We are making safe spaces to breathe!

4th 4th Generation Filter-less Fume Elimination System

TCM SOLUTION

4th Generation Filter-less Fume Elimination System

Air Tech.

AllsWell

AllsWell # 912, Smart Valley Building B, 30 Songdo Mirae-ro, Yeonsu-gu, Incheon
TEL 032) 225-5028, FAX 032) 225-5030
www.alls-well.co.kr

Leaping

Leaping from South Korea's first professional air technology company to become a world-renowned air technology specialist company.

AllsWell

ALLSWELL Website: http://www.alls-well.co.kr
(Scan the QR code to get connected to the website.)

Established in 2015, ALLSWELL is Korea's first company specializing in air technology and provides customized solutions based on an optimized design given space characteristics and air flow.

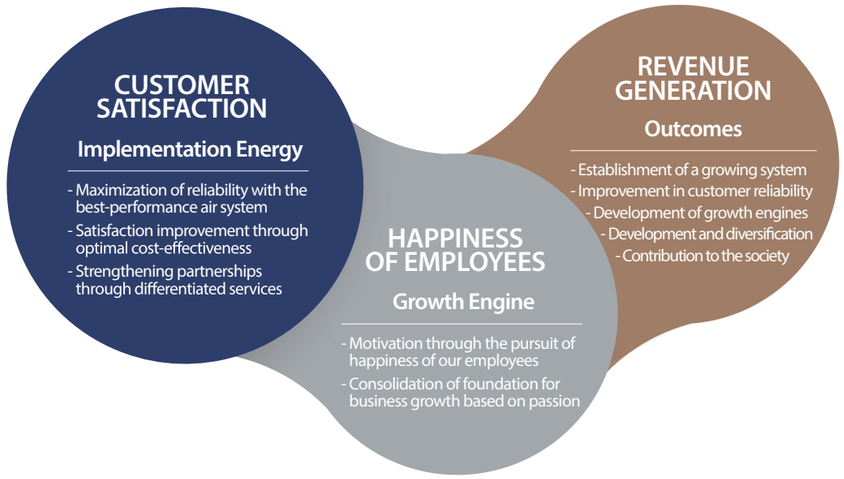
Value and Mission

ALLSWELL protects human life and health by creating space for people to breathe freely.

We put the greatest value on "people." We create a healthy and safe future for humanity with technology for people, and furthermore air technology for the world.

Management Philosophy

A company that contributes to society based on the happiness of its members!
ALLSWELL pursues the "value" of "togetherness."



From Process Status Identification to Overall System Design,

We Provide Solutions for Rolling Process Conditions

Designed through optimal system design and accurate diagnosis from pollutant analysis to exhaust air quality,

W–FLES reduces emission substance concentration and fume scattering for productivity improvement to reduce product failure rates, minimize maintenance costs, and improve odor problems, contributing to corporate innovation.

Completely Eliminate Emissions with "Water"

Wet Type Filter-Less Air Purification System!

It is a unique air technology that purifies emissions using water without filters, and it is the most efficient solution to problems in rolling processes.

Wet Type Filter-Less Fume Elimination System(W-FLES)

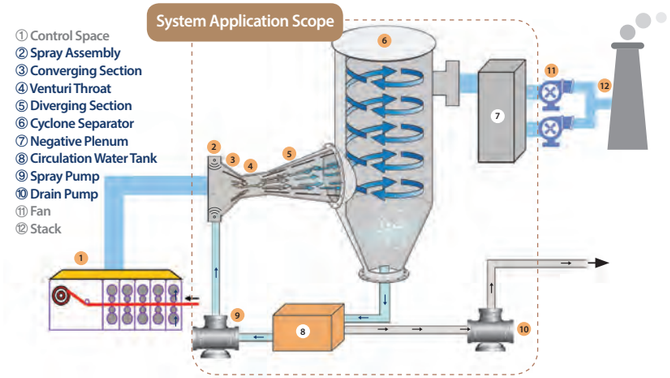
A system that uses water to eliminate pollutants generated during rolling

- Suitable for emissions of steam containing metallic contaminants or highly viscous substances
- There is no filter because emissions and water are combined for purification by gravity and centrifugal force generated by acceleration from pressure difference.

