Capacity Building workshop

Pollution Control System

2nd May 2018 at Indore

Under the project
Capacity Building of Local Service Providers (LSPs)

Supported by
GEF-UNIDO-BEE Project
Promoting Energy Efficiency and Renewable Energy in selected MSME clusters in India

Table of contents

Workshop summary

Overview of workshop

Capacity Building workshop of Local Service Providers (LSPs) on Pollution control systems for foundry industry was organized by TERI on 2nd May 2018 in association with The Institute of Indian Foundrymen (IIF), Indore Chapter under GEF-UNIDO project. Total 24 participants were present during the workshop and for the industry visit, which was organized after the workshop. Agenda of the workshop and list of participants are attached in the annexure 1 and annexure 2 respectively.

Summary of points discussed in the meeting

The welcome address was made by Mr. C Harinarayan, Chairman, IIF-Indore Chapter. He emphasized that control of pollutions like suspended particulate matter (SPM) is very importance in foundry industry.

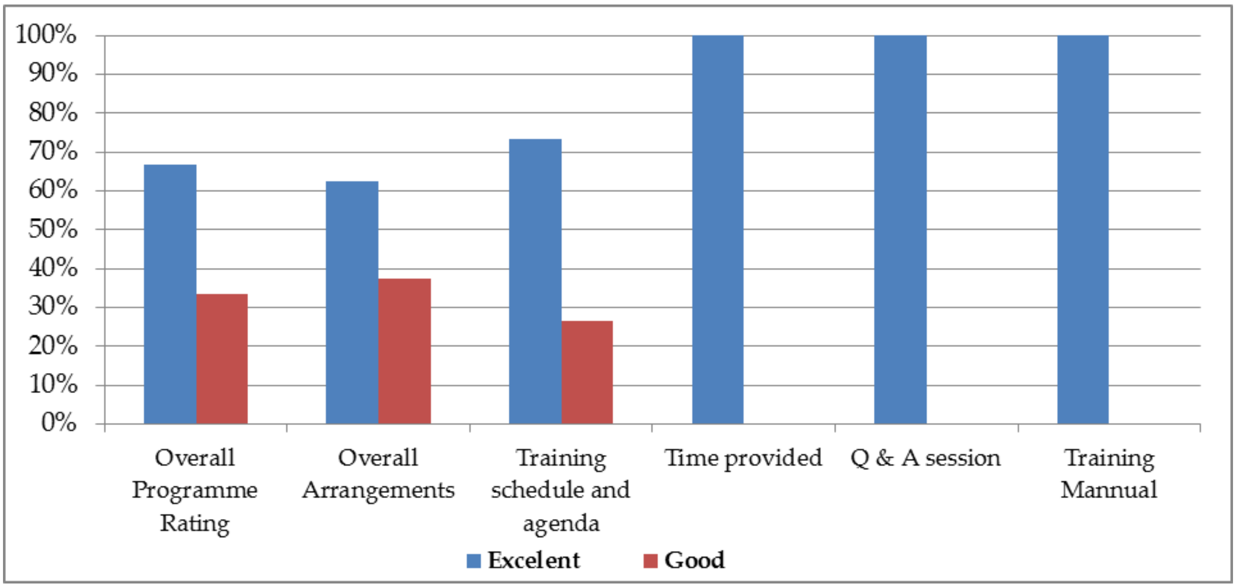
Mr. Prosanto Pal, TERI, made a presentation on common types of pollution control systems (PCS), stack monitoring done by TERI for cupola furnaces and issues in taking correct measurement of the stack. PCS can be broadly classified into four categories (a) Initial separators (settling chamber, baffle chamber) (b) Centrifugal separators (cyclone, multiple cyclone) (c) Low energy scrubbers (spray tower, centrifugal wet cyclone) and (d) High energy scrubbers (venturi-scrubber, fabric filter). Fines in cupola emissions is high (about 16% by weight of particles are < 5 µm 16%). With such high percentage of fines, only high energy scrubbers are useful.

Mr Debasis Bandyopadhyay, GEA Process Engineering, made detailed presentation of the emissions from foundry industry both at work zone and stack, and pollution control systems in use. Design of the hood is very important for induction furnaces. Parameters like position and size of the hood and suction pressure are important in hood design. There should not be any sharp bends in the exhaust pipeline. There are guidelines for industrial ventilation which should be followed. He elaborated a special type of medium efficiency wet collector developed by GEA having good collection efficiency but cheaper compared to venturi scrubber. He explained in detail the operation of venturi-scrubber. The principle of bag filters (pulse jet) was explained by him. He mentioned that the temperature of gases is a limiting factor in use of bag filters. The temperatures should be less than 240 oC for fabric filters. His presentation was followed by a detailed Q&A session.

After the lunch, plant tour to M/s Jash Engineering Foundry Division was arranged. The foundry has a variety of PCS like venturi-scrubber and cyclones. Hence the participants could see actual implementation of pollution control measures and benefit from the site visit. Selected photos of the workshop and visit are attached in the annexure 3.

Feedback forms

Based on the analysis of the feedback forms received from the participants, it is observed that workshop was well received by the participants and 100% participants were satisfied with field visit, Q&A session and training module provided to them. About 65% participants have rated overall program as "Excellent" while rest of them have rated it as "Good". More than 70% of participants were satisfied with arrangements made, training schedule and agenda of the program. Few sample feedback forms are attached in the annexure 4.



Analysis of feedback forms

Suggestions by participants

Some participants have made suggestions as follows;

1) Additional program on induction furnace control equipment
2) Demonstration of pollution control system

Learning's by participants

Some of the topics learned by the participants and mentioned by them are listed below;

1) Selection of pollution control systems
2) Purpose of hoods and its proper utilisation
3) Stack monitoring
4) Operation and maintenance of dust collector system
5) Filter bag monitoring using pressure

Annexures

Annexure 1: Agenda of the program

Capacity building workshop

Pollution control systems for foundry industry

Wednesday, 2 May 2018

Tangarine-2, Lemon Tree Hotel, R.N.T. Road, Indore

Under the project:

Capacity Building of Local Service Providers (LSPs)

Supported by:

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Promoting Energy Efficiency and Renewable Energy in selected MSME clusters in India

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Agenda (draft)

10:00 – 10:30	Registration
10:30 – 10:45	**Welcome Addresses** Mr C Harinarayan, Chairman, IIF-Indore Chapter Mr Prosanto Pal, TERI
10:45 – 11:00	**GEF-UNIDO-BEE project and initiatives in Indore cluster** Mr Prabhat Sharma, UNIDO Cluster Leader - Indore
11:00 - 11:50	**Stack monitoring and commonly used pollution control systems in foundries** Mr Prosanto Pal, TERI
11:50 – 12:50	**Air pollution control systems for foundries - selection, design and performance** Mr Debasis Bandyopadhyay, GEA Process Engineering (india) Pvt. Ltd, Mumbai
12.50 – 13:00	Q&A
13:00 – 14:00	Lunch
14:00 – 16:00	Site Visit / On-site training
16.00 – 16:30	Feedback from participants
16:30 – 16:45	Vote of thanks

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Annexure 2: List of participants

S.No	Name	Organization	Mobile No	Email ID
1	L D Amin	Jash Engineering Ltd	9755416000	ida@jashindia.com
2	Atin Jain	Porwal Auto Components Ltd	9826570094	atinjain@porwalauto.com
3	Devendra Jain	Porwal Auto Components Ltd	9893130999	devendrajain@porwalauto.com
4	Hari Narayan	Pioneer, Ujjain	9630079091	
5	A N Pandey	Pioneer, Ujjain	7389941905	Anpandey1963@gmail.com
6	S Solania	Pioneer, Ujjain	7389941902	
7	Manish Neema	Malika Alloy	9770287443	Manish20270@yahoo.co.in
8	N Garg	N G Enterprises	9827033041	gargniranjan@yahoo.com
9	Kapil Shakely	Porwal Auto Component	8982210801	Kapil.shakely@gmail.com
10	Nutan Jogi	Porwal Auto component	9826059220	nutanjogi@porwalauto.com
11	Sangam Patil	Jash Engineering Ltd	7869962233	sangam@jashindia.com
12	R B Raghuwanshi	Fluidomat Ltd	9425988754	info@fluidomat.com
13	Rajdeo Sah	Infinite Solution	9583182981	rajdeo@infisolutions.org
14	Vijay Verma	Jash Engineering Ltd	9929291092	vijayvermamouls@gmail.com
15	Suyash Pandey	Jash Engineering Ltd	9039512126	Suyashpandey88@gmail.com
16	Anil Dhavale	EX CL	9644400045	Anil181818@gmail.com
17	Manish M	Jash Engineering Ltd	9893348936	manishmuds@jashindia.com
18	Rakesh Swami	Mantra Filtration Products	9303909333	sales@mantrafiltration.com
19	Prasad Vyas	Green Star APC Tech Pvt Ltd	9981514500	Prasad.vyas@greenstar.co.in
20	Aalok Singh	Mitasha Industries	9826047592	mitashaindustries@gmail.com
21	Prosanto Pal	TERI	9811799933	prosanto@teri.res.in
22	Nilesh Shedge	TERI	9579448627	Nil.shedge@gmail.com
23	Prabhat Sharma	GEF-UNIDO-BEE	7470375107	cl.indorecluster@gmail.com
24	Debasis Bandyopadhyay	GEA Process Engineering (india) Pvt. Ltd	8452845471	debandy@gmil.com

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Capacity building workshop

Pollution control systems for foundry industry

2 May 2018, Tangarine-2, Lemon Tree Hotel, R.N.T. Road, Indore

S. No	Name	Organization	Mobile No	Email ID	Signature
1.	L. D. Arun	JASH Engineering Ltd.	9755416000	lda@jashindia.com	[signature]
2.	ATIN JAIN	PORWAL AUTO COMPONENTS LTD	9826570094	atinjain@porwalauto.com	[signature]
3.	DEVENDRA JAIN	PORWAL AUTO COMPONENTS LTD	9893130949	devendrajain@porwalauto.com.	[signature]
4.	HARINARAYAN	Pioneer_Ujjain	9630073091	[illegible]@gmail.com	[signature]
5.	A.N. Pandey	" "	7389941905	anpandy1963@gmail.com	[signature]
6.	S. [illegible]	" "	7389941902		[signature]
7.	MANISH NEEMA	MALLIKA ALLOT	9776287443	manish20270@yahoo.com	[signature]

