ENCO ENVIRONMENTAL DESIGN CO.,LTD.

AIR POLLUTION CONTROL SYSTEM
ODOR CONTROL SYSTEM
VOCs CONTROL SYSTEM

| **DESIGNER**
| **FABRICATION**
| **INSTALLATION**

COMPANY PROFILE

INTRODUCTION

ENCO ENVIRONMENTAL DESIGN CO., LTD. is a company that has personnel specializing in the design of air pollution treatment systems for industrial plants for more than 20 years.

In designing ENCO's air pollution treatment system for customers will take into account the appropriate and reasonable expenses concerning

- The type of air pollution treatment system selected
- The cost of using the system
- The cost of maintaining the system
- Selection of materials used to manufacture the system

Considering the actual pollution In order to solve problems on the spot and save the cost of customers as much as possible

In the design of the air pollution treatment system, ENCO will focus on reducing installation time. at the job site as little as possible The system will be designed to be able to test the assembly at the factory first and disassemble the parts and transport them to install at the job site

(Knock down)

INFORMATION

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SYSTEM AND OUR SERVICES LIST

BIOTECHNOLOGY



PACKED BED SCRUBBER



SPARE PARTS





CARBON ADSORPTION



SPECIAL AIR POLLUTION CONTROL

BIOTECHNOLOGY SYSTEM

Three primary biotechnology system configurations are available to treat stationary sources of air pollution such as those emitted from industrial. These various reactor configurations are generally referred to as biofilters, biotrickling filter and bioscrubbers (Ottengraf, 1987; van Groenestijn and Hesselink, 1994). Each technology operates under different conditions as summarized briefly in Table 1 and Table 2

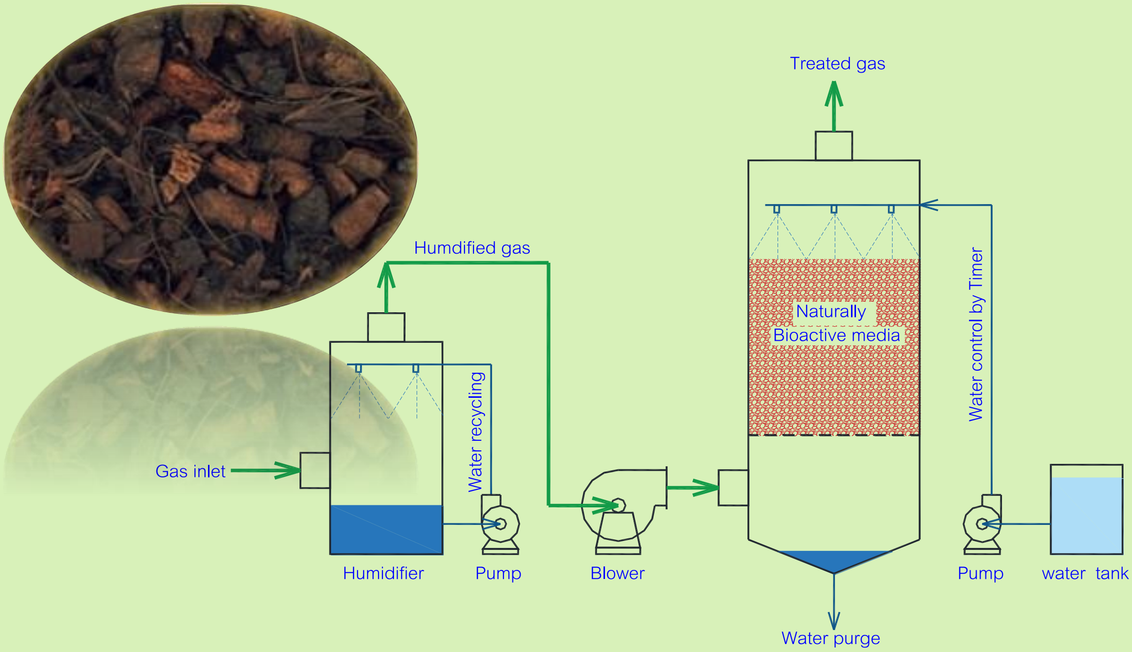
Table 1 Difference between biofilter, biotrickling filter and bioscrubber in terms of microorganisms and water phase [Devinny et al., 1999]

Reactor	Microorganisms	Water phase
Biofilter	**Fixed**	**Stationary**
Biotrickling filter	**Fixed**	**Flowing**
Bioscrubber	**Suspended**	**Flowing**

Table 2 Relative advantages and disadvantages of air phase bioreactors [Wittorf et al., 1993 *in* Edwards and Nirmalakhandan, 1996]

Biofilter	Biotrickling filters	Bioscrubbers
Advantages - Simple operation - Low investment costs - Low running costs - Degradation of less water soluble pollutant - Suitable for reduction of odorous pollutants	- Simple operation - Low investments costs - Low running costs - Suitable for moderately contaminated waste air - Ability to control pH - Ability to add nutrients	- Good process control Possible - High mass transfer - Suitable for highly contaminated waste air - Suitable for process Modeling - High operational stability - Ability to add nutrients
Disadvantages - Low waste-air volumetric flow rate - Only low pollutant concentration - Process control impossible - Channeling of air flow is normal - Limited service life of filter bed - Excess biomass not disposable	- Limited process control - Channeling can be a problem - Limit service life of filter bed - Excess biomass not disposable	- High investment cost - High running cost - Production of excess biomass - Disposal of water - Possible plugging in adsorption stage

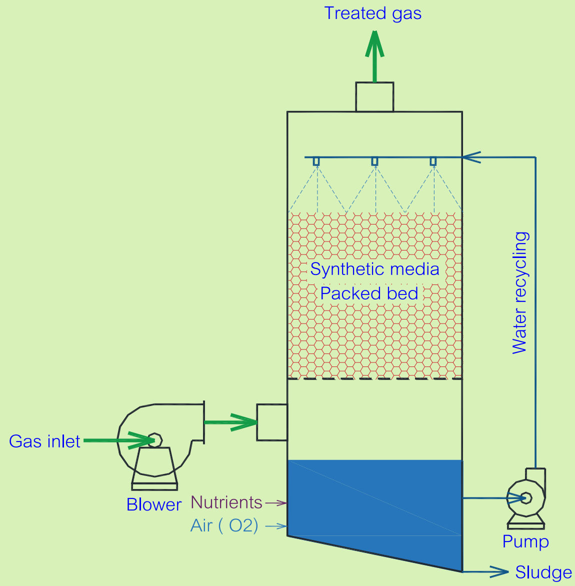
BIOTECHNOLOGY SYSTEM



Biofilter system

Biofilters are the simplest and oldest of the three vapor-phase bioreactors and involve passing a contaminated air stream through a reactor containing biologically-active packing material. The contaminants are transferred from the air stream into a biofilm immobilized on the support media and are converted by the microorganisms into carbon dioxide, water, and additional biomass. Moisture is typically supplied to the biofilm in a humid inlet waste gas stream. Packing media used in biofilter beds can be broadly categorized as either “natural” or “synthetic”. Natural media include wood chips, peat, and compost, with compost by far the most widely used. Synthetic media include activated carbon, ceramic pellets, polystyrene beads, ground tires, plastic media, and polyurethane foam (Moe and Irvine, 2000, 2001). Natural organic packing media generally contain a supply of nutrients (*i.e.*, nitrogen, phosph orus, and other elements necessary for microbial growth) as a naturally occurring component of the packing itself. When a synthetic support medium is used, nutrients must be added for microbial growth. Nutrients may be mixed with the packing material before biofilter assembly or added in solution sprayed on or mixed with the packing material after construction. If a biofilter requires additional nutrients, a nutrient solution may be sprayed on to the reactor’s packing medium; however, a continuous flowing liquid stream is not present (Devinny *et al.*, 1999; van Groenestijn and Hesselink, 1994).

