3 - AR No. # - Install Humidity Controls

Original Template Apr 2018, style 2018 v1.0

Recommendation

Install humidity controls on Paint Booth 2. This will increase first-pass yield by 10% and reduce annual repainting and refinishing time by 11%.

Annual Savings Summary

Source	*Quantity*	*Units*	*Cost Savings*
Labor Hours	320	hrs	$20,800

Implementation Cost Summary

Description	*Cost*	*Payback (yrs)*
Implementation Cost	$7,140	0.3

Facility Background

The facility currently has two paint booths for use in the production line: Paint Booth 1 and 2. Paint Booth 2 is mainly used for painting large dome structures used in aerospace applications. According to facility personnel, Paint Booth 2 needs to be maintained between 45-60% relative humidity to ensure proper curing. Facility personnel estimated an 80% first-pass yield out of Paint Booth 2, mainly due to incorrect relative humidity in the paint booth, resulting in 40 domes being refinished each year. Each time a dome does not pass the quality check, the dome must be sanded and repainted through an estimated eight-hour job. Facility personnel were interested in installing humidity controls on Paint Booth 2 to achieve a first-pass yield of at least 90%.

Opportunity Background

Humidity and temperature have a large influence in the paint curing process. As ambient temperature decreases, paint coating thickens, resulting in a longer time for solvent to evaporate. A longer curing time results in more time for the paint to run and higher chance of wrinkling. When relative humidity is higher than 65% the paint is exposed to a greater concentration of water in the air, also resulting in a longer curing time. When relative humidity is too low, the paint will dry too quickly, resulting in cracks. In general, the optimum curing conditions are 60-80 °F and 40-65% relative humidity [1]. Ambient temperature is usually easy to control without special equipment but relative humidity is not. The facility is currently meeting temperature requirements in Paint Booth 2, but relative humidity often differs from the ideal 40-65%. Relative humidity controllers can be installed in paint booths that measure the relative humidity of the air and adjust the moisture content according to a user-set relative humidity.

3 - AR No. # - Install Humidity Controls

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Proposal

Install humidity controls on Paint Booth 2. This will increase first-pass yield to at least 90%. Annual cost savings are estimated at $20,800 after an implementation cost of $7,140 resulting in a simple payback period of 0.3 years.

Implementation

The humidifier and controller will work in conjunction with the paint booth fan to maintain the 45-60% relative humidity range. If the measured relative humidity is beneath 45%, the humidifier will turn on. If the measured relative humidity is above 60%, the paint booth fan will increase air flow rate. Due to air quality requirements, the fan must remain on at a certain air flowrate even if the relative humidity is below 45%.

Incentives

This recommendation does not decrease energy consumption and will likely not qualify for typical incentives. This does not necessarily mean incentives are unavailable; custom incentives can sometimes be arranged.

Calculation Methodology

Annual cost savings were calculated assuming the first-pass yield can be increased from 80% to 90%. Facility personnel mentioned a 90% first-pass yield has been achieved before. For labor savings, the time spent repainting poor quality domes was multiplied by the hourly rate of the painter to calculate an annual cost savings.

Next Steps

Analysts recommend that an in-depth analysis of the humidification requirements be performed to adequately size a humidifier for Paint Booth 2. To do this, exact dimensions of the paint booth, temperature of the paint booth, incoming air flowrate, and make-up air flowrate are required. This information could not be obtained for this recommendation.

Notes

The facility is currently meeting customer demand; however, additional sales revenue would be available in the form of increased throughput if demand for domes were to increase.

Additional savings will arise from decreased paint use. These savings were not included due to insufficient paint use data.

Facility personnel only expressed interest in improving first-pass yield through Paint Booth 2.

References

[1] The Importance of Paint Booth Humidification System. (2017). [online] smartfog.com. Available at: http://www.smartfog.com/importance-of-paint-booth-humidification-systems.html [Accessed 6 Apr. 2018].

[2] RSMEANS. (2016). RSMeans Mechanical Cost Data 2016. [S.l.]: GORDIAN, p.420.

