Technical Bulletin No. 1

Meeting Cluster Rule Bleach Plant Requirements Using the RotaBed™ Fluidized Bed Scrubber

Introduction

The USEPA recently promulgated a new set of regulations for the Pulp and Paper industry. Called the "Cluster Rule", the EPA sought to combine both air and water regulations into one all-encompassing regulation. This action has caused engineers and scientists in the paper industry to examine plant operations in light of meeting these requirements. Of particular interest are those aspects of the "Cluster Rule" pertaining to air pollution control from the bleach plant.

With proper design and application, "Cluster Rule" requirements can easily and economically be met on modern kraft bleaching sequences using RotaBed™ fluidized bed gas scrubbing technology.

The "Rule"

In general, the "Cluster Rule" requires that pulp bleaching processes switch from those using elemental chlorine (Cl_2) to those using oxidants and specialized extraction sequences that produce minimal or no amount of adsorbable organic halide (AOX) compounds. These AOX compounds, though low in concentration, are suspected of causing adverse ecological and health effects. Elemental chlorine can produce chloroform and other Hazardous Air Pollutants (HAPs).

Process modifications away from elemental chlorine can serve to reduce such pollutants. High efficiency gas scrubbers are presently used on kraft bleach plants to control the residual gaseous Cl_2 and ClO_2. Mills abandoning elemental chlorine and substituting chlorine dioxide in bleaching sequences become ECF or "Elemental Chlorine Free." Other mills that have switched to a nonchloride containing bleach sequence are called TCF mills or "Totally Chlorine Free." A summary of "Cluster Rule" requirements was published in TAPPI, volume 81, No. 2, by Kirsten Vice and Robert Carrol in an article entitled "The Cluster Rule: A Summary of Phase 1." This survey provides more details about this issue. According to the Cluster Rule, the bleach plant scrubber used must reduce the HAPs by 99% or have an aggregate chlorinated HAP loading of under 10 ppmv. Mills already using fluidized bed type bleach plant scrubbers are easily meeting these requirements.

The primary reason these scrubbers are successful is due to the fact they easily handle bleach plant emission surges. There are also many other reasons:

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Advantages of the RotaBed™ Fluidized Bed Scrubber for Bleach Plant Applications

1. Highest Removal Efficiency

No bleach plant scrubber provides higher removal efficiency than a fluidized bed type scrubber. Repeated tests on fluidized bed scrubbers since 1985 have shown that they fully meet all emissions regulations.

Table 1 shows results of emissions testing at a mill in North Carolina that uses fluidized bed scrubbers on two separate diffusion bleach lines.

2. Most Compact Design

No scrubber can process more bleach plant vent gases in as little space as RotaBed fluidized bed scrubbers can. Figure 1 (on last page) shows a typical RotaBed fluidized bed scrubber arrangement. Figure 2 (on last page) shows the footprint of a 30,000 acfm RotaBed scrubber and that of a conventional packed tower.

Since these scrubbers are typically roof or cantilever deck mounted at high elevations, the compact size facilitates installation and keeps costs low in both existing and new mills.

3. Lowest Pumping Cost– No Steam, No Air Compressors

Bleach plant scrubbers are typically installed above vent sources, while scrubbing liquid supply pumps are normally located at grade. Pumping heads are a significant operating cost. The header pressure of RotaBed liquid headers is a mere 3 psig. Spray or "fog" mist type scrubbers typically waste 30-40 psig, and packed towers 10-20 psig, just to deliver scrubbing liquid into the gas stream.

In addition to pumping the scrubbing liquor, mist or fog type scrubbers also require supplemental steam or compressed air that can elevate operating costs significantly. These costs are sometimes overlooked in equipment evaluations but are extremely important over the operating life of the system.

Since the RotaBed scrubber does not use any compressed air or steam, costs are zero. More importantly, air compressor and steam supply maintenance costs are also zero.

