Improving Air Emission Profiles Using Baghouses and Other Processes

EVRAZ INC NA Canada Environmental Affairs Department

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EVRAZ Regina Steel Making

- Steel recycling using scrap steel, about 1Mt/a
- Electric Arc Furnaces (EAF) with natural gas burners
- Scrap steel placed into EAFs with clam-shell buckets
- Lime (= “EAF Steel Slag”) added to top of molten steel to insulate and occlude air
- Processing with fine carbon and oxygen
- Tapping into ladles for further processing in Ladle Metallurgy Furnace (LMF), before casting
Exhaust Diagram (NTS) After Installation of Mikropul Baghouse (#4) (diameter in brackets ft-in) flow in boxes ACFM x 1000, October 13-15, 2010
Emissions from EAF melting are exhausted in a water cooled (WC) system after the ‘fourth hole’ elbow, into a drop box for post-combustion and where the larger pieces of debris are deposited.

The exhaust travels thence to a Spark Box (SB), where heavier dust and materials settle, and then is routed to the Mikropul baghouse.
When emptying the furnace, eccentric bottom tapping is used, and the liquid steel flows to a ladle through a tap hole in the base of the furnace.

Exhaust during furnace tapping is pulled through a side draft (items L and F on diagram) which is then routed through the water cooled exhaust piping.
EVRAZ Emission Control Design cont’d

- Emissions from the two Electric Arc Furnaces (EAF) into the building occur, as a charge plume to the canopy when the furnace lid is lifted and new scrap charges are added, or during slag pour-off.
- Fume flowing into the canopy is exhausted to the Procedair and the AAF baghouses.
- Canopy hood velocity design is greater than 60 cm/s.
- The LMF exhaust is drawn into a plenum (item E on the diagram) and then into the canopy. If there are any issues with the Mikropul baghouse, exhaust duct flow can be rerouted and the air emissions can be exhausted into the Procedair and the AAF baghouses.
EVRAZ Emission Control Design cont’d

- Meltshop Canopy Ducting

Photograph of the exhaust ductwork to the baghouses

Photograph of exhaust system and spark box
EVRAZ Regina Baghouses

- Evacuation design rate is about 1.5 acfm per Ton/year of Steel produced; (usual practice has been 1.0).
- “Net*Net” design; i.e. without two compartments per baghouse

- EVRAZ has three (3) baghouses in operation, named based upon Manufacturer
- Two Positive Pressure
  - Mikropul -- about 1 M acfm
    - 12 compartments, 336 bags/compartment (4,032 bags)
    - Three fans, two in operation continuously
    - Maximum A/C ratio is 3:1
    - Most recent addition
  - AAF – about 0.3 M acfm
    - 10 compartments, 128 bags/compartment (1,280 bags)
    - Three fans, two in operation continuously
- One Negative Pressure
  - Procedair – about 0.2 M acfm
    - 10 compartments, 180 bags/compartment (1,800 bags)
    - One fan in operation continuously
Baghouse Basics - Bag Types

Can be made out of woven or non-woven materials. Some of the common types and their characteristics are listed below.

- **Polyester**
  - Synthetic fibre
  - Acid, alkaline and abrasion resistant
  - Inexpensive

- **Fibreglass**
  - Synthetic fibre
  - High temperature application use
  - More chemically resistant

- **Gore™**
  - Expanded polytetrafluoroethylene (PTFE) membrane
  - Laminated with various fibres to create
  - Wear resistance, longer life
  - Lower friction, higher flow
EVRAZ INC NA Canada Baghouses cont’d

- Mikropul Baghouse
- AAF Baghouse
EVRAZ INC NA Canada Baghouses cont’d

- Procedair Baghouse
Baghouse Basics

- Fabric filtration is a common technique for emission control and is otherwise called a baghouse.
- Filters with their supports are referred to as bags.
  - Bags hang vertically in fabric filter shell.
- Dust is collected either inside or outside of the bag.
  - During compartment cleaning and upon removal dust particles fall into the hopper and are removed.
- Bag material must be matched to the cleaning methodology.
- Baghouses are classified based upon the cleaning mechanism.

