

Development of Electric Steam Type Dryer for Radiation Controlled Area

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LJIN Radiation Engineering Co., Ltd

Presentation

I. Introduction

II. Main subject

- 1 Performance of the current working clothes dryer and its defect
- 2 Development of Electric Steam type dryer
- 3 Development effect of Electric Steam type dryer
- 4 Extended suggestions in development of Electric Steam type dryer

III. Conclusion

I . Introduction

- Several troubles were incurred due to insufficient performance of the dryer for the radiation controlled area goods is not enough.
- Improving the drying performance and supplying the effective working
- Parallel development focusing on the decrease of radioactive waste amount generated by abrasion and damage

II. Main subject

Performance of the current working clothes dryer and its defects

Long time to dry fabrics

- Washing : 30 min, drying : 70 min
- Waiting time similar to a planning overhaul
- Increased abrasion and damage due to long washing time

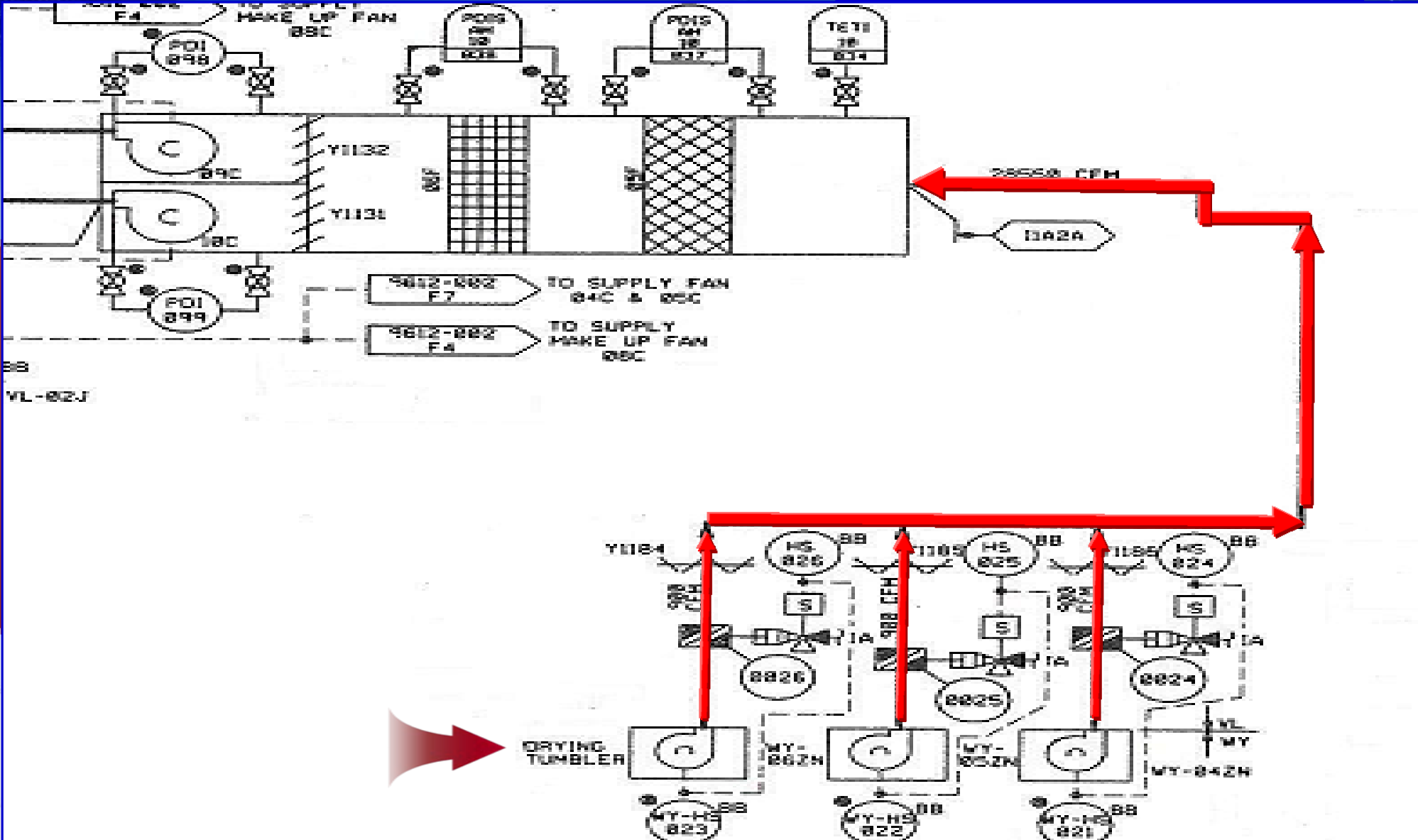


Problems from the dust filter

- Reduced hat air circulation effect due to accumulated dust
- Waiting time similar to a planning overhaul
- Decreased performance of filter system due to clogging
- Risk of air pollution's spreading

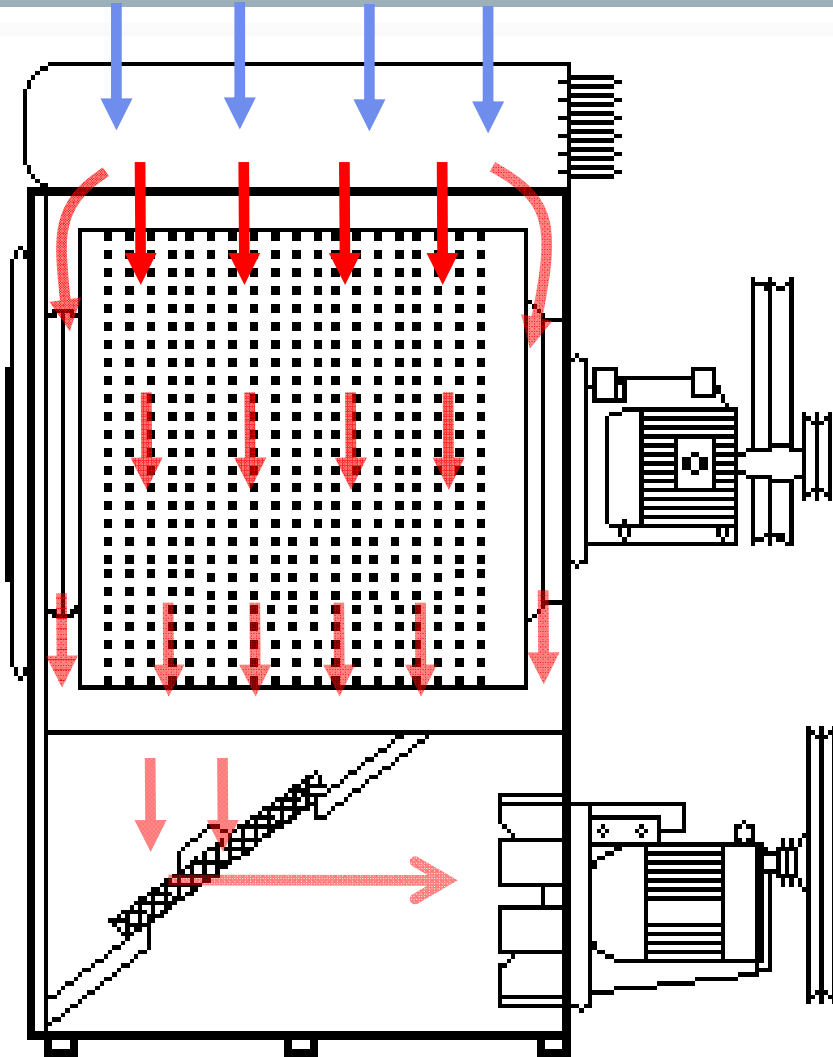


Performance of the current working clothes dryer and its defects



Development of Electric Steam type dryer

Defects in Electric Heater hot air circulation type



Insufficient hot air circulation due to adherence of clothes to the perforated plate