4. Lowest Maintenance and No Downtime– No Spray Nozzles or Packing to Plug

The reason RotaBed header pressure is so low is, in part, because it was designed so that there are no spray nozzles in the scrubbing zone.

The liquid headers used are retractable, eliminating the need to open the scrubber to service the headers.

RotaBed's "packing-less" design eliminates plugging and cleaning of packed beds that can result in scrubber downtime. This eliminates all costs associated with further replacement of packing every few years.

5. Highest Surge Capacity

Bleach plant vent emissions are not steady state operations. Surges of bleach gases can and do occur and must be accommodated. To provide consistently low emissions, a truly effective bleach plant scrubber must do its job well under normal conditions, as well as upset or surge conditions.

No scrubber on the market today has greater surge capacity than the RotaBed fluidized bed type scrubber. Approximately one third of the total flow of scrubbing liquid is "held up" in the fluidized zone. On a 30,000 acfm scrubber example, this means about 120 gallons or about 990 lbs. of scrubbing liquor is held in reserve in the scrubber at all times. It operates at the "flooding point" at all times. No conventional packed tower can operate with the same stability under flooding conditions. Packing will start to fluidize and can possibly be ejected out of the tower.

This means that there is always an excess of neutralizing chemicals in the RotaBed tower to handle a surge.

Table 1: Emissions Test Results, Fluidized Bed Scrubber:

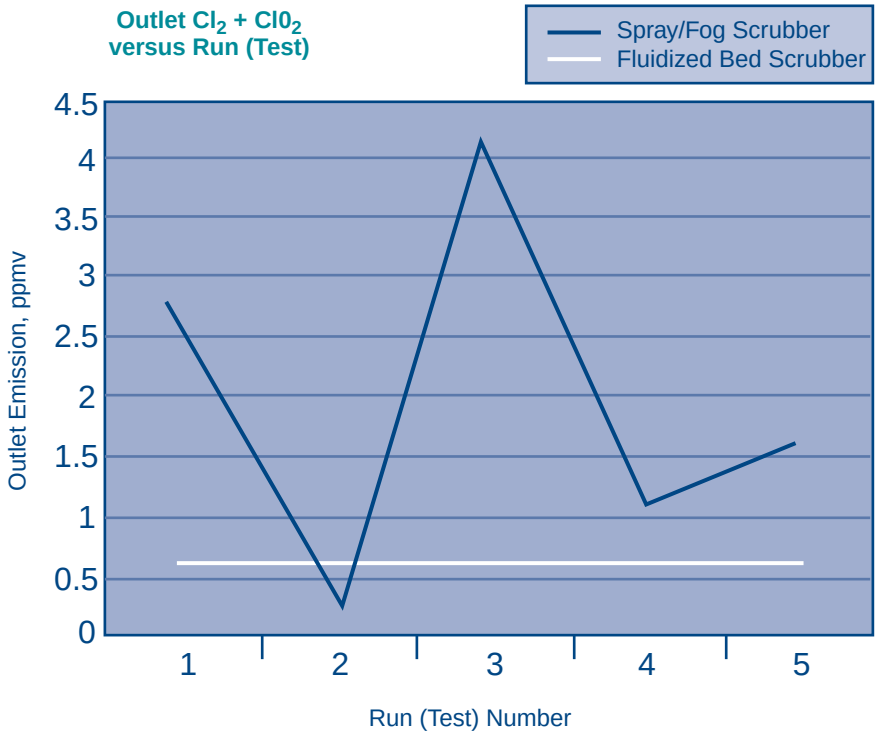
Four (4) Grid Wet Fluidized Bed Scrubber, East Coast Mill
Ahlstrom (Kamyr) Diffusion Bleaching Systems, White Liquor Scrubbing Media

	Line #6				Line #7			
	Run			Avg.	Run			Avg.
	1	2	3		1	2	3	
Chlorine	0.342	0.358	0.360	0.354	0.349	0.359	0.359	0.356
Chlorine Dioxide	0.228	0.239	0.240	0.236	0.233	0.239	0.239	0.237
Total	0.590				0.593			
ACFM	7829				11090			
Stack Temp. F°	141.5				132.4			
Total bhp/cfm*	0.0027				0.0024			