Photograph of bag tubes in the EVRAZ Mikropul Baghouse
Baghouse Basics – Cleaning Mechanisms

- **Intermittent cleaning**
  - Commonly used for compartmentalized baghouses
  - Can also be used for single compartment baghouses
  - One compartment removed from service at a time and cleaned
  - Rotational between compartments

- **Continuous cleaning**
  - Fully automatic, row of bags always being cleaned in baghouse
  - Does not require taking the baghouse or compartment out of service for cleaning

- **Compartmentalized baghouses**
  - Used for continual operating facilities with large exhaust volumes
  - Can have one compartment offline for cleaning and another offline for maintenance, with the remainder in operation
Baghouse Cleaning Mechanisms cont’d

- **Shaking**
  - Interior filtration (dust collection inside of the bags)
  - Manual or mechanical shaking of a shaft that moves a rod connected to the bags resulting in dust falling into the hopper
    - Generally horizontal shaking
  - Higher cleaning & filtering stress on bag
  - Older technology

- **Reverse Air**
  - Commonly used for compartmentalized baghouses
    - Enables compartment to be offline
  - Air / gas flow stopped and compartment backwashed with low pressure air
  - Dust collection inside of the bags
    - Sealed at top and open at bottom
    - Bag has rings (~1 m apart) to prevent complete collapse during cleaning
  - During cleaning the bags are allowed to collapse
    - Dust breaks and falls into hopper
  - Usually used on woven fabrics
  - Less cleaning & filtering stress on bag
  - Either cycled or initiated by pressure drop switch
  - Use inlet and outlet dampers for filtering and bag cleaning sequences
    - In operation both dampers are open
    - During cleaning the outlet damper is closed blocking the flow of air / gas through compartment and reverse air damper is opened to allow fresh air for cleaning
Baghouse Cleaning Mechanisms cont’d

- **Pulse jet cleaning**
  - High pressure jet of air into the top of the bag tube removing the dust from the exterior of the bag
  - Bags supported by rings or metal cages held at top with clamps and closed bottom
  - Used for cleaning bags with exterior filtration system
  - Dirty air / gas flow is not stopped
  - Cleaning done row by row
  - Can also be used in compartmentalized baghouses and compartment taken offline via poppet valve closure
  - Higher cleaning & filtering stress on bag
  - Important to space bags to reduce bag abrasion
  - Less commonly used

- **Sonic**
  - Sound generator produces low frequency noise causing vibration
  - Typically used in addition to other cleaning techniques
Baghouse Design

- **Positive pressure baghouse**
  - Fan is upstream or before the filter
  - Pushes air / gas through the filter
  - More prone to pressure leaks and fan wear
  - Commonly used for dusts easily ignited due to air infiltration-related fires

- **Negative pressure baghouse**
  - Fan is downstream or after the filter
  - Air / gas is pulled through the filter
  - Requires more structural reinforcement due to suction on baghouse shell

- **Fans are integral part of baghouse thus maintenance is crucial**
  - More wear on positive pressure baghouse fans than negative pressure baghouses
  - Can shutdown entire baghouse, thus best to have on-line spare
  - Fans are expensive

- **Air to Cloth (A/C) Ratio**
  - Dependant on material, particle size distribution of collected material, particulate matter characteristics, humidity and bag spacing
  - As ratio increases so does seepage through filter medium, baghouse gas inlets and bags and also increases bag breakage
  - Increases as gas volumetric flow rates increase and could decrease bag life
  - Lower A/C based on Net*Net design is key for proper performance and operation
Baghouse Design cont’d

- Gas temperature
  - Important because of bag operation design range
  - Operation of a baghouse below dew point temperatures of the gas stream can result in moisture or acid condensation
    - Condensation is a main bag failure cause
  - Consider also in-leakage into gas stream
  - Often tied to alarm to notify of trouble

- Pressure drop
  - Based upon gas volumetric flow rate
  - Fluctuates with cyclic cleaning process
  - Increases as dust accumulates on / in bags
  - Decreases after compartment cleaning
  - Indicates gas flow resistance and effectiveness of the cleaning system
  - Can indicate maintenance required

- Hoppers
  - Store collected dust before removal and disposal
  - Dust removal should be frequent to reduce packing of the dust
    - Double dump discharge device
    - Rotary Air lock valve – shaft mounted paddle wheel driven by a motor
    - Screw conveyor (auger)
    - Drag conveyor
    - Paddle conveyor
  - Access door or port to enable dust removal
  - Vibrators and plates
Particulate Matter (PM), Carbon Monoxide (CO) and other emissions are collected by building roof ducts which are connected to the baghouse(s).

