## Recommendation

Install a 150 hp motor to replace the 250 hp motor on mixing tank, this will allow normal mixing operations to continue and reduce associated annual energy consumption by 40.0%.

### Annual Savings Summary

| *Source* | *Quantity* | *Units* | *Cost Savings* |
|---|---|---|---|
| Electrical Consumption | 45,213 | kWh (site) | $2,645 |
| Electrical Demand | 942 | kW Months / yr | $5,152 |
| **Total** | **154** | **MMBtu** | **$7,797** |

### Implementation Cost Summary

| *Description* | *Cost* | *Payback (yrs.)* |
|---|---|---|
| Before Incentives | $13,333 | 1.7 |
| After Incentives | $5,333 | 0.7 |

## Facility Background

The facility uses one 250 hp motor for mixing asphalt and flux into a heterogeneous mixture which is applied to the shingles. Facility personnel estimated the mixing process runs for approximately 48 hours per month. This motor is fixed on the roof of a tank. Facility personnel informed analysts that this motor was now oversized since the installation of a new agitator has reduced load on this motor. Facility personnel told analysts the motor could be replaced with a 150 hp motor to perform the same operation. On assessment day, the facility was not mixing, which prevented analysts from retrieving a live reading of the motor under load.

## Opportunity Background

The efficiency of a motor is greatly influenced by the percent of full-load amperage it experiences while operating. Oversized motors perform effectively when under a large load, but are less efficient than a motor that is sized for the same load. Replacing an oversized motor with an appropriately sized one represents a significant energy savings opportunity.

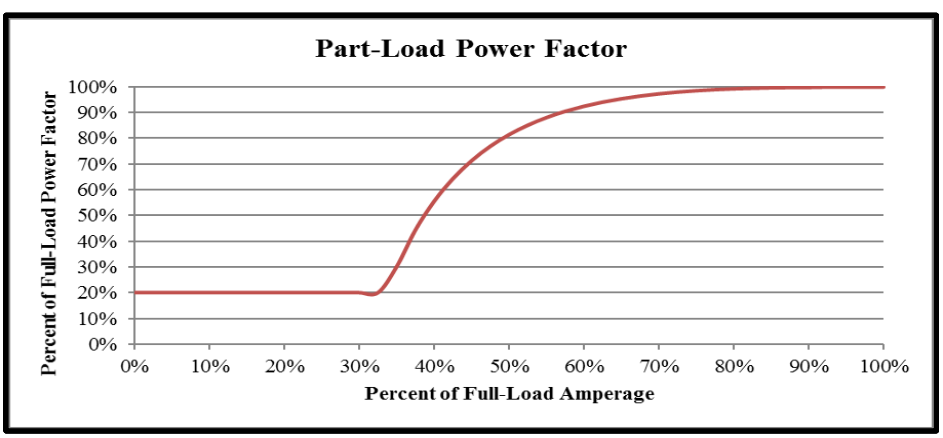


Figure 2-1 Efficiency curve of a typical motor. [1]

## Proposal

Install a 150 hp motor to replace the current 250 hp motor used to mix hot asphalt in the mixing tank.Annual cost savings are estimated at $7,797 after an implementation cost of $13,333 resulting in a simple payback period of 1.7 years.

## Implementation

The existing 250 hp motor should be removed from the mixing tank. A 150 hp motor can be installed with the same equipment used to remove the current motor. According to RSMeans [1], the material cost of a 150 hp motor is $12,600 with a $730 installation.

## Incentives

Energy Trust of Oregon provides incentives for industrial projects involving motor replacement. The typical incentive is $0.25 per annual kWh saved, up to 50% of the project cost.

## Calculation Methodology

Analysts estimate the load using the Motor Analysis Tool, assuming that the maximum load applied to the proposed 150 hp motor is the maximum load rated for that motor. The same load is applied to the 250 hp motor. Energy savings is calculated from the difference in electricity consumption by the current 250 hp motor and the proposed 150 hp motor.