*** Total brake fan and pump horsepower per cubic foot of gas treated**

Some mills currently use a mist or fog type scrubber for bleach plant emissions control. In this design, scrubbing chemical is pressurized, atomized into a fog, and then injected into a containing vessel. The fog or mist flows concurrent with the gas stream. Since every gallon of scrubbing liquid requires 1 or more scfm of air or steam to atomize the liquid, the design severely restricts the amount of liquid required to operate cost competitively. In addition, every gallon sprayed in must be removed prior to the gas leaving the scrubber.

Since the gas/liquid flow pattern is concurrent, this design can also suffer when surges (sharp increases) in pollutants occur. The amount of required reactant scrubbing liquid is directly related to the amount of surge. To meet this need, an exotic monitoring and response system inclusive of backup nozzles, additional air source, etc. is needed. The only other alternative is to maintain a costly excess fog which wastes both chemical scrubbing reagent and energy.



6. Consistently Low Outlet Loadings to Meet Cluster Rule Requirements

Total chloride outlet loadings from the RotaBed Fluidized Bed Scrubber are not just low, they are consistently low.

The following graph shows a comparison of reported outlet loadings of combined chlorine and chlorine dioxide from a spray (fog) type scrubber and a fluidized bed type scrubber on bleach plant emissions. Graph data plotted from emission test results is for a fluidized bed type scrubber versus published data on an atomized liquid fog type "Waterloo" scrubber (source of Waterloo scrubber data, "Effective Reduction of Acidic Gas Emissions with Waterloo Scrubber" Brian P. Scott, Process Engineer, Prince George Pulp, April 1990, Table 7, page 14).

The uniformity of the fluidized bed scrubber's consistently low outlet loadings is striking. By comparison, fog type scrubber performance is extremely erratic.

7. Lowest Installed Cost

The design of the RotaBed scrubber makes it the lowest cost fluidized bed type scrubber on the market today. These design details are so unique that a patent application has been filed.

Given its compact size and low pumping requirements, evaluations based upon total installed cost have consistently shown RotaBed has the lowest installed cost of any bleach plant scrubber. We encourage engineering firms and mill professionals to make their own evaluations to discover the installed cost advantages of a RotaBed scrubber.

The RotaBed™ Scrubber

Bionomic Industries' RotaBed scrubber is superior in every performance aspect when compared to other fluidized bed scrubbers. By using a Coriolis Effect, it causes the fluidized bed to slowly rotate, imparting much needed stability to the fluidized zone. The RotaBed scrubber offers superior turndown at a lower operating cost as well. Figure 1, below, shows a typical RotaBed scrubber.

The Coriolis Effect can often be observed as liquid drains. The rotation of the Earth tends to induce a swirling action to draining liquid. The effect is "free" in that it occurs without manmade interference or input of additional energy.

The RotaBed scrubber's "pack-less" design uses simple, conical, highly open grids to form and control the fluidized zone. These grids may be made of alloy, CPVC or, in some bleach plant applications, titanium grade 2. The vessels are typically FRP construction with a double Nexus interior surface veil and vinyl-ester resin system. The RotaBed scrubber can operate at gas velocities of 16 - 30 feet/second without efficiency loss, making it the most advanced fluidized bed scrubber technology available.