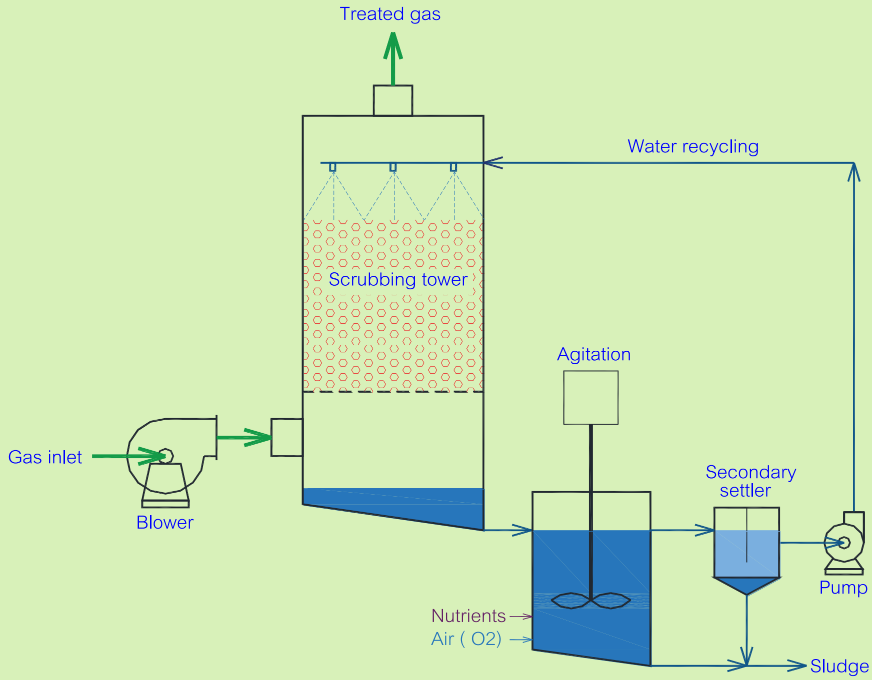
BIOTECHNOLOGY SYSTEM



Biotrickling

Biotrickling filters are similar to biofilters with the exception that there is a liquid nutrient medium continuously recirculating through the column. To facilitate recirculation of the liquid phase, rigid synthetic media (*e.g.*, plastic media, polyurethane foam, or lava rock) is used as the packing medium. Microorganisms grow primarily as a fixed film on inert packing media; however, organisms also present in the liquid phase both because they can grow suspended in the liquid and because the flowing liquid imparts a sufficient shear force to detach biomass from the solid support media. The air and liquid streams can move either co-currently or countercurrently depending on the operating conditions. Contaminants are transferred from the air stream into the liquid phase and biofilm for subsequent degradation (Devinny *et al.*, 1999; van Groenestijn and Hesselink, 1994). In comparison to conventional biofilters, biotrickling filters offer the advantages of increased operator control over such key parameters as nutrient concentrations and *p*H, as well as the opportunity to wash degradation by-products out of the reactor (Devinny *et al.*, 1999; van Groenestijn and Hesselink, 1994). A potential disadvantage of biotrickling filter operation, however, is that clogging of the pore space can occur if the biotrickling filter is treating high VOC loads and is provided excess nutrients (Webster *et al.*, 1998a; 1998b; Sabo *et al.*, 1998, Cox and Deshusses, 1997; Sorial *et al.*, 1995). An additional disadvantage to biotrickling filter operation compared to “classic” biofilters is the need to manage the liquid stream. Furthermore, the specific surface area in biotrickling filters is generally lower than in biofilters (Ottengraf, 1987); therefore, biotrickling filters may have more difficulty treating poorly soluble compounds.

BIOTECHNOLOGY SYSTEM

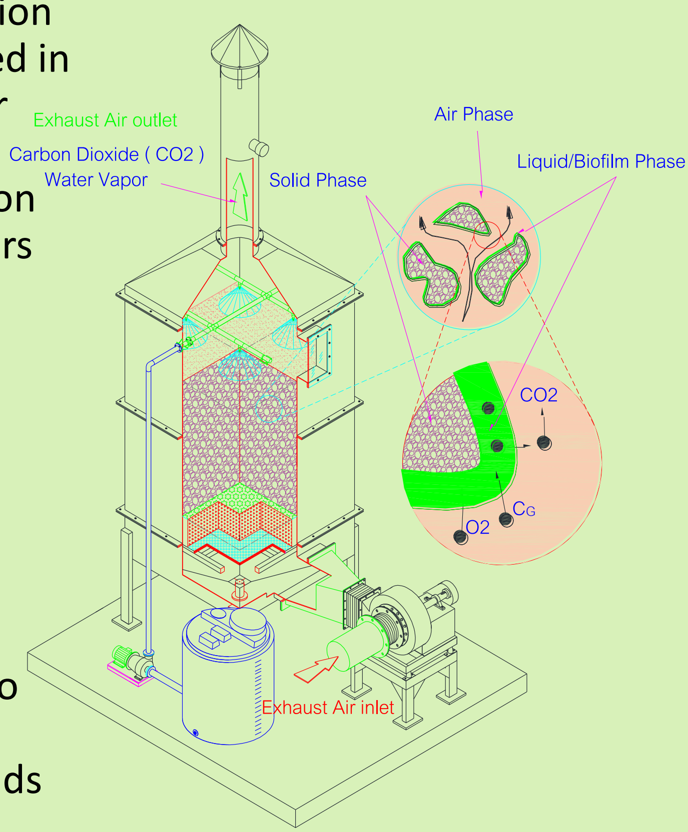


Bioscrubber

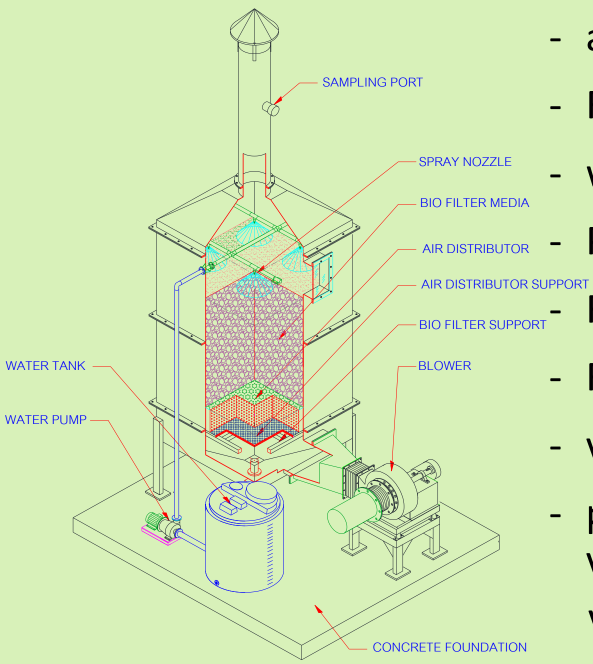
Bioscrubbers combine physical–chemical treatment with biological treatment using two separate reactors to accomplish treatment. In the first reactor, the contaminated air stream is contacted with water in a reactor packed with inert media, resulting in contaminant transfer from the air phase to the liquid phase. The liquid is then directed into an activated sludge reactor where the contaminants are biologically degraded (van Groenestijn and Hesselink, 1994; Ottengraf, 1987). The separate activated sludge tank allows the reactor to treat higher concentrations of compounds than biofilters can handle. In addition, since compound transfer and degradation occur in separate reactors, optimization of each reactor can take place separately. As with biotrickling filters, bioscrubbers offer greater operator control over nutrient supply, acidity, and the build up toxic by-products. A potential disadvantage of bioscrubbers over biofilters, however, is that slower growing microorganisms may be washed out of the system and disposal of excess sludge is required (Kok, 1992).

BIOTECHNOLOGY SYSTEM

Biofilter system It is an air pollution treatment system. That is widely used in many countries around the world for more than 30 years, relying on microorganisms. in the decomposition Pollutants or odorous chemical vapors such as volatile organic compounds (VOCs), hazardous chemicals (HAPs), hydrocarbons, organic and inorganic substances, etc.



Biofilter system There will be an intermediary that is the habitat of microorganisms. when there is a chemical vapor flowing through the medium, microorganisms attached to the medium will decompose the chemical vapors into small compounds such as hydrocarbon gas and water.



Industrial Applications of Bioilter Systems

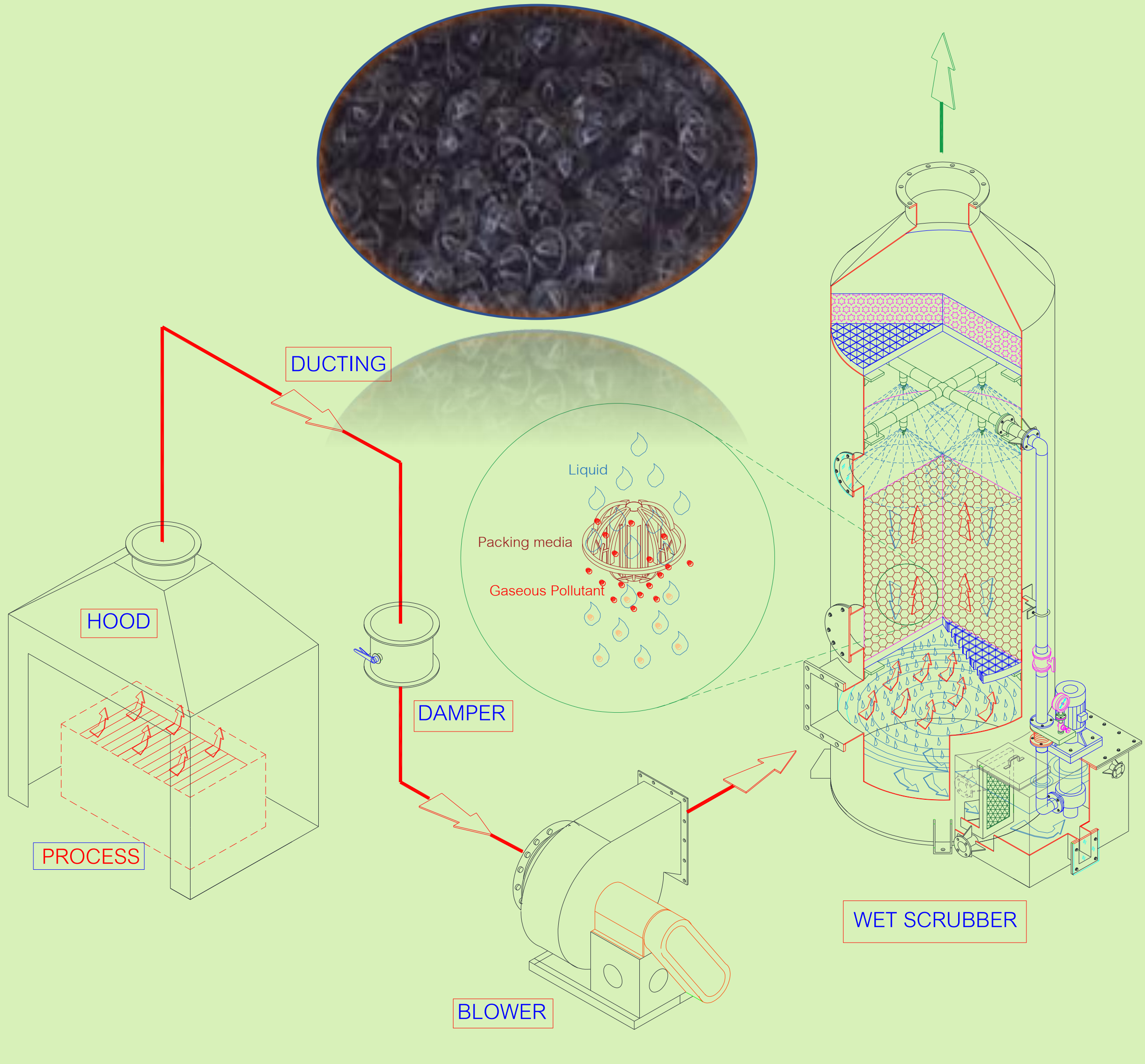
- animal feed factory
- Rubber and latex products factory
- wastewater treatment plant
- Paper and Pulp Factory
- Food Processing Plant
- Fishmeal and bone meal factory
- various production processes that smell
- production process containing chemical vapor

  VOCs , H_2S , NH_3 etc.