## Notes

Because live readings were not available, analysts must estimate the load based on the sizing of the motor proposed by the facility.

## References

[1] A. C. Charest, Ed., *RSMeans Electrical Cost Data 2015* , 38th ed. Norwell, MA: RSMeans, 2014, p. 303.

[2] US Department of ENergy, “Motor Tip Sheet #3.” National Renewable Energy Laboratory, Jan-2000.

# Motor Analysis Tool - Datalog (MAT)

Oregon State University | Energy Efficiency Center

*Motor Datalog Analysis Tool Nov. 2013a, style 2013b*

## Motor Identification

| | | |
|---|---|---|
| Motor Description | *Current Mixer Motor* | |
| Motor Location | *Hot asphalt tanks* | |

## Data Collected

### *Motor Nameplate Data*

| | | | | |
|---|---|---|---|---|
| Motor Power Supply Type | | *Three-Phase AC* | | **(N. 1)** |
| Motor Enclosure Type | | *TEFC* | | **(N. 1)** |
| Motor Drive Type | | *Standard V-Belt* | | **(N. 1)** |
| Rated Horsepower | ($W_R$) | *250.0* | hp | **(N. 1)** |
| Rated Voltage | ($V_R$) | *460* | volts | **(N. 1)** |
| Rated Full-Load Amperage | ($I_R$) | *285.0* | amps | **(N. 1)** |
| Rated Full-Load Speed | ($N_R$) | *1,180* | rpm | **(N. 1)** |

### *Operation Data*

| | | | | |
|---|---|---|---|---|
| Montly Operation Hours | ($t_M$) | *48* | hrs/month | **(N. 2)** |

## Motor Performance Analysis

| | | | | |
|---|---|---|---|---|
| Mechanical Drive Efficiency | ($\eta_D$) | *93.0%* | | **(Rf. 1)** |
| Synchronous Speed | ($N_S$) | *1,200* | rpm | |
| Full-Load Amperage | ($I_R$) | *285.0* | amps | |
| Full-Load Efficiency | ($\eta_{FL}$) | *95.0%* | | **(Rf. 2)** |
| Full-Load Power Factor | ($PF_{FL}$) | *83.0%* | | |
| Full Load Power | ($P_{FL}$) | *196.24* | kW | **(Eq. 1)** |

## Energy Analysis

### *Current Conditions*

| | | | | |
|---|---|---|---|---|
| Annual Operation Hours | ($t_O$) | *576* | hrs | **(N. 2, Eq. 2)** |
| Energy Demand | ($E_D$) | *2,355* | kW-mo/yr | **(Eq. 3)** |
| Energy Consumption | ($E_C$) | *113,032* | kWh/yr | **(Eq. 4)** |

## Notes

**N. 1)** Nameplate data was collected during the site assessment from site personnel and equipment.

**N. 2)** Estimate obtained from facility personnel based on monthly production data.

**N. 3)** Obtained from USDOE Motor Tip Sheet #3 [2].

**N. 4)** Obtained from NEMA Standards Publication MG 1-2006 (Premium Efficiency Motors).

## Equations

**Eq. 1)** Full Load Power ($P_{FL}$)

$$\frac{W_R}{\eta_{FL}} \times \frac{0.7457\ kW}{1\ hp}$$

**Eq. 2)** Annual Operation Hours ($t_O$)

$$t_M \times \frac{12 months}{year}$$

**Eq. 3)** Electrical Demand ($E_D$)

$$P_{FL} \times \frac{12 months}{year}$$

**Eq. 4)** Energy Consumption ($t_O$)

$$P_{FL} \times t_O$$

# Motor Analysis Tool - Datalog (MAT)

Oregon State University | Energy Efficiency Center

*Motor Datalog Analysis Tool Nov. 2013a, style 2013b*

## Motor Identification

| | | |
|---|---|---|
| Motor Description | *Proposed Mixer Motor* | |
| Motor Location | *Hot asphalt tanks* | |