S. No	Name	Organization	Mobile No	Email ID	Signature
8.	N Garg	N.G. Enterprises	98270-33041	gargniranjan@yahoo.com	
9.	Kapil Sharady	Porwal Autocompont	8982210801	Kapil.sharady@gmail.com	
10	Nutan Johri	"	9826059220	nutanjohri@porwalauto.com	
11	Sangram Patil	Jash Engineering Ltd.	7869962233	sangram@jashindia.com	
12	R.B. Raghuwanshi	Fluidomat Ltd Dewas	9425988754	Info@Fluidomat.com	
13	Rajdeo Sah	Infinite Solutions	9583182981	Rajdeo infisolutions.org	
14	VIJAY VERMA	Jash Engineering Ltd	9929291092	vijayvermamails@gmail.com	
15	Suyash Pandey	Jash Engg Ltd	9039512126	SuyashPandey88@gmail.com	
16	Anil Dharade	EX CL	9644400045	anil181818@gmail.com	
17	Manishmodi	Jash Eng LTD	98933 48936	manishmodi@jashindia.com	

S. No	Name	Organization	Mobile No	Email ID	Signature
18	Rakesh Swami	Mantra filtration Products	9303909333	Sales@mantrafiltration.com	[signature]
19	PRASAD VYAS	GREEN STAR APC TECH PVT LTD	99815-14500	Prasad.vyas@greenstar.co.in	[signature]
20	Aalok Singhi	MITASHA INDUSTRIES	98260-47592	MITASHA INDUSTRIES@GMail.Com.	[signature]
21	Prosanto Pal	TERI	9811799933	prosanto@teri.res.in	[signature]
22	Nilesh Shedge	TEES	9579448627	nil.shedge@gmail.com	[signature]
23	Prabhat sharma	CEF - UNIDO - BEE	7470375107	cl.indorecluster@gmail.com	[signature]
24	Debasis Bandyopadhyay	GEA - Mumbai	8452845471	debucy@gmail.c	[signature]
25					
26					
27					

Annexure 3: Selected photographs of the event

Annexure 4: Sample feedback forms

Capacity building workshop

Pollution control systems for foundry industry

2 May 2018

Tangarine-2, Lemon Tree Hotel, R.N.T. Road, Indore

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Promoting Energy Efficiency and Renewable Energy in selected MSME clusters in India

Evaluation Sheet for Participants

Feedback Form for Participants			
Parameter	***Feedback***		
	Excellent	Good	Average
How would you rate the overall programme?		✓	
How would you rate overall arrangements?		✓	
How was the training schedule and agenda?		✓	
How was the industrial site visit?		✓	
Do you think that adequate time was provided for each topic?	Yes [✓]	No [ ]	
Do you think that satisfactory answers were given to your questions during the training programme?	Yes [✓]	No [ ]	
Do you think that the background training manual is informative and useful enough?	Yes [✓]	No [ ]	
Do you think that the discussion on EE/RE will help you in your work?	Yes [✓]	No [ ]	
Suggestions & Recommendations for improvement:			
Name two learning, which from this programme you will be able to implement in your plant?			
1) Bag. filter design.			
2) Hood design on Induction Furnace			
Signature:			
Name of participant: Devendra Jain			
Organization: Porwal Auto Components Ltd			
Mobile No: +91 98931 30999			
Email ID: devendrajain @ porwalauto.com.			

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gef UNIDO ENERGY IS LIFE BEE CONSERVE IT

Capacity building workshop

Pollution control systems for foundry industry

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Do you think that the background training manual is informative and useful enough?	Yes [✓]	No [ ]	
Do you think that the discussion on EE/RE will help you in your work?	Yes [✓]	No [ ]	
Suggestions & Recommendations for improvement:			
Name two learning, which from this programme you will be able to implement in your plant?			
(1) Dustcollector pipe line modification work.			
(2) Dust collector bags proper fitement.			
Signature: [signature]			
Name of participant: A.N. Pandya			
Organization: Pioneer Engg. Ujjain. M.P			
Mobile No: 7389941905			
Email ID: anpandya1963@gmail.com			

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Do you think that the background training manual is informative and useful enough?	Yes [✓]	No [ ]	
Do you think that the discussion on EE/RE will help you in your work?	Yes [✓]	No [ ]	

Suggestions & Recommendations for improvement:

Overall Programme was Very good. but you should Present Demonstration If we dont Aware for Enviromental. what kind of disease bad effect we will get.

Name two learning, which from this programme you will be able to implement in your plant?

(1) Dust filter Bags Recheck And Presser meter down from 6.5 to 4.5.

(2) On Induction furnace & wet collector Process.

Signature: [signature]

Name of participant: Kapil Shakaly.

Organization: Porwal Auto Components Ltd.

Mobile No: 8982710801

Email ID: kapil-shakaly@gmail.com.

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Do you think that the background training manual is informative and useful enough?	Yes [✓]	No [ ]	
Do you think that the discussion on EE/RE will help you in your work?	Yes [✓]	No [ ]	

Suggestions & Recommendations for improvement:

Overall Programme was very good And good for Environment Safety, but my suggestion about you should shown problem abt Environment & climate If we dont flow Rules.

Name two learning, which from this programme you will be able to implement in your plant?

1) We definitely work to compressed Air. on dust filter bags
2) Particulate collection on Sand Plant filter bags throw Con velocity.

Signature: [signature]
Name of participant: Nutan Joshi
Organization: Porwal Auto component Ltd
Mobile No: 9826059220
Email ID: nutanjoshi@porwalauto.com

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Annexure 5: Copy of presentation

Stack monitoring and commonly used pollution control systems in foundries

Training program under GEF-UNIDO-BEE project

Indore

Prosanto Pal
Senior Fellow, TERI, New Delhi
prosanto@teri.res.in

2 May 2018

Outline

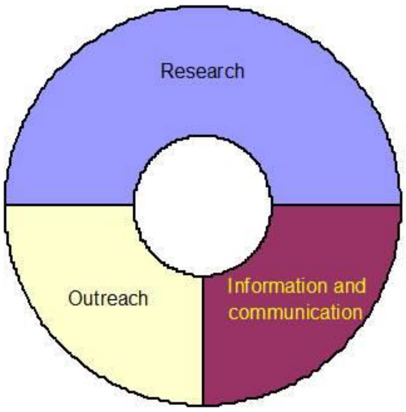
- About TERI
- Common types of pollution control systems used by foundries
- Stack monitoring results
- TERI-SDC technology demonstration for cupola foundries
- Issues in stack monitoring

Origins of TERI

- Conceived by Late Sri Darbari Sethi of Tata Chemicals
- Registered as 'Tata Energy Research Institute' in 1974
- 1974-82 – operated from Mumbai
- Moved to Delhi in 1982
- Own premises at India Habitat Centre in 1994

Research orientation

- Independent, non-profit, research institute
- Core competencies – research, information & communication and training & outreach
- Undertakes sponsored research projects in energy, environment and sustainable development areas
- Major sponsors include GOI, corporate, multilateral & bilateral agencies



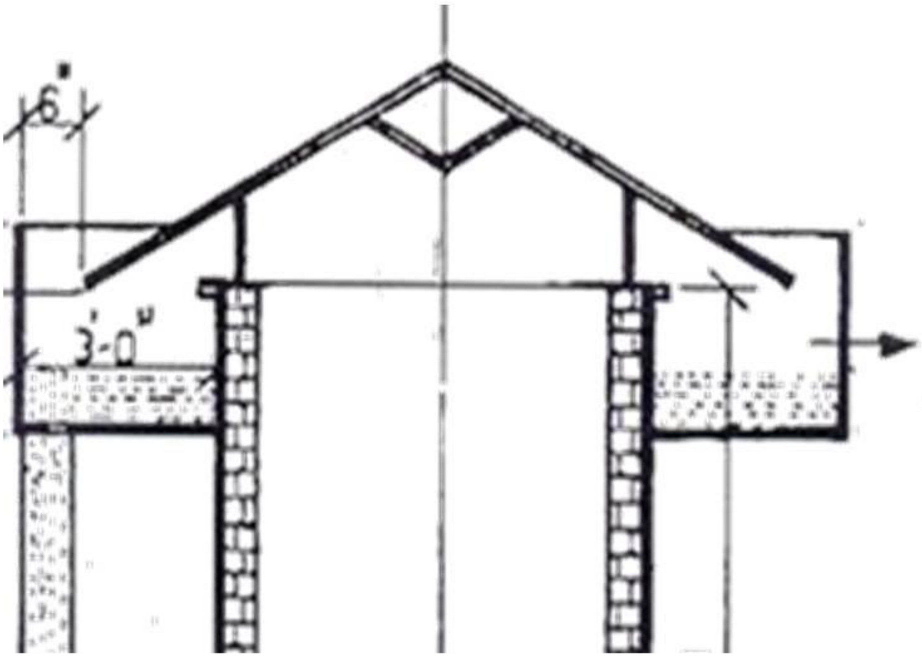
Present PCS status in foundries

- Variety of PCS designs used
- Installed PCS have short life span
- Foundries have poor knowledge on selection of PCS
- Selection of PCS based on informal feedbacks from SPCB
- Lack of knowledge on proper stack monitoring

Important considerations in PCS selection

- Gas velocity and temperature (IS: 11255 (Part III): 1985)
- Dust concentration (IS: 11255 (Part -1): 1985)
- Particle Size Distribution (sieve arrangement)
- Quantify of gases like CO, NOx, SO2 etc (analysers required)

Initial separator - spark arrestor

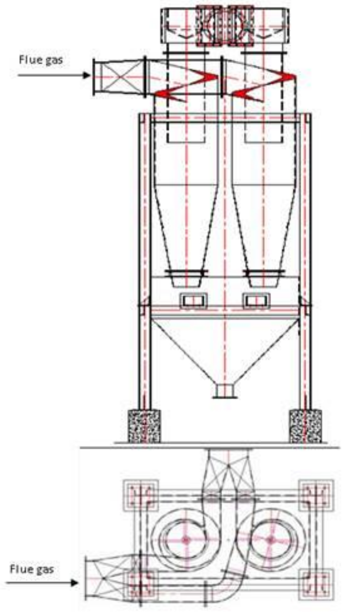


Selection of PCS

*Initial separators (*settling chamber, baffle chamber)

- remove about 90% of larger particles (> 50 μm)
- overall collection efficiency is low (30 - 40%)