PACKED BED WET SCRUBBER

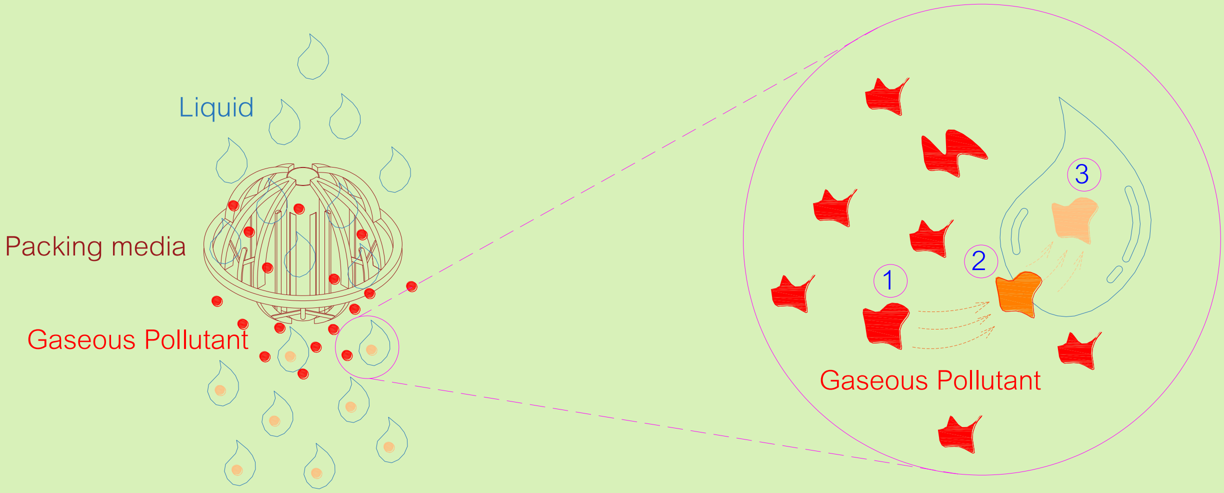
Packed bed wet scrubber has been widely used by many industries to limit the discharge of air pollutants. Typically, the applications are plating operations, chemical processing, pharmaceutical processing, chlorination processing, and fertilizer processing and so on.

Packed bed wet scrubber involves mass transfer operation. Mass transfer of the packed bed wet scrubbers is defined as the transfer of gas molecules to the liquid. The operation of mass transfer occurs between a soluble gas and a liquid solvent where the gaseous pollutant is transferred from the process stream (gas phase) to the scrubbing liquid (liquid phase). The mass transfer rate is important for the performance of the packed bed scrubbers because it greatly influences the rate at which the pollutant is removed.



PACKED BED WET SCRUBBER

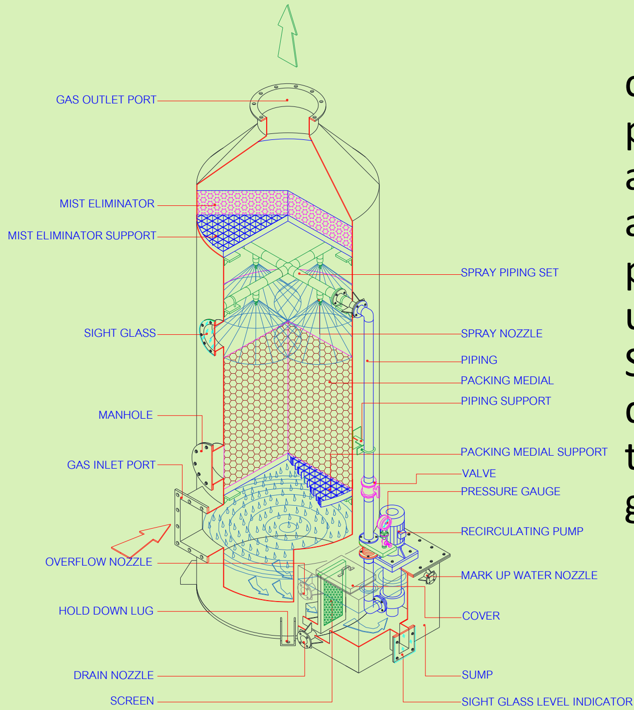
Absorption, an operation of mass transfer is the mechanism used in packed bed scrubber to remove gaseous contaminant from the exhaust gas stream. Absorption is said to occur when the gaseous pollutants dissolve in the scrubbing liquid droplets. The driving force for absorption is the concentration difference of the contaminants between the gas and liquid phases. Absorption will cease if the concentration of contaminants in the gas phase are in equilibrium with the pollutant’s concentration in the liquid phase. Solubility of pollutant in the liquid is a factor controlling the concentration difference. A gas which is more soluble tends to be absorbed faster.



There are three stages associated with gas absorption. Figure above shows the gaseous contaminant of Gasseous pullutant diffuses to the interface between the gas and liquid from the bulk area of the gas phase. The gaseous molecule transfers rapidly to the liquid phase across the interface in the second stage. The molecule is then diffuse to the bulk area of the liquid in the final stage

PACKED BED WET SCRUBBER

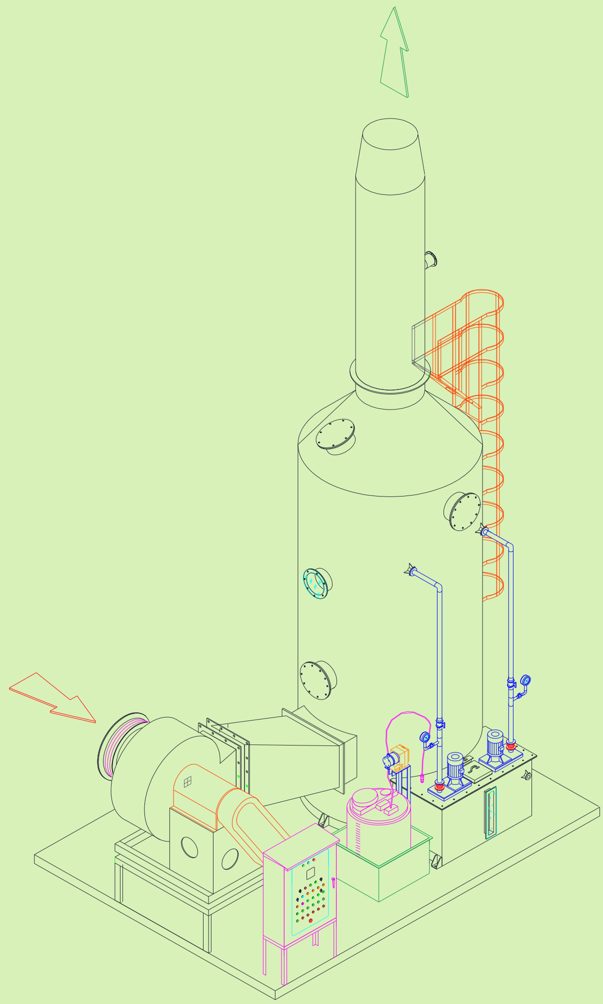
COUNTER-FLOW PACKED BED WET SCRUBBER



Counter current flow is the most common type of flow arrangement for packed bed scrubber. With this arrangement, exhaust gas stream enters a scrubber at the bottom of a bed of packing and the gas moves vertically upwards through the packed bed. Scrubbing liquid is distributed downwards by nozzles or sprays at the top of the packed bed to encounter the gas stream in the opposite direction.

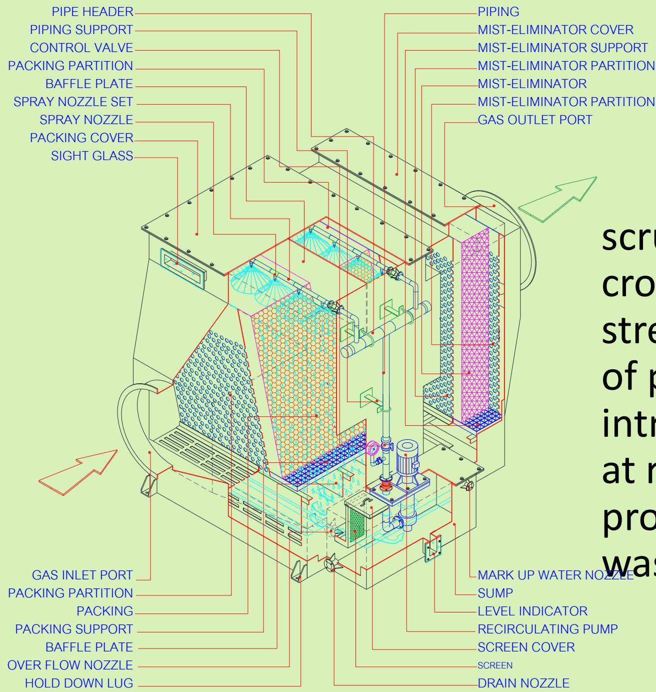
The exhaust stream is forced in the direction of winding as it moves through the packing so that both the liquid and exhaust streams have intimate mixing between each other. After that, the gas stream moves through an entrainment separator which is situated at the top of nozzles. This is to prevent entrained droplets and hazardous particulate from escaping. Packing support is used to carry the weight of packing and it needs to be tough.

