Use of Baghouse in Controlling Emission from Ice on Ship

Cadet Nitilaksh Desai[1], Cadet Nitish Saini[2], Arjit Mourya[3]
[1,2]2nd Year B.Tech Marine Engineeering
Marine Engineering & Research Institute, Mumbai-400033
[3]2nd Year B.E.Mechanical Engineering, Jabalpur Engineering College, Jabalpur, Madhyapradesh

Abstract: The Baghouse is a generic name for Air Pollution Control Equipment (APC) that is designed around the use of engineered fabric filter tubes, envelopes or cartridges in the dust capturing, separation or filtering process. Emission from the shipping contribute significantly to the concentration and fallout of harmful air pollutants and around 80-90% pollution can be reduced by some protective measures. The emission can be filtered from the baghouse before directly discharging the exhaust gases and also if the gases can be stored for short distance voyages and then discharged to port then gases can easily be purified. Baghouse is very efficient particulate collector. This method is now used in many industry and can also serve successfully in maritime industry

1. INTRODUCTION

Fabric filtration is the most common technique used to collect the particulate matter. Fabric filtration process is often called as "BAGHOUSE' consist of following basic components:

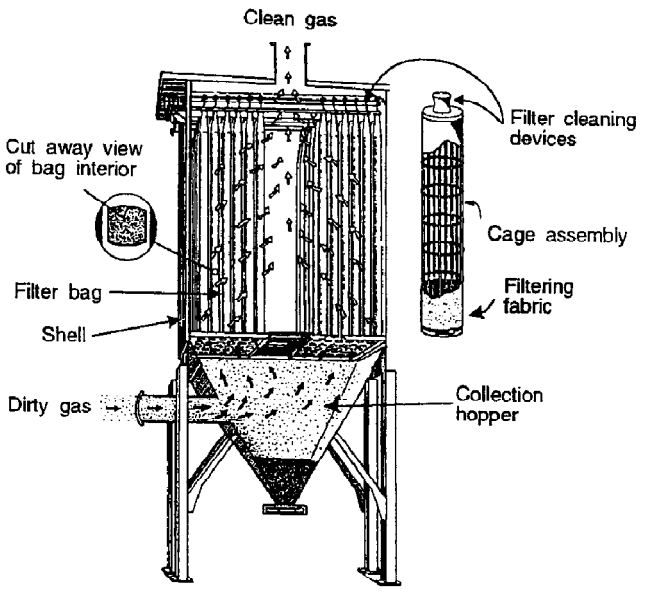
- Filter medium (i.e. filtering fabric) and supports (cages).
- Filter cleaning device.
- Collection hopper.
- Shell.

The filters with their supports are termed as bags and hence the term baghouse derived. The number of filter bags in each shell depends upon the size and varies from hundreds to thousands.

2. BAGHOUSE: DETAILED STUDY

When the dirty exhaust gas is entered in the baghouse gas first enters the collection hopper, after being processed from the collection hopper where the heavy particulate matter of exhaust gas settles down and other gases goes to the long cylindrical filter bags .Then after being processed from filter bags the exhaust gas passes through the filter cleaning device where it is filtered by cage assembly and filtering fabric. After all this process is completed then comparatively clean gas is obtained

This is the general working principal of the baghouse but onboard ship this can be also utilized in different ways which we will see later on.



3. DIFFERENT MECHANISMS WHICH TAKE PLACE IN FABRIC FILTERS AND BAGS

- **INERTIAL COLLECTION**
  The collection hopper is placed at the inlet of dirty exhaust gas and whole system of baghouse is perpendicularly aligned to this hopper .So, the lighter exhaust gases directly moves to the filter bags and little heavy particles settles down which can be further removed .So at the first stage only major portion of particulate matter is being removed because of which now we only need to filter the lighter gases.

- **INTERCEPTION**
  In this process when the particles reaches the filter bags the exhaust particles hit the surface of bags continuous therefore some of the particles collect on the fabric surface and forms dust cake and rest al move forward.

  One of the major design parameter is the air to fabric ratio. This ratio is defined as the amount of air or process gas entering the Baghouse divided by the sq. ft. of cloth in the Baghouse. This ratio vary depending upon cloth type, particle size, distribution and characteristic of material collected and bag spacing.

ISBN: 978-81-93024-71-3

Under standard conditions, as the size of holes on fabric increases less effective will be the filtration and purification.

- **BROWNIAN MOTION**
  Diffusion is the capture mechanism resulting from the Brownian motion caused by the multiple collision of the gas molecules. The consequences of this is that flow line represents only the net motion these submicron gas particles, and their total motion consisting of the random zig-zag particles onto which straight flow is superimposed.