Most hot air is exhausted after just heating the surface of Basket

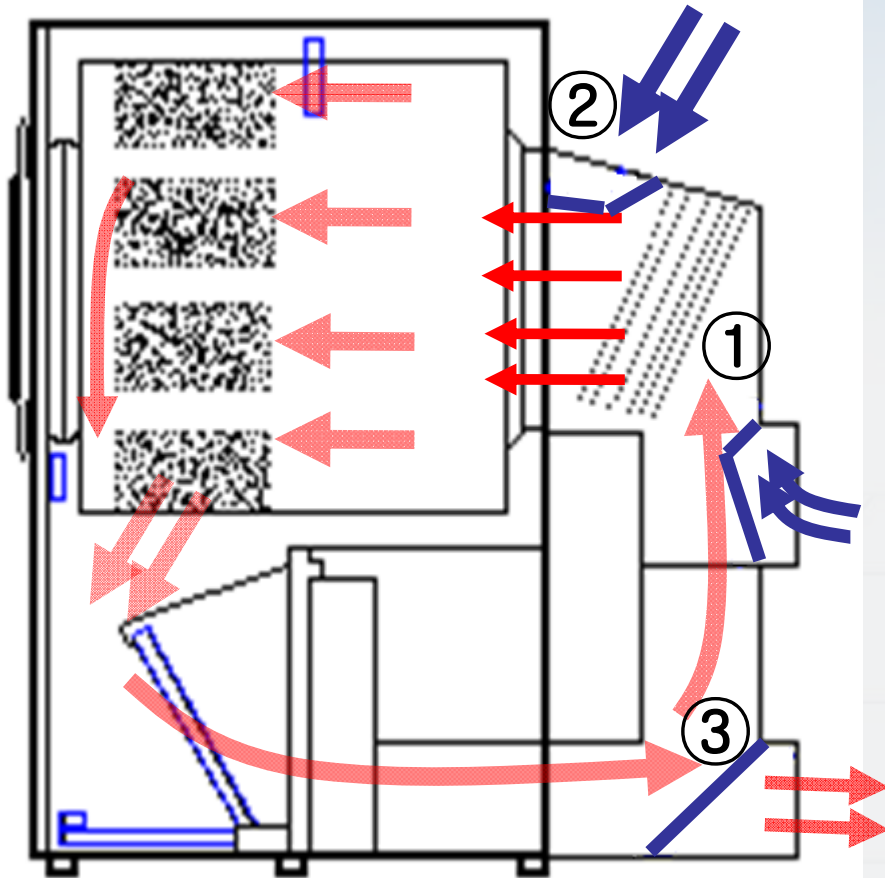
Increased drying time

Increased abrasion and damage on the working clothes

Heating and steaming type dryer from abroad are similar

Development of Electric Steam type dryer

Improved Electric Steam hot air circulation type



- Installed heat exchanger at the latter part of Basket
- Installed Vent Damper

- Chilly wind/vent Damper is closed during operation.
- Warm wind Damper is closed if it reaches the saturated level of water vapor pressure by hot air circulation

- Chilly wind/vent Damper is opened if drying is completed by humidity control system

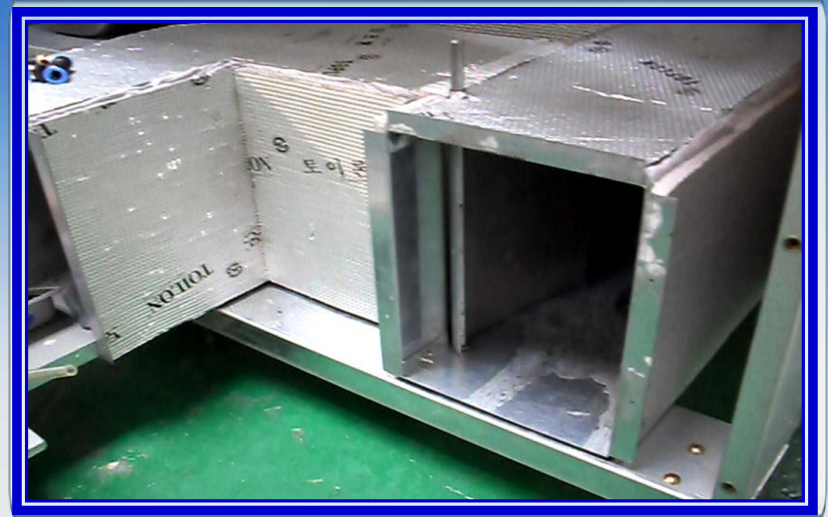
Development of Electric Steam type dryer

Main point No. 1 in hot air circulation technology development

1. Installed heat exchanger at the latter part of Basket

2. Changed design so that hot air can circulate inside the Basket

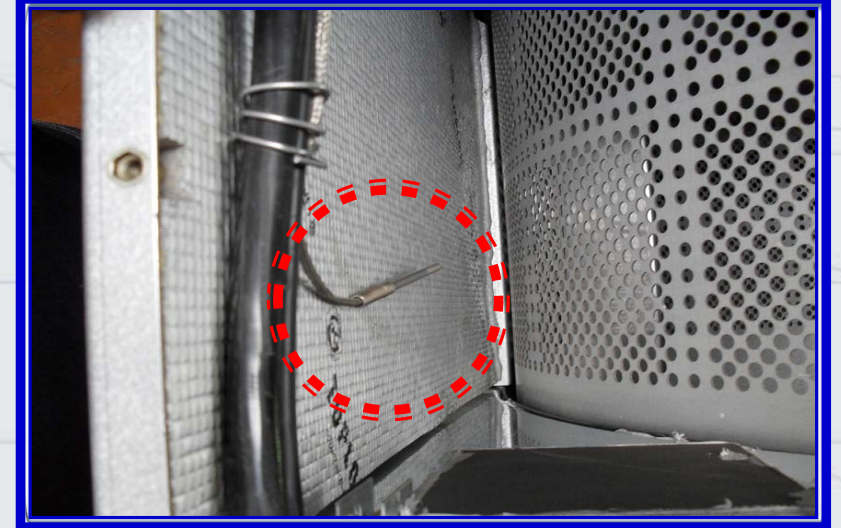
3. Installed Vent Damper so that hot air and steam can not escape at once



Development of Electric Steam type dryer

Main point No. 2 in hot air circulation technology development

1. Warm wind Damper of heat exchanger is closed if it reaches the proper saturated water vapor pressure.
2. Minimizing heat loss
3. Installed internal sensor to maintain precise temperature and humidity



Development of Electric Steam type dryer

Main point No. 3 in hot air circulation technology development

1. Amount of loading fabrics = Amount of steam in the dryer
2. Humidity control is important to keep steam amount constant
3. Installed control system so that it can work properly according to the operation condition