System Specification Decision Scope

System Application Scope

① Control Space
② Spray Assembly
③ Converging Section
④ Venturi Throat
⑤ Diverging Section
⑥ Cyclone Separator
⑦ Negative Plenum
⑧ Circulation Water Tank
⑨ Spray Pump
⑩ Drain Pump
⑪ Fan
⑫ Stack



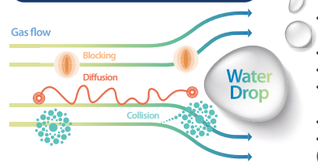
W-FLES

Differences

- Filters are not used
  → No blockage
- Water recirculation system
- Optimized for removing iron dust, gas or viscous pollutants
- High temperature gas treatment possible

Most optimized for high temperature gas operating conditions

Purification Concept of W-FLES



- Mass increase due to collision, blocking and diffusion of water, and emission substances
- Pressure drop according to the acceleration at the venturi throat
- Gas and liquid separation by cyclone internal gravity and centrifugal force
- Temperature decrease with increasing ΔP and passage of venturi, saturated flow
- Water condensation (iron dust acts as a condensation nucleus)
- Dust, fume, oil, acid, odor, etc. removable

(Optimized for removal of hot, viscous dust at high humidity)

Core Technology

- Accurate ΔP calculations based on acceleration of venturi throat
- Accurate calculations of diameter and height to maximize centrifugal force inside cyclone and gravitational effects

Chosen by Global Steel Companies

Productivity improvement and operating cost reduction

Annual Savings (case of Company D)

KRW **440** million

Industrial Air Technology!

Based on W-FLES which is applied at Korea D Steel for the first time in Korea, ALLSWELL's TCM[1] specialized Industrial Air Technology is being recognized by global steel makers including World No.2 biggest chinese company.

1) TCM : Tandem Cold rolling Mill

Major Project Performance and Progress

Korea D Steel (Completed in December 2015)
- World's first application of W-FLES
- Productivity improvement
- TVOCs, odor reduction
- Reduced operating costs (USD 360,000/year)
- Replacement of the SMS design facility

China B Steel (Completed in December 2018)
- FAT result: 7 guaranteed items satisfy the criteria
  - Oil mist concentration, odor, NMHC concentration, air volume, water mist scattering, noise, chimney rain phenomenon
- Replacement of SMS facility

Project Completed

China B Steel
- Further discussions underway on two production lines
- Planning sequential progress in the first half of 2020
- Current SMS facility being applied

China S Steel
- Had the first meeting in December 2018
- Completed technical agreement in 2019
- Current MITSUBISHI facility being applied

China A Steel
- Had the first meeting in December 2017
- Completed technical agreement in 2019
- Current SMS facility being applied

Project in Progress

Project History of Chinese Company B

Existing System

Competing with Global Companies

Differentiation

AllsWell VS SMS

AllsWell		SMS
Hard	Design	Easy
Simple	Structure	Complex
Average	Operating Cost	High
Improvement	Malodor	Worsen
Improvement	Productivity	Worsen

Issues of existing process ventilation purification system (filter-type dust collector)
- Filter clogging and performance deterioration: Reduced capture of emissions
- Additional costs incurred: Filter cleaning, replacement, etc.
- Odor occurrence: Accumulation and decay of emissions

Resolved with Filter-less Air Purification System

Improvements after installation of filter-less air purification system

Quality Improvement
- Reduced defect rate
- Reduced pollution around equipment and surface defects due to moisture

Cost Improvement
- RImproved required costs
- Improved power usage
- Productivity improvement

Environmental Improvement
- Prevented oil contamination
- Improved worker satisfaction
- Reduced contaminant emissions and odorsimprovement

Fundamental Problem Cause is Resolved

Accurately identifying and diagnosing problems in the rolling process, cost reduction, environmental improvement and product quality is improved by installing an optimized air purification system. .

