3 - AR No. 1 - Replace SBM Machines

Original Template May 2016, style 2013b

Recommendation

Incrementally replace the facility's injection stretch-blow molding (SBM) machines. This will decrease lost productivity due to downtime by 74%, and reduce associated annual energy consumption by 15%.

Annual Savings Summary

Source	*Quantity*	*Units*	*Cost Savings*
Primary Product	542,620	units	$154,598
Electrical Consumption	44,306	kWh	$1,825
Electrical Demand	183	kW Months / yr	$1,370
Total	**151**	**MMBtu**	**$157,793**

Implementation Cost Summary

Description	*Cost*	*Payback (yrs)*
Before Incentives	$301,613	1.9
No Incentives Found	-	-

Facility Background

The facility currently has six SBM machines ranging from 13 to 25 years of service. These machines are used to produce various types of products for customers. Due to unpredictable scheduling based on customer demand, these machines require approximately 24 hours of changeover time to prepare the machines to produce another product.

Recently, the facility has sought after improving their machines to increase production. An SBM machine vendor has provided some analysis for the facility to either retrofit their current machines or to install new machines. Current and proposed operational data and prices have been provided by the facility and vendor.

Technology Background

In the SBM process raw polymer pellets are preformed into an injection mold and then blown using high pressure compressed air to fit the desired shape using a mold. SBM machine technology has improved the energy required and productivity for the plastic product manufacturing industry. Machine components require less power reducing annual energy consumption. Productivity has been increased by reducing the machine's required cycle time by enabling preforms to be injection molded and heat conditioned simultaneously. Additionally, the machine vendor has reported that the time required to perform mold changeovers has been reduced significantly, which lowers machine downtime and increases productivity.

3 - AR No. 1 - Replace SBM Machines

Original Template May 2016, style 2013b

Proposal

Replace SBM machine and purchase new molds as machines reach the end of their useful life to increase productivity. This will save $157,793 annually and reduce associated energy consumption by 44,306 kWh. Incremental Implementation costs are estimated at $301,613 for a simple payback period of 1.9 years.

Calculation Methodology

Analysts determined the required power for the current and proposed SBM machines. Average machine hours were calculated based on the total machine hours year-to-date, 01/01/2016-06/21/2016. The facility provided current production details and estimates, and the machine vendor provided key machine specifications that affect production for the current and proposed machine. Analysts compared the energy required and the production capabilities in this analysis.

Notes

This analysis compares the incremental benefits of purchasing new SBM machines versus retrofitting the current machines. Further, it evaluates the benefit of replacing one machine at a time as machines need replacement.

The facility provided information for the vendor and machine models to be analyzed. The current machine in the analysis is model SBIII-1000L-150, and the proposed machine is model SBIII-350LL-100.

The machine vendor provided an analysis showing four options for using model SBIII-350LL-100. Analysts used the average operational characteristics between all four options in their analysis because analysts did not have the facility's production profile to determine the best option.

The facility can reuse current molds when retrofitting the current machine. New molds will have to be purchased when purchasing a proposed option. Facility personnel provided analysts an estimate of the price per mold.

SBM machine scheduling is unpredictable, and analyst obtained the year-to-date [01/01/2016-06/21/2016] total hours for all SBM machines the day before the facility visit. To model the remainder of the year's production for all machines the facility agreed that analysts can assume production would remain constant and the annual value would be double the year-to-date hours. Analysts assumed the machines operate an equal amount of time and took the average between all six machines.

3 - AR No. 1 - Analysis

Oregon State University | Energy Efficiency Center

Original Template May 2016, style 2013b

General Data

Utility Data

Incremental Electricity Cost	(IC_E)	*$0.04119*	/kWh	**(Rf. 1)**
Incremental Demand Cost	(IC_D)	*$7.50*	/kW·mo	**(Rf. 1)**

Site Data

Load Factor	(LF)	*70%*		**(N. 1)**
Air Compressor Performance	(m)	*0.2709*	kW/ACFM	**(Rf. 2)**
Number of SBM Machines	(n_1)	*6*		**(Rf. 3)**
YTD SBM Operation Hours	(t_{YTD})	*12,470*	hrs	**(Rf. 3)**
Average SBM Machine Operation	(t_{OP})	*4,157*	hrs/yr	**(N. 2, Eq. 1)**

Current SBM Machine Data

Hydraulic Pump Motor	(P_1)	*75*	kW	**(Rf. 3)**
Heater	(P_2)	*19*	kW	**(Rf. 3)**
Operational Air Requirement	(Q_C)	*25*	ACFM	**(N. 3)**
Power to Compress Air	($P_{CA,C}$)	*7*	kW	**(Eq. 2)**
Power Draw	(P_{DC})	*101*	kW	**(Eq. 3)**