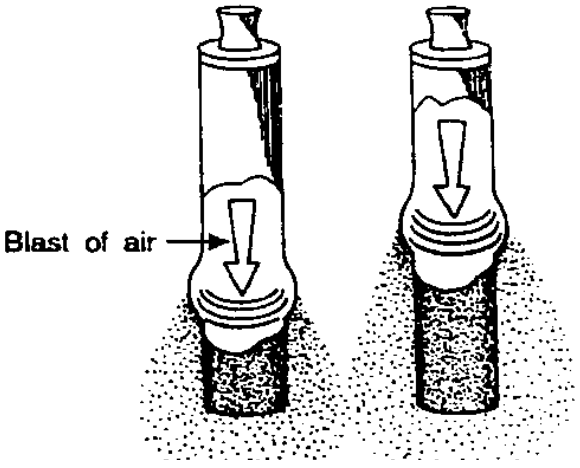
- **ELECTROSTATIC FORCE**
  As the gas particles collide with each other in the filter bags the electrostatic force is produced as a result of which electrostatic charge on the particles can increase the dust capture.

4. BAGHOUSE CLEANING METHODS

- **PULSE JET SYSTEM**
  Method:

  Uses high-pressure air directed down into the clean side of a filter bag in order to remove the dust cake from the surface of the media.

- **Airflow:**
  This cleaning system can operate with airflow still going through the bag to the exhaust fan
  (On-line cleaning).



Air to Cloth Ratio:
Generally from 4-6 to 1.

Advantages:

1. Have high collection efficiency for respirable dust
2. Can have high air-to-cloth ratio (6 to 10 ft/min)
3. Have increased efficiency and minimal residual dust buildup due to aggressive cleaning action
4. Can clean continuously
5. Can use strong woven bags
6 Have small size and fewer bags because of high air-to-cloth ratio
7. Some designs allow bag changing without entering baghouse
8. Have low pressure drop for equivalent collection efficiencies

Disadvantages:

1. Require use of dry compressed air
2. May not be used readily in high temperatures unless special fabrics are used.
3. Cannot be used if high moisture content or humidity levels are present in the exhaust gases

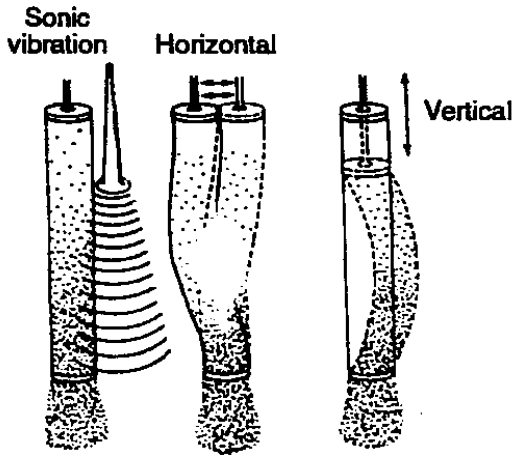
- **SHAKER STYLE SYSTEM**

Method:

Physically shakes the bags in order to mechanically release the dust cake.

Airflow:

This style of cleaning method requires the bag "module" or compartment to be isolated from the gas stream to the exhaust fan (off-line cleaning).



Air to Cloth Ratio:
Generally from 2-4 to 1.

Advantages:

1. Can use strong woven bags, which can withstand intensified cleaning cycle to reduce residual dust buildup
2. Simple to operate

ISBN: 978-81-93024-71-3

3. Have high collection efficiency
4. Have low pressure drop for equivalent collection efficiencies

Disadvantages:

1. Have low air-to-cloth ratio
2. Cannot be used in high temperatures
3. Require large amounts of space
4. Need large numbers of filter bags
5. Consist of many moving parts and require frequent maintenance
6. Personnel must enter baghouse to replace bags, creating potential for exposure to toxic dust
7. Can result in reduced cleaning efficiency if even a slight positive pressure exists inside bags

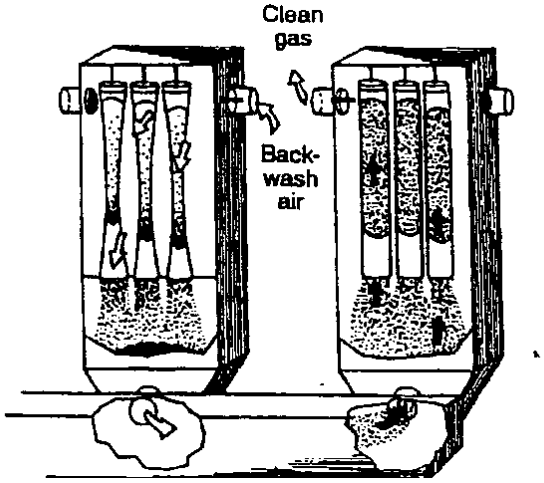
REVERSE AIR SYSTEM

Method:

Physically collapses the bags in order to mechanically "shear" the dust cake from the bag surface.