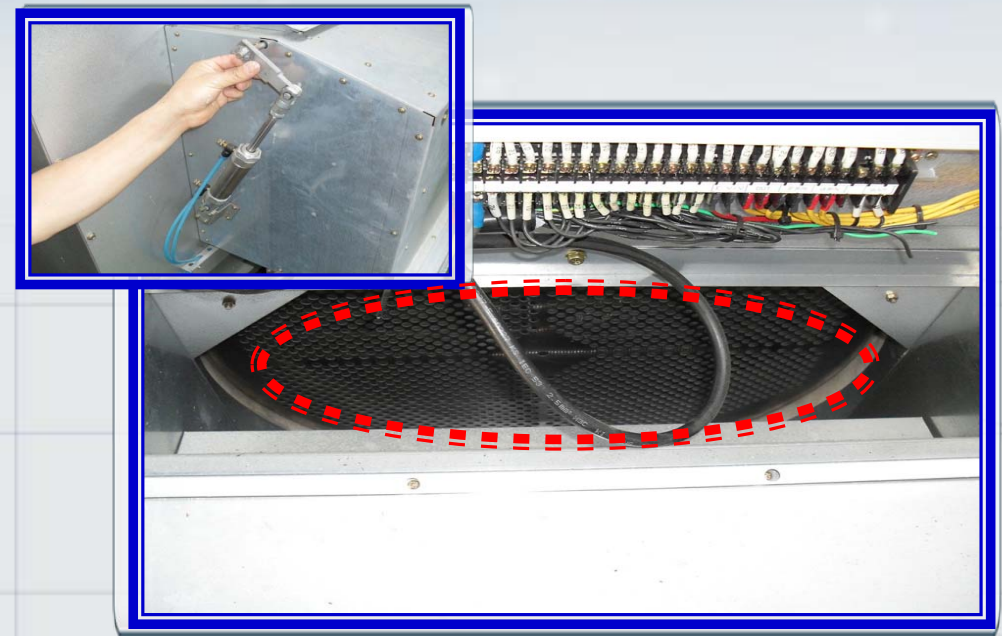
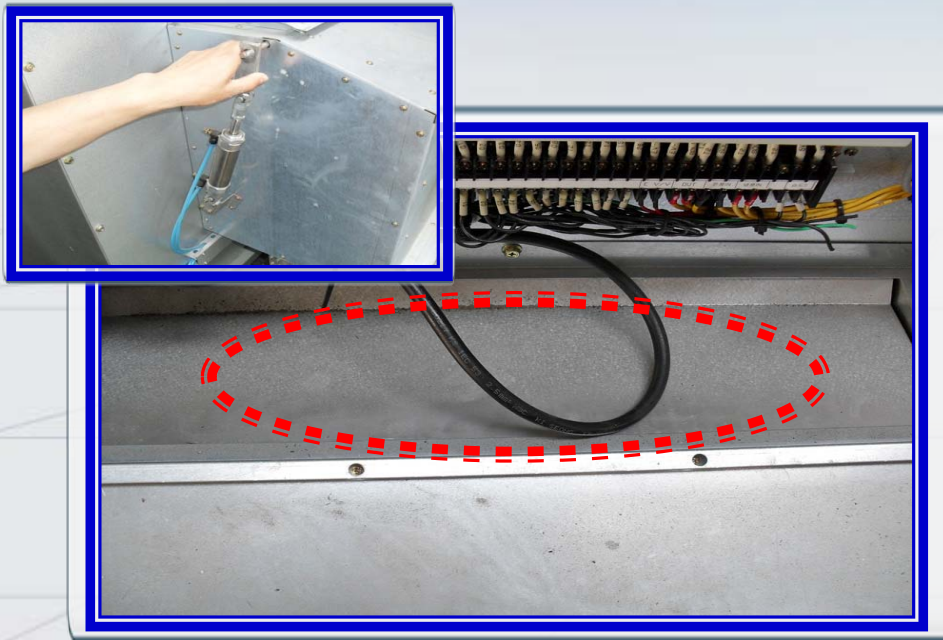


Development of Electric Steam type dryer

Main point No. 4 in hot air circulation technology development

1. Chilly air damper on the upper part is opened if drying is completed.
2. Vent damper is opened at the same time.

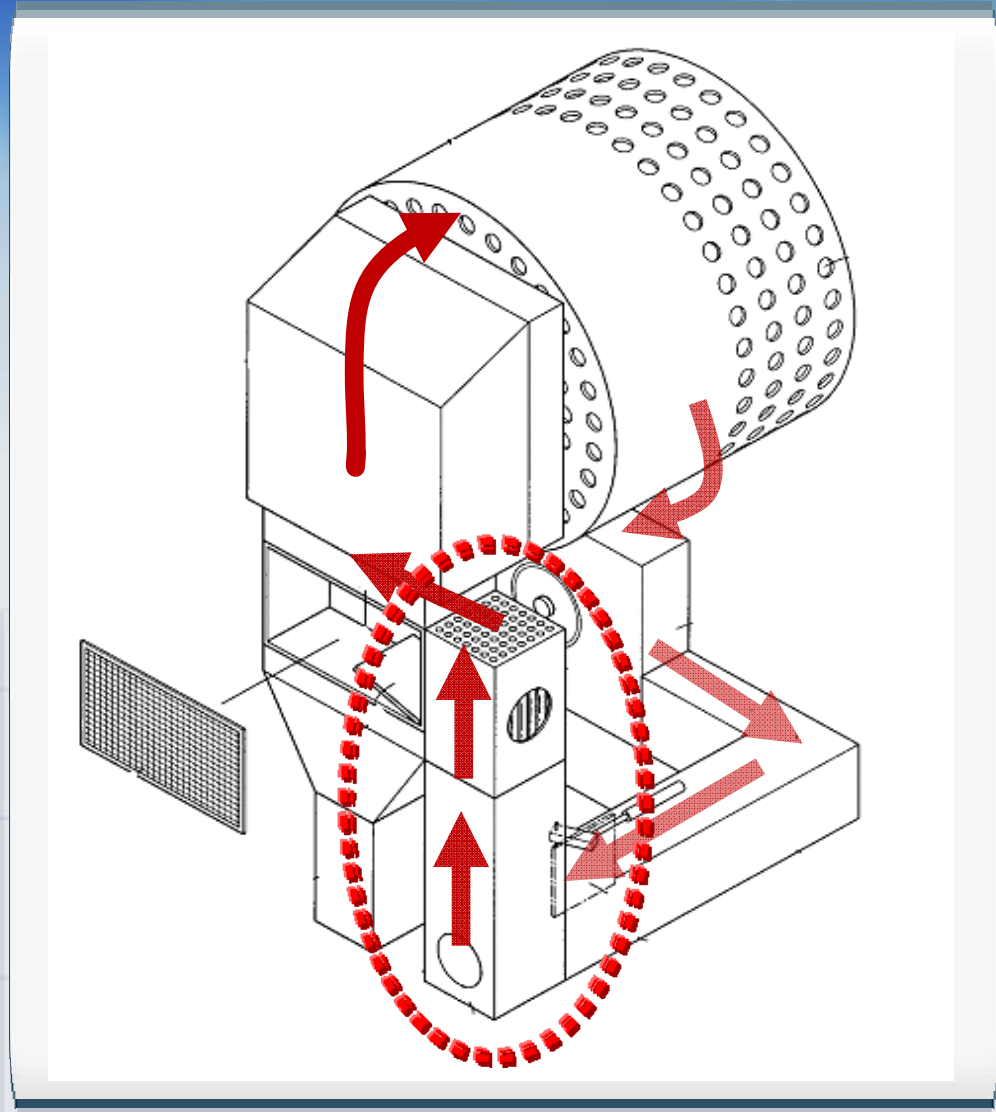
3. Chilly air period is minimized.
4. Dried state is good without wrinkle.