In theory, counter current flow arrangement has the highest efficiency as compared to cross flow and concurrent flow configurations



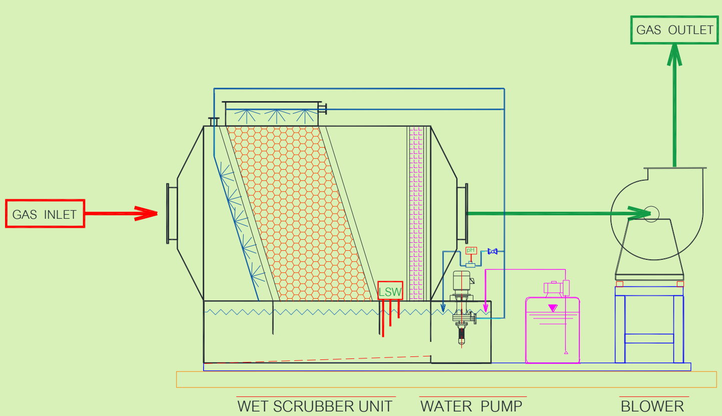
PACKED BED WET SCRUBBER

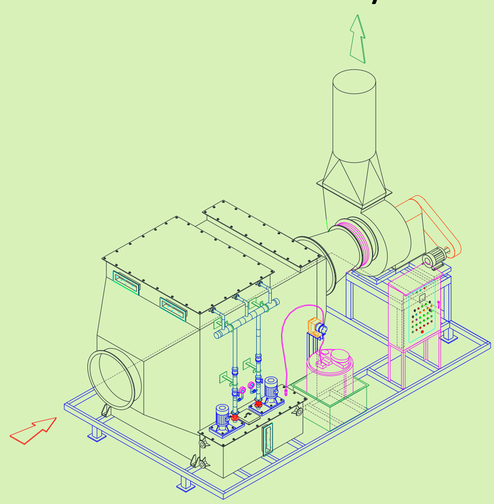
CROSS-FLOW PACKED BED WET SCRUBBER



Cross flow packed bed wet scrubber has a horizontal profile. For cross flow arrangement, exhaust gas stream flows horizontally through a bed of packing. Scrubbing liquid is introduced at the top of the packed bed at right angle to the gas stream to provide wet film for packing and to wash away collected material.

At the front of the packed bed, there are nozzles or sprays to scrub the entering gas and the face of the packed bed. The purpose is to ensure an absolute wetting of the packing. As the gas stream leaves the packed bed, it flows through an entrainment separator. The entrainment separator is located subsequent to the packed bed so that entrained droplets and particle matter in the gas stream are completely captured before they are discharged to the atmosphere. Apart from that, the packed bed is sloped at the leading face in the direction of the oncoming gas stream. The sloping can reduce plugging of particles and allow the scrubbing liquid to be able to flow down to the bottom of the packed bed before it is pushed back by the entering gas. As a consequence of this, the front packing can be absolutely wetted by the font nozzles. This process increases removal efficiency

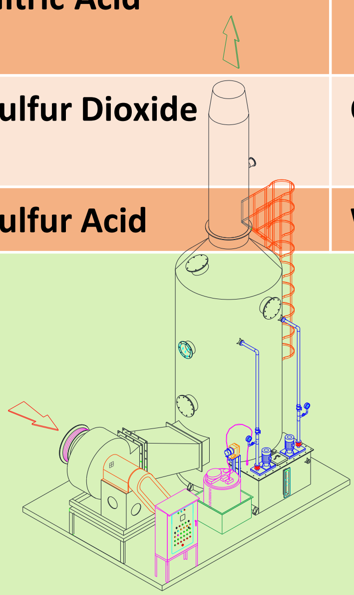


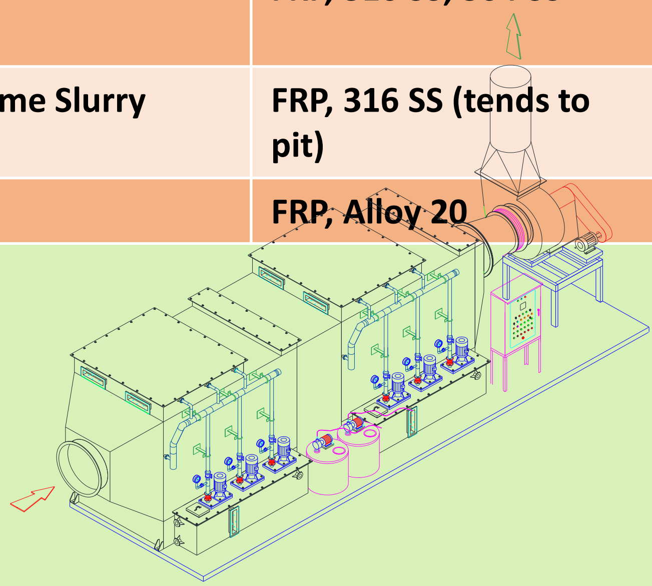


PACKED BED WET SCRUBBER

Suggested scrubbing liquid and scrubber material for certain gases

Gas	Scrubbing Liquid	Scrubber Material
Ammonia	Water	Cast iron, steel, FRP, PVC, Ni-Resist
Chlorine	Water	Fiberglass, Haveg, PVC
Chlorine	Caustic	FRP, PVC, Kynar
Carbon Dioxide/ Air	Caustic	Cast iron, steel, Ni-Resist
Hydrogen Chloride	Water/Caustic	FRP, PVC, Kynar
Hydrogen Fluoride	Water	FRP (with Dynel Sheild), rubber lined steel, graphite lined, Kynar
Hydrogen Sulfide	Caustic	FRP, 316 SS, PVC
Hydrogen Sulfide	Sodium Hydrochloride	FRP, PVC, Kynar, Teflon
Nitric Acid	Water	FRP, 316 SS, 304 SS
Sulfur Dioxide	Caustic/ Lime Slurry	FRP, 316 SS (tends to pit)
Sulfur Acid	Water	FRP, Alloy 20