Centrifugal separator - cyclone



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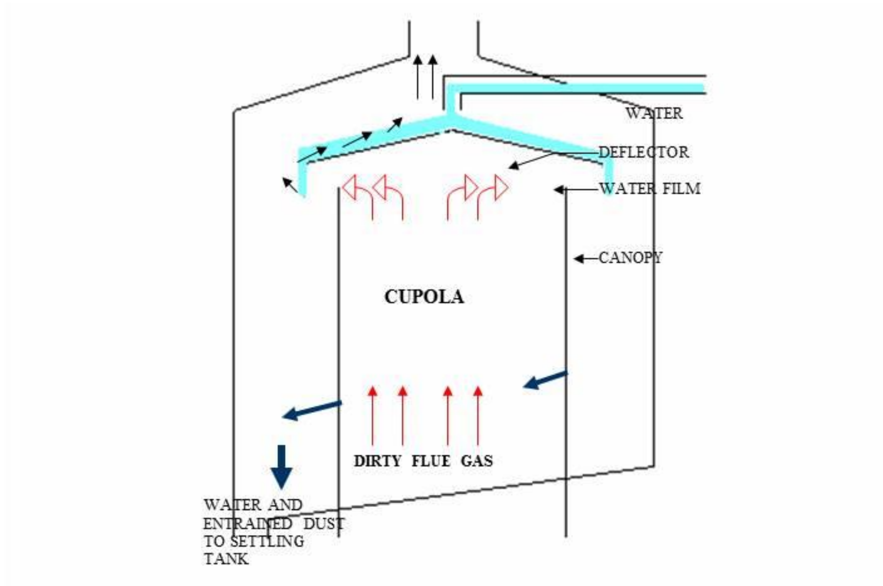
Selection of PCS

Centrifugal separators (cyclone, multiple cyclone)

- remove about 90% of the particles above 10 μm
- overall collection efficiency are about 70%

10

Low energy wet-scrubber system



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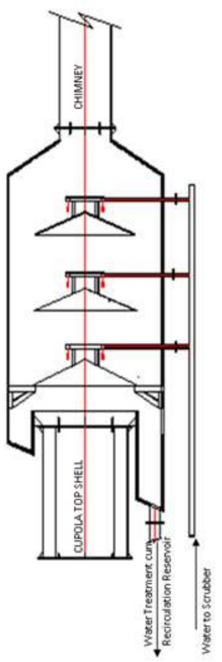
Three stage wet-scrubber system



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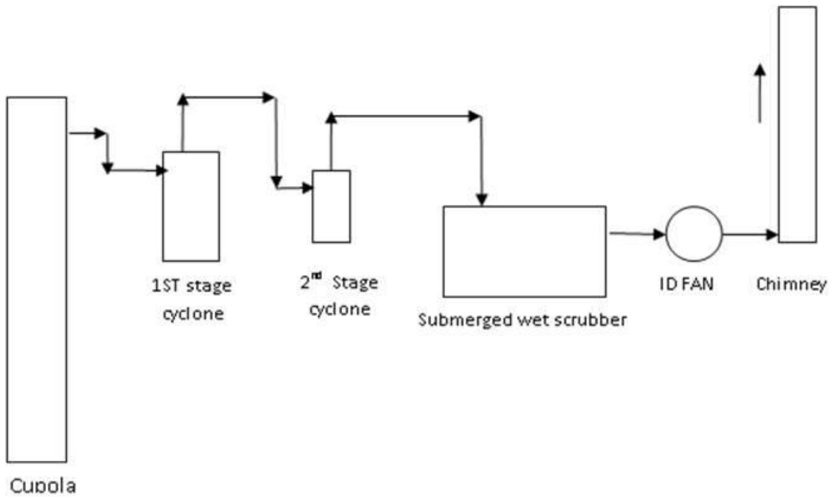
Combination of cyclone and wet scrubber



13

Selection of PCS

Low energy scrubbers (spray tower, centrifugal wet cyclone)

- remove the particle size more than 5 μm
- with the overall efficiency of 90%
- Have an added advantage of removing gaseous pollutants like NOx, SO2

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Selection of PCS

High energy scrubbers

Venturi scrubber

- Particles upto 0.5 µm can be collected with an efficiency of 99%

Fabric filter

- Can remove 0.2 µm size particles with 99% efficiency

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Commonly used PCS

	Minimum Particle size, µm	Collection efficiency, %
Initial separators (settling chamber, baffle chamber)	> 50 µm	30-40
Centrifugal separators (cyclone, multiple cyclone)	> 10 µm	70
Low energy scrubbers (spray tower, centrifugal wet cyclone)	> 5 µm	90
Venturi-scrubber	> 0.5 µm	99
Fabric filter	> 0.2 µm	99

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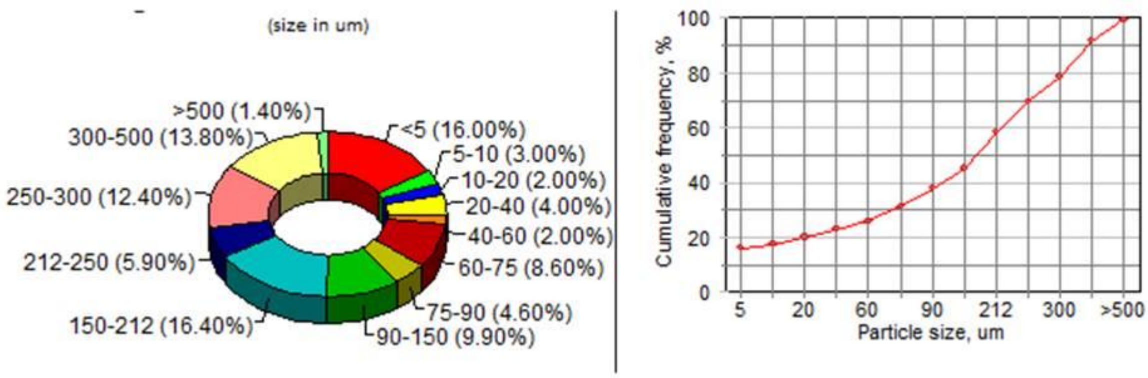
Stack monitoring results

17

Particle size distribution of cupola flue gas analysed by centrifugal dust classifier



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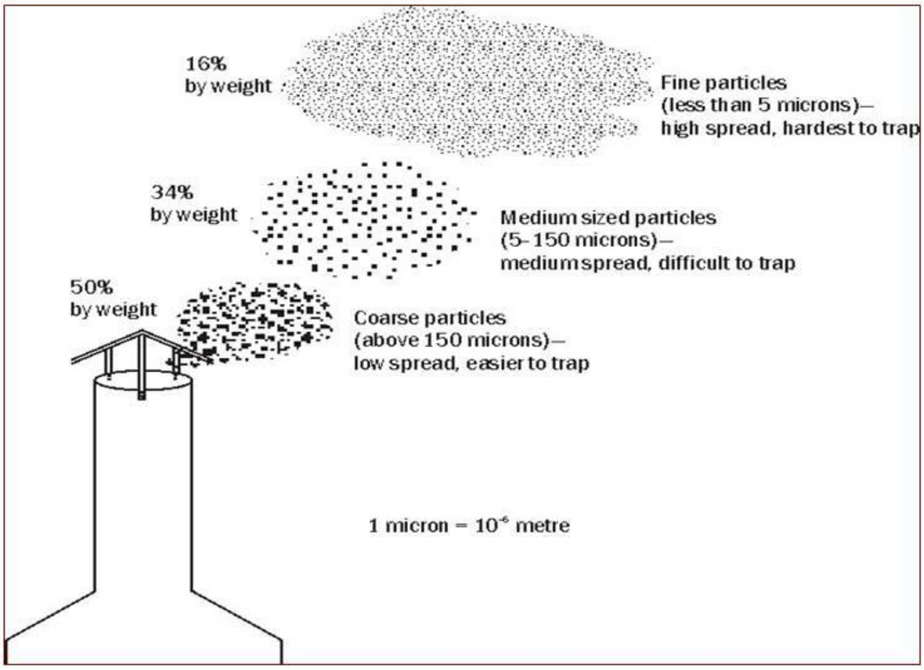

Figure 3

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Typical emission levels from cupola

Unit	Location	Particulate matter emission, g/Nm^3
Foundry 1	Below scrubber, charging door open	1.17
	Below scrubber, charging door open	2.20
Foundry 2	Sampling port, charging door open	1.38
	Sampling port, charging door open	3.94

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Selection criteria of PCS

- Fines in cupola emissions is high (< 5 μm 16%)
- Ability to meet the 150 mg/Nm3 norm
- Life of the equipment
- Ability to control SO2 emissions

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TERI-SDC demonstration Plant

Demonstration Plant at Bharat Engineering Works, Howrah

Commissioned 1998

DBC – Divided Blast Cupola

Bucket charging system

PCS – Pollution Control System (venturi-scrubber)

100 ft free standing chimney

22

Salient features of the new design

- Divided blast cupola
- Venturi scrubber system
  - fitted with variable throat
  - critical surfaces made of stainless steel
  - gas tight construction with explosion doors

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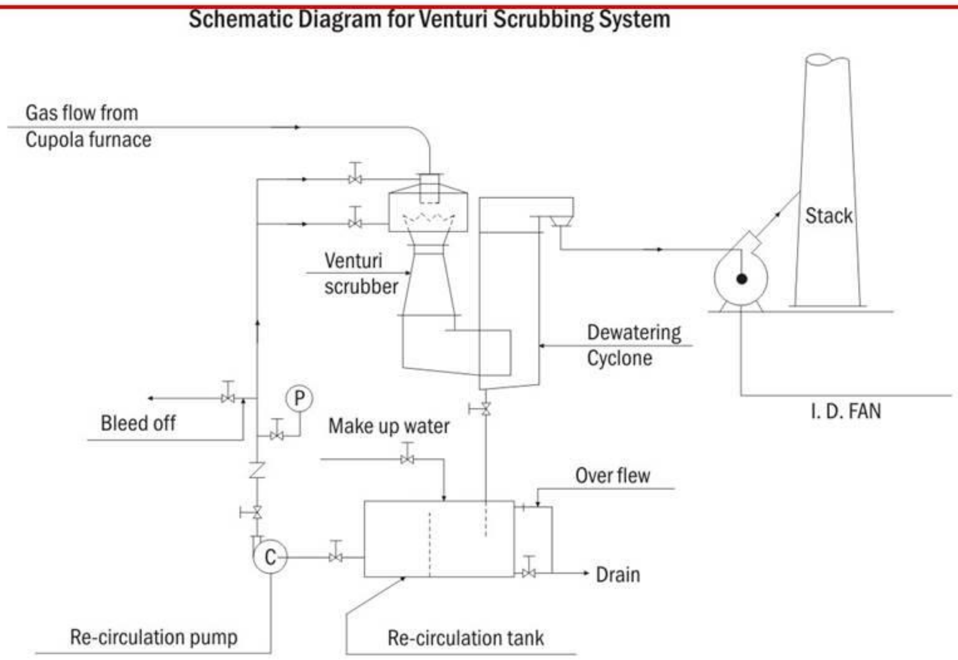
Selection criteria of PCS