Development of Electric Steam type dryer

Main point No. 5 in hot air circulation technology development

- Recovering system of waste heat (superconducting heat pipe) is applied to Electric Steam dryer
- Recovered waste heat is circulated from the beginning of drying to the end
- Consumption of electric power : decreases by 60%.
- Drying time : decreases by 50%.

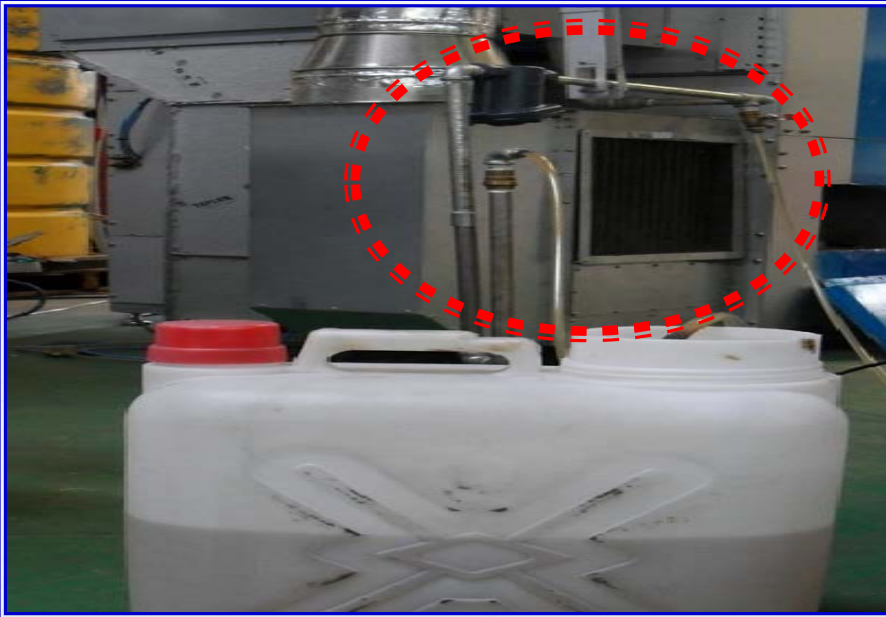


Development of Electric Steam type dryer

Main point No. 6 in hot air circulation technology development

1. Condensed water outlet is installed at the side face of the vent hole

2. Installed filter for blocking steam/ discharging condensed water



Development of Electric Steam type dryer

Evaluation of Electric Steam type washer & dryer

- Washing and spin-drying of pollution-free working cloths from radiation controlled area
- Pollution inspection/Transfer preparation



- Keep moisture from evaporating by using vacuumed pack, etc.
- Being transferred to the company with ice-box packing



- Drying working clothes by using electric steam dryer
- Checking the drying time and the dried state

Development of Electric Steam type dryer

Comparison of drying time and the dried state

Dried amount Type	Electric Heater	Electric Steam	Comparison
10 kg (8set)	40min	20min	Heater type requires 20 min. for pre-heating.
30 kg (24set)	70min	30min	If same period is applied, in case of Heater type, the remained moisture is found in some places such as pickpocket, collar, etc.
50 kg (40set)	80min	60min	

(required time for completing dry after washing and spin-drying)

Development of Electric Steam type dryer

Kind of dust filter and change order & Test 1

1. Current 5 mm dust filter and vent hole



2. Newly designed 5 μ m screen dust filter



Development of Electric Steam type dryer

Kind of dust filter and change order & Test 2

1. Outlet for sampling is installed at the vent hole behind the two kinds of dust filters
2. Air pollution degree is measured/analyzed with the same condition during operation



Development of Electric Steam type dryer

Kind of dust filter and change order & Test 3

(단위: Bq/cm³)

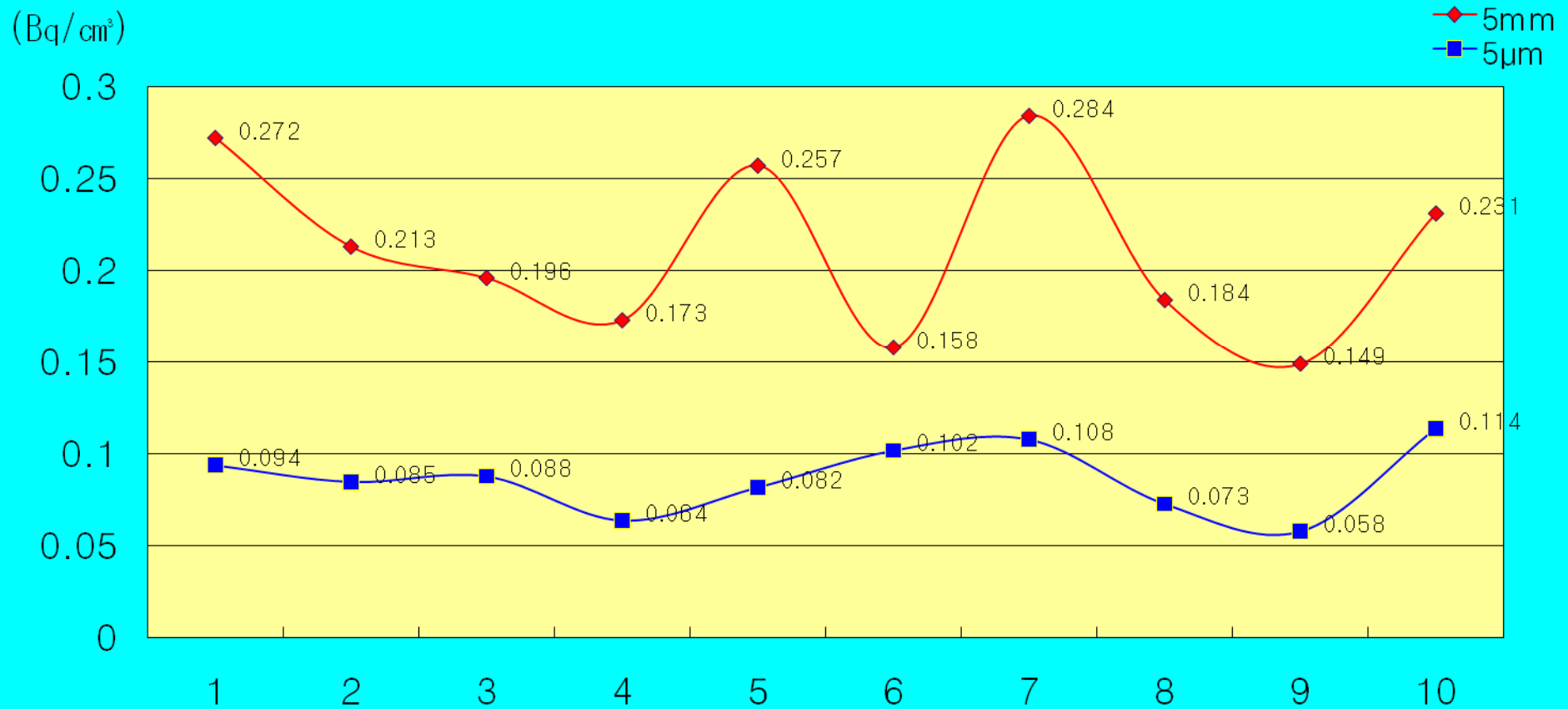
Frequency Method	1	2	3	4	5	6	7	8	9	10
5mm	0.272	0.213	0.196	0.173	0.257	0.158	0.284	0.184	0.149	0.231
5μm	0.094	0.085	0.088	0.064	0.082	0.102	0.108	0.073	0.058	0.114