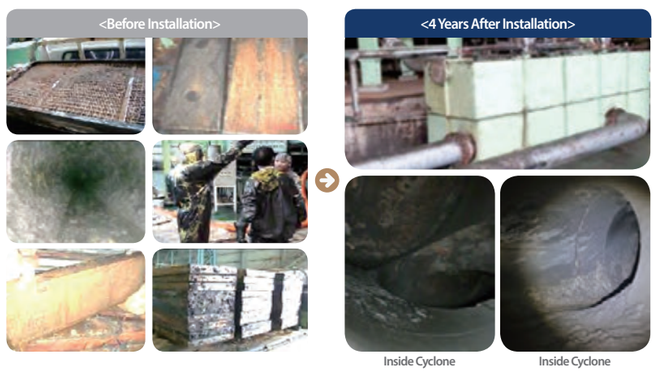
D Steel Installation Results

Project Overview
- Construction completed: December 2015
- Installation period: 5.5 days (including dismantling)
- Airflow: 3,500CMM (Max 5,000CMM)

Improvement Requirement
- Need to resolve issues with the existing TCM fume eliminator

Quality Improvement	• Reduced product contamination by easily eliminating pollutants such as oil and iron→ Defect rate reduced • Reduced moisture condensation in the rolling equipment→ Reduced facility contamination and surface defects caused by moisture
Cost Improvement	• Cost saved due to the reduced cost for filter clogging/cleaning/replacement • Improved power usage • Increased productivity by ensuring stable production conditions
Environmental Improvement	• Prevention of oil contamination around the air purification system • Easy maintenance due to the simple facility structure→Worker satisfaction improved • Reduced air contaminant emissions and odor

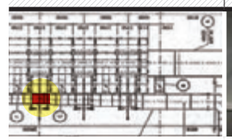
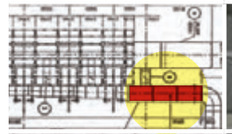
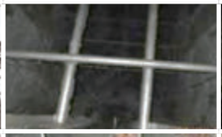
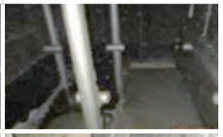
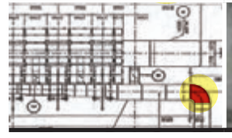
Before/After Installation



Status of Facility Operation

Facility Operation (2016. 8.)	
OP Side of TCM (2017. 2.)	
Entire TCM (2017. 2.)	

Stand Duct Internal Scum

Location	System Replacement (Duct Internal Cleaning)	After 1 Year
		
		
		

Meeting the Needs of Business and More

Improvements after installation of filter-less air purification system

Environmental Improvement
- Reduced contaminant emissions and odors
- Improved worker satisfaction
- Prevented fume exposure

Production/Quality Improvement
- Productivity improvement
- Prevented oil contamination

Reducing Pollutant Concentrations and Satisfying Environmental Standards!

We have been recognized as a strong small-sized company in industrial air technology by improving the workplace environment in preparation for the Chinese government's environmental regulations, as well as product quality stabilization and productivity improvement due to reduced pollution and more.

B Steel Installation Result

Project Overview
- Construction completed: December 2018
- Installation period: 6 days (including dismantling)
- Airflow: 4,500CMM

Improvement Requirement
- Top priority on environmental improvement

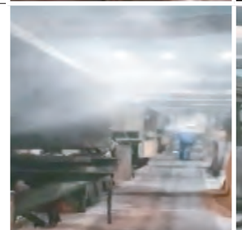
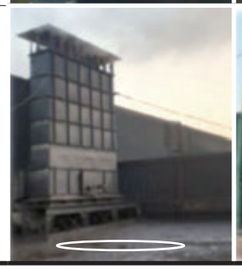
Environmental Improvement	• Reduced air contaminant emissions and odor • Easy maintenance due to the simple facility structure→ Worker satisfaction improved • Prevention of exposure through effective removal of fume • Satisfying environmental regulations
Production/ Quality Improvement	• Productivity improvement by ensuring stable production conditions • Prevention of oil contamination in facilities/workspaces
Safety/Health Improvement	• Zero possibility of safety accidents caused by cleaning and maintenance

Before/After Installation

<Before Installation>

<After Installation >

Status of Facility Operation

Location	Before Installation	After Installation
TCM Top 1		
TCM Top 2		
Drive Side		
Chimney Rain		

Become a New Standard for Solution of Rolling Fume Elimination

Accurate Diagnosis and Reflection of the Business Needs!

