HAMON

Environmental

AIR POLLUTION CONTROL

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Hamon Environmental in a few words

In 1906, the Hamon Group started its industrial activity in Europe and developed the cooling tower business with growing mining and heavy industry sectors. Since then, Hamon became a world leader in the product lines it chose to be in, respectively: wet cooling towers, air-cooled heat exchangers, air pollution control equipment and chimneys.

Nowadays, the Hamon Group operates in the Air Pollution Control field through two main organisations, Hamon Research-Cottrell in the USA and Hamon Environmental in Europe, sharing technologies and experience.

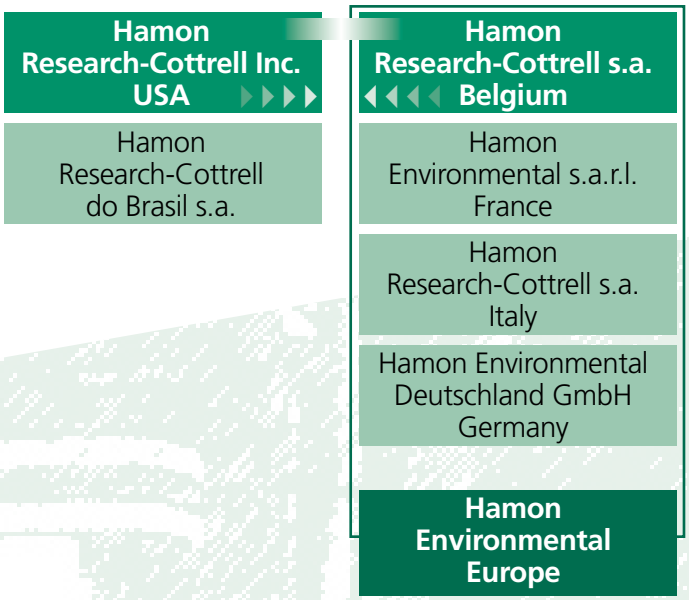
Hamon Environmental

Hamon Environmental, European business unit of the Air Pollution Control Division of the Hamon Group, has been created by the merging of the activities of Research-Cottrell and Walther France, with the purpose to create an integrated organisation capable to serve the global market of Air Pollution Control.

Hamon Research-Cottrell began when Dr. Frederick Gardner Cottrell invented the first industrial electrostatic precipitator in 1907. To support scientific research, Dr. Cottrell co-founded the non-profit Research Corporation in 1912. Forty years later, Research Corporation gave birth to Research-Cottrell.

Hamon Environmental continues the tradition of engineering excellence by designing, building, and servicing quality Air Pollution Control Systems for the industries and utilities of the world.

Hamon Group
The Air Pollution Control Division



Mission

Reducing emissions is a complex task for any industry. The result must not only comply with present and future regulatory requirements, it must also integrate the needs of your specific production process, schedule and budget.

Hamon Environmental has decades of experience in the engineering, design, construction, start-up, operation and maintenance of air pollution control systems. In order to test and optimize many of our engineering designs, we have conducted our own in-house flow dynamics models and computer simulations.

This experience, which includes countless emission control systems for numerous and varied processes, allows us to confidently apply technology to your specific requirements.

Knowledge and Understanding of Regulations

The ever-changing industrial and governmental rules and regulations is a challenge that Hamon Environmental readily accepts. We constantly monitor the regulations to ensure that our systems, parts and services meet the shifting and more stringent demands.

Main Product Lines

DUST EMISSION CONTROL	ACID GAS REMOVAL SYSTEMS	NOx REMOVAL SYSTEMS	CUSTOMER SERVICE
Dry and Wet ESP's	Dry type FGT Systems	SCR DeNOx Systems	ESP and FF large Rebuilds
Fabric Filters Hybrid Collectors	Semi-Dry FGT Systems	NOx and CO Catalyst SCR	Repairs and Maintenance
Multicyclones	Combined Wet/Dry FGT Systems	Tail end or high Dust SCR	Spare Parts
Flue Gas Conditioning	Dioxines and Heavy Metals Control	SNCR DeNOx Systems	Diagnostic and CFM
Impingement Scrubbers	Wet FGD scrubbing for Industrial Boilers and Diesel Engines	U_2A – Urea to Ammonia System	
	Wet FGD Exxon Process for FCCU		

ESP	electrostatic precipitator
FF	fabric filter
FGT	flue gas treatment
FGD	flue gas desulphurization
SCR	selective catalytic reduction
SNCR	selective non-catalytic reduction
CFM	computerized flow modeling