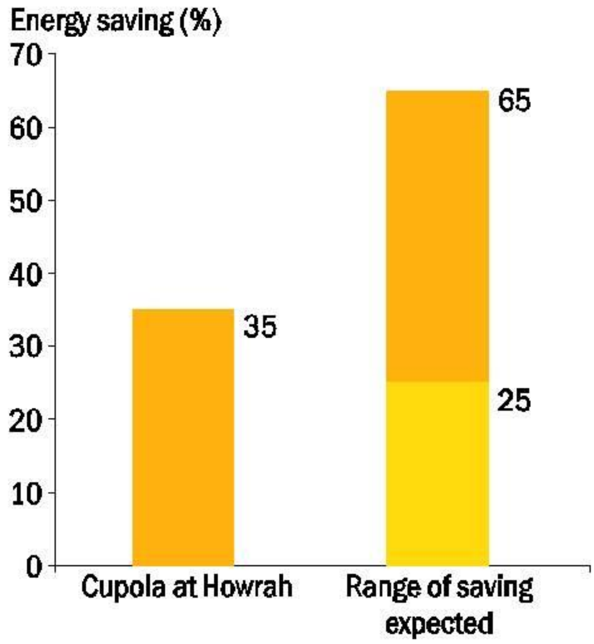
24

Energy performance

Coke charge in CC 13.6%

Coke charge in DBC 8.8 %

Energy savings 35 %
[(13.6 – 8.8)/13.6]



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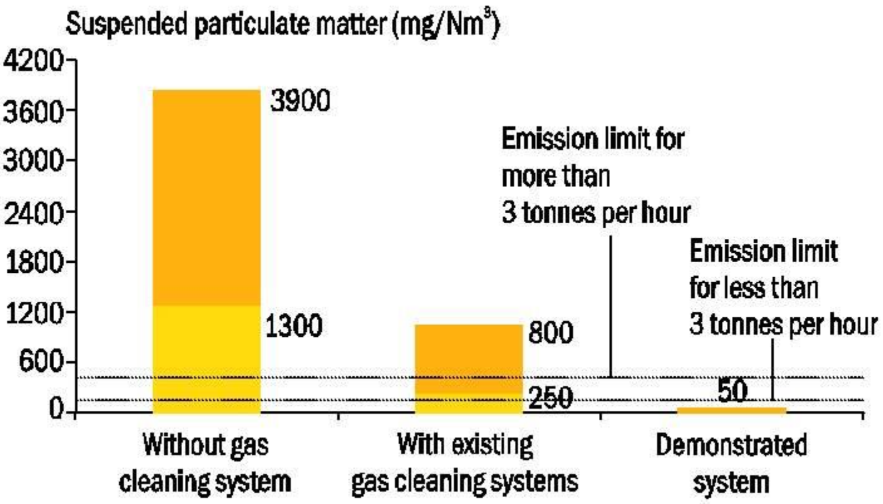
Environment performance



26

Issues in iso-kinetic sampling

- Gas velocity needs to be calculated at different traverse points in the stack
- Gas flow rate (m3/hr) is then calculated from average velocity and duct cross-sectional area
- Correct determination of the average velocity of flue gas is most important
- Velocity of flue gas also determines iso-kinetic sampling required for emission measurement
- About 5 Pa is the lowest pressure difference that can practically be measured under field conditions using standard pitot tube and inclined mannometer. This is equivalent to a gas velocity of about 3 m/s

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Issues in measuring dust concentration

- Particle size distribution of the flue gases is the most important guiding factor for selection of pollution control devices
- It is a recognised fact that the correct determination of particle size distribution of the stack flue gases is the difficult task
- Usually fibre glass filter papers are used during sampling of stack particulate emission. Finer particulates get deposited on the fibre glass filter paper, due to having fibre on filter paper, it is very difficult to remove particulates from filter paper which would lead to erroneous results. Image analyzer would be better choice for particle size analysis

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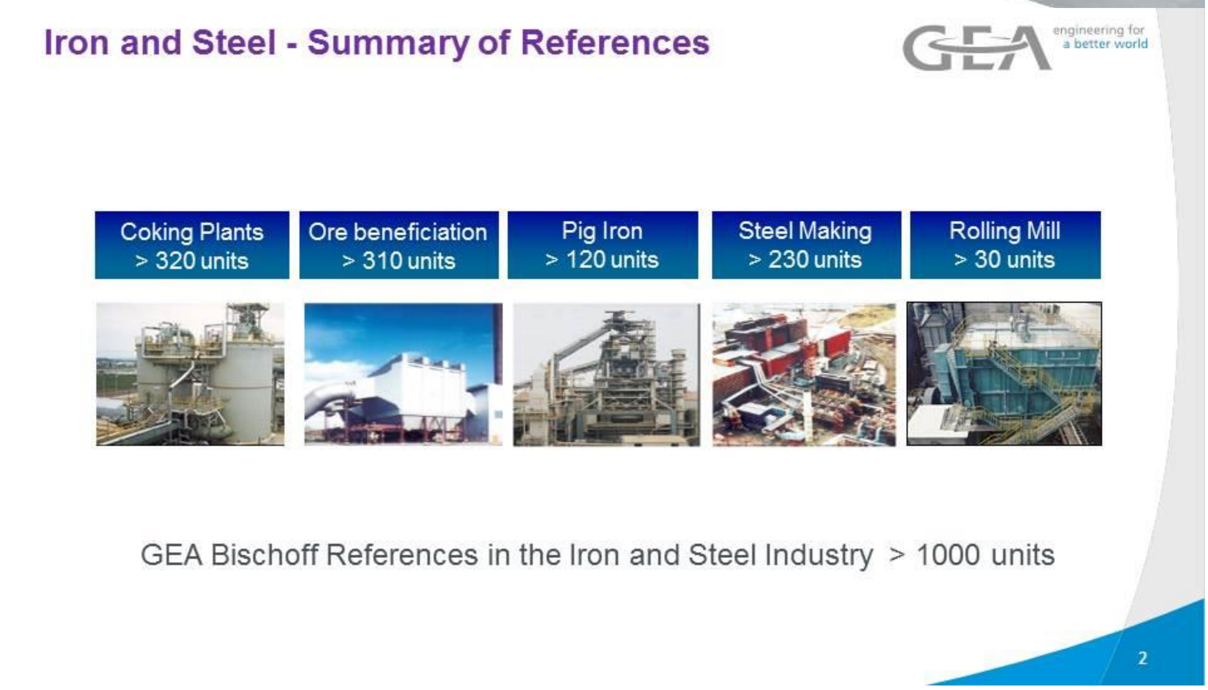
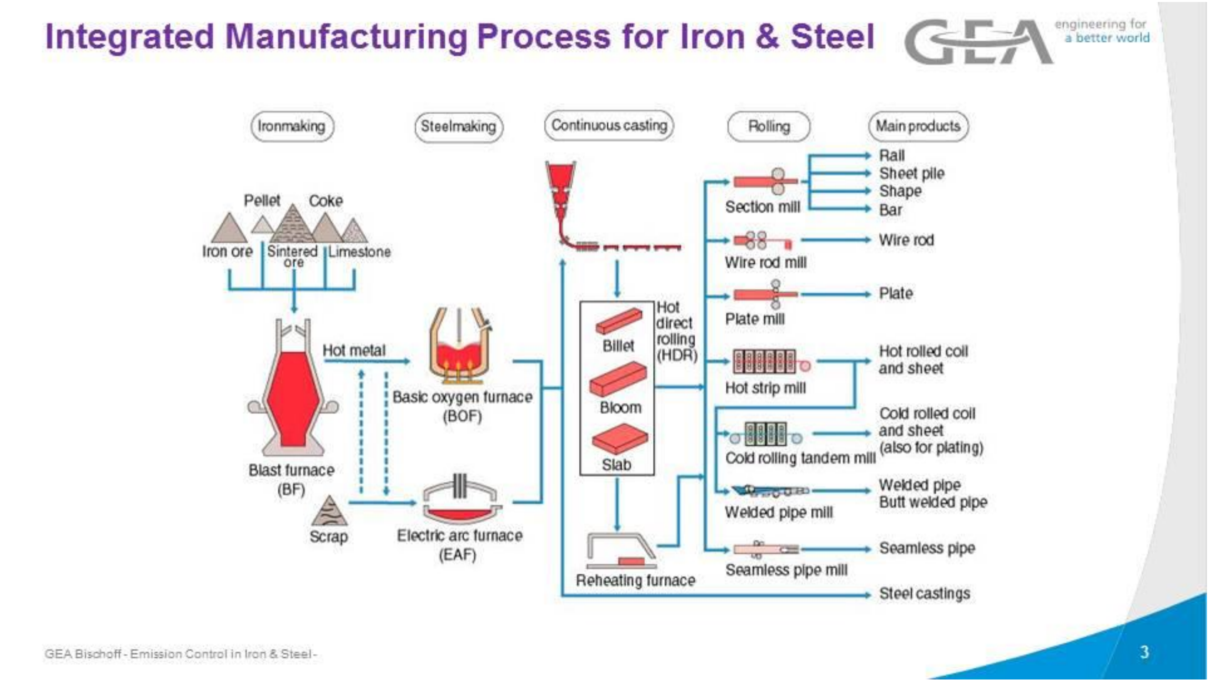
Thank you
for your kind attention!


