NORAM

engineering + constructors

Turboscrubber®

Bleach Plant Scrubber

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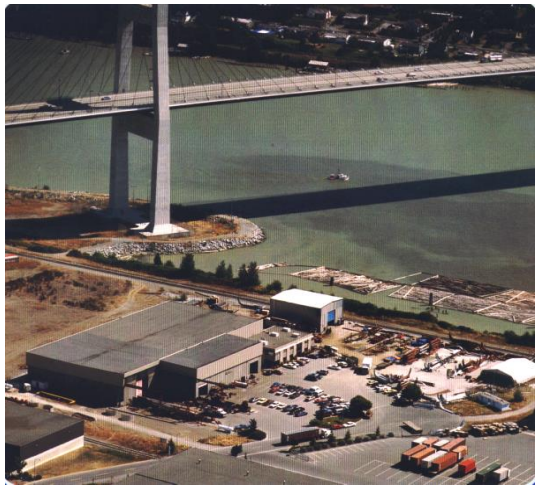
PAPTAC Bleaching Committee Meeting Fall-2018

NORAM Company Profile

NORAM
Engineering and Constructors Ltd.

Engineering Offices



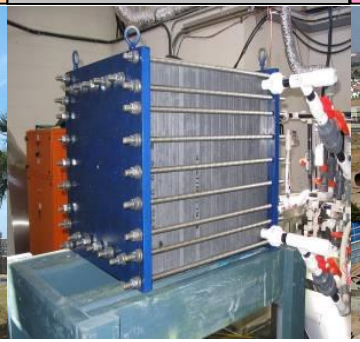
Axton

Fabrication, Assembly

BC Research

Technology Incubator

Corporate Profile

Nitration	Sulphuric Acid	Electrochemical	Biosystems	Pulp & Paper
				

TurboScrubber® TECHNOLOGY

➢ FLUIDIZED BED TECHNOLOGY

- Scrubbers, Absorbers & Strippers

➢ HISTORY

- Developed & progressed by FTL & Osprey since 1991
- Over **400** scrubber and stripper plants installed worldwide including U.K., Germany, USA & Australia

➢ PULP & PAPER CLIENTS

- **AV Group, Atholville, NB:** SO_2 absorption in $Mg(OH)_2$ slurry
- **Visy Pulp & Paper, Australia:** Strip TRS from White Water
- **Huhtamaki Group, USA :** Heat Recovery from Vacuum Forming Machine Off Gas to White Water

TurboScrubber® Process

- **3-Phase Fluidized bed: Plastic packing, gas and liquid**
  - Non-plugging, handles slurries (Packed Towers ⇒ Blockage from solids or dust particles ⇒ increases in ΔP & diminished efficiency).
  - High mass transfer (Traditional Packed Towers limited by their **Available Surface Area for Mass Transfer)**
  - High heat transfer
  - Particle/aerosol removal down to sub 0.5 micron
  - High turndown ratio (1:12), Flexibility

