CHAPTER 9

CONCLUSION AND RECOMMENDATOINS

9.1 Conclusions

9.1.1 Thesis approach is started from studying actual working at cleaning process of reworked part. I have made further study to search more information from text book, Internet, technical abstract which related to CO_2 cleaner parameter setting in order to make this thesis completely.

9.1.2 Study work instruction in each cleaning process, actual operation factor influence and part cleanliness analysis.

9.1.3 Consider the Pros and Cons if we implement CO_2 cleaner for reworked part. More study about impact the quality of Base Machine consequential applying CO_2 cleaning on surface of Base machine. The result after visual mechanical inspection on surface of Base machine, acoustic test and function test, all have passed. And their yield comparison are same as normal yield.

9.1.4 Identify the problem related to particle contamination at reworked line and analyze what kind of particle contamination. All particles are harmful to hard drive function must be removed after CO_2 cleaning. After checking the result of samples that we submitted to Material Laboratory, the harmful particle (i.e. Stainless) wasn't detected. However, aluminum can be found, but the amount is very low. This level is acceptable, it won't effect to Hard disk malfunction.

9.1.5 Collect data from normal process. The data were collected from 7 weeks continuously. The result is very useful information, it can make us more understanding that the particles are significantly removed after applying CO_2 cleaner.

9.1.6 Conduct experiment to identify appropriate CO_2 cleaning conditions. Factorial design is used for this experiment. There are four factors and two levels (minimum and maximum level) were selected based on CO_2 cleaner maker recommendation and also we have preliminarily observed our normal process of CO_2 cleaning operation to find out the most influence factor can make different the part cleanliness level.

The Four factors with two levels (2^4), minimum and maximum level, of each factor are determined as below,

- Completed Dry Air Heater Temp.(C) 80 (min) - 120 (max)
- Pressure (PSI) setting 650 (min) - 950 (max)
- CO_2 amount setting 0.1 (min) - 1 (max)
- Distance of CO2 nozzle (Inch) 0.5 (min) - 2 (max)

9.1.7 Collect data from 16 experiments which having different parameter: Completed Dry Air Heater Temp, Pressure (PSI) setting, CO_2 amount setting and Distance of CO2 nozzle. There are three samples in each experiment.

9.1.8 Submit forty-eight samples to Material Laboratory for analysis. The Liquid Particle Count is measurement data that we need to know. Then takes those data for analysis of experiment.

9.1.9 Analyze all data with MINITAB software to find out an appropriate CO_2 cleaning condition.

9.1.10 Make decision an appropriate condition, from the result of experiment for finding appropriate condition. The parameter of temperature isn't significantly different. Therefore, we determine an appropriate conditions of CO_2 are [1] pressure 950 PSI, [2] CO_2 amount 0.1 And [3] Distance of CO_2 nozzle to 2 Inch.

9.1.11 Make confirmation experiment with selected best factors. There were six samples have done CO_2 cleaning for this confirmation.

9.1.12 Submit six samples to Material Laboratory for Liquid Particle Count analysis. Based on data, they show that the setting pressure to 950 PSI, CO_2 amount to 0.1 and set Distance of CO_2 nozzle 2 Inch. can keep the LPC data of reused part lower than another factor setting.

9.1.13 The results of this research can be concluded that Pressure (PSI) , CO_2 amount and Distance of CO_2 nozzle (Inch) are main effect to cleaning process. And this appropriate condition will be applied to the cleaning process, leading to the reduction of particles contamination. The appropriate condition are showed as follows,

1. Set pressure to 950 PSI
2. Set CO_2 amount to 0.1
3. Set Distance of CO_2 nozzle to 2 Inch

9.2 Recommendations for Experiment

9.2.1 The pressure limit of CO_2 tank between 650 – 950 PSI. From observation, If CO_2 volume in tank close to minimum level, the CO2 sprays out at nozzle not consistency. Experimenter needs more frequent check if CO_2 volume decreases to haft volume of CO_2 tank.

9.2.2 The measurement of reuse part cleanliness is showed quantitative data (counting number of particle only). If experimenter want to know the source of contamination, further analysis is required for qualitative data (know element of counted particles)

9.2.3 To make more accurate and precise data, the samples part after completed CO_2 cleaning must be kept in cleanroom plastic bag with seal. Then submits the samples Material Laboratory for further analysis.

9.3 Recommendations for Further Study

This experiment is performed to find out an appropriate CO_2 cleaner condition. After completed this trial, the parameter optimization are chosen for CO_2 cleaner set-up. Nevertheless, experimenter needs to do further study for reuse part cleanliness continuous improvement. The road map for continuous improvement are illustrated as tables below,

Further Study Procedure	Technique
1. Analyze improved parameter	- Design of experiment (DOE) - Factorial design 2^k with center point
2.Optimise parameter	-Response Surface Methodology (RSM) -Measurement System Analysis (MSA)

Table 16 illustrate continuous improvement

9.3.1 Analyze improved parameter

[1] Design of experiment, experimenter needs to understand the three basic principles of experimental design which are described as follows,

- Randomization The propose is to Balance out data from Noise effect. Trial of the experiment is to be performed is randomly determined. Statistical methods require that the observation (or errors) be independently distributed random variables. Randomization usually makes this assumption valid.

- Replication The propose is to average out data from and Noise effect. Replication has two important properties. First, it allows the experimenter to obtain an estimate of the experimental error. This estimate of error becomes a basic unit of measurement for determining whether observed differences in the data are really statistically different. Second, if the sample mean is used to estimate the effect of a factor in the experiment, replication permits the experimenter to obtain a more precise estimate of the effect.

- Blocking The propose is to reduce noise effect to make data more precision. Blocking is a design technique used to improve the precision with which comparisons among the factors of interest are made. Often blocking is used to reduce or eliminate the variability transmitted from nuisance factors.

[2] Factorial design 2^k with center point This is an additional method concerning center points to the 2^k design. A potential concern in the use of two-level factorial designs is the assumption of linearity in the factor effects. Of course, perfect linearity is unnecessary, and the 2k system will work quite well even when the linearity assumption holds only very approximately. In fact, we have noted that if interaction terms are added to a main effects or first-order model, resulting in

$$y = \beta_o + \sum_{j=1}^{k} \beta_j x_j + \sum_{i<j} \sum \beta_{ij} x_i x_j + \varepsilon$$

then we have a model capable of representing some curvature in the response function. This curvature, of course, results from the twisting of the plane induced by the interaction terms $\beta_{ij} x_i x_j$.

Factorial design 2^k with center point. The purpose of this experiment is to perform repeatability at center point to find out Pure Error (PE)

$$SSPE = \frac{n_F n_C (\overline{yF} - \overline{yC})^2}{n_F + n_C}$$

There is a method of replicating certain points in a 2k factorial that will provide protection against curvature from second order effects as well as allow an independent estimate of error to be obtained The method consist of adding center points to the 2k design.

9.3.2 Optimize parameter

1. Response Surface Methodology, or RSM is a collection of mathematical and statistical techniques that are useful for the modeling and analysis of problems in which a response of interest in influenced by several variables and the objective is to optimize this response. There is little curvature in the system and the first-order model will be appropriate. The objective is to lead the experimenter rapidly and efficiently along apart of improvement towards the general vicinity of the optimum.

2. Measurement System Analysis (MSA) The purpose is to consider attribute and variable data. We use Gage repeatability and reproducibility studies determine how much of we observed process variation is due to measurement system variation. The method breaks down the overall variation into three categories: part-to-part, repeatability, and reproducibility.