

CHAPTER 7

FACTOR SCREENING EXPERIMENT

7.1 Experiment and Data Collection

The experiment is designed for 16 trials which having different parameter: Completed Dry Air Heater Temp, Pressure (PSI) setting, CO₂ amount setting and Distance of CO₂ nozzle.

Factor Screening Experiment

There are four factors and two levels (minimum and maximum level) were selected based on CO₂ cleaner maker recommendation and also we have preliminarily observed our normal process of CO₂ cleaning operation to find out the most influence factor can make different the part cleanliness level.

The reason why minimum and maximum for each factor are determined to set, because of limited equipment setting and equipment range adjusting. Moreover, we made pilot experiment and found that setting at minimum and maximum point can get more significant data of part cleanliness.

The Four factors with two levels (2⁴), 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)
- CO₂ amount setting 0.1 (min) - 1 (max)
- Distance of CO₂ nozzle (Inch) 0.5 (min) - 2 (max)

Completed Dry Air Heater Temp.(C°) is factor A, and the two level are :
Completed Dry Air Heater Temperature 80 C° is represented by -1.
Completed Dry Air Heater Temperature 120 C° is represented by +1.

Pressure (PSI) setting is factor B, and the two level are :
Pressure (PSI) setting 650 is represented by -1
Pressure (PSI) setting 950 is represented by +1

CO₂ amount setting is factor C, and the two level are :
CO₂ amount setting 0.1 is represented by -1.
CO₂ amount setting 1 is represented by +1 ,

Distance of CO₂ nozzle (Inch) setting is factor D, and the two level are :
Distance of CO₂ nozzle (Inch) setting 0.5 is represented by -1.
Distance of CO₂ nozzle (Inch) setting 2 is represented by +1

A table for data collection of the experiment is design in table 7.

Run	Factor A	Factor B	Factor C	Factor D	Replicates		
					1	2	3
1	-1	-1	-1	-1			
2	+1	-1	-1	-1			
3	-1	+1	-1	-1			
4	+1	+1	-1	-1			
5	-1	-1	+1	-1			
6	+1	-1	+1	-1			
7	-1	+1	+1	-1			
8	+1	+1	+1	-1			
9	-1	-1	-1	+1			
10	+1	-1	-1	+1			
11	-1	+1	-1	+1			
12	+1	+1	-1	+1			
13	-1	-1	+1	+1			
14	+1	-1	+1	+1			
15	-1	+1	+1	+1			
16	+1	+1	+1	+1			

Table 7 illustrated the table for Data Collection of Factor Screening Experiment

7.2 Collected Data

Factor Screening Experiment

The data collection from the experiment is illustrated in table 8, and the four factors that are Completed Dry Air Heater Temperature, Pressure setting, CO₂ amount setting and Distance of CO₂ nozzle. And the level of the factors are represent as follows.

- Factor A is Completed Dry Air Heater Temp.(C°), -1 and +1 represent Temperature 80 C° and 120 C° respectively.
- Factor B is Pressure (PSI) setting, -1 and +1 represent Pressure 650 and 950 respectively
- Factor C is CO₂ amount setting, -1 and +1 represent CO₂ amount 0.1 and 1 respectively
- Factor D is Distance of CO₂ nozzle (Inch) setting, -1 and +1 represent Distance of CO₂ nozzle 0.5 and 2 respectively

Run	Factor A	Factor B	Factor C	Factor D	LPC		
					1	2	3
1	-1	-1	-1	-1	5,251	6,325	6,267
2	+1	-1	-1	-1	6,525	6,491	3,424
3	-1	+1	-1	-1	3,059	3,184	2,421
4	+1	+1	-1	-1	2,363	2,171	2,469
5	-1	-1	+1	-1	3,715	2,643	3,608
6	+1	-1	+1	-1	3,787	2,987	3,853
7	-1	+1	+1	-1	2,064	1,984	2,989
8	+1	+1	+1	-1	2,845	3,651	2,040
9	-1	-1	-1	+1	4,899	3,136	5,771
10	+1	-1	-1	+1	2,677	4,693	2,384
11	-1	+1	-1	+1	1,787	1,779	2,043
12	+1	+1	-1	+1	2,691	2,480	1,435
13	-1	-1	+1	+1	2,211	1,816	1,805
14	+1	-1	+1	+1	2,069	1,851	2,928
15	-1	+1	+1	+1	1,379	2,861	3,472
16	+1	+1	+1	+1	1,485	3,029	2,952

Table 8 illustrated the Data of Factor Screening Experiment

Remark : LPC = Liquid Particle Count

7.3 Data Analysis of Experiment

Factor Screening Experiment

From the data collection of the factor screening experiment and running an experiment to determine the actual effects of the four factors as follows,

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

Table 9 is illustrated measurement trial from 16 trials. There are three samples are representative from each trial. Then calculated the measurement data in average value for factorial design analysis.

Trial#	Heater Temp.(C)	Pressure (PSI)	CO2 Amount	CO2 Nozzle Distance(Inch)	Sample (PCs)	LPC Result (Count/Part)			
						Data#1	Data#2	Data#3	Average
1	80	950	0.1	0.5	3	3,059	3,184	2,421	2,888
2	80	950	0.1	2.0	3	1,787	1,779	2,043	1,869
3	80	950	1.0	2.0	3	1,379	2,861	3,472	2,577
4	120	650	0.1	2.0	3	2,677	4,693	2,384	3,252
5	120	950	1.0	0.5	3	2,845	3,651	2,040	2,845
6	80	650	0.1	2.0	3	4,899	3,136	5,771	4,602
7	120	650	1.0	0.5	3	3,787	2,987	3,853	3,542
8	80	650	1.0	0.5	3	3,715	2,643	3,608	3,322
9	120	950	0.1	0.5	3	2,363	2,171	2,469	2,334
10	80	950	1.0	0.5	3	2,064	1,984	2,989	2,346
11	120	650	0.1	0.5	3	6,525	6,491	3,424	5,480
12	80	650	1.0	2.0	3	2,211	1,816	1,805	1,944
13	120	650	1.0	2.0	3	2,069	1,851	2,928	2,283
14	120	950	0.1	2.0	3	2,691	2,480	1,435	2,202
15	80	650	0.1	0.5	3	5,251	6,325	6,267	5,948
16	120	950	1.0	2.0	3	1,485	3,029	2,952	2,489

Table 9 illustrated the parameter setting and measurement data

Graph below is an average data which calculated from three samples in each trial.