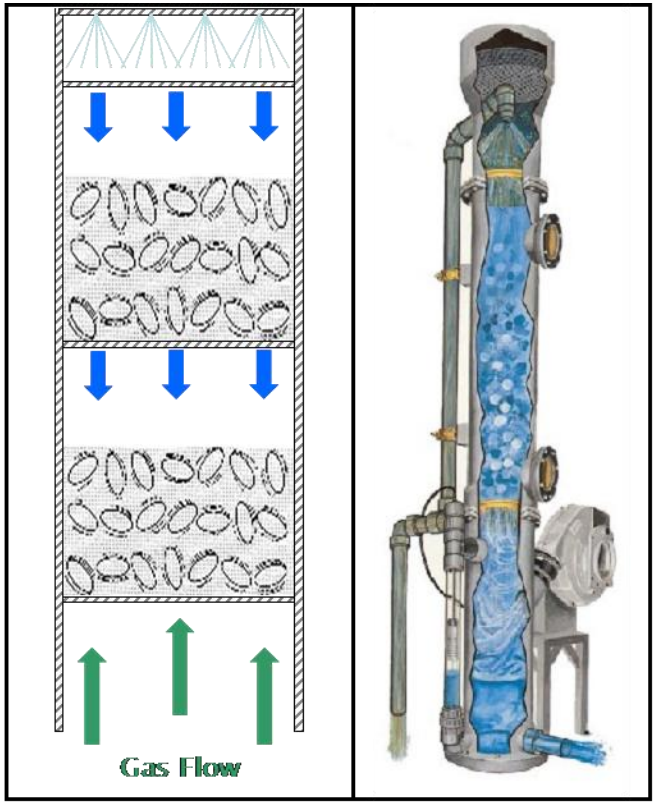
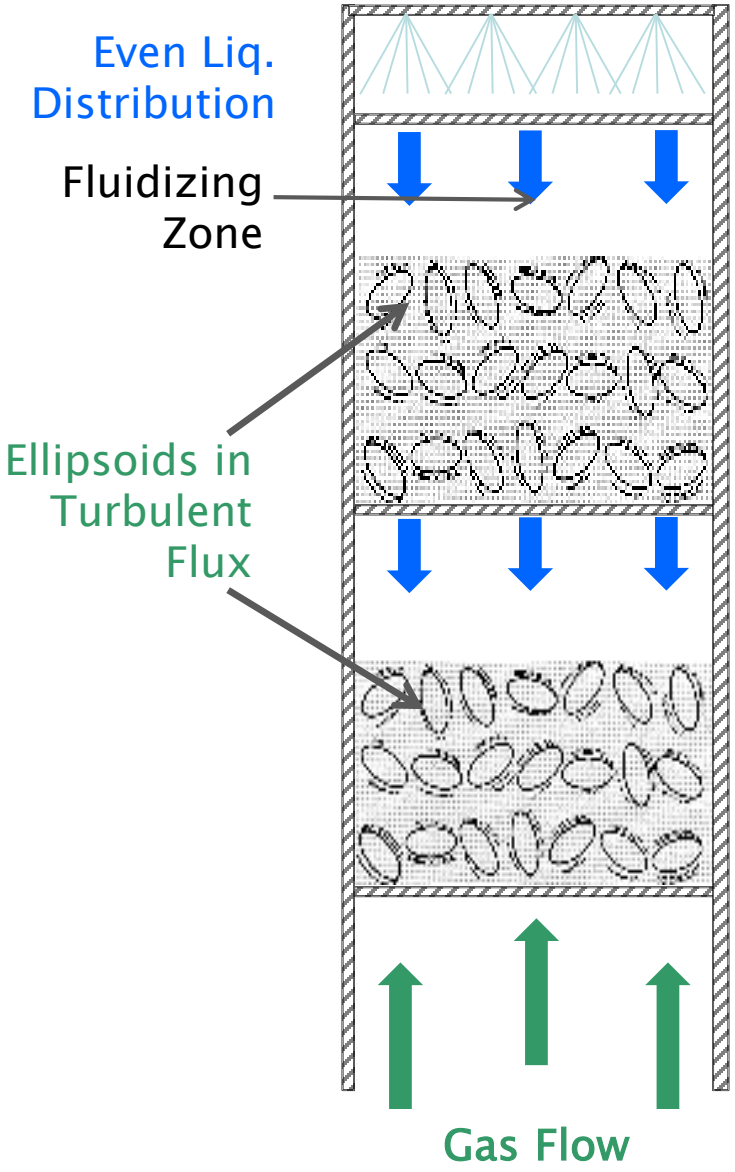


Fig. 1: Photos of the two main packing elements. Left: Turboid®. Right: TurboPak®. Materials: PP and PVDF