Accurate Diagnosis and Reflection of the Business Needs!
Our overwhelming measurement result improved by customized solutions is setting a new standard for industrial air technology solutions.

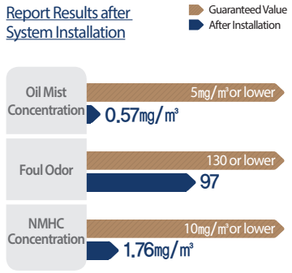
B Steel (China)

Guaranteed Item	Measurement Method	Guaranteed Value	Measurement Result	
			Before Improvement (Existing System)	After Improvement (Our System)
Oil Mist Concentration	China Environmental Protection Administration Standard	5㎎/㎥ or lower	7㎎/㎥	0.57㎎/㎥
Foul Odor	China Environmental Protection Administration Standard	130 or lower	260	97
NMHC concentration	China Environmental Protection Administration Standard	10㎎/㎥ or lower	15mg/m3	1.76㎎/㎥
Fume scattering near TCM	Visual inspection	Fume invisible	High amount	None
Chimney rain phenomenon	Visual inspection	No chimney rain phenomenon	Severe chimney phenomenon	None
Airflow	ISO 3966:2008 (Third-party measurement institution)	270,000CMH ±10%	370,000CMH (Spec.)	270,000CMH ±10%
Noise	1 meter from the facility	85 dB(A) or lower	-	85 dB(A) or lower

D Steel (Korea)

Guaranteed Item	Measurement Method	Guaranteed Value	Measurement Result	
			Before Improvement (Existing System)	After Improvement (Our System)
THC (Total Hydrocarbon Content)	Ministry of Environment Standard	40㎎/㎥ or lower	–	0.5㎎/㎥
TVOCs (Total Volatile Organic Compounds)	Ministry of Environment Standard	–	–	1.01㎎/㎥
Foul Odor	Ministry of Environment Standard	1,000 or lower	–	132 on average

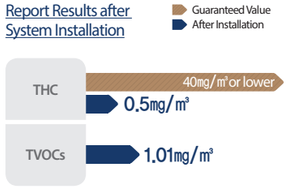
Report Results after System Installation



B Steel (China)

Category	Odor Concentration	Oil Mist Concentration	NMHC Concentration
Institute of Measurement	Company B (Industrial Technology Service Co., Ltd. under Company B)		
Measurement Date	2019. 7. 9.	2019. 7. 9.	2019. 7. 9.
Place of Measurement	TCM chimney		
Measurement Result	97	0.57㎎/㎥ on average	1.76㎎/㎥
Result Report			

Report Results after System Installation



Data Measurement Results - B Steel

Category	THC		TVOCs	
Institute of Measurement	P Environment (Government-certified air measurement agency)		KTR (Korea Testing & Research Institute)	
Measurement Date	2017. 5. 16.	2020. 1. 30.	2017. 5. 23.	2020. 1. 30.
Place of Measurement	TCM chimney	TCM chimney	TCM chimney	TCM chimney
Measurement Result	2.6㎎/㎥	0.5㎎/㎥	3.48㎎/㎥	1.01㎎/㎥
Result Report				

Category	Foul Odor						
Institute of Measurement	P Environment (Government-certified air measurement agency)						
Measurement Date	2017. 4. 10.						2020. 1. 30.
Place of Measurement	Rolling Oil Return Tank	TCM Drive Side	Emulsion House	50 meters away from TCM plant	200 meters away from TCM plant	TCM chimney	TCM chimney
Measurement Result	4	3	4	3	3	120	144
Result Report							

Economic Effects of Installation Case - 1 year monitoring after operation of D Steel (Korea)

