This response is faster than traditional oil hydrodynamic control systems and provides effectively shortened cycle time and increased productivity.

The Servomotor rotor turns with a very low moment of inertia by utilizing permanent magnets to create high responsiveness of the system.



5. Successful case

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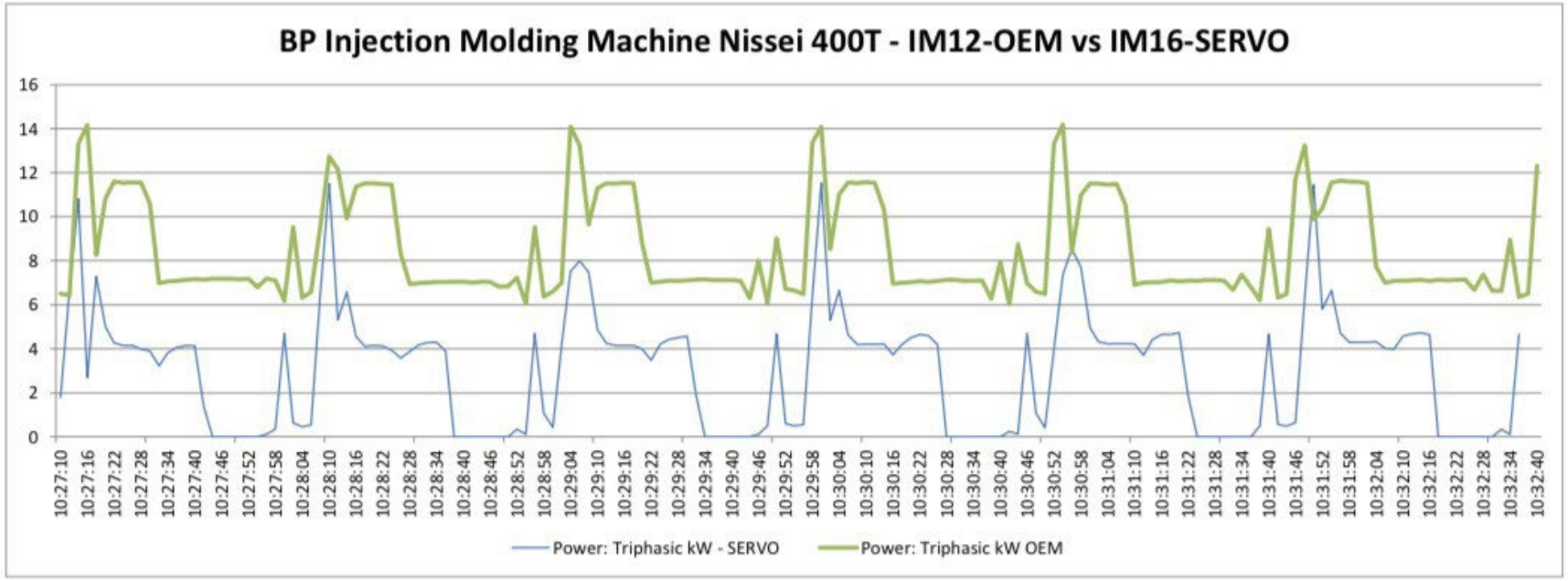
► *energy saving*

40%-80%



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NISSEI FN6000

BEFORE

AFTER

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I-P Press #19: Nissei 320T FN6000: 320T OEM vs 320T-SERVO OEM
45kW OEM Motor vs 48kW Servo Motor

IM Machine Make & Model	Nissei 320T FN6000	Nissei 320T FN6000
IM Machine Type	Hydraulic Pump - 45kW	Electric Servo - 48kW
Tonnage	320UST	320UST
Material Type	Polypropylene	Polypropylene
Mold Description	081A1 - Cap for Deodorant Stick - 8 Cavity	081A1 - Cap for Deodorant Stick - 8 Cavity
Parts/Mold	8	8
Shot Size (grams)	32.000 Grams	32.000 Grams
Average Cycle kW (kWh/h)	10.454 kW	2.772 kW
Cycle Time (Seconds)	9.15 Seconds	9.15 Seconds
Total Energy/Sec (kWh/s)	0.0029 kWh/sec	0.0008 kWh/s
Specific Energy (kWh/kg)	0.830 kWh/kg	0.220 kWh/kg
Specific Energy (kWh/part)	0.003 kWh/part	0.001 kWh/part
Specific Energy (kWh/shot)	0.027 kWh/shot	0.007 kWh/shot
Operation Hours/yr	8,000 Hours/year	8,000 Hours/year
Total Energy/Year	83,632 kWh/year	22,176 kWh/year
Demand (1 pm - 7 pm average) kWh/h	10.454 kW During Peak Period	2.772 kW During Peak Period
Total Product Produced / Year	25,180,328 Parts/year	25,180,328 Parts/year

kWh Savings:	**61,456 kWh/yr**	**kW Demand Savings:**	**7.68 kW**
kWh Savings (%):	**73.5%**	**kW Demand Savings (%):**	**73.5% kW**
kWh Savings ($):	**$9,218.40**	**kW Demand Savings ($):**	**$921.84 kW**