GEA Gas Cleaning Technologies
in the Iron & Steel Industry
Air pollution control systems for foundries – selection, design and performance
Indore – 2nd May 2018
GEA
engineering for a better world


Iron and Steel - Summary of References
GEA
engineering for a better world
Coking Plants > 320 units
Ore beneficiation > 310 units
Pig Iron > 120 units
Steel Making > 230 units
Rolling Mill > 30 units
GEA Bischoff References in the Iron and Steel Industry > 1000 units
2


Integrated Manufacturing Process for Iron & Steel
GEA
engineering for a better world
Ironmaking
Steelmaking
Continuous casting
Rolling
Main products
Pellet
Coke
Iron ore
Sintered ore
Limestone
Hot metal
Blast furnace (BF)
Scrap
Basic oxygen furnace (BOF)
Electric arc furnace (EAF)
Billet
Bloom
Slab
Hot direct rolling (HDR)
Reheating furnace
Section mill
Wire rod mill
Plate mill
Hot strip mill
Cold rolling tandem mill
Welded pipe mill
Seamless pipe mill
Rail
Sheet pile
Shape
Bar
Wire rod
Plate
Hot rolled coil and sheet
Cold rolled coil and sheet (also for plating)
Welded pipe
Butt welded pipe
Seamless pipe
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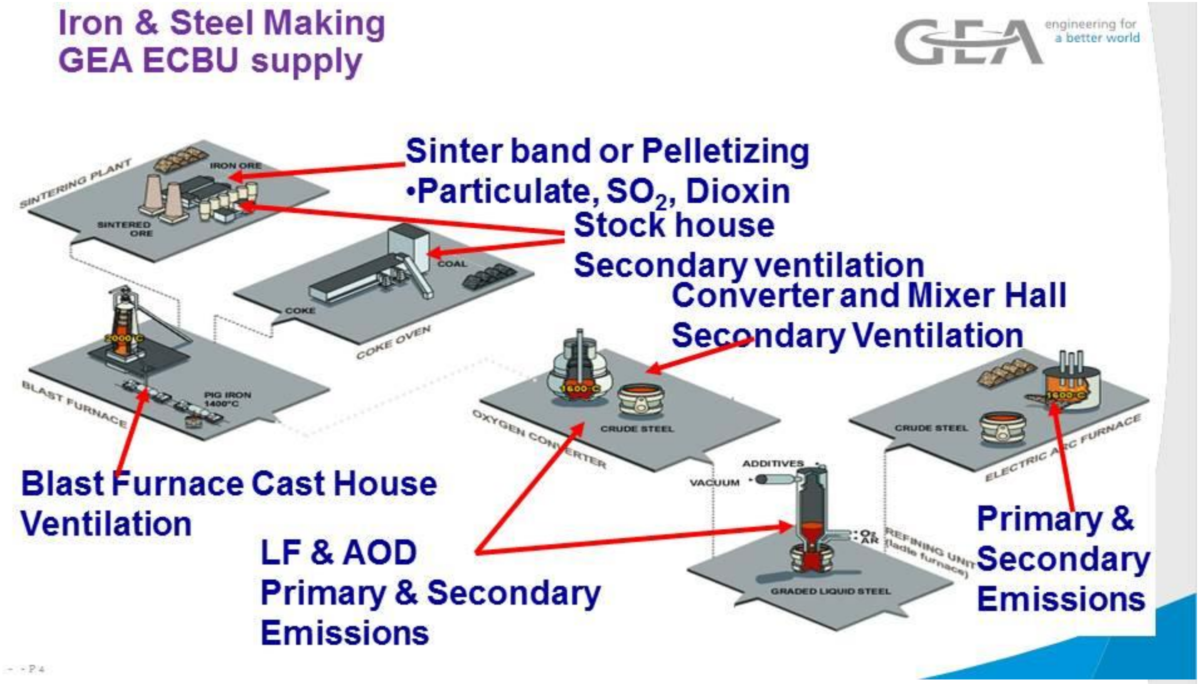
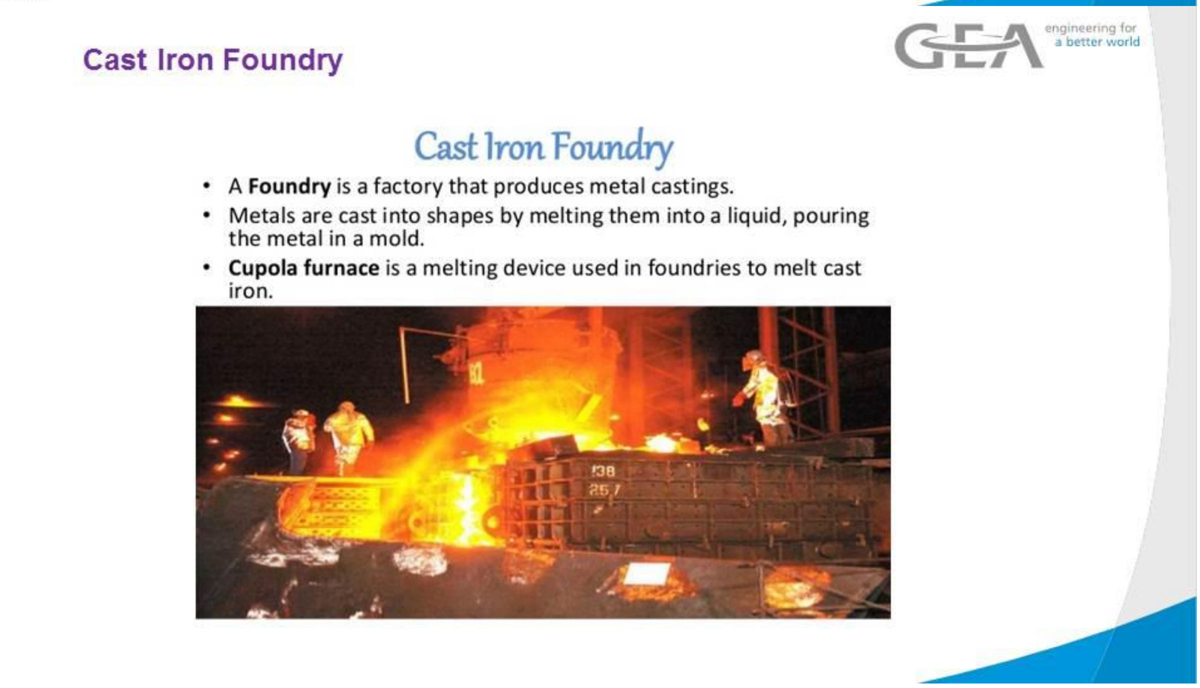

Iron & Steel Making
GEA ECBU supply
GEA engineering for a better world
Sinter band or Pelletizing
•Particulate, SO2, Dioxin
Stock house
Secondary ventilation
Converter and Mixer Hall
Secondary Ventilation
SINTERING PLANT
IRON ORE
SINTERED ORE
COAL
COKE
COKE OVEN
BLAST FURNACE
PIG IRON 1400°C
OXYGEN CONVERTER
CRUDE STEEL
ADDITIVES
VACUUM
GRADED LIQUID STEEL
REFINING UNIT (ladle furnace)
ELECTRIC ARC FURNACE
Blast Furnace Cast House Ventilation
LF & AOD
Primary & Secondary Emissions
Primary & Secondary Emissions


Cast Iron Foundry
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Cast Iron Foundry
• A Foundry is a factory that produces metal castings.
• Metals are cast into shapes by melting them into a liquid, pouring the metal in a mold.
• Cupola furnace is a melting device used in foundries to melt cast iron.

Cast Iron Foundry

Type of Air Pollution emitted from Foundries

- Particulates from mould making, melting, tapping, blasting, grinding and finishing

Volatile Organic Compounds (VOCs) emitted when:

- materials covered with cutting fluids or oils undergo scrap pretreatment.
- during mold and core making.
- from incomplete combustion, particularly if special alloys are used and produced

- Chlorine emissions from chlorine de-magging processes associated with Aluminium scrap processing
- Combustion by-products, such as Carbon monoxide(CO) and Nitrogen oxide (Nox) emitted from gas – fired smelters

Cast Iron Foundry

Typical gas conditions

	Typical	Max	Min
Temperature [°C]	200	350	100
Moisture [% v/v]	xx	xx	xx
Composition N_2	76		
[%v/v (dry) O_2	2		
CO_2	17		
SO_2	5		

Typical dust properties

	Typical	Max	Min
Inlet burden [g/Nm^3 (wet)	7	10	2
Resistivity	xxxxxx		
Grain size d50 [u]	xx		
Composition [%w/w]	Oxides of Fe, Si, Cu		

Foundry ventilation, general

Typical gas conditions

	Typical	Max	Min
Temperature [°C]	50	100	20
Moisture [% v/v]	xx	xx	xx
Composition N_2	xx		
[%v/v (dry) O_2	xx		
CO_2	xx		
SO_2	xx		

Typical dust properties

	Typical	Max	Min
Inlet burden [g/Nm^3 (wet)	3	5	1
Resistivity	xxxxxx		
Grain size d50 [u]	xx		
Composition [%w/w]	xx		
	xx		

Foundries- CPCB Emission Standards

31.0 FOUNDRIES : EMISSION STANDARDS

		Pollutant	Concentration (mg/Nm^3)
(a)	Cupola Capacity (melting rate):		
	Less than 3 tonne/hr	particulate matter	450
	3 tonne/hr and above	-do-	150
(b)	Arc Furnaces Capacity: All sizes	particulate matter	150
(c)	Induction Furnaces Capacity: All sizes	-do-	150

Note:

(i) It is essential that stack is constructed over the cupola beyond the charging door and the emissions are directed through the stack which should be atleast six times the diameter of cupola.

(ii) In respect of arc furnaces and induction furnaces, provision has to be made for collecting the metal fumes before discharging the emissions through the stack

Source : EPA Notification
[G.S.R. 742(E), dt 30th Aug., 1990]

21.0 CUPOLA FURNACE: EMISSION STANDARD

Parameter	Emission limit
Sulphur dioxide (SO_2)	300 mg/Nm^3 at 12% CO_2 corrections

To achieve the standard, foundries may install scrubber, followed by a stack of height six times the diameter of the Cupola beyond the charging door.

Note :
In case due to some technical reasons, installation of scrubber is not possible, then value of SO_2 to the ambient air has to be effected through the stack height.

Source : EPA Notification
[GSR No. 176(E), April 2, 1996]

4-26 **Industrial Ventilation**

Table 4–3. Dust Collector Selection Guide

Operation	Concentration Note 1	Particle Sizes Note w	Dry Centrifugal Collector	Wet Collector	Fabric Collector	Low-Volt Electrostatic	Hi-Volt Electrostatic
			Collector Types Used in Industry				
FOUNDRY							
a. Shakeout	light-moderate	fine	N	O	O	N	N
b. Sand handling	moderate	fine-medium	N	O	O	N	N
c. Tumbling mills	heavy	medium-coarse	N	S	O	N	N
d. Abrasive cleaning	moderate-heavy	fine-medium	N	S	O	N	N

Note 1: Light: less than 2 gr/ft^3; Moderage: 2 to 5 gr/ft^3; Heavy: 5 gr/ft^3 and up.
Note 2: Fine: 50% less than 5 microns; Medium: 50% 5 to 15 microns; Coarse: 50% 15 microns and larger.
Note 3: O = often; S = seldom; N = never.