TurboScrubber® ADVANTAGES

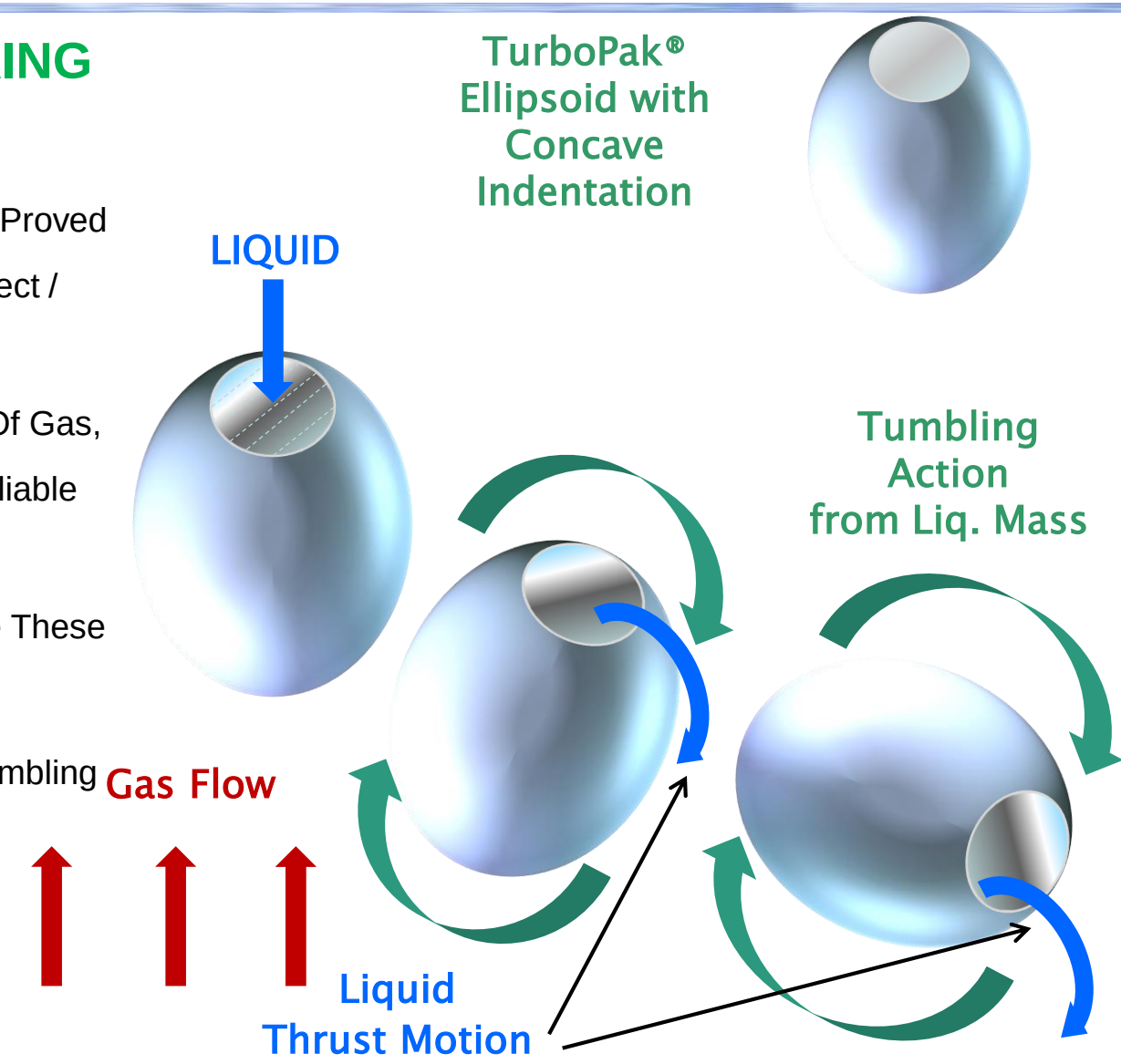
- **UNSURPASSES MASS AND HEAT TRANSFER**
  - Turbulence creates very high Reynold's Number ⇒ High Mass & Heat Transfer Coefficients
  - Intimate "Mixing" Provides Fast Contact-Driven Mass Transfer / Absorption
- **EQUIPMENT SIZE REDUCTION**
  - Reduced Equipment Height/Footprint compared to equivalent packed/sieve-plate tower
- **GUARANTEED BLOCKAGE-FREE APPLICATION**
  - Bed remains 100% blockage-free even using slurries, biomass & precipitating systems
- **MULTI-USE FRIENDLY**
  - Simultaneous Absorption, Particulate Removal & Heat Recovery In One
  - More Energy Efficient Than a Venturi / Packed Tower Combination For The Same Performance