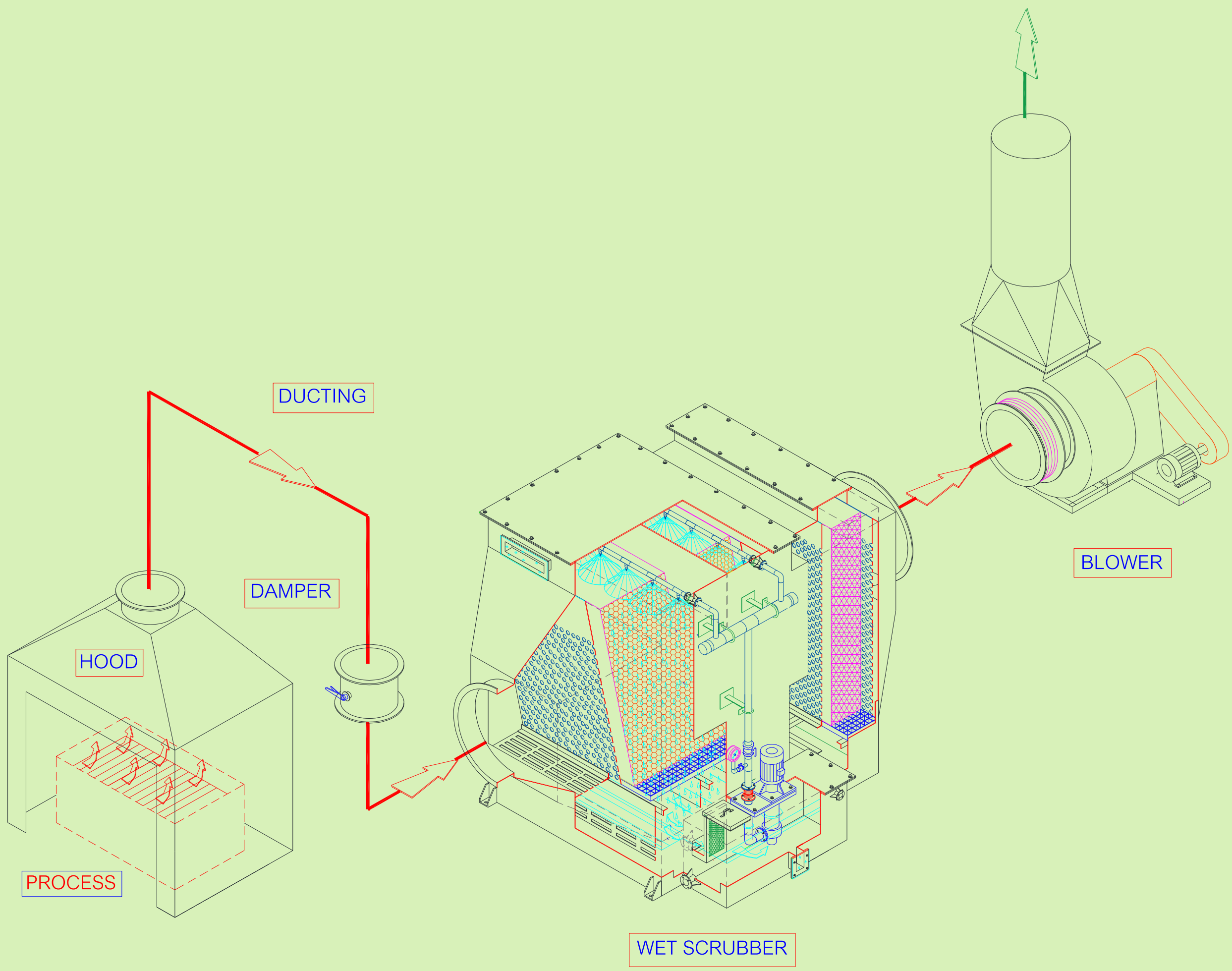




PACKED BED WET SCRUBBER

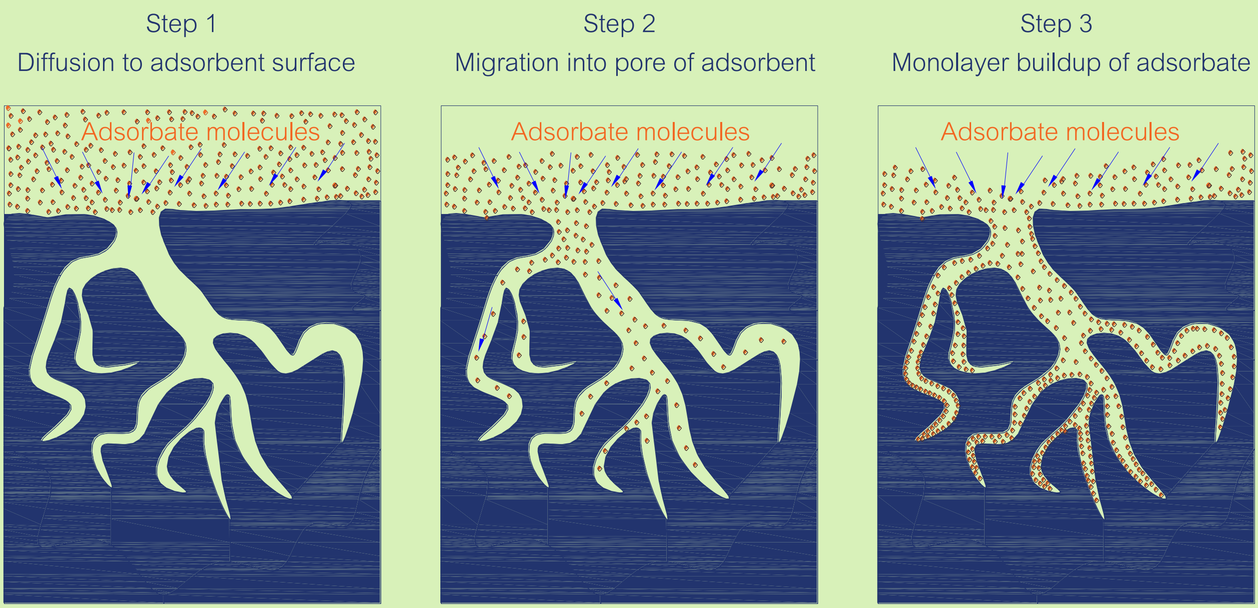
Industrial Applications of Packed bed wet scrubber Systems

- Electronic factory
- Chemical factory
- Agrochemical factory
- Metal smelting factory
- Metal casting factory
- Plating Plant
- Wastewater treatment plant
- Factory with high concentration of chemical vapor and soluble in water
- Etc.



CARBON ADSORPTION SYSTEM

The adsorption process begins with the mechanical movement of the vent stream through the carbon bed, which brings the organics molecules into contact with carbon pellets. The remainder of the adsorption process consists of three steps as illustrats in below Figure.



The adsorbate must first diffuse into the carbon bed to the surface of the carbon pellets. Next, the adsorbate molecule must diffuse from the surface into the pores within the carbon pellets. The extent of the diffusion within the pore is dependent on the size of molecule strikes the walls and sticks for short periods of time.

This diffusion process continues until the molecule reaches a location where it no longer has sufficient energy to escape the forces which hold it to the pore wall . This usually occurs where the pore diameter is not more than approximately twice the diameter of the adsorbate molecule.

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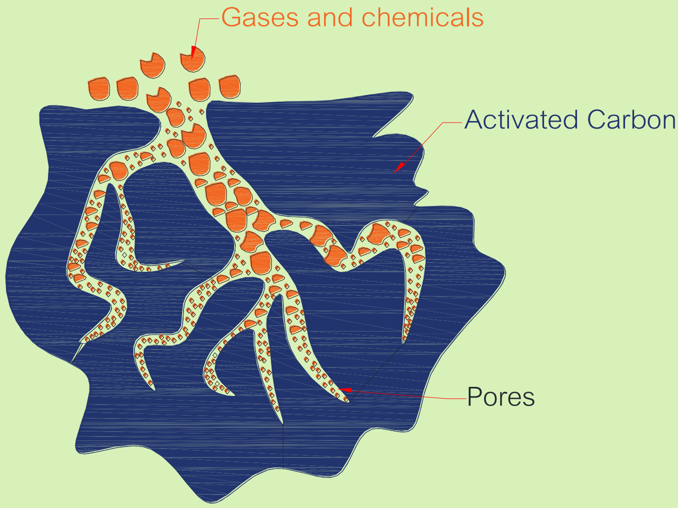
CARBON ADSORPTION SYSTEM



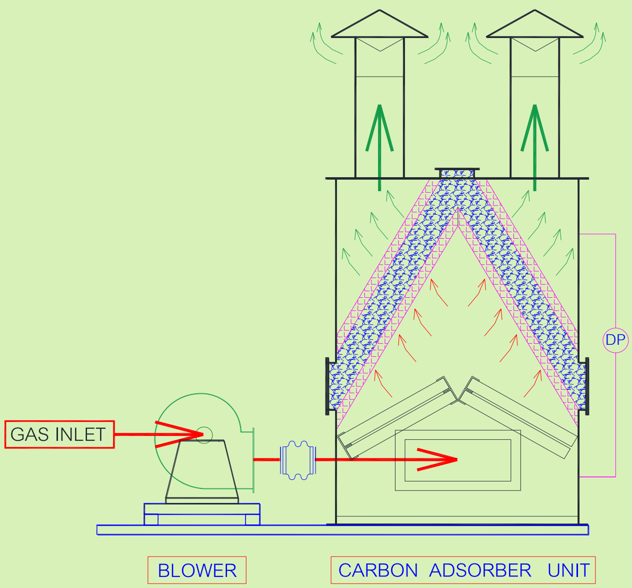
The adsorption process continues until the adsorbate on the carbon reaches a thermodynamic equilibrium is function of the carbon type , temperature of the carbon and adsorbate , and the adsorbate partial pressure (Concentration) in the vent stream. The amount of adsorbate a carbon can hold is called the equilibrium capacity