4-26 **Industrial Ventilation**

Table 4–3. Dust Collector Selection Guide

Operation	Concentration Note 1	Particle Sizes Note w	Collector Types Used in Industry: Dry Centrifugal Collector	Wet Collector	Fabric Collector	Low-Volt Electrostatic	Hi-Volt Electrostatic
METAL MELTING							
a. Steel blast furnace	heavy	varied	N	O	S	N	S
b. Steel open hearth	moderate	fine-coarse	N	O	S	N	S
c. Steel electric furnace	light	fine	N	S	O	N	S
d. Ferrous cupola	moderate	varied	N	O	O	N	
e. Non-ferrous reverberatory	varied	fine	N	S	O	N	N
f. Non-ferrous crucible	light	fine	N	S	O	N	N

Note 1: Light: less than 2 gr/ft^3; Moderage: 2 to 5 gr/ft^3; Heavy: 5 gr/ft^3 and up.
Note 2: Fine: 50% less than 5 microns; Medium: 50% 5 to 15 microns; Coarse: 50% 15 microns and larger.
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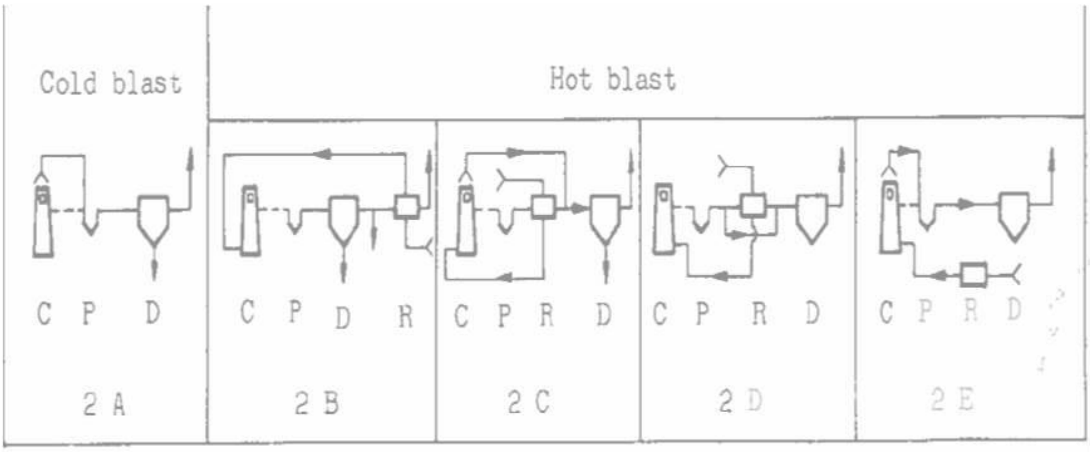
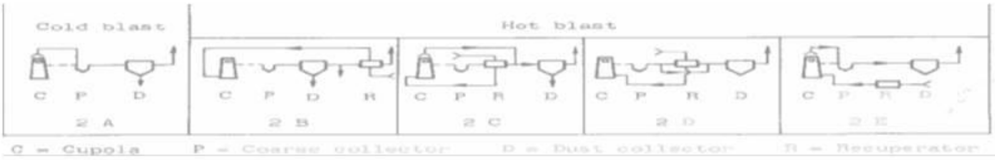
Alternatives for connecting dust collector to Cupola



C = Cupola P = Coarse collector D = Dust collector R = Recuperator

Alternatives for connecting dust collector to Cupola



In all alternatives as per figures above, a coarse collector has been installed immediately after the Cupola to reduce the coarse abrasive dust passed on the recuperator or dust collector.

In case of alternatives 2A and 2E, a spray chamber may also be mounted directly on top of furnace, if the purification requirement fall within the capacity of this dust collector

Locating the recuperator ahead of the the dust collector as in figures 2C and 2D will result in higher maintenance costs for the recuperator as compared with figure 2B, where the same has been located after the dust collector

In the case of all alternatives above, higher gas temperature are encountered during burn down and the extraction systems must thus be designed with this in mind.

Induction Furnace

An **Induction Furnace** is an electrical furnace in which the heat is applied by induction heating of metal. Induction furnace capacities range from less than one kilogram to one hundred tonnes, and are used to melt iron and steel, copper, aluminium, and precious metals.

The advantage of the induction furnace is a clean, energy-efficient and well-controllable melting process compared to most other means of metal melting.

Most modern foundries use this type of furnace, and now also more iron foundries are replacing cupolas with induction furnaces to melt cast iron, as the former emit lots of dust and other pollutants.

Induction Furnace

Induction furnaces are of two types: crucible type and channel type. Recently the channel type is more widely used because of its higher overall heat efficiency. A crucible type furnace was conventionally used for melting cast iron, using coke or low frequency noniron core induction as a heat source. The current trend is to perform continuous operation and save energy using a channel type low frequency furnace

Since no arc or combustion is used, the temperature of the material is no higher than required to melt it; this can prevent loss of valuable alloying elements.

The one major drawback to induction furnace usage in a foundry is the lack of refining capacity; charge materials must be clean of oxidation products and of a known composition and some alloying elements may be lost due to oxidation (and must be re-added to the melt).

1/95

Table 12.13-1 (Metric Units). EMISSION FACTORS FOR STEEL FOUNDRIES

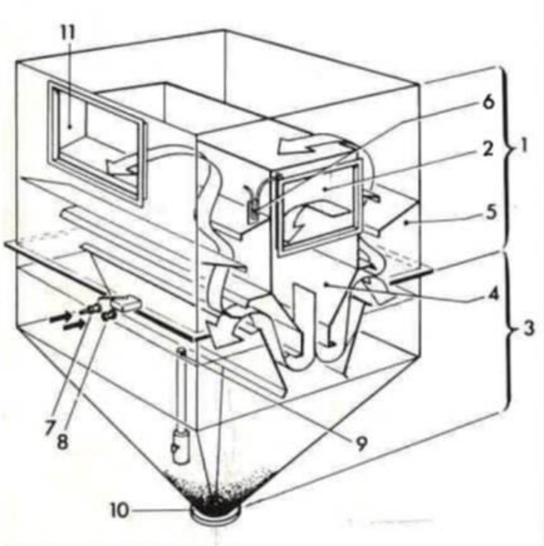
Process	Filterable Particulate[a] (TSP)	EMISSION FACTOR RATING	Nitrogen Oxides	EMISSION FACTOR RATING	Filterable PM-10	EMISSION FACTOR RATING
Melting						
Electric arc[b,c] (SCC 3-04-007-01)	6.5 (2 to 20)	E	0.1	E	ND	NA
Open hearth[d,e] (SCC 3-04-007-02)	5.5 (1 to 10)	E	0.005	E	ND	NA
Open hearth oxygen lanced[f,g] (SCC 3-04-007-03)	5 (4 to 5.5)	E	ND	NA	ND	NA
Electric induction[h] (SCC 3-04-007-05)	0.05	E	ND	NA	0.045	E
Sand grinding/handling in mold and core making[j] (SCC 3-04-007-06)	ND	NA	NA	NA	0.27[k] 3.0	E E
Core ovens[j] (SCC 3-04-007-07)	ND	NA	ND	NA	1.11[k] 0.45	E E
Pouring and casting[j] (SCC 3-04-007-08)	ND	NA	ND	NA	1.4	E
Casting cleaning[j] (SCC 3-04-007-11)	ND	NA	NA	NA	0.85	E
Charge handling[j] (SCC 3-04-007-12)	ND	NA	NA	NA	0.18	E
Casting cooling[j] (SCC 3-04-007-13)	ND	NA	NA	NA	0.7	E

[a] Expressed as kg/Mg of metal processed. If the scrap metal is very dirty or oily, or if increased oxygen lancing is employed, the emission factor should be chosen from the high side of the factor range. SCC = Source Classification Code. ND = no data. NA = not applicable.
[b] Electrostatic precipitator, 92 to 98% control efficiency; baghouse (fabric filter), 98 to 99% control efficiency; venturi scrubber, 94 to 98% control efficiency.
[c] References 2-7.
[d] Electrostatic precipitator, 95 to 98% control efficiency; baghouse , 99.9% control efficiency; venturi scrubber, 96 to 99% control efficiency.
[e] References 2,8-10.
[f] Electrostatic precipitator, 95 to 98% control efficiency; baghouse, 99% control efficiency; venturi scrubber, 95 to 98% control efficiency.
[g] References 5,11.
[h] Usually not controlled.
[j] Reference 13.
[k] Emission factor expressed as kg of pollutant/Mg of sand handled.

Metallurgical Industry

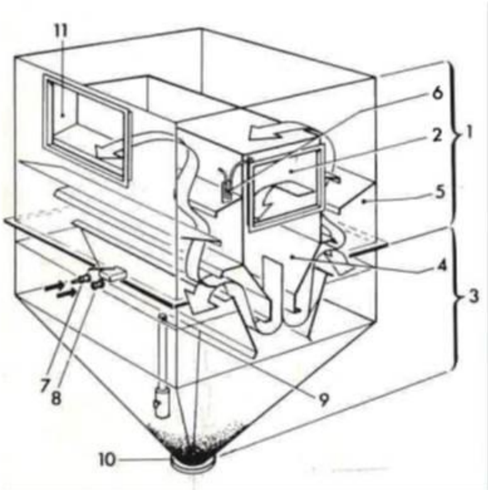
12.13-5

Wet Collector – Medium efficiency



1. Upper section
2. Inlet chamber
3. Lower section with hoppers
4. Scrubber unit
5. Dewatering zone
6. U-tube manometer
7. Level regulator with topping-up valve
8. Rapid filling valve
9. Overflow pipe with water lock
10. Flange for connecting to discharge device
11. Gas outlet

Wet Collector – Medium efficiency



The figure shows a type of Wet collector which offers 60-85% efficiency approximately.

This kind does not generally utilize circulating water.

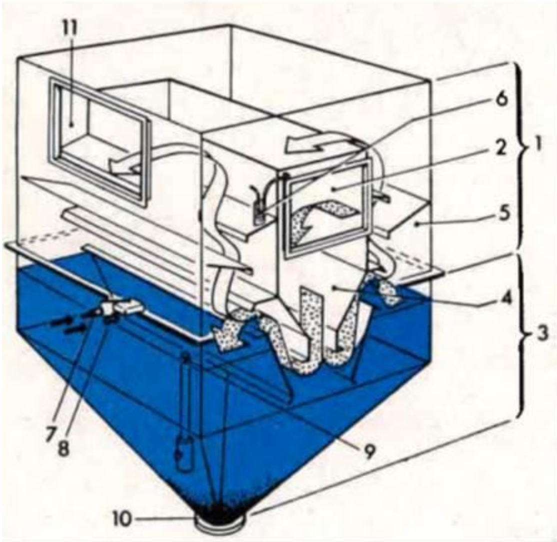
Normally, the gas temperature must be reduced to 200-400 deg.C before entering the collector due to mechanical design.

This wet collector is of medium pressure type and suitable for 6000 – 72000 m3/hr

The collector can be used for both low and high dust concentrations upto 20 gm/m3

The collection efficiency is adjustable to suit different types of dust.