Economic effects after installation of filter-less air purification system

70% Odor

50% Power Consumption

Cost reduction by company

KRW **2.6** million ~

KRW **440** million

Improvements

Category	Existing Air Purification System (Before Improvement)	Filter-less air purification system (After Improvement)	Cost (thousand KRW)		Remarks
			Before Improvement	After Improvement	
Emission Removal	Stand Outer Wall Contamination	Painting cycle (4 months -> 1 year)	20,000	6,000	Labor cost, Painting cost
	Poor condensation of back emission	No surface defects	45,000	0	Improvement cost
Filter Cost	Stagnation and decay of emissions	No replacement cost	100,000	0	Filter replacement and manufacturing costs
		Odor reduction (70% ↓)			
	Stagnation of Emissions in Duct	No cleaning cost thanks to no stagnation of emissions	40,000	0	Cleaning cost
Electricity Usage	70~90% use (350kw X 2 units)	Less than 50% use	505,890	266,112	Reduced power usage
Loss cost (year)			710,890	272,112	**KRW 440 million/year saved**

Quantitative Effects - Case-Based

Environment & Safety

Company Name	Category	Before Improvement	After Improvement
Company A	Foul Odor	-	130
Company B	Foul Odor	260	100 or less
	Chimney Rain	Yes	No

Elimination of environmental & safety risks

- Protecting workers' safety (preventing the risk of accidents)
- Satisfying environmental regulations

Odor reduction by 60%

Emission Substance

Company Name	Category	Before Improvement	After Improvement	Reduction Rate
Company B	Oil Mist	5㎎/㎥	0.7㎎/㎥	86%
	NMHC	10㎎/㎥	3~4.5㎎/㎥	55%
	FUME	High amount	Very small amount	
Company C	Fine Dust Concentration	1,059㎍/㎥	370㎍/㎥	65%

Emission reduced by 69% on average

Qualitative Factors

Satisfying environmental regulations prevents potential costs such as overcharges and penalties

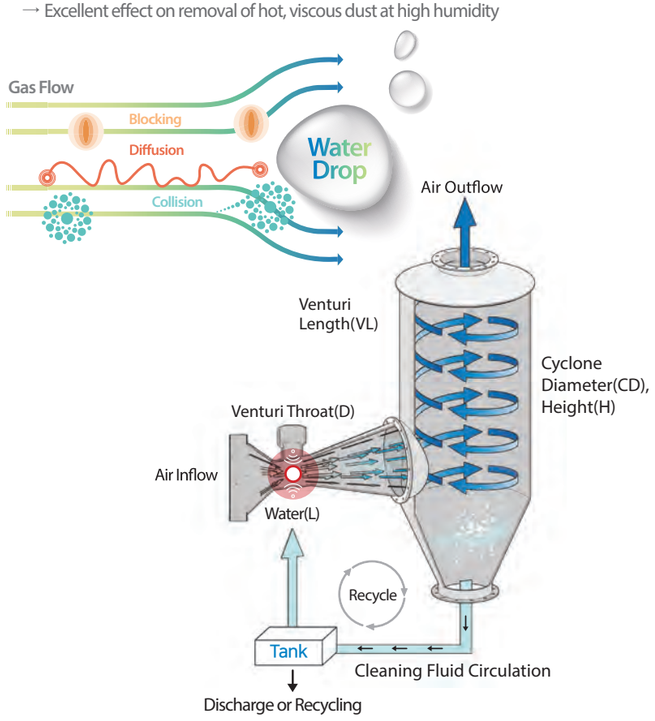
Innovate with Engineering-Based Industrial Air Technology

From Mass & Energy Balance to Required Airflow Calculation

We provide total air solution for TCM through industrial air technology ranging from mass & energy balance, condensation quantity calculation, emission substance concentration calculation, evaporation calculation, required airflow calculation, blower specification determination, and to wastewater calculation.