## Data Collected

### *Motor Nameplate Data*

| | | | | |
|---|---|---|---|---|
| Motor Power Supply Type | | *Three-Phase AC* | | **(N. 1)** |
| Motor Enclosure Type | | *TEFC* | | **(N. 1)** |
| Motor Drive Type | | *Direct Drive* | | **(N. 1)** |
| Rated Horsepower | ($W_R$) | *150.0* | hp | **(N. 1)** |
| Rated Voltage | ($V_R$) | *460* | volts | **(N. 1)** |
| Rated Full-Load Amperage | ($I_R$) | *163.0* | amps | **(N. 1)** |
| Rated Full-Load Speed | ($N_R$) | *1,180* | rpm | **(N. 1)** |

### *Operation Data*

| | | | | |
|---|---|---|---|---|
| Montly Operation Hours | ($t_M$) | *48* | hrs/month | **(N. 2)** |

## Motor Performance Analysis

| | | | | |
|---|---|---|---|---|
| Mechanical Drive Efficiency | ($\eta_D$) | *99.5%* | | **(Rf. 1)** |
| Synchronous Speed | ($N_S$) | *1,200* | rpm | |
| Full-Load Amperage | ($I_{FL}$) | *163.0* | amps | |
| Full-Load Efficiency | ($\eta_{FL}$) | *95.0%* | | **(Rf. 2)** |
| Full-Load Power Factor | ($PF_{FL}$) | *83.0%* | | |
| Full Load Power | ($P_{FL}$) | *117.74* | kW | **(Eq. 1)** |

## Energy Analysis

### *Proposed Conditions*

| | | | | |
|---|---|---|---|---|
| Annual Operation Hours | ($t_O$) | *576* | hrs | **(N. 2, Eq. 2)** |
| Energy Demand | ($E_D$) | *1,413* | kW-mo/yr | **(Eq. 3)** |
| Energy Consumption | ($E_C$) | *67,819* | kWh/yr | **(Eq. 4)** |

## Notes

**N. 1)** Nameplate data was collected during the site assessment from site personnel and equipment.

**N. 2)** Estimate obtained from facility personnel based on monthly production data.

**N. 3)** Obtained from USDOE Motor Tip Sheet #3 [2].

**N. 4)** Obtained from NEMA Standards Publication MG 1-2006 (Premium Efficiency Motors).

## Equations

**Eq. 1)** Full Load Power ($P_{FL}$)

$$\frac{W_R}{\eta_{FL}} \times \frac{0.7457\ kW}{1\ hp}$$

**Eq. 2)** Annual Operation Hours ($t_O$)

$$t_M \times \frac{12 months}{year}$$

**Eq. 3)** Electrical Demand ($E_D$)

$$P_{FL} \times \frac{12 months}{year}$$

**Eq. 4)** Energy Consumption ($t_O$)

$$P_{FL} \times t_O$$

# 3 - AR No. 2 - Analysis

Oregon State University | Energy Efficiency Center

*Replace Oversized Motor, style 2018 v1.0*

## Key Input Data

### *Recommendation Data*

| | | | | |
|---|---|---|---|---|
| Current Operation Time | ($t_C$) | *576* | hrs./yr. | **(N. 1)** |
| Total System Energy | ($E_T$) | *113,032* | kWh | |

### *Electricity Data*

| | | | | |
|---|---|---|---|---|
| Incremental Electricity Cost | ($IC_E$) | *$0.0585* | /kWh | **(N. 3)** |
| Current Electrical Consumption | ($E_{C,E}$) | *113,032* | kWh | **(N. 2)** |
| Proposed Electrical Consumption | ($E_{P,E}$) | *67,819* | kWh | |

### *Demand Data*

| | | | | |
|---|---|---|---|---|
| Incremental Demand Cost | ($IC_D$) | *$5.47* | /kW·mo | **(N. 3)** |
| Current Electrical Demand | ($E_{C,D}$) | *2,355* | kW·mo | |
| Proposed Electrical Demand | ($E_{P,D}$) | *1,413* | kW·mo | |