(dust filter air pollution degree comparison table)

- Sample collection period is complete clying before 20 minutes and sample collect 10 minutes by same method
- New filter's air contamination reduction effect is more 50% than that of current dust filter(5mm)

Development of Electric Steam type dryer

Kind of dust filter and change order & Test 4



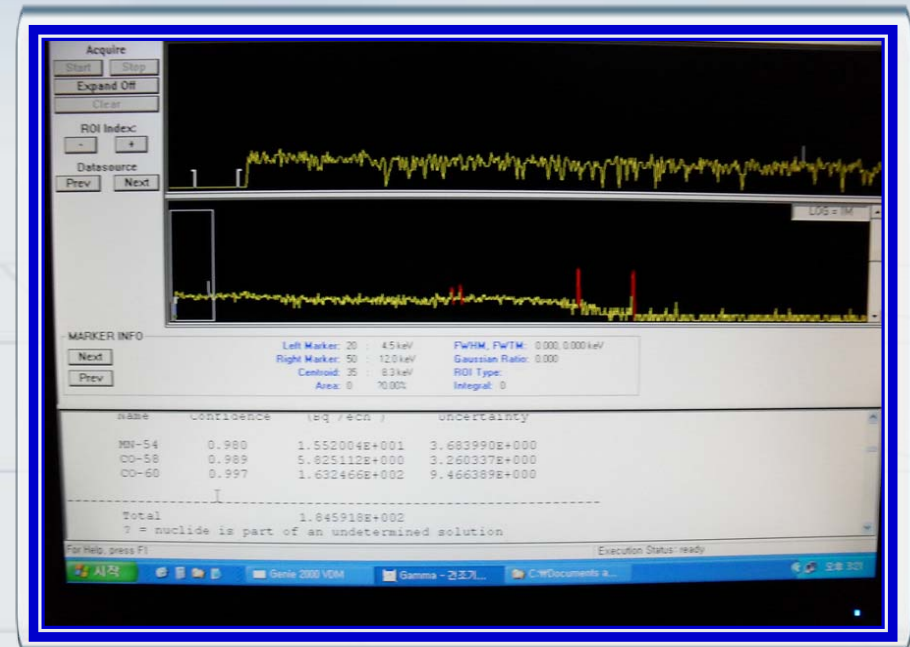
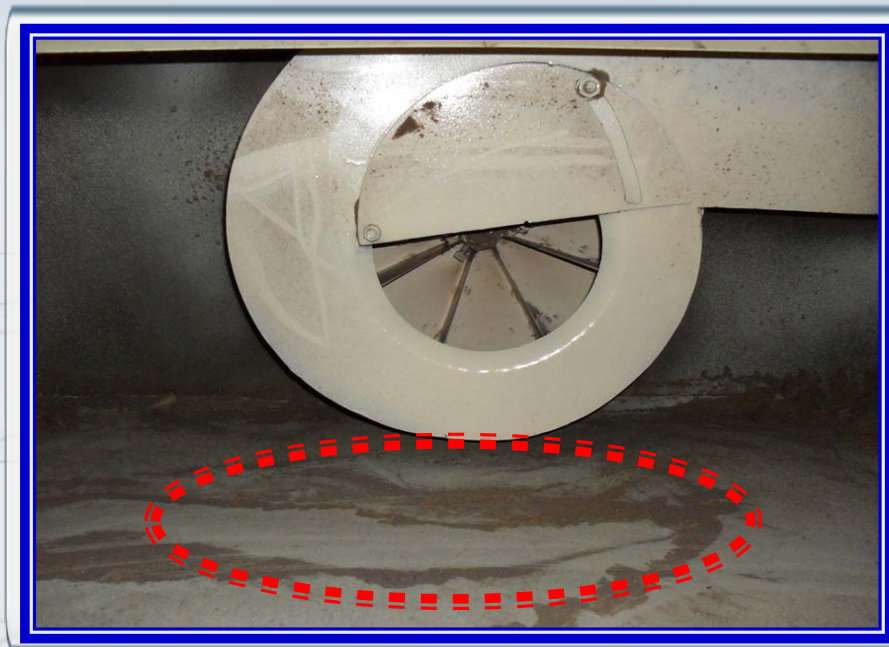
(dust filter air pollution degree comparison graph)

Development of Electric Steam type dryer

Kind of dust filter and change order & Test 5

1. State of the inside—remained dust after removing the dust filter

2. Nuclide analysis after collecting the remained dust



Development of Electric Steam type dryer

Kind of dust filter and change order & Test 6

(단위:Bq/g)

Method \ Nuclide				
	Mn-54	Co-58	Co-60	Total
5mm	1.55E+01	5.83E+00	1.63E+02	1.85E+02
5μm	N/D	4.13E+00	5.05E+00	9.10E+00

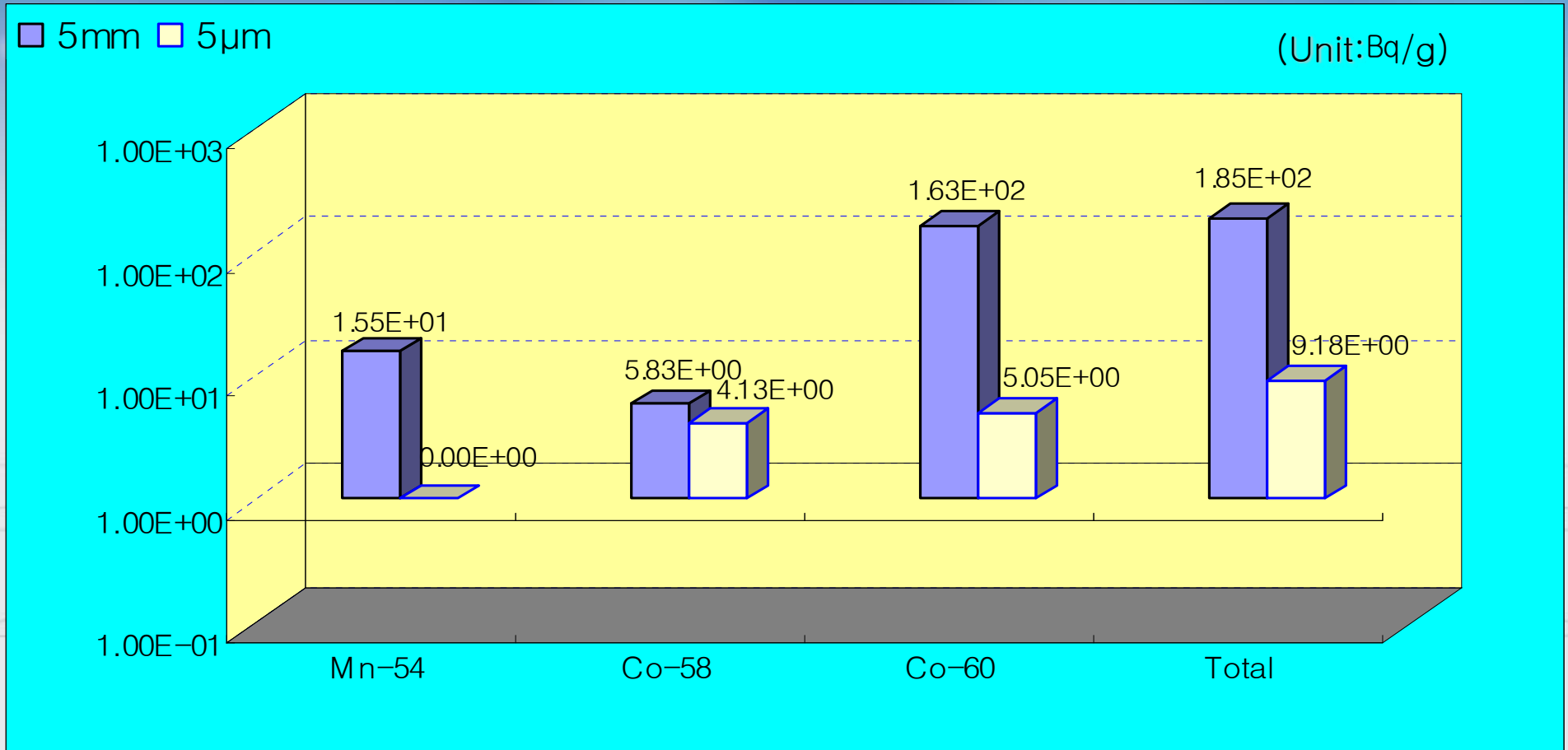
(remained dust nuclide analysis table)