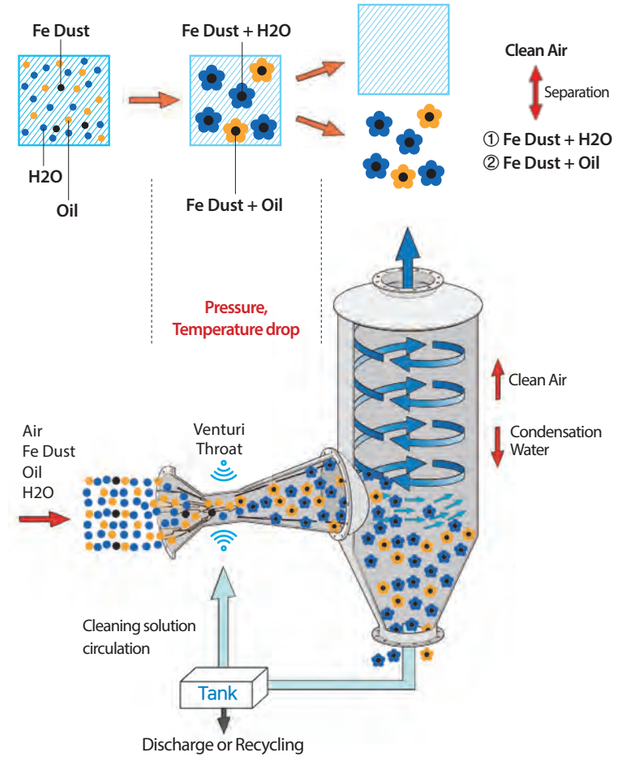
Air Purification Principle

- Mass increase due to collision, blocking and diffusion of water and emission substances
  → Acceleration of emissions from venturi throat
- Separation of air/liquid by centrifugal force and gravity in the cyclone
- Elimination of ultrafine dust (PM2.5 or below), oil, acid, and odor at the same time
  → Excellent effect on removal of hot, viscous dust at high humidity



- Temperature drop due to ΔP increase (through venturi)→
  Moisture condensation occurs due to saturation
- Especially, Fe dust acts as a condensation nucleus→
  80% moisture above ΔT 20°C, oil condensation
- Increasing condensation by increasing ΔP→
  Eliminating odor-causing oil, moisture condensation, and Fe dust