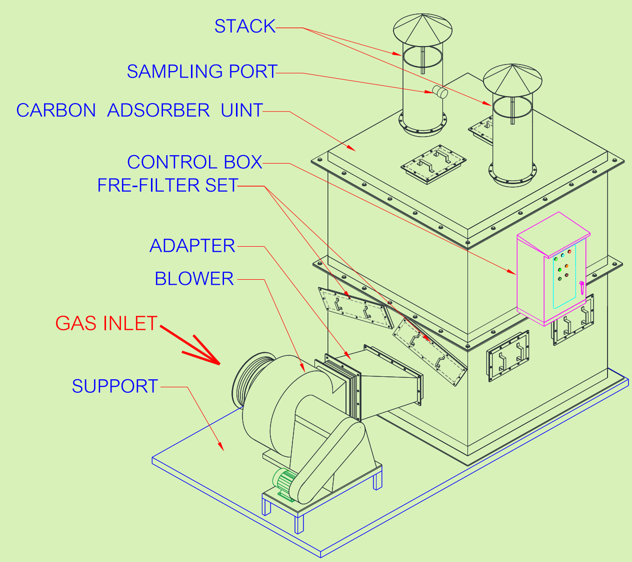

EXTRUDED


GRANULAR


POWDER

Carbon adsorption system that ENCO supply as a fix-bed type

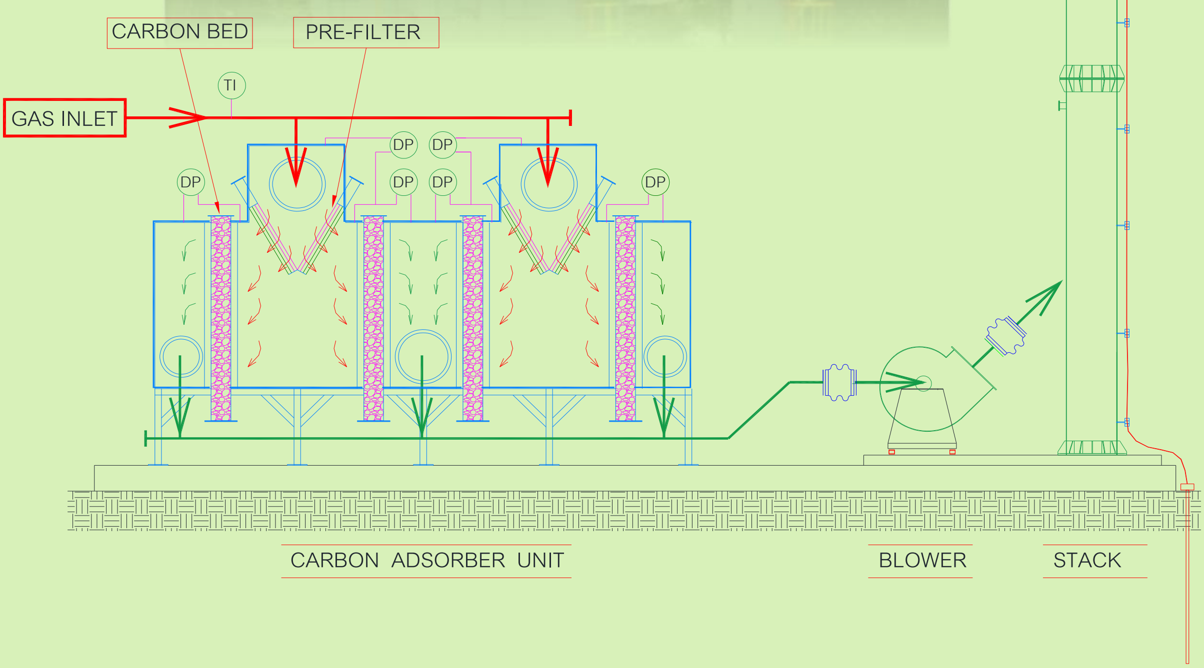




CARBON ADSORPTION SYSTEM

Industrial Applications of Carbon adsorption system

- Painting room
- Fiberglass parts factory
- Solvent manufacturing plant
- Wastewater treatment plant
- Dry Cleaning process
- Production process Volatile Organic Compounds (VOCs) occur.
- Etc.



CARBON ADSORPTION SYSTEM

Activated Carbon Capacity Index Chart Explanation

The capacity index chart lists substances by both chemical and common name. It is a general list of the most common compounds found in the workplace. The efficiency and capacity of activated carbon to adsorb these substances varies with the concentration in the air, relative humidity and temperature. The capacity index numbers are representative under average conditions and may vary under local conditions.

Acetaldehyde***	2	Decane	4	Iodoform	4	Pentylene***	3
Acetic Acid	4	Decaying Substances	4	Irritants	4	Penlyne***	3
Acetic Anhydride	4	Deodorants	4	Isophorone	4	Perchloroethylene	4
Acetone	3	Detergents	4	Isoprene***	3	Perfumes, Cosmetics	4
Acetylene***	1	Dibromethane	4				
		Dichlorobenzene	4	Isopropyl Acetate	4	Perspirations	4
Acrolain***	3	Dichlorodifluoromethane	4	Isopropyl Alcohol	4	Persistant Odors	4
Acrylic Acid	4	Dichloroethane	4	Isopropyl Ether	4	Pet Odors	4
Acrylonitrile	4	Dichloroethylene	4	Kerosene	4	Phenol	4
Adhesives	4	Dichloroethyl Ether	4	Kitchen Odors	4	Phoagene	3
Air-Wick	4	Dichloromonofluormethane	3	Lactic Acid	4	Pitch	4
Alcoholic Beverages	4	Dichloronitroethane	4	Lingering Odors	4	Plastics	4
Amines***	2	Dichloropropane	4	Liquid Fuels	4	Pollen	3
Ammonia***	2	Dichlorotetrafluoroethane	4	Liquid Odors	4	Popcorn & Candy	4
Amyl Acetate	4	Diesel Fumes & Odors	4	Lubricating Oils & Greases	4	Poultry Odors	4
Amyl Alcohol	4	Diethylamine***	3	Lysol	4	Propane	2
Amyl Ether	4	Diethyl Ketone	4	Masking Agents	4	Proplonaldehyde***	3
Animal Odors	3	Dimethylaniline	4	Medicinal Odors	4	Proplonic Acid	4
Anesthetics	3	Dimethylsulfate	4	Melons	4	Propyl Acetate	4
Aniline	4	Dioxane	4	Menthol	4	Propyl Alcohol	4
Antiseptics	4	Dipropyl Ketone	4	Mercaptans	4	Propyl Chloride	4
Asphalt Fumes	4	Disinfectants	4	Mesityl Oxide	4	Propyl Ether	4
Automobile Exhaust	3	Embalming Odors	4	Methane	1	Propyl Mercaptan	4
Bathroom Smells	4	Ethane	1	Methyl Acetate	3	Propylene***	2
Bleaching Solutions***	3	Ether	3	Methyl Acrylate	4	Propyne***	2
Body Odors	4	Ethyl Acetate	4	Methyl Alcohol	3	Purefying Substances	3
Borane	3	Ethyl Acrylic	4	Methyl Bromide	3	Putrescine	4
Bromine	4	Ethyl Alcohol	4	Methyl Buty Ketone	4	Pyridine	4
Burned Flesh	4	Ethyl Amine***	3	Methyl Cellosolve	4	Radiation Products	2
Burned Food	4	Ethyl Benzene	4	Methyl Cellosolve Acetate	4	Rancid Oils	4
Burning Fat	4	Ethyl Bromide	4	Methyl Chloride	3	Resins	4
Butadiene	3	Ethyl Chloride	3	Methyl Chloroform	3	Reodorants	4
Butane	2	Ethyl Ether	3	Methyl Ether	3	Ripening Fruits	4
Butonone	4	Ethyl Formate	3	Methyl Ethyl Ketone	4	Rubber	4
Butyl Acetate	4	Ethyl Mercaptan	3	Methyl Formate	3	Sauerkraut	4
Butyl Aclcohol	4	Ethyl Silicate	4	Methyl Isobutyl Ketone	4	Sewer Odors	4
Butyl Cellosolve	4	Ethylene***	1	Methyl Mercaptan	4	Skatole	4
Butyl Chloride	4	Ethylene Chlorhydrin	4	Methylcyclohexane	4	Slaughtering Odors	3
Butyl Ether	4	Ethylene Dichloride	4	Methylcyclohexanol	4	Smog	4
Butylene***	2	EthyleneOxide	3	Methylcyclohexone	4	Soaps	4
Butyne***	2	Essential Oils	4	Methylene Chloride	4	Smoke	4
Butyraldehyde***	3	Eucalyptole 4 Mildew	3			Solvents	3
Butyric Acid	4	Exhaust Fumes	3	Mixed Odors	4	Sour Milks	4

CARBON ADSORPTION SYSTEM

Activated Carbon Capacity Index Chart Explanation

Camphor	4	Fertilizer	4	Mold	3	Spilled Beverages	4
Cancer Odor	4	Film Processing Odor	3	Momochlorobenzene	4	Spoiled Foodstuffs	4
Caprylic Acid	4	Fish Odors	4	Monofluorotrichloromethane	4	Stale Odors	4
Carbolic Acid	4	Floral Scents	4	Moth Balls	4	Stoddard Solvent	4
Carbon Disulfide	4	Fluorotrichloromethane	3	Naptha (Coal Tar)	4	Stuffiness	4
Carbon Dioxide***	1	Food Aromas	4	Naptha (Petroleum)	4	Styrene Monomer	4
Carbon Monoxide	1	Formaldehyde***	2	Napthalene	4	Sulfur Dioxide***	2
CarbonTetrachloride	4	Formic Acid	3	Nicotine	4	Sulfur Trioxide***	3
Cellosolve	4	Fuel Gases	2	Nitric Acid***	3	Sulfuric Acid	4
Cellosolve Acetate	4	Fumes	3	Nitro Benzenes	4	Tar	4
Charred Materials	4	Gangrene	4	Nitroethane	4	Tarniching Gases***	3
Cheese	4	Garlic	4	Nitrogen Dioxide***	2	Tetrachloroethane	4
Chlorine	3	Gasoline	4	Nitroglycerine	4	Theatrical Makeup Odors	4
Chlorobenzene	4	Heptane	4	Nitromethane	4	Tobacco Smoke Odors	4
Chlorobutadiene	4	Heptylene	4	Nitropropane	4	Toilet Odors	4
Chloroform	4	Hexane	3	Nonane	4	Toluene	4
Chloronitropropane	4	Hexylene***	3	Octalene	4	Toluldine	4
Chloropicrine	4	Hexyne***	3	Octane	4	Trichlorethylene	4
Cigarette Smoke Odors	4	Hospital Odors	4	Odorants	4	Trichloroethane	4
Citrus & Other Fruits	4	Household Smells	4	Onions	4	Turpentine	4
Cleaning Compounds	4	Hydrogen	1	Organic Chemicals	4	Urea	4
Combustion Odors	3	Hydrogen Bromide***	2	Ozone	4	Uric Acid	4
Cooking Odors	4	Hydrogen Chloride***	2	Packing House Odors	4	Valeric Acid	4
Corosive Gases	3	Hydrogen Cyanide***	2	Paint & Redecorating Odors	4	Valericaldehyde	4
Creosole	4	Hydrogen Fluoride***	2	Palmitic Acid	4	Varnish Fumes	4
Cresol	4	Hydrogen Iodide***	3	Paper Deteriorations	4	Vinegar	4
Crolonaldehyde	4	Hydrogen Salenide***	2	Paradichlorobenzene	4	Vinyl Chloride	3
Cyclohexane	4	Hydrogen Sulfine***	3	Paste & Glue	4	Waste Products	3
Cyclohexanol	4	Incense	4	Pentane	3	Wood Alcohol	3
Cyclohexanone	4	Indole	4	Pentanone	4	Xylene	4
Cholohexene	4	Iodine	4				

Interpretation

All substances are rated on a scale from 1 – 4.