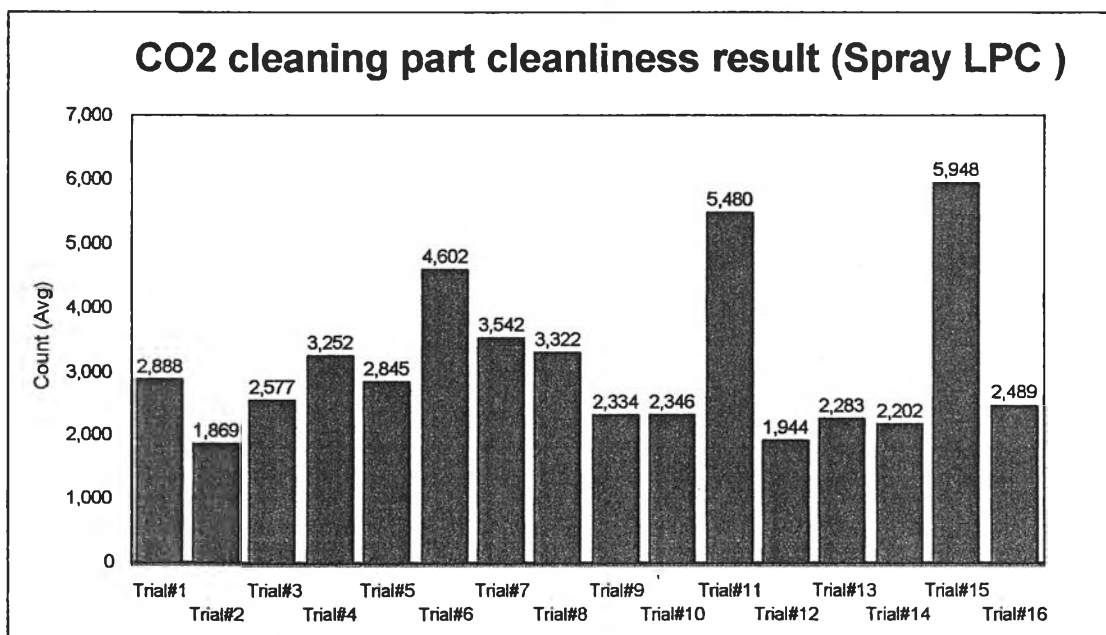


Figure 30 illustrated CO2 cleaning part result

To confirm what particle contamination left on Base machine. All particles are harmful to hard drive function must be removed after CO₂ cleaning. After checking the result of samples that we submitted to Material Laboratory, the harmful particle (i.e. Stainless) wasn't detected. Even though Aluminum can be found, but the amount is very low. This level is acceptable, it won't effect to scratch problem. See figure 31 for particle analysis result.

Label A: CF0597 MRG-L3 S/N K3G9D9AC

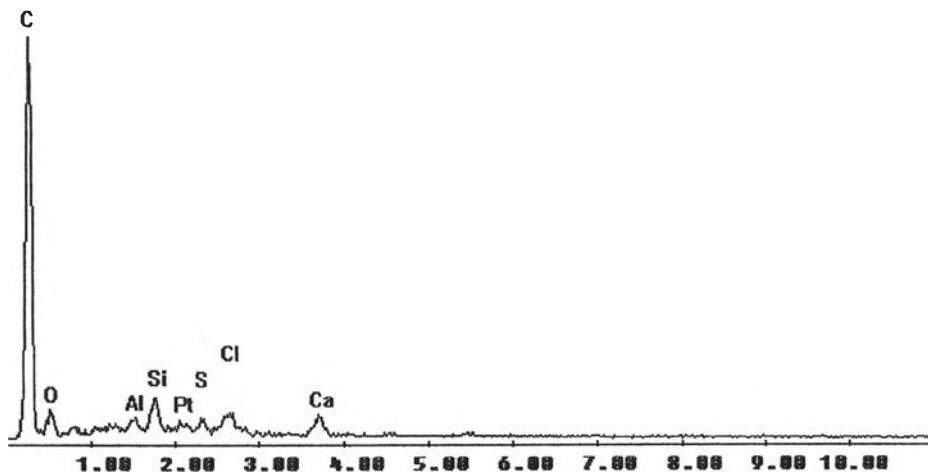


Figure 31 illustrated the spectrum of particle analysis by means of SEM

Source :Material Laboratory, IBM Storage Products (Thailand) limited

To confirm any defect on surface of Base Machine after cleaning with CO₂, currently we used DI water cleaning. There are 50 samples were picked up to check the surface under microscope 30 times. The result show no defect, dent and peeling-off are observed.

To confirm Hard Disk Drive function which are used the reworked Base machine. There are 3 tests provided for this item confirmation. 100 samples were tested as follows,

-Acoustic test, result showed that yield is not different if compare with new Base Machine.

-Reliability test, result showed that yield is not different if compare with new Base Machine.

- Function test, result showed that that yield is not different if compare with new Base Machine.