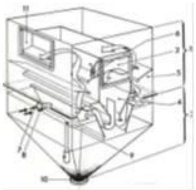
Wet Collector – Medium efficiency



The dust-laden gas is admitted into the inlet chamber and then flows downwards through the scrubber units, where it is forced to flow between the lower edges of the scrubber units and a water surface. Owing to the pressure difference caused by the resistance to flow in the contact zone, the water is dispersed to very small droplets. These droplets trap the dust particles into agglomerates. The larger agglomerates sink to the hopper, whereas the smaller dust particles are entrained with the water droplets and are separated out with the droplets in a series of dewatering plates.

The collecting performance can readily be varied to suit the requirements, simply by adjusting the setting of the level regulator. This controls the water level in the collector and a change in the level also implies that the pressure drop across the collector will be altered. The normal range of pressure drops across the collector is 1600—3000 Pa (160—300 mm w.g.) and the actual pressure drop can be read on the U-tube manometer.

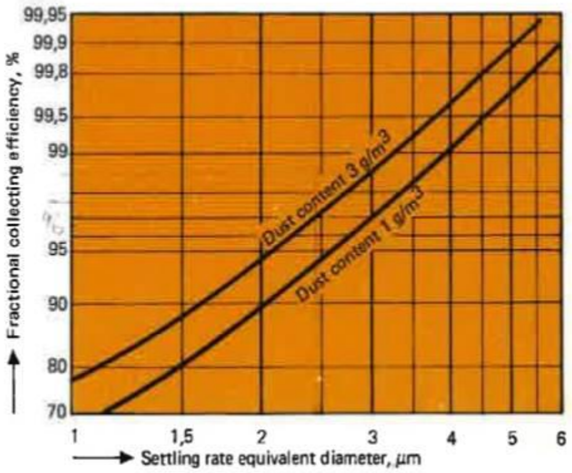
Wet Collector – Medium efficiency



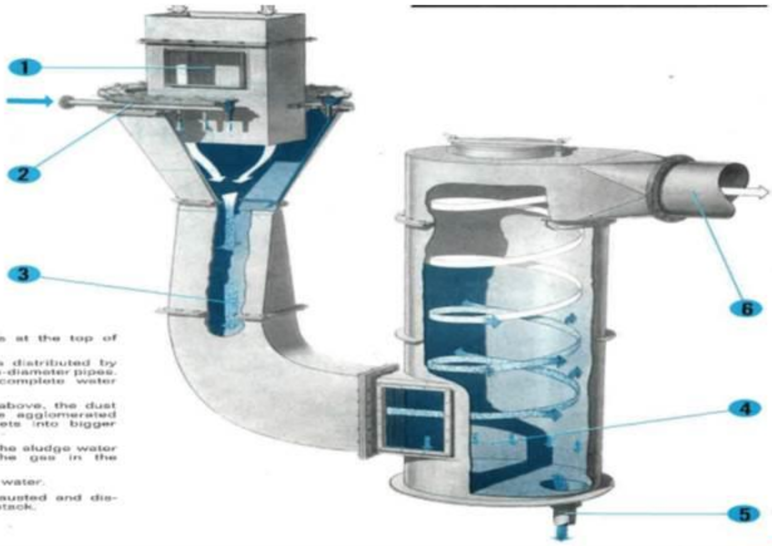
Collecting efficiency

The graph below shows the collecting efficiency as a function of the settling rate equivalent diameter at a pressure drop across the collector of approx. 1800 Pa (180 mm w.g.). Particulars of the collecting efficiency at other pressure drops are available on request. The curve applies to finely-ground dolomite as test dust.

The settling rate equivalent diameter of a particle is the diameter of a sphere with a density of 1 g/cm³ which has the same settling rate as the relevant particle in air at 20°C and 1.013 bar (760 mm Hg).

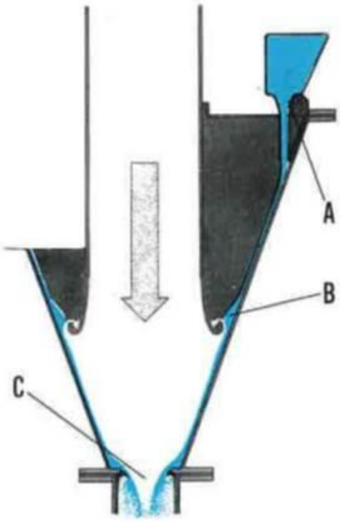


High Efficiency Wet type collector using Venturi Principle



① Dust-laden gas enters at the top of the mixing chamber.
② The water supplied is distributed by means of several large-diameter pipes. The water forms a complete water film on the walls.
③ In the venturi throat above, the dust particles in gas have agglomerated with the water droplets into bigger particles.
④ By centrifugal action the sludge water is separated from the gas in the cyclone.
⑤ Drain pipe for sludge water.
⑥ The clean gas is exhausted and discharged through the stack.

High Efficiency Wet type collector using Venturi Principle



A No clogging—large-diameter supply pipes. Water with high dust content can be recirculated.

B No dust deposits on the walls which are completely covered by a uniform film of water.

C Gas flow accelerates water stream, and increases atomization without pumping effect.

High Efficiency Wet type collector using Venturi Principle

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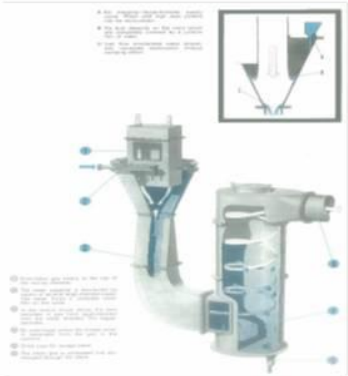

- The Venturi principle (allowing the attainment of great differences in velocity between water droplets and dust particles) is employed for high efficiency collection
- The finer dust particles encounter water droplets in the venture throat causing them to agglomerate. These agglomerates thus formed are subsequently collected in mechanical collector of cyclone type.
- In general, it may be said of wet type collectors that water may absorb upto 70-80% of the SO_2 according to type of collector and the pH of water.
- In order to avoid water pollution it is normal to employ a closed circulating system. In such a system, the pH of the water must be checked in order to avoid corrosion of the parts of the system that are in contact with the water.
- For full protection against corrosion, the entire wet collector should be built of corrosion resistant materials, since sulphuric acid may condense in parts of the system which are not flushed by water- e.g. in greater part of cyclone as well as in Fan and Stack.

High Efficiency Wet type collector using Venturi Principle

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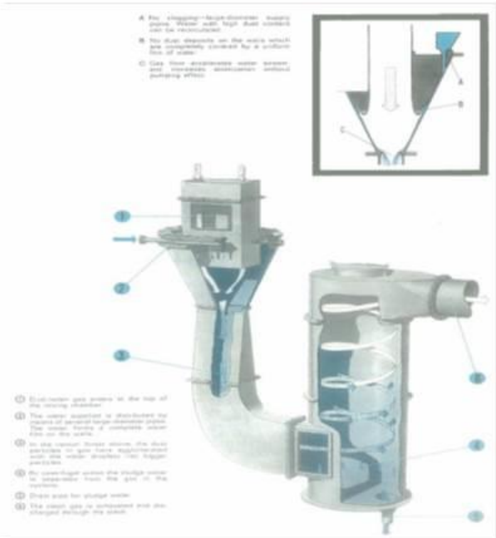
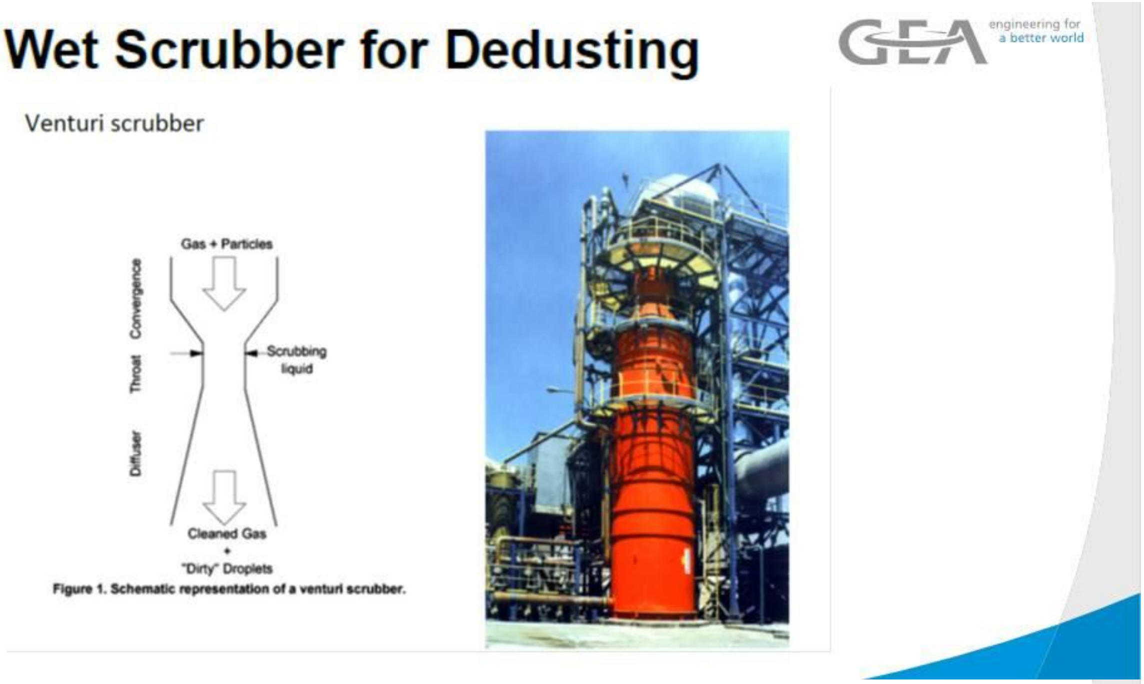


- The Venturi Scrubber is used for high-efficiency collection of ultra- microscopic <0.2 μ or microscopic particles 0.2-10 μ, whether in solid, fluid or vapour form
- It can also be used for air and gas conditioning, absorption of acids and similar products.
- High temperature gas upto 1000 deg.C can be handled by Venturi Scrubber with special design
- Combination of Scrubber can be used to handle different quantities of gas.
- Most designs of Wet type collector have no moving parts and hence none of the associated wear and clogging problems. They are highly reliable and have lower Installation cost compared to dry collectors like Bag Filter
- However, they do have the higher power consumption compared to dry collectors.