Total Annual Savings: $10,140.24

5. Successful case

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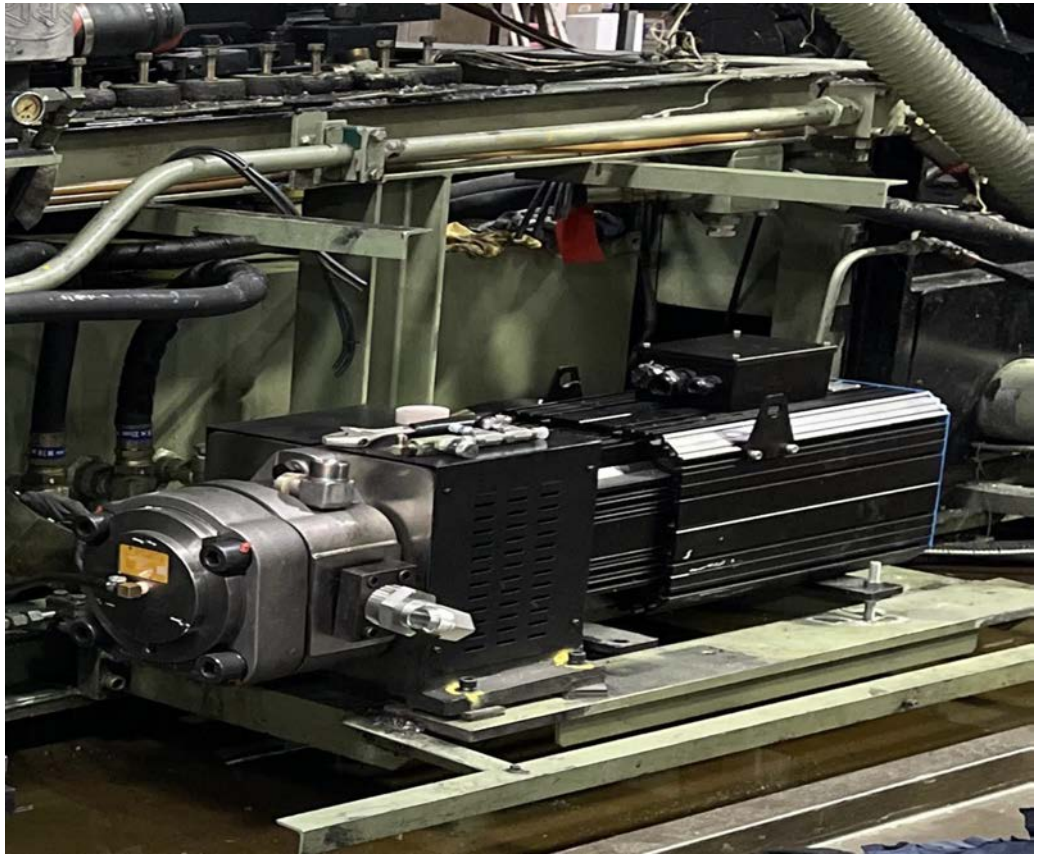
► *energy saving*

40%-80%

Nissei FV9200 1000 Ton



5. Successful case

LOGO

Baytech Plastics Injection Molding Machine Nissei 1500T FV9400 vs SERVO Motor & Drives
75kW + 55kW OEM Motors vs 2 x 67.5kW Servo Motors

IM Machine Make & Model	Nissei 1500T FV9400	Nissei 1500T FV9400
IM Machine Type	Hydraulic Pumps - 75kW + 55kW	Electric Servo Motors - 2 x 67.5kW
Tonnage	1500UST	1500UST
Average Cycle kW (kWh/h)	63.405 kW	29.593 kW
Cycle Time (Seconds)	77.84 Seconds	73.75 Seconds
Total Energy/Sec (kWh/s)/Machine	0.0176 kWh/sec	0.0082 kWh/s
Operation Hours/yr	6,060 Hours/year	5,742 Hours/year
Energy/Year/Machine	384,236 kWh/year	169,911 kWh/year
Demand (1 pm - 7 pm average) kWh/h/Machine	63.405 kW During Peak Period	29.593 kW During Peak Period
Total Quantity Machines	1.000	1.000
Total Energy/Year	384,236 kWh/year	169,911 kWh/year
Total Demand (1 pm - 7 pm average) kWh/h	63.405 kW During Peak Period	29.593 kW During Peak Period

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kWh Savings:	**214,326 kWh/yr**	**kW Demand Savings:**	**33.81 kW**
kWh Savings (%):	**55.8%**	**kW Demand Savings (%):**	**53.3% kW**
kWh Savings ($):	**$30,005.58**	**kW Demand Savings ($):**	**$4,057.48 kW**

Total Annual Savings: $34,063.06

5. Successful case

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2009/06/05
Model: 650 Ton
Original system flow: 415 L/MIN
Post retrofit system flow: 420L/MIN
Original daily consumption：
710KWH
Retrofit daily consumption：
320KWH (reduction of 390 Kwh)
Saving rate：55%

5. Successful case

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2009/07/28
Model: FT1500 Ton
Original daily consumption：
1123 KWH
Retrofit servo daily consumption：
460 KWH (reduction of 663 Kwh)
Saving rate：59%
Original system flow：640 L/MIN
Retrofit system flow: 660 L/MIN

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Thank You!

LOGO