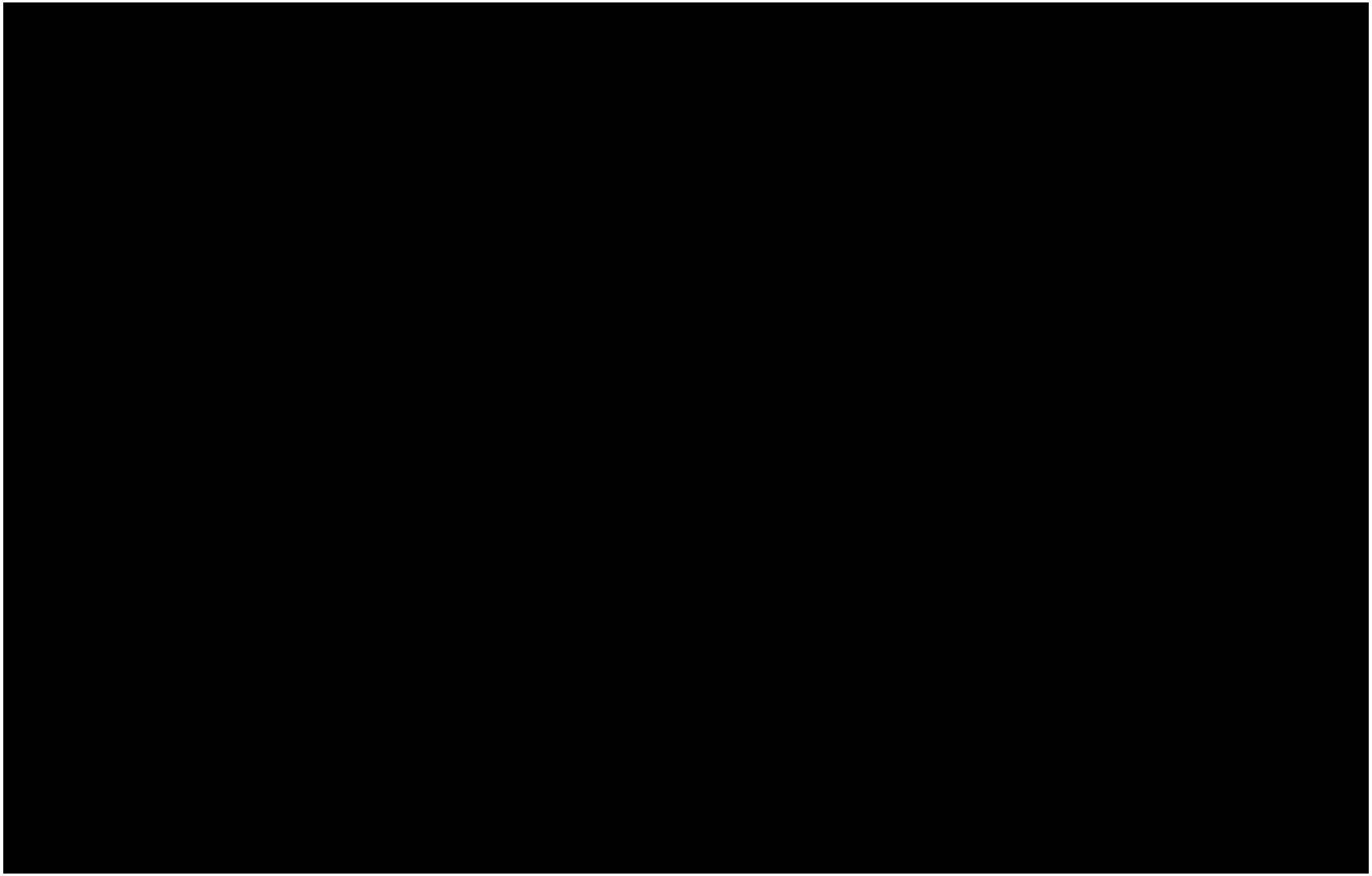
TurboScrubber® PACKING

➢ AERODYNAMIC PACKING

- Patented Turboid® & Turbopak ®
- Traditional Sphere Shaped Packing Proved Aerodynamically Unstable (Swirl Effect / Sideways Movement)
- Other Issues Included Channelling Of Gas, Poor Distribution of The Bed & Unreliable Performance
- Patented Ellipsoid Shape Overcame These
- More Energy Efficient To Fluidize
- Indent Adds Extra Thrust To The Tumbling Motion



Movie



Pulp & Paper Applications

- Heat recovery up to 2MMBtu/hr at Huhtamaki's Waterville, Maine plant.
- Robust non clogging highly turbulent fluidized bed process
- High heat transfer coefficient in excess of 150KW/m3 °K
- Un-fouled tower despite wax & soot deposits.