※ Securing the optimal driving power value and condensation efficiency



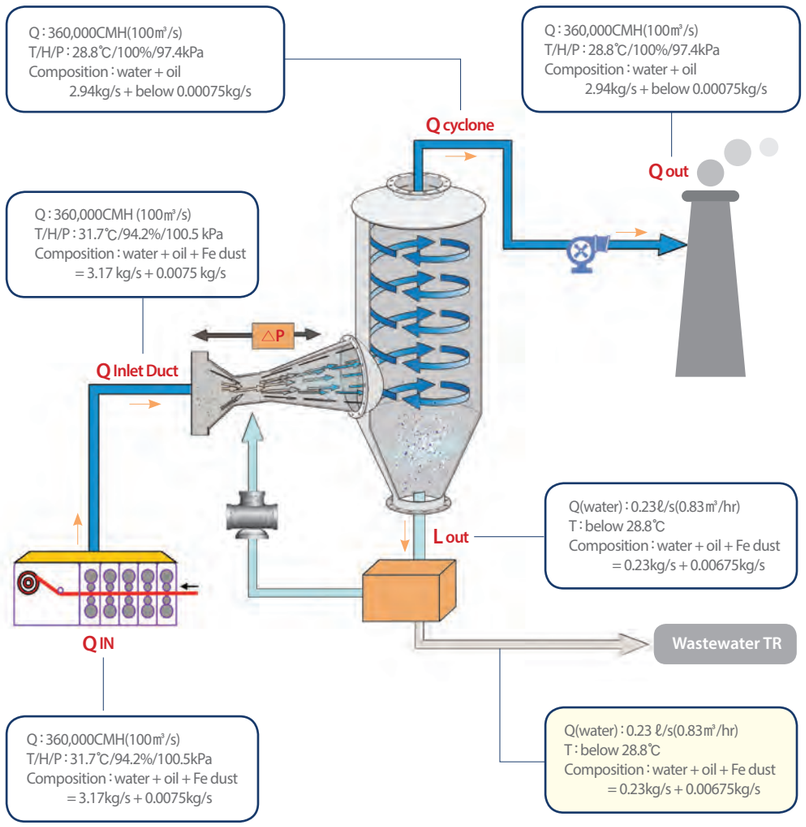
Core Technology

- ΔP calculation according to the acceleration at the venturi throat
  → Ensuring driving power through accurate calculation of ΔP of the entire system
- Calculation of the diameter and height to maximize the effect of cyclone's internal centrifugal force and gravity
- Increasing cooling condensation effect due to pressure drop →
  Scum and odor removal effect
- It is possible to recycle condensed water and drastically reduce wastewater generation.

Total Mass & Energy Balance

- Calculation of mass & energy balance for the entire air purification system
  → Calculation of condensation quantity and stack discharge temperature/ humidity

Q	Flow rate	T	Temperature
P	Pressure	H	Humidity



※The example data are of company S.

- The inflow/outflow of matter and energy are the same (First Law of Thermodynamics)
  → Temperature/Humidity of the outflow air is determined

  – Mass Balance gas $\dot{m}_{inlet\ duct} = \dot{m}_{cyclone} - \dot{m}_{cond}$ (Condensation Amount)
  liquid $\dot{m}_{in} + \dot{m}_{cond} = \dot{m}_{out}$

  – Energy Balance $\frac{d(mU)_{cv}}{dt} + \Delta\left[\left(H + \frac{1}{2}u^2 + zg\right)\dot{m}\right] = \dot{Q} + \dot{W}$

  $H = f$ (Pressure, Temperature, Relative HumidityAmount)

  Heat loss due to internal and external temperature difference

- Pressure loss due to venturi neck acceleration
  → $\Delta P = K_1 \frac{1}{2}\rho v^2 = f$ (Airflow, Water Injection Volume, Sectional Area, Length)
- Pressure loss caused by centrifugal force, gravity, and friction
  → $\Delta P = K_2 \frac{1}{2}\rho v^2 = f$ (Airflow, Inlet/Outlet Sectional Height)

By change of pressure loss, heat loss, and kinetic/position energy, outlet temperature and relative humidity are determined

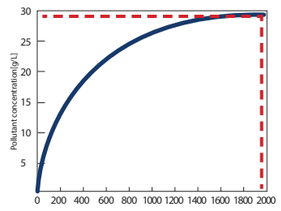
- Condensation quantity = [Mass of water in W-FLES inlet gas] – [Mass of water in W-FLES outlet gas]

Emission Substance Concentration

- Concentration of emissions after n minutes

$$C_n = \frac{V \cdot C_{n-1} + L_{out1} \cdot C_{out1} + L_{out2} \cdot C_{out2}}{V + L_{out1} + L_{out2}}$$

- C_n : Pollutant concentration after n minutes
- C_{n-1} : Pollutant concentration after (n-1) minutes
- C_{out1} : Pollutant concentration of condensate water from W-FLES
- C_{out2} : Pollutant concentration of condensate water from stack
- V : The amount of water in the circulation water tank (water level = 1.2m)
- L_{out1} : The amount of condensate water from W-FLES
- L_{out2} : The amount of condensate water from stack



- Equilibrium concentration in the circulation water tank
  → After 24 hours (1440 minutes), the concentration of contaminants in the circulating water tank is 29g/L.

Calculation of Evaporation Amount

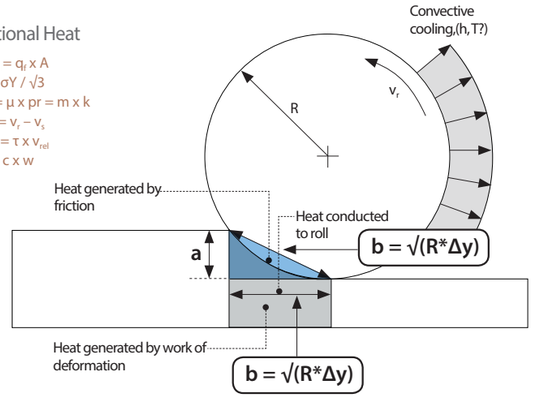
Calculation of the total calorific value based on frictional heat and plastic deformation heat generated from PCM roll/strip