Proposed SBM Machine Data

Pump	(P_3)	*45*	kW	**(Rf. 3)**
Turn Table Motor	(P_4)	*3*	kW	**(Rf. 3)**
Barrel Heater	(P_5)	*20.5*	kW	**(Rf. 3)**
Hot Runner Heater	(P_6)	*9.2*	kW	**(Rf. 3)**
Operational Air Requirement	(Q_P)	*28*	ACFM	**(N. 3)**
Power to Compress Air	($P_{CA,P}$)	*8*	kW	**(Eq. 2)**
Power Draw	(P_{DP})	*85*	kW	**(Eq. 4)**

Energy Analysis

Current Conditions

Energy Consumption	(E_C)	*292,487*	kWh	**(Eq. 5)**
Electrical Demand	(D_C)	*1,206*	kW·mo	**(Eq. 6)**

Proposed Conditions

Energy Consumption	(E_P)	*248,181*	kWh	**(Eq. 5)**
Electrical Demand	(D_P)	*1,024*	kW·mo	**(Eq. 6)**

Savings

Energy Savings	(E_S)	*44,306*	kWh	**(Eq. 7)**
Demand Savings	(D_S)	*183*	kW·mo	**(Eq. 8)**
Energy Cost Savings	(C_{ES})	*$1,825*	/yr	**(Eq. 9)**
Demand Cost Savings	(C_{DS})	*$1,370*	/yr	**(Eq. 10)**

Notes

N. 1) Analysts were unable to obtain live readings during site visit. This is a conservative estimate of expected motor load.

N. 2) Analysts assumed annual production is double the year-to-date value provided and it is balanced across all machines.

N. 3) Analysts assumed 1 SCFM = 1 ACFM.

Equations

Eq. 1) Average SBM Machine Operation (t_{OP})

$$t_{YTD} \times \frac{2}{n_1}$$

Eq. 2) Power to Compress Air ($P_{CA,[C,P]}$)

$$Q_{[i]} \times m$$

Eq. 3) Current Power Draw (P_{DC})

$$P_1 + P_2 + P_{CA,C}$$

Eq. 4) Proposed Power Draw (P_{DP})

$$P_3 + P_4 + P_5 + P_6 + P_{CA,P}$$

Eq. 5) Energy Consumption ($E_{[C,P]}$)

$$LF \times t_{OP} \times P_{D[i]}$$

Eq. 6) Electrical Demand ($D_{[C,P]}$)

$$P_{D[i]} \times 12 \frac{mo}{yr}$$

Eq. 7) Energy Savings (E_S)

$$E_C - E_P$$

Eq. 8) Demand Savings (D_S)

$$D_C - D_P$$

Eq. 9) Energy Cost Savings (C_{ES})

$$IC_E \times E_S$$

Eq. 10) Demand Cost Savings (C_{DS})

$$IC_D \times D_S$$

References

Rf. 1) Developed in the Utility Analysis located in the Site Data section of this report.

Rf. 2) Developed in the CABAT located in the Site Data section of this report.

Rf. 3) Obtained from facility personnel during site visit.

3 - AR No. 1 - Analysis

Oregon State University | Energy Efficiency Center

Original Template May 2016, style 2013b

Productivity Cost Analysis

Productivity Data

Average Weekly Changeovers	(n_2)	*5*	/wk	**(Rf. 3)**
Weekly Changeovers per Machine	(n_3)	*0.83*	/wk	**(Eq. 11)**
Average Product Profit	(IC_P)	*$0.13*	/unit	**(Rf. 3)**

Current Conditions

Unit Output	(β_C)	*703*	units/hr	**(Rf. 3)**
Machine Changeover Time	(t_C)	*24*	hrs	**(Rf. 3)**
Productivity Lost	(UP_{LC})	*731,120*	units/yr	**(Eq. 12)**
Annual Productivity	(UP_{AC})	*2,922,137*	units/yr	**(Eq. 13)**
Lost Productivity Cost	(C_{LC})	*$91,390*	/yr	**(Eq. 14)**
Annual Productivity Value	(C_{AC})	*$365,267*	/yr	**(Eq. 15)**

Proposed Conditions

Unit Output	(β_P)	*870*	units/hr	**(N. 4, Rf. 3)**
Machine Changeover Time	(t_P)	*5*	hrs	**(Rf. 4)**
Productivity Lost	(UP_{LP})	*188,500*	units/yr	**(Eq. 12)**
Annual Productivity	(UP_{AP})	*3,616,300*	units/yr	**(Eq. 13)**
Lost Productivity Cost	(C_{LP})	*$23,563*	/yr	**(Eq. 14)**
Annual Productivity Value	(C_{AP})	*$452,038*	/yr	**(Eq. 15)**

Savings

Lost Productivity Savings	(UP_{LS})	*542,620*	units/yr	**(Eq. 16)**
Annual Productivity Gain	(UP_{AS})	*694,163*	units/yr	**(Eq. 17)**
Lost Productivity Cost Savings	(C_{LS})	*$67,828*	/yr	**(Eq. 18)**
Annual Productivity Gain Value	(C_{AS})	*$86,770*	/yr	**(Eq. 19)**

Notes

N. 4) Analysts were provided a vendor analysis with four options for upgrading their SBM machines. The value represents the average of the four different new output rates.