Airflow:

This style of cleaning method requires the bag "module" or compartment to be isolated from the gas stream to the exhaust fan (off-line cleaning).



Air to Cloth Ratio:

Generally from 1-3 to 1.

Advantages:

1. Have high collection efficiency for respirable dust
2. Are preferred for high temperatures due to gentle cleaning action
3. Have low pressure drop for equivalent collection efficiencies

Disadvantages:

1. Have low air-to-cloth ratio (1 to 2 ft/min)
2. Require frequent cleaning because of gentle cleaning action
3. Have no effective way to remove residual dust buildup
4. Cleaning air must be filtered
5. Require personnel to enter baghouse to replace bags which creates potential for toxic dust exposure

5. TYPICAL EMISSION POINTS AND INSPECTION AREAS

The uncollected effluent emission from the fabric filter are generally emitted through a stack or vent that follows the fabric or path of fabric system.

The major inspection areas for fabric filters are:

1. Stack or vent exits and stack pressure gauge.
2. Doors/hatches.
3. Hoppers
4. Solid discharge valve.
5. Cleaning mechanism.
6. Bags, cages, bag attachments.

6. USE OF BAGHOUSE IN SHIPPING

The emissions of air pollutants from ships engaged in International trade in the seas surrounding Europe – the Baltic, the North Sea, the north-eastern part of the Atlantic, the Mediterranean, and the Black Sea – were estimated to have

been 2.6 million tons of sulphur dioxide and 3.6 million tons of nitrogen oxides (expressed as NO2)a year in 2000 .

While pollutant emissions from land-based sources are gradually coming down, those from shipping show a continuous increase. Even after accounting for enforcement of MARPOL Annex VI, which sets limits on the sulphur content of marine fuels for the Baltic Sea, the North Sea and the English Channel, emissions of SO2 from international shipping are expected to increase by more than 42 per cent by 2020, and those of NOx by two thirds

	Sulphur dioxide	Nitrogen oxides
1990[1]	2,001	2,808
2000	2,578	3,617
2010-Low (1.5% growth/yr)	2,845	4,015
2010-High (3% growth/yr)	3,294	4,649

(data in kilo tonnes)

By using the baghouse filter technique most of the emission can be brought down.

	CO_2	PM	SO_2	NOx	VOCs
Heavy truck with trailer:					
Before 1990	50	0.058	0.0093	1.00	0.120
Euro 0 (1990)	50	0.019	0.0093	0.85	0.040
Euro 1 (1993)	50	0.010	0.0093	0.52	0.035
Euro 2 (1996)	50	0.007	0.0093	0.44	0.025
Euro 3 (2000)	50	0.005	0.0093	0.31	0.025
Cargo vessel:					
large (>8000 dwt)	15	0.02	0.26	0.43	0.017
medium size (2000-8000 dwt)	21	0.02	0.36	0.54	0.015
small (<2000 dwt)	30	0.02	0.51	0.72	0.016
RoRo (2-30 dwt)	24	0.03	0.42	0.66	0.029

Emissions are average in each case.

Trucks: maximum overall weight 40 tons, loading 70 per cent, operating on diesel with a sulphur content of 300 ppm.

Cargo vessel: bunker oil with and average sulphur content of2.6 per cent, no cleaning of NOx.

If the baghouse are used then most of the emission can be reduced and as a result less pollution and environment will also be protected.

Reduce in level of pollutants

Type of pollutant	Reduction in level (%)
Particulate matter	48-52
SOx	39-45
NOx	25-30

So using baghouse can be very beneficial for shipping industry as the three major pollutants by ships are reduced to great level.

Another alternate which can be used is that after complete purification of exhaust gas from the baghouse is done and if found that gas is clean and can be used on ship then it can compressed and be used in many places onboard vessel and if found it is partially clean, then especially for short distance voyage some arrangements can be done and that gas can be stored and then be discharged on the ports therefore on the land that gas can be completely purified.

So by using this method inspite of discharging the exhaust gases from ships we are using the gases and if the gases cannot be used we are processing it and as a result we preventing pollution.

REFERENCES

[1] [1] A briefing document by;

[2] *The European Environmental Bureau (EEB)*

[3] *The European Federation for Transport and Environment (T&E)*

[4] [2]Fabric *Filtration for Combustion Sources: Fundamentals and Basic Technology* by Donovan pg185.

[5] [3] *Exhaust gas monitoring*: C.S. Brookman (Marine Safety Agency) IMAS Conference 1996

[6] [4] http://en.wikipedia.org/wiki/Baghouse