Wet Scrubber for Dedusting
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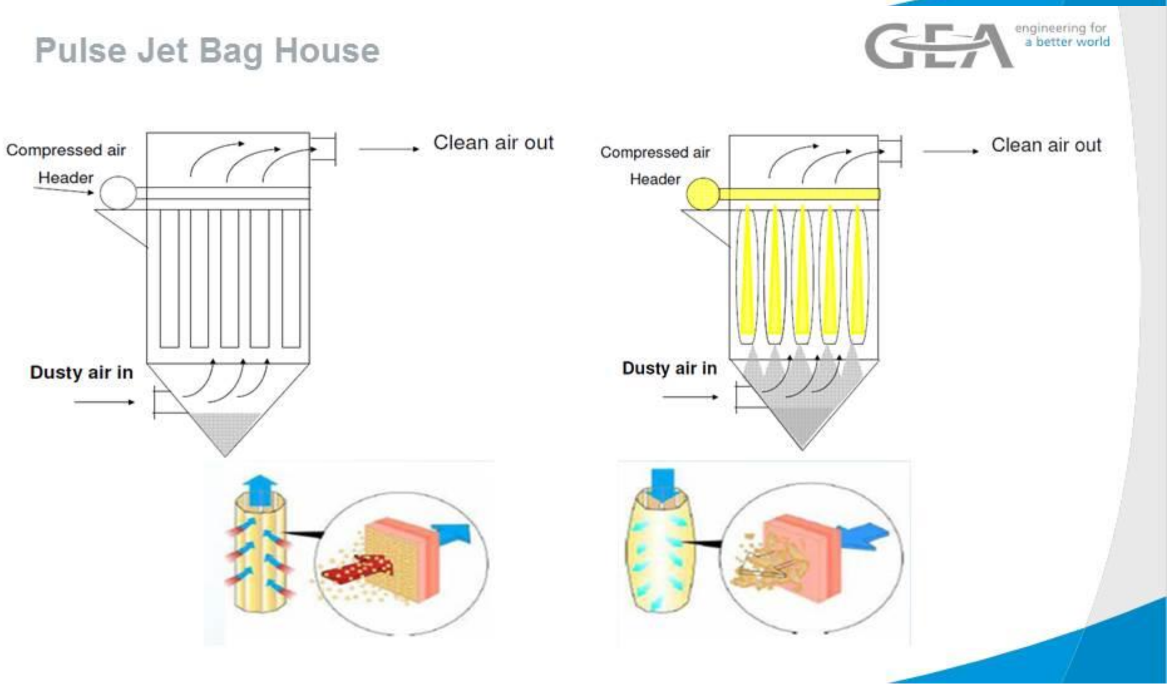
Venturi scrubber
Gas + Particles
Convergence
Throat
Diffuser
Scrubbing liquid
Cleaned Gas
+
"Dirty" Droplets
Figure 1. Schematic representation of a venturi scrubber.


Pulse Jet Bag House
GEA engineering for a better world
Compressed air
Header
Clean air out
Dusty air in
Compressed air
Header
Clean air out
Dusty air in

Dry dust collector – Fabric Filter

A Fabric Filter separates dust from gas flow by a Strainer effect. The dust collected on the Fabric is removed by reverse pulse jet by compressed air.

In view of the greater sensitivity of fabrics to temperature, the equipment for lowering gas temperature must be reliable. The following alternatives are available for the reduction of temperature of the gases, which may be as hot as 1200 deg.C during blow out.

- Dilution with air: Easiest method with least risk of operating troubles. Gives the highest volume of gases to be handled by the collectors and hence higher installation cost.
- Cooling by water in a spray tower: The most efficient method but can give rise to condensation problems if temperature are not watched carefully. Is best used in combination with air dilution.
- Radiation: Final temperature is difficult to monitor and the method should be used in combination with some other. Require large cooling surfaces
- Recuperator: Best combined with some other method, since the final temperature is difficult to monitor

- To prevent the formation of pockets of explosive gases and reduce the amount of oily contaminants etc., it is best to burn the gases before they enter the fabric collector installation. Fabric Filters achieve very high efficiency and work at lower pressure drops compared to wet collectors.
- They are however, sensitive to temperature and gas conditions and also require regular maintenance

Fabric Filter Design

- **Filter Type and Size (Air to Cloth Ratio-** Application specific**)**
- **Filter Bag Material (**Chosen as per requirements of service life, pressure drop and dust emission)
- **Bag Geometry** (Depends on type of filter design, round for HPBH and elliptical for LPBH, Bag Length-Standard available, selection is based on Process application, foot print)
- **On-Line Maintenance** (Compartmentalized design, one compartment can be maintained On-line at a time)

Structural/Modular Fabric Filter *(One row or two rows- maximum 3 modules/compartments per row is recommended)*

- **Inlet/Outlet Plenums (**For proper gas distribution**)**
- **Dampers** (For Isolation during on line maintenance)
- **Hoppers** (To ensure proper dust discharge)
- **Maintenance Access**
- **By-Pass** – Process application specific.
- **Thermal Expansion** – as required.
- **Controls and Monitoring**

Filter media summary

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Material	PP	PES	PAC	PPS	APA	PI	PTFE	GLS
Polymer Common trade name	Polypropylene	Polyester	Dolanit Ricem	Ryton Procon Torcon Fortron	Nomex	P84	Teflon	Fibreglass
Temperature degC								
Continuous	90	135	120	170	190	190	240	240
Peak	95	150	130	190	220	260	260	280
Resistance								
Acid	5	3	4	4	2	3	5	4
Alkali	5	2	3	4	4	3	5	3
Hydrolysis (H2O)	5	2	4-5	5	2	3	5	5
Oxidation (O2)	3	5	3	3	3-4	3-4	5	5
Abrasion	5	5	3-4	3-4	5	4	3	1
Price rel. to PES	1	1	1.5	3.5	5	6.5	15	2-3

1 = Bad, 2 = Mediocre, 3 = Generally good, 4 = Good, 5 = Excellent

- This table summarizes the properties of the most common filter materials. The table also includes material resistance rankings with regard to acid attack, hydrolysis (moisture attack) etc.
- The Gas temperature and dust analysis are decisive in the choice of fabric.
- Since glass fibre is sensitive to flourine compounds, it cannot be used if fluorspar is added to the Cupola charge

Dust Particle Size Information

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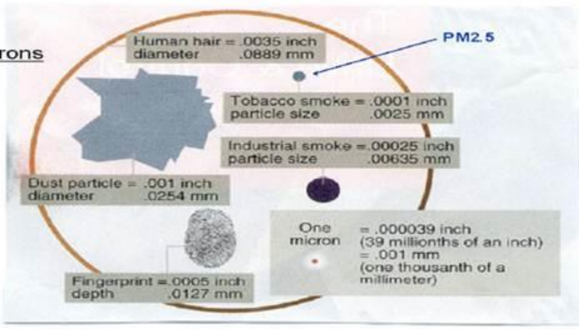
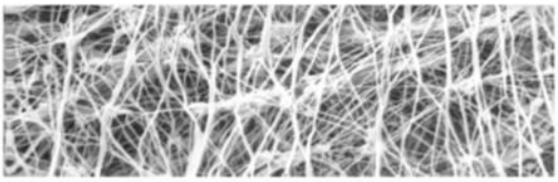
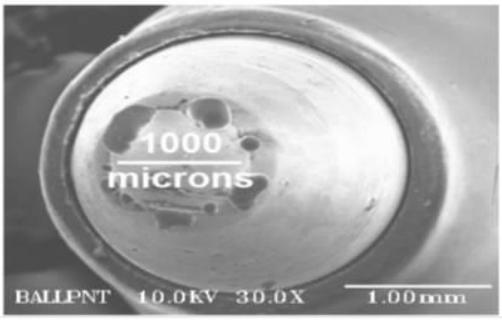
What is PM2.5?

Particulate Matter <2.5 microns
Solid Particles
Metals
Hg^{o} & Hg^{P}
Acid Mists
Liquid Droplets



Felt Pore Size





-Average Membrane Pore Size 0.5 - 1 micron, effective pore size much smaller.

-Traditional woven / felts typically have a 20 micron pore size.

-Can fit approximately 1000-2000 pores across the tip of a ball point pen.

-100 million pores per square centimeter

Compressed Air Supply

- For the function of the total filter as well as the cleaning system it is of great importance that the compressed air has a good quality and that the system has sufficient capacity .
- A bad quality may give corrosion in the pressure tank, disturbances in the function of the pulse valve and clogging of filter bag.
- Insufficient capacity will give a too long pause-time which will reduce the possibility to clean the filter bags during high load resulting in high pressure drop and decreased gas flow.
- General demands for the compressed air

Filter classes according to ISO 8573.1:2001:

Water content	Filter CLASS 4
Particle content	Filter CLASS 3
Oil content	< 0,02g/Nm³

The absolute values for each class can be read in the table

Compressed Air Purity Classes A, B, C:

Where:
A = solid particle class designation
B = humidity and liquid water class designation
C = oil class designation

CLASS	SOLID PARTICLES, PARTICLE SIZE, d (mm)			HUMIDITY AND LIQUID WATER		OIL	
	0.10 < d ≤ 0.5	0.5 < d ≤ 1.0	1.0 < d ≤ 5.0	PRESSURE DEW POINT		TOTAL CONCENTRATION: AEROSOL, LIQUID AND VAPOR	
	MAXIMUM NUMBER OF PARTICLES PER m³			°C	°F	mg/m³	ppm/w/w
0	As Specified			As Specified		As Specified	
1	100	1	0	≤-70	-94	≤0.01	≤0.008
2	100,000	1,000	10	≤-40	-40	≤0.1	≤0.08
3	—	10,000	500	≤-20	-4	≤1	≤0.8
4	—	—	1,000	≤+3	38	≤5	≤4
5	—	—	20,000	≤+7	45		
6				≤+10	50		
				LIQUID WATER CONTENT Cw g/m³			
7				Cw ≤ 0.5			
8				0.5 < Cw ≤ 5			
9				5 < Cw ≤ 10			
PER ISO8573-1: 2001(E)							

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Installation of Bag and Bag cage.

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Cage and Bag assembly at shop

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Installation of Bag and Bag cage.

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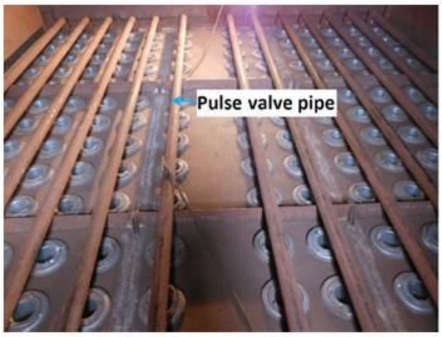

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