• Plastic Deformation Energy

$$e_j = \frac{K v_r y_n}{y_j b}\left(\frac{2}{\sqrt{3}}\ln\left(\frac{y_j}{y_{j+1}}\right)\right)^{n+1}$$

• Frictional Heat

$q_{(total} = q_f \times A$
- $k = \sigma Y / \sqrt{3}$
- $\tau = \mu \times pr = m \times k$
- $v_{rel} = v_r - v_s$
- $qf = \tau \times v_{rel}$
- $A = c \times w$



Symbol	Meaning
k	dynamic yield shear stress
σY	yield coefficient
τ	friction stress
μ	slip coefficient
pr	contact pressure
m	shear friction coefficient
vrel	slip velocity
vr	linear velocity of roll
vs	moving velocity of plate
qf	heat flux

Symbol	Meaning
A	area of contact
c	length of contact
w	width of plate
qf, total	Frictional Heat
c1	fraction of qs carried to the roll
K	strength coefficient
n	strength hardening exponent
R	work roll radius
c2	fraction of qf carried to the roll

Dispensing amount of rolling oil, reflecting property data
→ Calculation of the evaporation amount of rolling oil based on the total calorific value

Calculation of Required Air Volume

Q_1	
Airflow rate	75m³/s
Temperature	11.7℃
Pressure	101.3kPa
Humidity	58 %

+

m_{w2}	
Water vapor	3.09kg/s
Temperature	56.2℃
Pressure	101.3kPa

+

q
8845 kJ/s
Deformation and friction heat

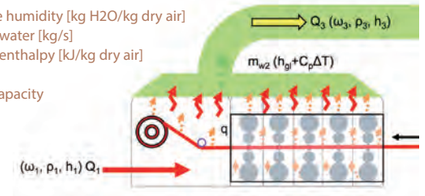
=

Q_3	
Airflow rate	75m³/s (=4500CMM)
Temperature	44.3℃
Pressure	101.3kPa
Humidity	100%

1. Mass balance of water
$\omega^1\rho^1Q^1 + mw^2 = \omega^3\rho^3Q^3$

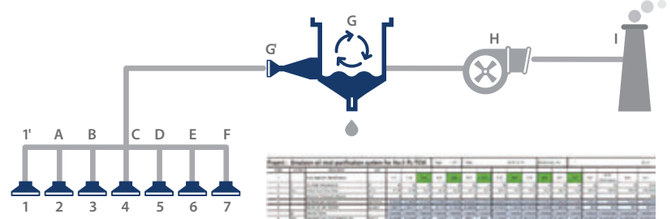
2. Energy Balance
$\rho^1Q^1h^1 + mw^2(hgl+CP\Delta T) + q = \rho^3Q^3h^3$

- ω : Absolute humidity [kg H2O/kg dry air]
- m : Mass of water [kg/s]
- h : Specific enthalpy [kJ/kg dry air]
- ρ : Density
- Cp : Heat Capacity



Calculation of the required air volume (Q) by reflecting the calculated amount of rolling oil evaporation and climate characteristics of the area
→ Prediction of the consumption of rolling oil (pure + undiluted solution) due to evaporation possible

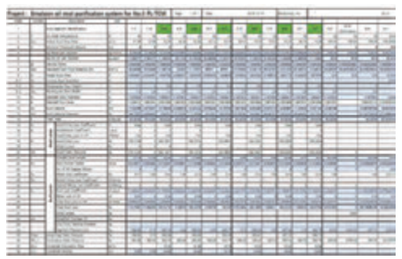
Duct Segments Balancing Method



Actual Flow Rate
4,500 ± 10%CMM

System SP
3,500 ~ 4,000Pa

Total Power
500 ~ 580kW



Calculation of the required static pressure from the stand hood to the stack to determine the final specifications (air volume, static pressure) of the blower
→ Air volume (Q) x static pressure (P) = Power required for the blower