It depends on the dried material, but, if seeing the nuclide analysis result during development period, in case of changing the dust filter, it shows that it decreases by more than 50% than before.

Development of Electric Steam type dryer

Kind of dust filter and change order & Test 7



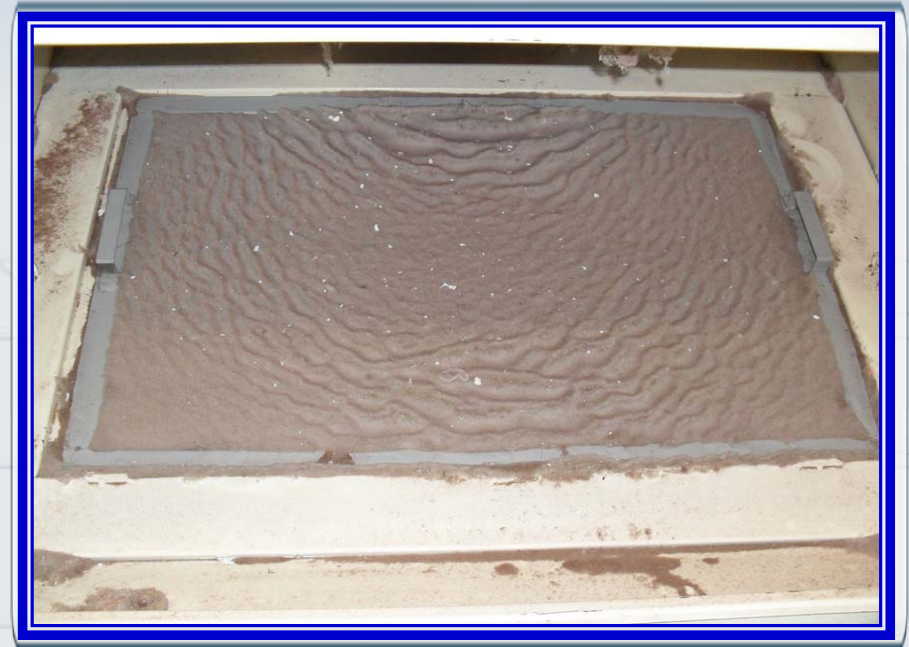
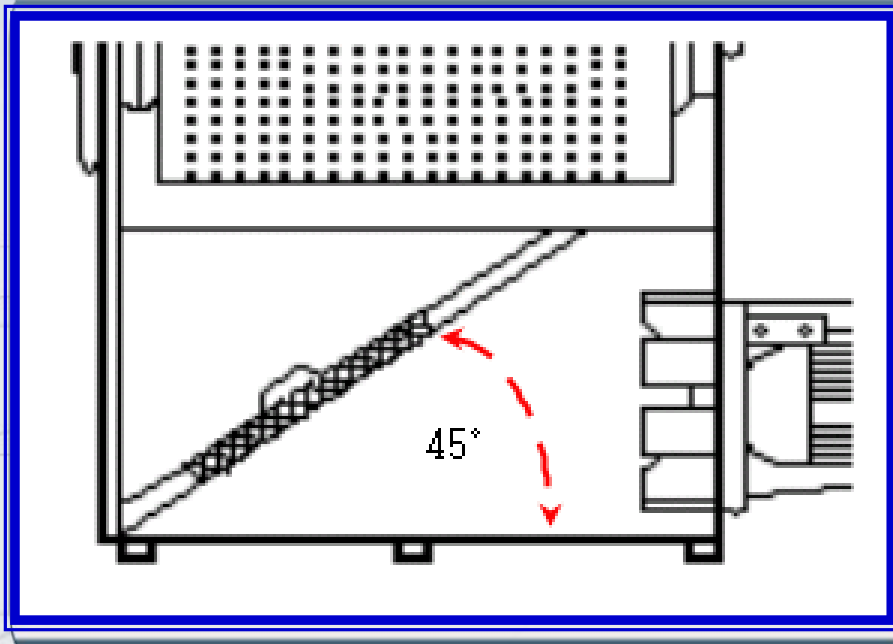
(remained dust nuclide analysis comparison table)

Development of Electric Steam type dryer

Kind of dust filter and change order & Test 8

1. Side view of the current type dust filter

2. Figure of fiber dust accumulated on the filter



Development of Electric Steam type dryer

Kind of dust filter and change order & Test 9

It is not easy to remove frequently



It is required to stop drying temporarily.

Interruption of hot air circulation



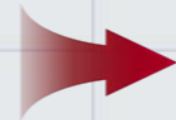
dryer's performance is decreased

Inflammable fiber dust



High fire risk during operation

Removing the dust inside the machine



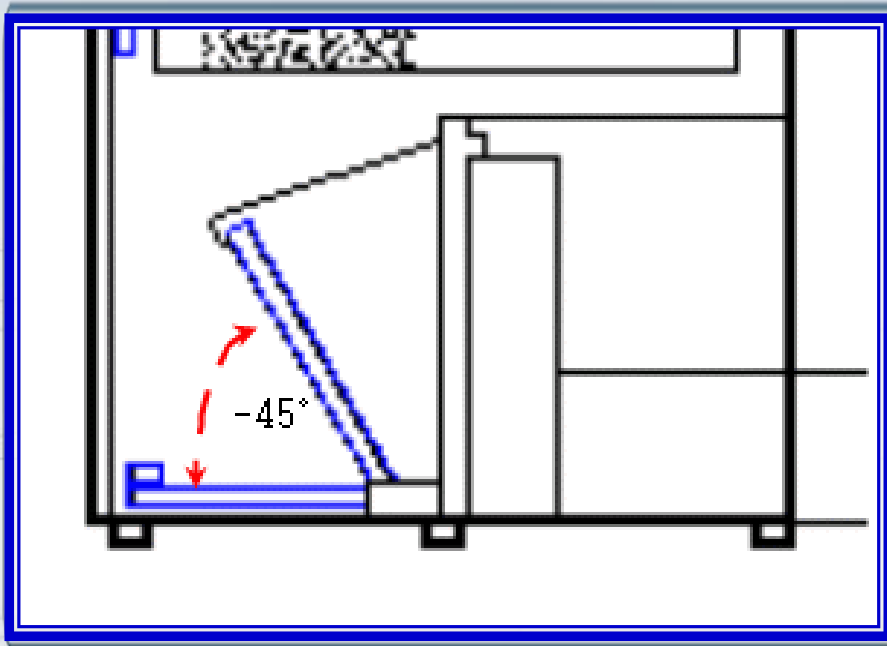
Exposed to the internal exposure

Development of Electric Steam type dryer

Kind of dust filter and change order & Test 10

1. Side view after the improved dust filter is installed

2. State of the dust inside the newly made dust filter



Development of Electric Steam type dryer

Kind of dust filter and change order & Test 11

Making dust go down before/after hot air circulation by 45° installing in the opposite direction