4 High adsorption capacity. Substances are adsorbed very efficiently. One pound of activated carbon adsorbs about 20% to 50% of its own weight – average about 1/3 (33%). This category includes most of the odor causing substances.

3 Satisfactory adsorption capacity. Substances are adsorbed well, but not as efficiently as substances rated 4. One pound of activated carbon adsorbs about 10 to 25% of its weight average about 1/6 (16.7%).

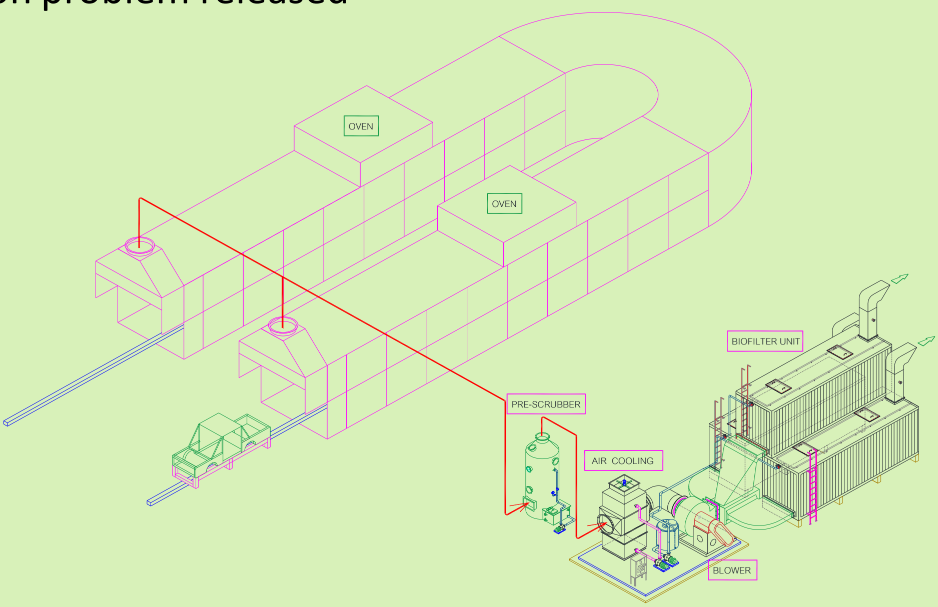
2 Moderate adsorption capacity. Substances are not highly absorbed but might be adsorbed sufficiently to give acceptable results under the particular operating conditions. These require individual checking

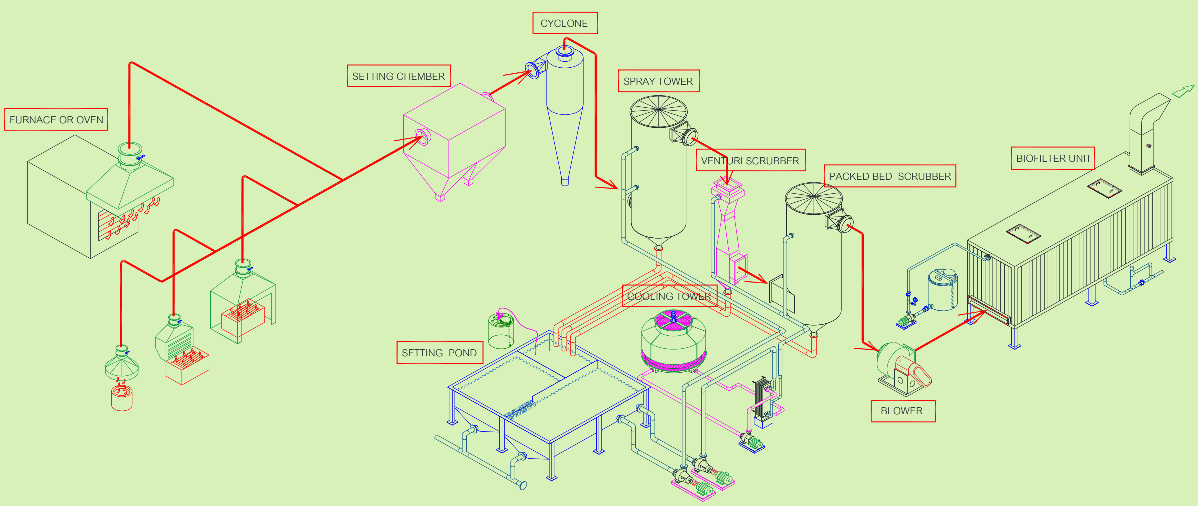
1 Poor adsorption capacity. Substances that are not adsorbed by activated carbon fall into this category

Note: Substances marked with * are not adequately adsorbed by standard activated carbon. It is necessary to use treated (KMN) carbon to increase the adsorption efficiency.**

SPECIAL AIR POLLUTION CONTROL SYSTEM

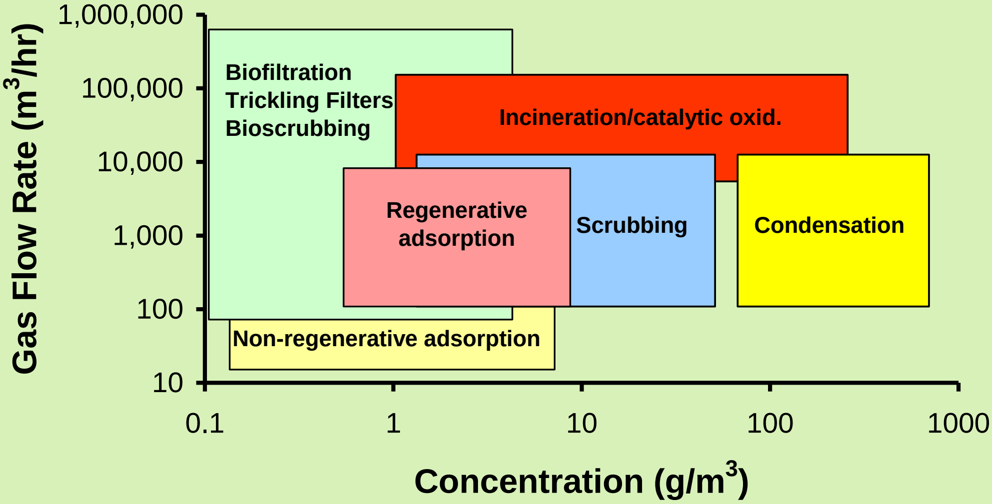
Special air pollution control system or Combinations air pollution control system is a continuous installation of various types of air pollution treatment systems. In order to solve the problem of pollution caused by various production processes of industrial plants that have more than one type of pollution or have conditions that are different from normal, such as polluted air High temperature , smoke , smell , high concentration of chemical vapors or other things coming out at the same time. in the design of air pollution treatment systems will consider choosing Various types of air pollution treatment systems are installed in order to solve the problem. There will be more than one type of air pollution treatment system that works in harmony or has other accessories. in order to solve the pollution problem released





ODOR/VOCs CONTROL SYSTEM

ODOR /VOCs CONTROL SYSTEM COMPARISION



Analysis of various VOCs control techniques

Techniques	Annual operating cost $/cfm	Removal efficiency %	Secondary waste generated	Positive remarks	Negative remarks
Thermal oxidation	15–90 forrecuperative, 150 forregenerative	95–99	Combustion products	Energy recovery is possible(maximum up to 85%)	Hallogenated and other compounds may require additional control equipment downstream
Bio-filtration	15–75	60–95	Biomass	Requires less initial investment, less non-harmful secondary waste, and non-hazardous	Slow, and selective microbes decomposes selective organics, thus requires a mixed culture of microbes (which is difficult). No recovery of material.
Condensation	20–120	70–85	Condensate	Product recovery can offset annual operating costs	Requires rigorous maintenance. Not recommended for the materials having boiling points above 33°C
Absorption	25–120	90–98	Wastewater	Product recovery can offset annual operating costs	Requires rigorous maintenance. May require pretreatment of the VOCs. Design could be difficult due to lack of equilibrium data
Activated carbon	10–35	80–90	Spent carbon and collected organics	Recovery of compounds, which may offset annual operating costs	Susceptible to moisture, and some compounds (ketones, aldehydes, and esters) can clog the pores, thus decreasing the efficiency

F.I. Khan, A. Kr. Ghoshal / Journal of Loss Prevention in the Process Industries 13 (2000) 527–545

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ODOR/VOCs CONTROL SYSTEM

COSTS OF ODOR /VOCs CONTROL SYSTEM BY VARIOUS TECHNOLOGY

Technology or Methods	Investment cost	operating costs	Electricity or fuel	Chemicals used	Efficiency
Neutralize or deodorize	moderate	depending on usage	low	They are expensive because they tend to be specific substances that deodorize them.	Depending on the use in each case, such as spraying on the surface of the waste pile would be less effective than other methods
Condensation system	moderate	Medium (cooling system)	Medium (but the odor-causing substance can be reused)	medium, such as an intermediary	Only applicable in very high concentrations of volatile substances.
Direct combustion system	moderate	moderate	very high	oil or gas	high on organic matter The smell should be highly concentrated and have a calorific value.
The combustion system using a catalyst	high	high (control system)	moderate	oil or gas	high on organic matter The smell should be highly concentrated and have a calorific value.
Oxidation system	moderate	Low to medium if expensive catalysts are used.	Low to medium if ozone generating electricity is used	Expensive if used in large quantities	Depending on the application, for example, if the reaction takes place in a pipe or chimney, it depends on how well the design mixes.
Scrubbing system	high	High (water systems, wastewater treatment, chemicals)	high, especially if using high pressure	Water and chemicals depending on usage.	Up to 90-95% for H_2S and ammonia, but low for hydrocarbons.
Adsorption system	high	Medium (fan system)	moderate	high cost (activated carbon)	high and can only be used for most volatile substances
Biological system	moderate	Medium (water system) needs a lot of space.	low	water and nutrients	Relatively higher than 95%, but the smell must be of low concentration.
Release through the high chimney	low	low	low	do not have	Depends on distance, smell receptors and climate.