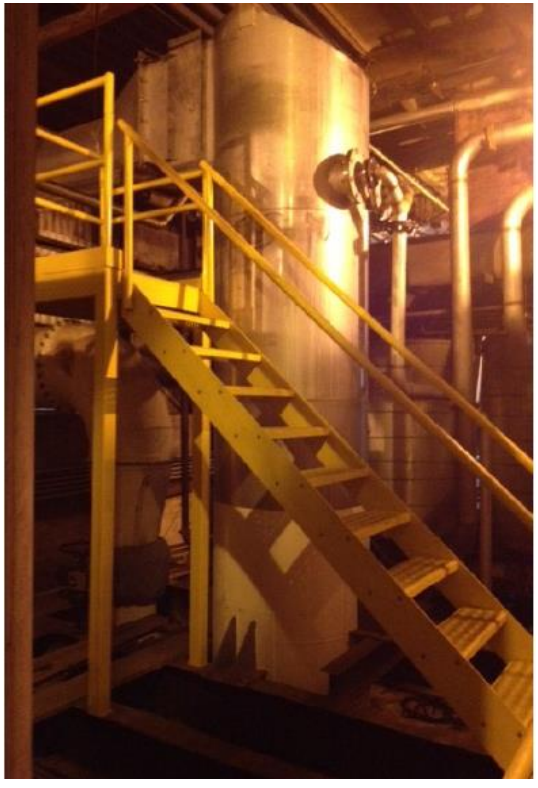
Heat Recovery, Gas & Particulate Removal	
Application	Vacuum Forming Machine Off Gas
Liquid Medium	White Water
Particle Data	
Airborne Particulates	Carbonaceous PM's and Wax
Mean Particle Size	Submicron
Percentage Removal	90-99%
Heat Transfer	
Inlet Gas Temperature	151-153˚C
Outlet Water Temperature	70-72˚C
Heat Transfer Rate	0.55 MW
Fluid Dynamics	
Gas Flowrate	5000-6000 Am^3/hr
Pressure Drop	2.6 KPa
Tower	
Diameter	0.6m (2')
Overall Height	4.2m (13'8")
Material	SS316

TurboScrubber® at Huhtamaki, Waterville, Maine, USA

Pulp & Paper Applications

- Heat recovery up to 6 MMBtu/hr at Huhtamaki's Hammond, IL plant.
- Robust non clogging highly turbulent fluidized bed process
- High heat transfer coefficient in excess of 80KW/m3 °K
- Un-fouled tower despite wax & soot deposits.

Heat Recovery, Gas & Particulate Removal	
Application	Vacuum Forming Machine Off Gas
Liquid Medium	Water
Particle Data	
Airborne Particulates	Carbonaceous PM's and Wax
Mean Particle Size	Submicron
Percentage Removal	90-99%
Heat Transfer	
Inlet Gas Temperature	151-152˚C
Outlet Water Temperature	61-62˚C
Heat Transfer Rate	1.7 MW
Fluid Dynamics	
Gas Flowrate	18000 Am^3/hr
Pressure Drop	1.5 KPa
Tower	
Diameter	1.22 m (4')
Overall Height	6.6m (21'6")
Material	SS316

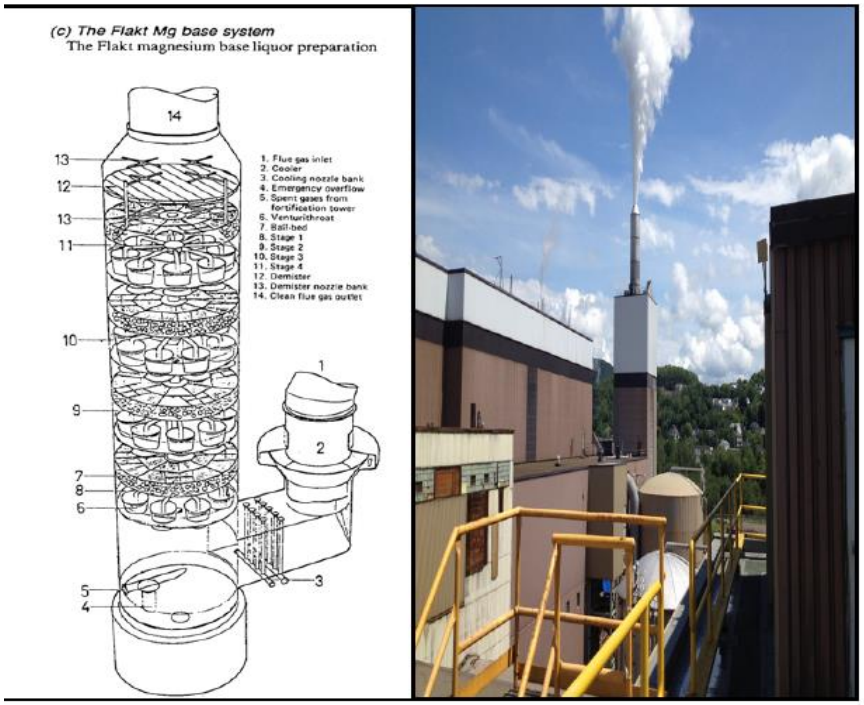


TurboScrubber® at Huhtamaki, Hammond, Illunois, USA

Pulp & Paper Applications

- Retrofit on existing system to boost SO_2 removal performance, minimize constant plugging issues and debottleneck the column
- Since 2013 maintaining SO_2 performance with nearly half of the previous pressure drop, providing plugging & clogging free operation and no longer prone to frequent & unexpected shutdowns which previously averaged every 2-3 months