Screen mesh(T-No), which has excellent safety/strength in heat resistance /expansibility, is applied

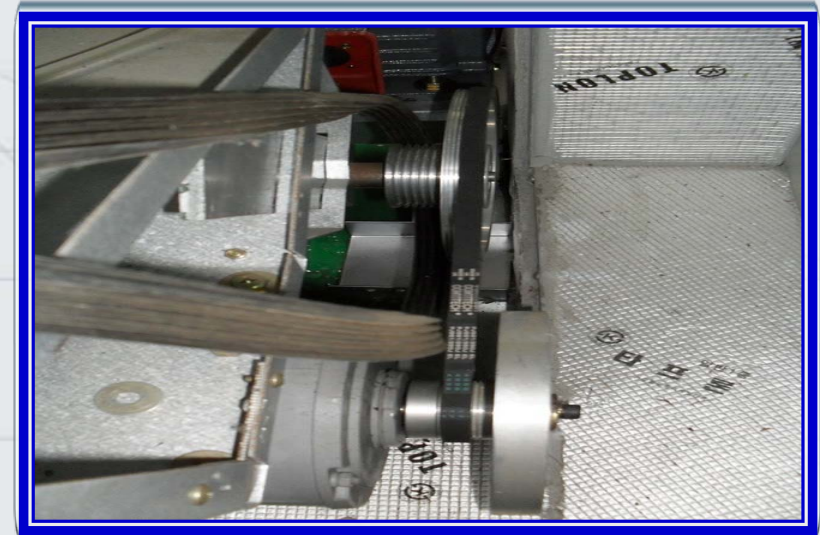
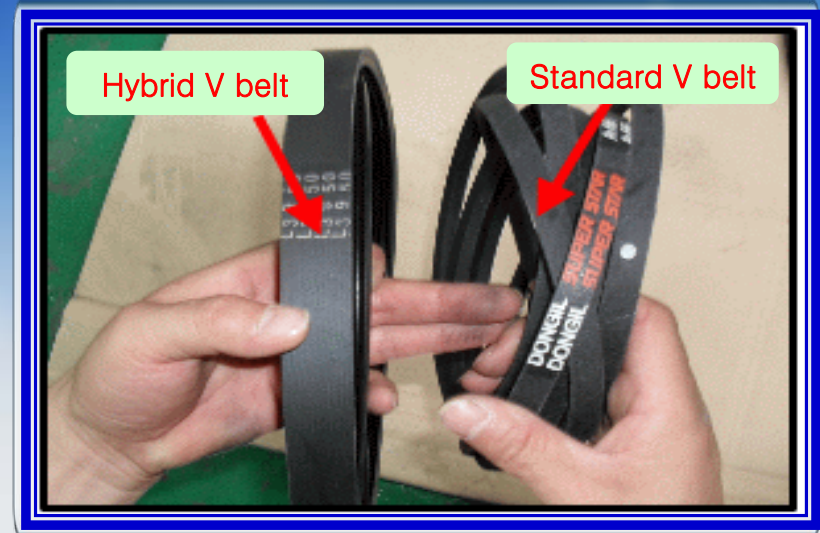
The dried state is excellent because of the smooth hot air circulation

Easy dust removal by the installed collector on the lower part of the filter

Development of Electric Steam type dryer

No.1 compensation of the current dryer's defects

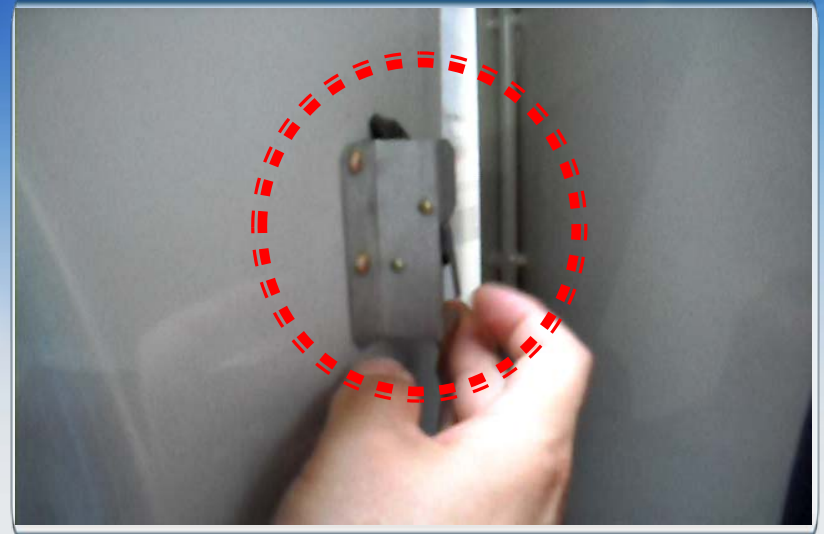
- Standard V belt inside the machine is cut off frequently because of its weakness property
- Combined V belt, which can be used semi-permanently, is applied.
- Figure before installing inside the machine



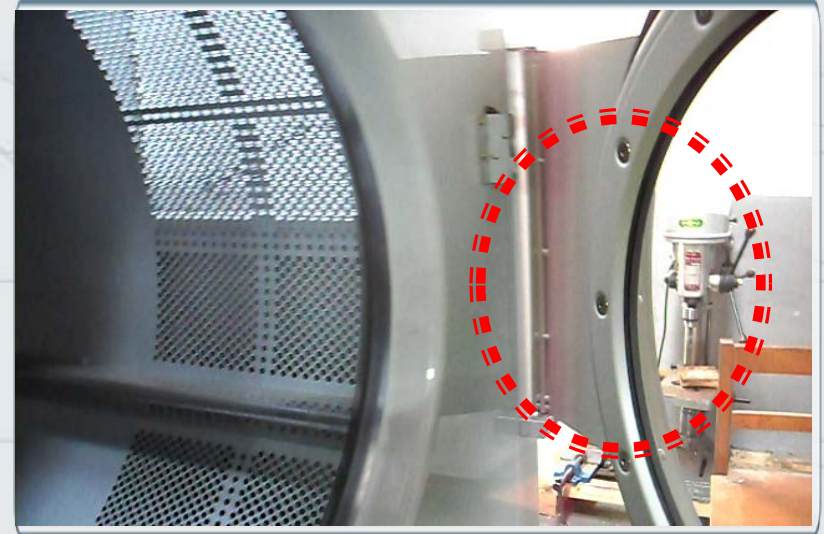
Development of Electric Steam type dryer

No.2 compensation of the current dryer's defects

- Installed inter-lock device, safety Device, at sliding door so that the basket is stopped when the door is opened randomly



- Planarization of the screws so that the abrasion by the inside-projections can be minimized