(PCD. Ministry of Natural Resources and Environment)

ODOR/VOCs CONTROL SYSTEM

Selection of the appropriate odor control system

Industry	Smell or Odor	Treatment methods
1. fishmeal factory, bone meal factory	Amines, ammonia, rotten egg gas, grilled fish, dust	C, F, E, H
2. Cooking process	Oil vapor. Pungent smell of chili.	I, J
3. Fish drying factory, dried fish	amines, rotten egg gas	A, C, F, H
4. Cassava strands, tapioca flour, cassava strips or pellets.	Vinegar, fatty acids, liqueur flavor	C, F, H
5. Seafood processing plant	Amine , ammonia, rotten egg gas	A, C, F, G, H
6. Animal feed factory	amines, fatty acids	A, C, F, H
7. Chemical Fertilizer Mixing Plant or pesticides	Ammonia, solvent odor, drug odor such as Carbofuran , Chlordane	B, C, D, F, G, H
8. Rubber factory and products from latex	ammonia , burnt rubber	F, H
9. Chemical and petrochemical plants	many kinds of scents	B, C, D, F, G
10. Paint, solvent or solvent distillation plant	Solvent odor, hydrocarbon	A, B, C, D, G, H
11. Refinery	Oil hydrocarbon odor of sulfur , sulfur dioxide, Lahore.	B, C, D, G, H
12. Fiber and plastic factory	Phenol Formaldehyde Combustion Aldehyde Styrene Acrylate	B, C, D, G, H
13. A factory that uses animal wax or fat in the production process	oil vapor, fatty acid	I, J
14. Tanning Factory	Hydrogen sulfide, Merrill caps instead of hydrochloric acid.	A, C, D, F, G, H
15. Paper and Pulp Factory	Hydrogen sulfide , Merrill captan , sulfur dioxide.	C, D, F, G, H
16. Liquor factory	(Yeast smell of fermentation), hydrogen sulfide ,Merrill caps instead.	A, B, C, F, G, H
17. Wastewater treatment plant	Hydrogen sulfide, Merrill captan , fatty acids.	C, F, G, H
18. Garage, car assembly plant	Solvent	C, G
19. Printing house	Solvent	C, G
20. Animal Farm	Amines, ammonia and rotten egg gas	A, E, H

(PCD. Ministry of Natural Resources and Environment)

KEY treatment methods as above :

A: Deodorant or deodorant
B: Condensation and/or reuse
C: Direct combustion system
D: Catalytic combustion system or low temperature sintering
E: Oxidation by ozone or chlorine
F: Scrubbing system (usually water or odor absorbing spray solution)
G: Adsorption system (usually activated carbon)
H: Biological system
I: How high enough air is released through the chimney? (Not recommended as a first choice, preferably through therapy)
J: Steam catcher

PROJECT REFFERENCE

BIOTECHNOLOGY SYSTEM

Customer : 3M Innovation Thailand Co.,Ltd.

Process : Oven and Spray booth process

Pollutant : Phenol and Formaldehyde

Capacity : 47,000 CFM.

APC Type : Biotrickling system

Customer : Dana Spicer (Thailand) Co.,Ltd.

Process : Spray booth painting process

Pollutant : VOCs

Capacity : 35,000 CFM.

APC Type : Biotrickling system

Customer : Soongnern Waste disposal center

Process : Waste Disposal treatment (Refuse Buildind)

Pollutant : H_2S , NH_3

Capacity : 7,000 CFM.

APC Type : Wet scrubber + Biofilter system

Customer : US Boh Thong international Co.,Ltd.

Process : Reclaimed tire process

Pollutant : Acetaldehyde, SO_2 , H_2S ,Styrene , Butadiene

Capacity : 12,000 CFM.

APC Type : Wet scrubber + Biofilter system

PROJECT REFFERENCE

BIOTECHNOLOGY SYSTEM

Customer : Thainakorn patana Co.,Ltd.

Process : Waste water Treatment Plant

Pollutant : H_2S , NH_3 , VOCs

Capacity : 1,000 CFM.

APC Type : Biofilter system

Customer : Ajinomoto (Thailand)Co.,Ltd.

Process : Waste water Treatment Plant

Pollutant : H2S , NH_3 , VOCs

Capacity : 500 CFM.

APC Type : Wet Scrubber + Biofilter system

Customer : Thai Feed Mills (Suan-Luang)Co.,Ltd

Process : Feed Mills Drying

Pollutant : H_2S , NH_3 and Particulate

Capacity : 16,000 – 20,000 CFM.

APC Type : Wet scrubber +Biofilter system

Customer : Cadbury Adams (Thailand) Co.,Ltd.

Process : Waste water Treatment Plant

Pollutant : H_2S and VOCs

Capacity : 500 CFM.

APC Type : Biofilter system

PROJECT REFFERENCE

PACKED BED WET SCRUBBER SYSTEM

Customer : Almet Thai Co.,Ltd.

Process : Aluminium anodizing

Pollutant : NaOH fume and H_2SO_4 Fume

Capacity : 65,000 CFM.

APC Type : Cross-flow Packed bed Scrubber

Customer : Thai Paper Co.,Ltd.(Banpong)

Process : C-Washer and H2-Washer (wash the pulp)

Pollutant : Cl_2 fume

Capacity : 5,000 CFM.

APC Type : Counter-flow Packed bed Scrubber

Customer : Project D Engineering Co.,Ltd.

Process : Aluminium anodizing process

Pollutant : Acid fume

Capacity : 5,000 CFM.

APC Type : Counter-flow Packed bed scrubber

Customer : RB (Thailand) Co.,Ltd.

Process : Rubber gloves production process

Pollutant : Dust

Capacity : 11,000 CFM.

APC Type : Counter-flow Packed bed scrubber

PROJECT REFFERENCE

PACKED BED WET SCRUBBER SYSTEM

Customer : **Hino Motor Manufacturing (Thailand) Co.,L**

Process : CNC Welding Auto Parts.

Pollutant : Oil Mist , Smoke

Capacity : 28,000 CFM , 2 Unit , 10,000 CFM. 1 Unit

APC Type : Cross-flow Packed bed Scrubber

Customer : **BMA 4 (โรงควบคุมคุณภาพน้ำจตุจักร)**

Process : Waste water Treatment Plant

Pollutant : H_2S Gas and VOCs

Capacity : 15,000 CFM.

APC Type : Counter-flow Packed bed scrubber

Customer : **Vanachai chemical industries Co., Ltd**

Process : Urea formaldehyde resin , Formaldehyde

Pollutant : Formaldehyde (CH_2O)

Capacity : 1,000 CFM.

APC Type : Counter-flow Packed bed scrubber

Customer : **Stats Cippac (Thailand) Ltd.**

Process : Electroplating

Pollutant : Nitric Acid gas (HNO_3)

Capacity : 30,000 CFM.

APC Type : Counter-flow Packed bed scrubber

PROJECT REFFERENCE

SPECIAL AIR POLLUTION CONTROL SYSTEM

Customer : **Thai Paper Products Co., Ltd. (SCG-Ban Pong)**

Process : CNCG Cooling system

Pollutant : H_2S 6,000 ppm.

Capacity : 250 CFM.

APC Type : Multi stage Counter-flow scrubber

Customer : **Tile Product (Lampang) Co., Ltd. (SCG)**

Process : Autoclave

Pollutant : NH_3 1,200 ppm.

Capacity : 5,000 CFM.

APC Type : Air cooling + Counter-flow scrubber

Customer : **Denchai Bai Ya Plant (Tobacco Factory)**

Process : Tobacco leaf drying process

Pollutant : Particulate , NH_3

Capacity : 20,000 CFM. , 2 Unit

APC Type : Quencher + Counter- flow scrubber

Customer : **Dana spicer (Thailand) Co.,Ltd.**

Process : Sand blast machine

Pollutant : Particulate

Capacity : 1,000 CFM

APC Type : Jet venturi + Wet filter

PROJECT REFFERENCE

SPECIAL AIR POLLUTION CONTROL SYSTEM

Customer : **Mitsubishi Motors (Thailand) Co.,Ltd.**

Process : Oven

Pollutant : Oil mist and VOCs

Capacity : 12,000 CFM.

APC Type : Oil mist seperater + Counter-flow packed bed scrubber

Customer : **Ageless (Thailand) Co.,Ltd.**

Process : Blender machine

Pollutant : Particulate

Capacity : 7,000 CFM.

APC Type : Venturi +Counter-Flow Packed bed scrubber

Customer : **Mahle Engine Coponents (Thailand) Co.,Ltd.**

Process : Aluminium Melting Furnace

Pollutant : Particulate , NO_x , SO_2

Capacity : 25,000 CFM.

APC Type : Cyclone + Quencher + Packed bed Scrubber

Customer : **Advance Agro Public Co.,Ltd.**

Process : Paper pulp process

Pollutant : H_2S gas (60,000 – 80,000 ppm.)

Capacity : 580 - 880 CFM.

APC Type : Counter-flow Packed bed scrubber

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