## Energy Analysis

### *Current Conditions*

| | | | | |
|---|---|---|---|---|
| Current Electrical Consumption | ($E_{C,E}$) | *113,032* | kWh | |
| Current Electrical Demand | ($E_{C,D}$) | *2,355* | kW·mo | |
| Current Energy Cost | ($C_C$) | *$19,493* | /yr. | **(Eq. 1)** |

### *Proposed Conditions*

| | | | | |
|---|---|---|---|---|
| Proposed Electrical Consumption | ($E_{P,E}$) | *67,819* | kWh | |
| Proposed Electrical Demand | ($E_{P,D}$) | *1,413* | kW·mo | |
| Proposed Energy Cost | ($C_P$) | *$11,696* | /yr. | **(Eq. 1)** |

### *Savings*

| | | | | |
|---|---|---|---|---|
| Electrical Savings | ($E_{S,E}$) | *45,213* | kWh | **(Eq. 2)** |
| Demand Savings | ($E_{S,D}$) | *942* | kW·mo | **(Eq. 2)** |
| Cost Savings | (S) | *$7,797* | /yr. | **(Eq. 3)** |

## Equations

### *Analysis Equations*

**Eq. 1)** Energy Cost (C)

$$\sum E \times IC$$

**Eq. 2)** Energy Savings ($E_S$)

$$E_C - E_P$$

**Eq. 3)** Cost Savings (S)

$$C_C - C_P$$

## Notes

**N. 1)** Current operating hours of the energy consuming system.

**N. 2)** Developed on the Motor Analysis Tool pages of this recommendation.

**N. 3)** Developed in the Utility Analysis section of this report.

# 3 - AR No. 2 - Implementation

Oregon State University | Energy Efficiency Center

*Replace Oversized Motor, style 2018 v1.0*

## Implementation Cost Analysis

### *Material Costs*

| | | | | |
|---|---|---|---|---|
| 150 hp Motor | ($C_{M1}$) | *$12,600* | /unit | **(N. 4)** |
| Quantity | (Q) | *1* | unit | |
| Total Material Cost | ($C_M$) | *$12,600* | | **(Eq. 4)** |

### *Labor Costs*

| | | | | |
|---|---|---|---|---|
| Electrician Labor Rate | ($R_L$) | *$55* | /hr | **(N. 4)** |
| Electrician Labor Hours | ($t_L$) | *13.3* | hours | **(N. 4)** |
| Total Labor Cost | ($C_L$) | *$733* | | **(N. 4)** |

## Economic Results

| | | | | |
|---|---|---|---|---|
| Annual Cost Savings | (S) | *$7,797* | /year | **(Eq. 4)** |
| Implementation Cost | ($C_I$) | *$13,333* | | **(Eq. 5)** |
| Simple Payback | ($t_{PB}$) | *1.7* | years | **(Eq. 6)** |

## Incentive Data

| | | | | |
|---|---|---|---|---|
| Annual Energy Savings | ($E_s$) | *45,213* | kWh | **(Eq. 2)** |

## Equations

**Eq. 4)** Total Material Cost ($C_M$)

$$C_{M1} \times Q$$

**Eq. 5)** Total Material Cost ($C_M$)

$$C_M + C_L$$

**Eq. 6)** Simple Payback ($t_{PB}$)

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

## Notes

**N. 4)** Obtained from RSMeans Electrical Cost Data page 303 [1].

## Incentive Analysis Summary

| *Description* | *Incentive* | *After* | *Payback* (yrs) | *Notes* |
|---|---|---|---|---|
| *Energy Trust of Oregon* | *$8,000* | *$5,333* | *0.7* | *$0.25 per annual kWh saved, up to 60 - 75% of project cost.* |
| **Totals** | *$8,000* | *$5,333* | *0.7* | |