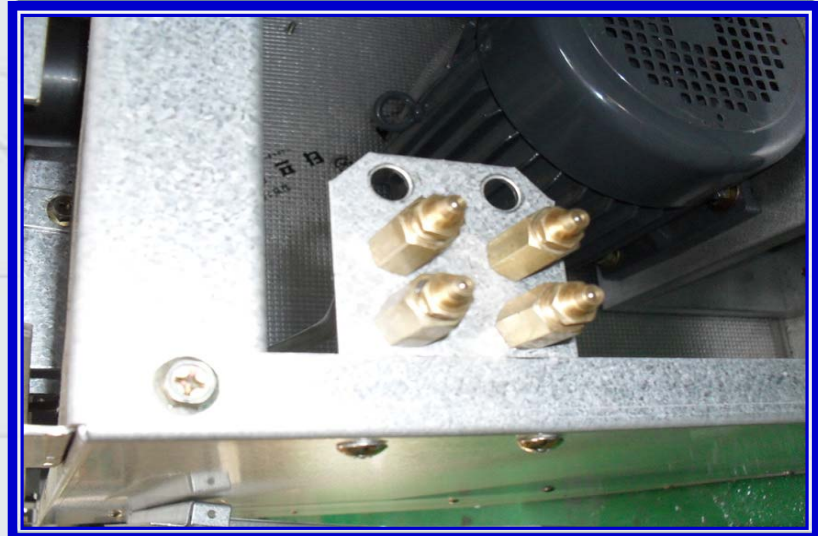
Development of Electric Steam type dryer

No.3 compensation of the current dryer's defects

- Current dryer is all-in-one, so it is not easy to transfer and dismantle for repairing.
(Figure after main body is dismantled)



- Being changing it to built-up-type to make maintenance easy
(Assembled part by screw at main body's edge)



Development of Electric Steam type dryer

Trial test No.1 on removing the particulate pollution

Purpose of Trial test

- Evaluating the removal degree of the particulate pollution, which exists between fibers, by using drier
- Proving that the particulate pollution degree can be decreased as water vapor is extracted and reacts as a mixed gas after reacting with the water-contained particle

Trial test method

- Gypsum coating on 10cm×10cm of washed/pin-dried 5 working clothes respectively
- Drying after it is applied equally to the current heater type and steam type

Development of Electric Steam type dryer

Trial test No.2 on removing the particulate pollution

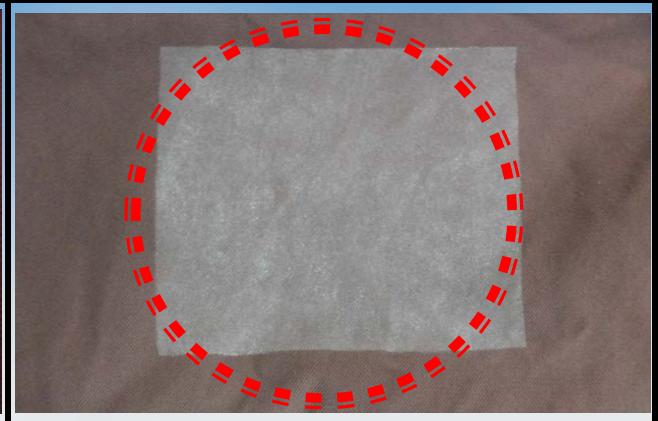
Trial test procedure and result



Picture after coating on the site-protective clothing



Coated part enlarged picture



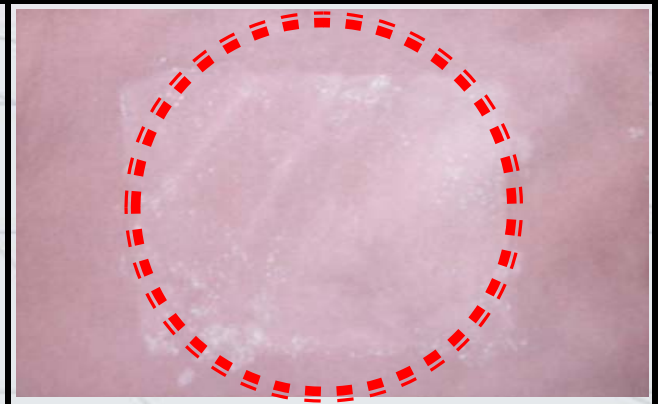
Picture after being dried by heater type



Picture after being coated by the company



Coated part enlarged picture



Picture after being dried by steam type

Development of Electric Steam type dryer

Trial test No.3 on removing the particulate pollution

Trial test result

- The removal degree of gypsum pack can not be identified visually
- In case of site-heater type, the result was secured after 40 min. drying, and in case of steam type, the result was secured after 17 min. drying
- If considering the completely dried time, it is expected to remove the particulate pollution

Development effect of Electric Steam type dryer

Tangible effect No. 1

Economical effect (individual performance comparison)

Division	Treated amount(kg) when operating 8 hrs	1 time cost (won)	annual operation cost(won)
Electric Heater 50Kg	368	1,729	6,003,339
Electric Heater 80Kg	521	2,882	9,465,311
Electric Steam	549	988	4,875,753

See the data of Korea Textile Machinery Research Institute

Development effect of Electric Steam type dryer

Tangible effect No. 2

Economical effect
(performance comparison when the same amount is treated, 549Kg)

Division	Division, 1 day/required time	monthly gas cost (won)	annual operation cost(won)
Electric Heater 50Kg	11.9	745,756	8,949,076
Electric Heater 80Kg	8.4	830,909	9,970,911
Electric Steam	8	406,313	4,875,753

See the data of Korea Textile Machinery Research Institute

Development effect of Electric Steam type dryer

Tangible effect No. 3

If they are compared with the consumed electric energy simply, the error can be generated in accuracy

By the same level's amount standard, the accumulated cost is the new dryer's price if it is used for more than 3 years

Drying time of working clothes is shortened(30~40%)

- Drying time can be shorten remarkably by improving the hot air circulation method
- Unnecessary waiting time can be reduced
- Damage and abrasion of working clothes are reduced

Development effect of Electric Steam type dryer

Intangible effect No. 1

Improved working surrounding by improving the dust filter

- the air pollution degree is decreased by using the newly manufactured dust filter (5 μ m)
- Dryer's fire risk and operator's internal exposure risk are decreased by the improved dust filter

Improved hot air circulation method and water collection method

- Working surrounding is improved because hot air and chill air are circulated inside the dryer
- Air circulation system's wholesomeness is maintained by collecting the water generated during drying

Development effect of Electric Steam type dryer

Intangible effect No. 2

Compensation of the current dryer's defects

- Using Hybrid V belt instead of standard V belt being cut off frequently
- Safety is emphasized by installing the basket stop switch on the sliding door
- Working clothes damage is minimized by minimizing the projects
- Designed as a built-up-type to make dismantle and maintenance easy

Extended suggestions in development of Electric Steam type dryer

Extended suggestion

Enlarging the using of the developed dryer

- In any water contained laundry, it is possible to dry without the damage by heat because it is not heater but steam type
- Cotton gloves and cotton socks from radiation controlled area can be dried perfectly without deformation
- Being testing on the proper temperature and saturated humidity in order to be applied to the recycling protectors such as rubber gloves, rag for removing pollution, etc

III. Conclusion

- Working surrounding is improved by the shortened working clothes drying time.
- Working clothes' abrasion and damage are minimized.
- The particulate pollution is prevented by the improvement of the filter.
- The improvement of protecting equipment in the radiation controlled area is led by preventing fire risk.

Thank you !!!



ILJIN Radiation Engineering Co., Ltd