3 - AR No. # - Analysis

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Data Collected

Production Data

Monthly Unit Production	(P_{UM})	*30*	units	**(N. 1)**
First-Pass Yield	(Y_{FP})	*80%*		**(N. 1)**

Labor Data

Time per Unit	(t_U)	*8*	hrs/unit	**(N. 1)**
Labor Cost	(C_L)	*$65*	/hr	**(N. 1)**

Production Analysis

Current Conditions

Annual Unit Production	(P_{UA})	*360*	units	**(Eq. 1)**
First-Pass Yield	(Y_{FPC})	*80%*		**(N. 1)**

Proposed Conditions

Annual Unit Production	(P_{UA})	*360*	units	**(N. 2)**
First-Pass Yield	(Y_{FPP})	*90%*		**(N. 3)**

Labor Analysis

Current Conditions

Annual Labor Hours	(H_{LC})	*2,880*	hrs	**(Eq. 2)**
Annual Labor Cost	(C_{LC})	*$187,200*		**(Eq. 3)**

Proposed Conditions

Annual Labor Hours	(H_{LP})	*2,560*	hrs	**(Eq. 4)**
Annual Labor Cost	(C_{LP})	*$166,400*		**(Eq. 5)**

Savings Analysis

Labor Savings

Annual Labor Hour Savings	(S_{LH})	*320*	hrs	**(Eq. 6)**
Annual Labor Cost Savings	(S_{LC})	*$20,800*		**(Eq. 7)**

Equations

Eq. 1) Annual Unit Production (P_{UA})

$$P_{UM} \times 12\ months$$

Eq. 2) Current Annual Labor Hours (H_{LC})

$$t_U \times P_{UA}$$

Eq. 3) Current Annual Labor Cost (C_{LC})

$$H_{LC} \times C_L$$

Eq. 4) Proposed Annual Labor Hours (H_{LP})

$$H_{LC} - \left[\left(\frac{P_{UA}}{Y_{FPP}} - P_{UA}\right) \times t_U\right]$$

Eq. 5) Proposed Annual Labor Cost (C_{LP})

$$H_{LP} \times C_L$$

Eq. 6) Annual Labor Hour Savings (S_{LH})

$$H_{LC} - H_{LP}$$

Eq. 7) Annual Labor Cost Savings (S_{LC})

$$S_{LH} \times C_L$$

Notes

N. 1) Obtained from facility personnel.

N. 2) Annual unit production will not be changing, only the amount of units refinished.

N. 3) Facility personnel mentioned a 90% first-pass yield is achievable when the relative humidity is within appropriate range.

3 - AR No. # - Implementation

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Vendor Data

Vendor Quote #1	(V_1)	*$7,140*		**(N. 4)**

Implementation Cost Analysis

Material Costs

Humidifier Unit	(C_{HU})	*$5,950*	/unit	**(N. 4)**
Quantity	(Q_{HU})	*1*	units	
Electric Controls	(C_{EC})	*$805*	/unit	**(N. 4)**
Quantity	(Q_{EC})	*1*	units	
Total Material Cost	(C_M)	*$6,755*		**(Eq. 8)**

Labor Costs

Electrician Labor Rate	(R_L)	*$55*	/hr	**(N. 4)**
Electrician Labor Hours	(t_L)	*7*	hrs	**(N. 4)**
Total Labor Cost	(C_L)	*$385*		**(Eq. 9)**

Economic Results

Annual Cost Savings	(S)	*$20,800*		**(Eq. 10)**
Implementation Cost	(C_I)	*$7,140*		**(Eq. 11)**
Simple Payback	(t_{PB})	*0.3*	yrs	**(Eq. 12)**

Equations

Eq. 8) Total Material Cost (C_M)

$$C_{HU} \times Q_{HU} + C_{EC} \times Q_{EC}$$

Eq. 9) Total Labor Cost (C_L)

$$R_L \times t_L$$

Eq. 10) Annual Cost Savings (S)

$$S_{LC} + S_{PC}$$

Eq. 11) Implementation Cost (C_I)

$$C_M + C_L$$

Eq. 12) Simple Payback (t_{PB})

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

Notes

N. 4) Cost for a 100 lb/hr humidifier unit on automatic controls with blower and operation cost included. A mid to upper size humidifier was chosen based on a size estimation of the paint booth. A more in-depth analysis of humidification requirements should be performed prior to sizing a humidifier [2].