Absorption Tower	
Gas Absorbed	SO_2
Liquid Medium	$Mg(OH)_2$ Slurry ($MgHSO_3$-$MgSO_3$ System)
SO2 Concentration	~8400 ppm
% Absorbed	99.9%
pH Control Range	4-6
Particle Transfer	
Particulates	Mag Sulphite Recovery Boiler Fume and Carboneceous
Mean Particle Size	Sub Micron
% Removal	>90%
Heat Transfer	
Inlet Gas Temperature	~71 ˚C
Heat Transfer Rate	2 MW
Fluid Dynamics	
Gas Flowrate	Up to 274,000 Am^3/hr
Pressure Drop	2 KPa
Operation Mode	Multi Stage Recirculation
Tower	
Diameter	5 m
Overall Height	30 m
Material	SS2205



AV Cell, Atholville, NB, Canada

Pulp & Paper Applications

- To Strip organic compounds from White Water.
- Continuous non clogging operation even with sticky pulp and solids laden white water

Stripper	
Gas Medium	Air
Liquid Medium	White Water
Mass Transfer	
Contaminants Desorbed	DMS, DMDS, MM
Inlet Concentration	10,000 ppb
Inlet Water Temperature	50-95˚C
% Desorbed	99.99%
Heat Transfer Rate	235 KW
Inlet Approach ΔT	<1.67 ˚C
% Approach Temperature	Within 2 °C
Fluid Dynamics	
Liquid Flowrate	130 m^3/hr
Pressure Drop	4.3 KPa
Operation Mode	Once through
Tower	
Diameter	1.2 m (4')
Overall Height	6 m
Material	SS304

Visy Pulp & Paper, NSW, Australia

Types of Scrubbers

- **Packed Bed Type**
  - Generally plug every 4-6 months
  - Require cleaning which can take up to 48 hours
  - Bleach plant washer fabric tears have immediate impact on scrubber performance
  - Generally require an upstream fiber filter on the scrubbing medium
  - Efficiency for ClO_2 removal depends heavily on chosen packing.
- **Cross Flow Type**
  - Efficiency highly dependent on the size and distribution of the atomized liquor droplets and hence clean nozzles
  - Efficiency also dependent on flow of liquid and gaseous atomizers with several mills switching from steam to air atomization
  - Nozzles prone to plugging with E-stage filtrate due to presence of fiber
  - Acid wash of spray nozzles must be done for white liquor/ weak wash systems due to $CaCO_3$ build-up

Bleach Plant E-Stage Filtrate

- Suitable for scrubbing Chlorine and Chlorine dioxide because E-stage filtrate is alkaline in nature and contains organic material that can be oxidized.
- E-stage filtrate is freely available and the reaction with Cl_2 and ClO_2 reduces the color of E-stage effluent.
- Effectiveness of the particular extraction effluent as a scrubbing medium is determined by the lignin compound content and pH
- Use of E-stage effluent widely practiced but fibers create problems for both major scrubber types

Applications

TurboScrubber® is used in over 400 diverse installations worldwide:

- Pulp & Paper plants
- Carbon capture
- SO2 and desulphurization
- Smelter off-gas
- Process exhaust
- Boiler flue gases
- NH3 scrubbing
- Incinerators
- Driers
- Syngas clean-up, gasification, pyrolysis
- Power generation

Summary

- TurboScrubber® has inherently high mass and heat transfer rates for a given gas-side pressure drop as compared to other gas-liquid contacting technologies such as packed towers, venturis, reverse jet resulting in a smaller equipment footprint and lower capital cost.
- TurboScrubber® provides guaranteed blockage free application, eliminating costly shutdowns for maintenance, without the need for upstream E-stage effluent fiber filters.
- TurboScrubber® works with all traditional scrubbing media such as $NaOH/Na_2CO_3$, H_2O_2, NH_3, Sea water, etc, and can also handle slurries owing to its non fouling nature of its fluidized bed.
- TurboScrubber® can handle gas turndown rates of up to 1:12 and hence the efficiency of ClO_2 removal can variably be increased during plant turndown and start-up operations.
- Low energy costs from optimized mass transfer operation

Thank You

Questions