- Large volumes of exhaust are created in the charge plume and must be held in the canopy hood until evacuated from the building.
- Tapping emissions are collected by the push-pull side collection hood at the furnace/ladle during tapping.
- PM is removed from melt cycle using the fourth hole.
- CO is either burned in furnace when sufficient oxygen is present or exhausted through the direct evacuated system (DES) where it is post-combusted at the drop box.
- Downstream ductwork can explode if excessive CO

Potential Fugitive Emissions at Baghouses

- Door seals
- Corroded points
- Warped access hatches
- Tube sheet cracking
EVRAZ Regina Baghouses – Cleaning System

- Reverse air is used
- Baghouse compartment cleaning cycles are controlled timing cycles, and/or by pressure drop
- Manual pressure gauges and electronic controllers are used
Each baghouse has broken bag detection sensors
- Sensors installed at the clean air outlet of each compartment
- When higher than normal amounts of particles collide with the sensor a frictional electrification will take place
- Reads in picoamps (pA)
- Provides signal when higher amounts of dust are discharged (except cleaning spikes)
- High amperage is indicative of broken bag(s)
- Data displayed on Programmable Logic Controller (PLC) screens
- Data saved on cards and files transferred to software
- Software called “Tribo” enables real time and historical view of activity including particulate spikes graphics and alarm history summarization
Radiation detection used in the baghouses
Scheduling of Baghouse Compartment Change-outs

- Wear and tear occurs on bags during operations
  - Bags Break
- Individual bags in each compartment will require periodic change-out
- Proper tracking of individual bag and compartment change-outs is crucial to effectively manage bag integrity and emission control

Photograph of broken bag
Scheduling of Baghouse Compartment Change-outs cont’d

- **Management of Change-outs**
  - Key is to manage and monitor change-outs
  - Individual bag change-outs, and
  - Compartment change-outs
- **Multiple baghouses and compartment change-out management**
  - Use tracking spreadsheets
  - One compartment per worksheet
  - Set up grid-like pattern to identify bag location in compartment
  - Complex calculations are used to summarize average compartment bag age and highlight when nearing life expectancy

- **Scheduling Compartment Bag Change-outs**
  - Enables the facility to maintain reasonable performance over the life of the bags
  - Can use various tracking spreadsheets and updating external linkages
  - Schedule based upon oldest average bags
  - Improves budgeting and evens out costs of compartment change-out over time
Cold Weather Operations and Issues

- **Condensation**
  - Water is generated by combustion in the EAFs, and WC duct leaks; outer wall insulation is needed.
  - Ice build up can cause exterior wall and roof corrosion of the baghouse shell
    - Internal hot air contacts cold sheeting
    - Hot air condenses on walls and collects on compartment floor
    - If water from floor contacts tube bag, then bag deterioration occurs
  - Can cause reaction with EAF dust in the bag causing a cement layer to form in the bag

- **Hopper problem reduction**
  - Insulation, Heaters
  - Air tight seals
  - Frequent dust removal (pneumatic through augers)
EAF Dust Removal

- Dust is removed from the baghouse hoppers, melt-shop floor and spark box
- EVRAZ contracts truck operators to remove EAF Dust, slurry with water
- Dust and water slurry produces an exothermic reaction with the lime, thus expansion room is required in the truck
- Classified as a Hazardous material
- EVRAZ has an engineered, licensed EAF Dust Storage Facility for dust disposal
- Aged and failed bags are also disposed at the Facility
- Disposal quantities are tracked on a monthly basis

![EAF Dust Stored - Landfilled](chart1.png)

![EAF Dust Produced per tonne Liquid Steel Melted](chart2.png)
References