FIGURE 1
RotaBed Fluidized Bed Bleach Plant Emissions Control

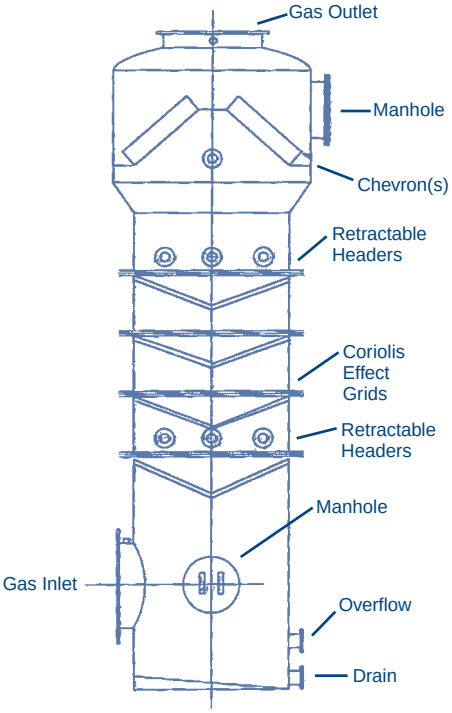
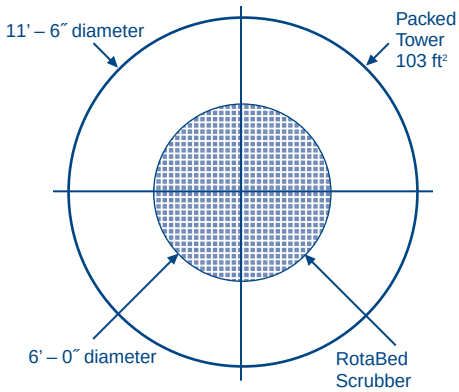


FIGURE 2
Mounting Footprint, Packed Tower versus RotaBed Scrubber



only 1/3 the area!

RotaBed Scrubber Design

Another important factor in the RotaBed scrubber's design is its ability to use various scrubbing liquors including Eo filtrate (extraction stage effluent). The Eo usually contains residual fibers that can easily plug a fog spray, packed or tray tower. Since Eo typically has some residual oxidant (such as peroxide) or residual and useful caustic in it, some mills want to use the Eo as a scrubbing stream. The Eo must have sufficient available alkalinity to neutralize the absorbed chlorides. Testing at Finch Pruyn (also confirmed at other mills) showed that the scrubbing liquid must also have a reducing agent or residual lignin to reduce the chlorine dioxide to chloride ion.

Extensive testing revealed that Eo could indeed be used if certain conditions are met. Bionomic Industries was one of the pioneers in the use of thiosulfate in bleach plant scrubbers for chlorine dioxide removal enhancement. Usually, a residual amount of reducing agent in excess of 50% of the stoichiometric rate is required to reduce the chlorine dioxide. Na_2S, NASH and other absorbed TRS compounds can also act as reducing agents.

If space is really at a premium, special designs are available that place the RotaBed absorber section on one location and the droplet eliminator in another (usually just ahead of the fan). The scrubber then appears almost like a section of ductwork.

Running at 16-24 feet/second gas velocity, the vessel is slightly larger than the vent duct but can still fit into extremely tight confines. The droplet eliminator and fan can then be placed at a location where space allows.

The recirculation rate when employing a commonly used solution of white liquor is only 10-12 gallons per 1000 acfm of treated gas. This rate is selected to handle the required surge capacity, not the RotaBed scrubber's mechanical operating requirement. As mentioned earlier, the header pressure is only 3 psig. On Eo units, the mill can dictate the Eo flow rate and the scrubber can then be designed to suit that rate. An 8,000 acfm fluidized bed scrubber at a mill in the Pacific Northwest sends 800 gpm of Eo through the unit rather than meter and control a smaller flow.

The RotaBed scrubber typically uses a counterflow conventional chevron as the droplet removal device. The chevron is located sufficiently distant from the upper most grid to allow liquid disengagement.

Multiple grids are typically used and most bleach plant applications usually employ four (4) grids. The pressure drop per grid is approximately 1.5" to 2" w.c. during operation. Since the scrubbing zone is dynamic rather than static (i.e., flowing over fixed packing), the scrubber tends to follow the fan curve. The greater the gas velocity, the higher the fluidized bed. The scrubber automatically compensates for volume changes and is sized to be compatible with the scrubber design.

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Engineered Air Pollution Control Systems with Unequaled Performance

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