Equations

Eq. 11) Weekly Changeovers per Machine (n_3)

$$\frac{n_2}{n_1}$$

Eq. 12) Productivity Lost ($UPL_{[C,P]}$)

$$n_3 \times \beta_{[i]} \times t_{[i]} \times 52 \frac{wks}{yr}$$

Eq. 13) Annual Productivity ($UP_{A[C,P]}$)

$$t_{OP} \times \beta_{[i]}$$

Eq. 14) Lost Productivity Cost ($C_{L[C,P]}$)

$$IC_P \times UP_{L[i]}$$

Eq. 15) Annual Productivity Value ($C_{A[C,P]}$)

$$IC_P \times UP_{A[i]}$$

Eq. 16) Lost Productivity Savings (UP_S)

$$UP_{LC} - UP_{LP}$$

Eq. 17) Annual Productivity Gain (UP_S)

$$UP_{AP} - UP_{AC}$$

Eq. 18) Lost Productivity Cost Savings (UP_S)

$$C_{LC} - C_{LP}$$

Eq. 19) Annual Productivity Gain Value (UP_S)

$$C_{AP} - C_{AC}$$

References

Rf. 4) Obtained from machine vendor during research.

3 - AR No. 1 - Analysis

Oregon State University | Energy Efficiency Center

Original Template May 2016, style 2013b

Implementation Cost Analysis

Current Machine Retrofit

SBM Machine Retrofit Cost	($C_{SBM,C}$)	*$904,667*		**(Rf. 3)**
SBM Mold Cost	(C_{MC})	*$0*		**(N. 5, Rf. 3)**
Number of SBM Molds	(n_{MC})	*0*		**(N. 5, Rf. 3)**
Total Machine Installation Costs	(C_{INT})	*$40,000*		**(N. 7, Rf. 3)**
Implementation Cost	(C_{IC})	***$944,667***		**(Eq. 20)**

Proposed Machine Replacement

SBM Machine Cost	($C_{SBM,P}$)	*$566,280*		**(Rf. 3)**
SBM Mold Cost	(C_{MP})	*$160,000*		**(Rf. 3)**
Number of SBM Molds	(n_{MP})	*4*		**(N. 6, Rf. 3)**
Total Machine Installation Costs	(C_{INT})	*$40,000*		**(N. 7, Rf. 3)**
Implementation Cost	(C_{IP})	***$1,246,280***		**(Eq. 20)**

Economic Results

Annual Cost Savings	(S)	***$157,793***	/yr	**(Eq. 21)**
Incremental Implementation Cost	(C_I)	***$301,613***		**(Eq. 22)**
Simple Payback	(t_{PB})	***1.9***	yrs	**(Eq. 23)**

Notes

N. 5) The facility would reuse current molds when retrofitting the current machine.

N. 6) Analysts were provided with the total molds the facility would need if the facility were to purchase six new machines. Analysts assumed the molds would be purchased incrementally in parallel with the new machines.

N. 7) Analysts did not account for possible facility systems upgrades.

Equations

Eq. 20) Implementation Cost ($C_{I[C,P]}$)

$$C_{SBM} + (C_{M[i]} \times n_{M[i]}) + C_{INT}$$

Eq. 21) Annual Cost Savings (S)

$$C_{ES} + C_{DS} + C_{LS} + C_{AS}$$

Eq. 22) Incremental Implementation Cost (C_I)

$$C_{IP} - C_{IC}$$

Eq. 23) Simple Payback (t_{PB})

$$\frac{C_I}{S}$$

3 - AR No. 1 - Incentive Analysis

Oregon State University | Energy Efficiency Center

Incentive Analysis template June 2016, Style 2016

Incentive Data

Annual Energy Savings	(E_s)	***44,306***	kWh	**(Rf. 1)**
Implementation Cost	(C_I)	***$301,613***		**(Rf. 1)**
Annual Cost Savings	(S)	***$157,793***	/yr	**(Rf. 1)**
Simple Payback	(t_{PB})	***1.9***	years	**(Rf. 1)**

Incentive Analysis Summary

No Incentives Found

This recommendation does not reduce significant energy use and the incentive value is marginal; analysts did not consider typical incentives. This does not necessarily mean incentives are unavailable; custom incentives can sometimes be arranged.

References

Rf. 1) Developed in this recommendation on the previous pages.