Main segments of activity

Hamon Environmental technology founds main application for :

- Power generation
  - *large utility boilers*
  - *industrial boilers*
  - *diesel generators stations*
  - *gas turbines combined cycles*
- Waste incineration
- Biomass
- Refineries
- Glass industry
- Cement and ore industry
- Steel and non-ferrous industry
- Fertilisers industry

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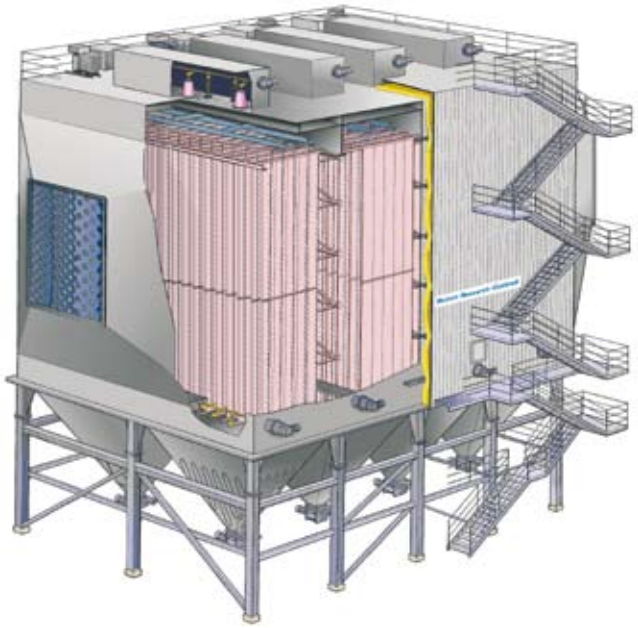
Electrostatic Precipitators

For nearly a century, electrostatic precipitators (ESP's) have been the preferred air pollution control technology for power generation and industrial processes throughout the world. ESP's are highly effective dust collectors with proven collection efficiencies of up to 99,99% with guaranteed outlet emissions as low as 10 mg/Nm^3 with minimal pressure loss.

Fact and figures:

- Gas flow over 2 000 000 Nm^3/h
- Collecting plate height over 15 m
- High frequency transformer efficiency
- ESP's on power plant in excess of 1 000 units and 200 000 MWe
- ESP's supplied for all industrial processes such as:
  - Power generation/utilities
  - Oil refineries
  - Waste and sludge incineration plants
  - Biomass plants
  - Cement and ore industry
  - Steel and non-ferrous industry
  - Glass furnaces
  - Pulp and paper

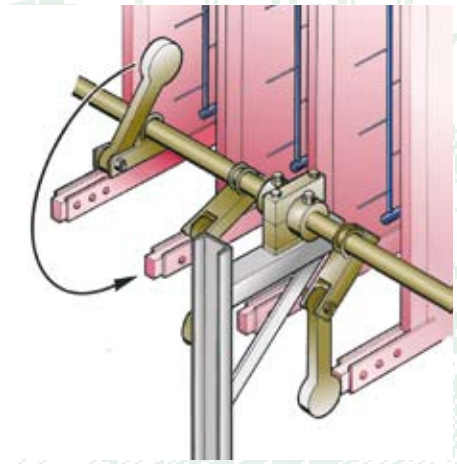
Total ESP's installed by Hamon Environmental: > 5 000 units.



Electrostatic precipitators technology includes:

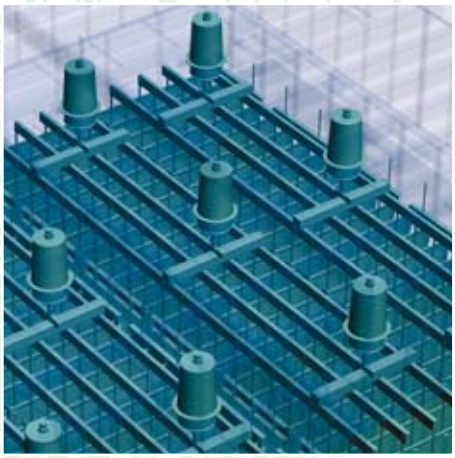
Compact type ESP

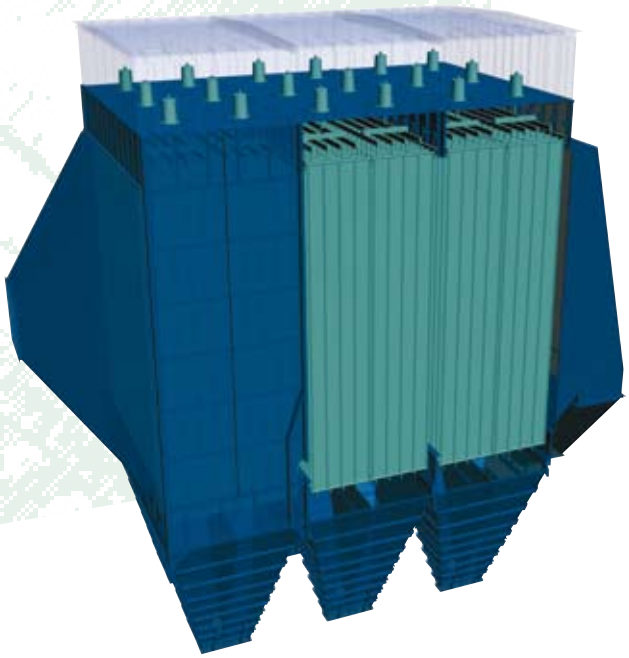
Thumbling hammers side rapping (European design)



Hi-R type ESP

MIGI hammers roof rapping (American design)





Wet ESP

Hamon Environmental can also supply tubular or irrigated plate type wet precipitators, which can be employed as polishing filtration elements in those processes where extremely low dust residue is allowed.

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Fabric Filters

The decision to use baghouses over other particulate control devices such as ESP's depends upon several factors. These include:

- Application
- Acidity of flue gas stream and materials being collected (ie. high sulfur coals)
- Particulate/ash resistivity
- Efficiency of collection required
- Operating temperatures
- Requirement to collect metals and toxic elements such as lead, cadmium, zinc, dioxins, HCl and mercury
- Fine particulates (PM 10, PM 2,5)

A fabric filter system is very effective at the collection of fine particulates and metals. With additional dry sorbents, air toxics such as mercury can be collected with substantially reduced injection rates of sorbents over ESP's. Additionally when following Dry Flue Gas Desulfurization (DFGD) systems, additional SO_2 capture takes place across the filter cake of the fabric which both enhances the total reduction across the system and at lower consumption rates over a DFGD and ESP system.

Hamon Research-Cottrell baghouses are so effective because a wide variety of bag cleaning technologies and associated fabric filter media are used to suit virtually all operations and dust characteristics. Filter types offered by Hamon Environmental include Pulse Jet, Reverse Air, and COHPAC™ (Compact Hybrid Particulate Collector) technologies.

Hamon Environmental offers three types of Pulse Jet technologies:

- Low pressure high volume (LPHV)
- Medium pressure medium volume (MPMV)
- High pressure low volume (HPHV)

The system is optimized by employing the best pulse jet technology depending on the application. Features of our Pulse Jet systems include:

- Wide range of applications, from 50 000 to over 2 000 000 Nm^3/h.
- High filtration rates (air to cloth ratio)
- Bag length up to 8 meters
- High reliability, low maintenance
- No compressors or dryers required with our LPHV type design
- Compartment arrangement, with either On-line of Off-line cleaning depending on the process application

Compact Hybrid Particulate Collector

An EPRI-licensed technology, the Compact Hybrid Particulate Collector is a fabric filter placed in series with an ESP. Implementing COHPAC technology keeps capital costs low and use of plant space to a minimum.

The technology is based on the fact that a fabric filter collects higher levels of particulate–and finer particulate–than an ESP of equal size. The fabric filter acts as a "polishing device". By using dry additives such as activated carbon, sodium or calcium compounds, COHPAC offers you the ability to significantly reduce mercury, sulfur dioxide, and other toxic emissions than an ESP alone could not economically collect.

COHPAC is the combination of your existing or new electrostatic precipitator with a Hamon high air to cloth ratio fabric filter.

- COHPAC I: The fabric filter is placed in a separate casing downstream of the ESP
- COHPAC II: within the existing ESP's casing by replacing one or more fields of collecting plates with fabric filter modules.

Features:

- High collection efficiencies (as high as 99,9%)
- Low capital cost (much lower than competing systems to achieve comparable particulate control levels)
- Compact footprint
- Works with a wide range of fuels (for flexibility in choosing the most available and economical coals)
- Can separate toxic emissions for cost-effective disposal options through the use of appropriate additives

Dry Process Scrubbing

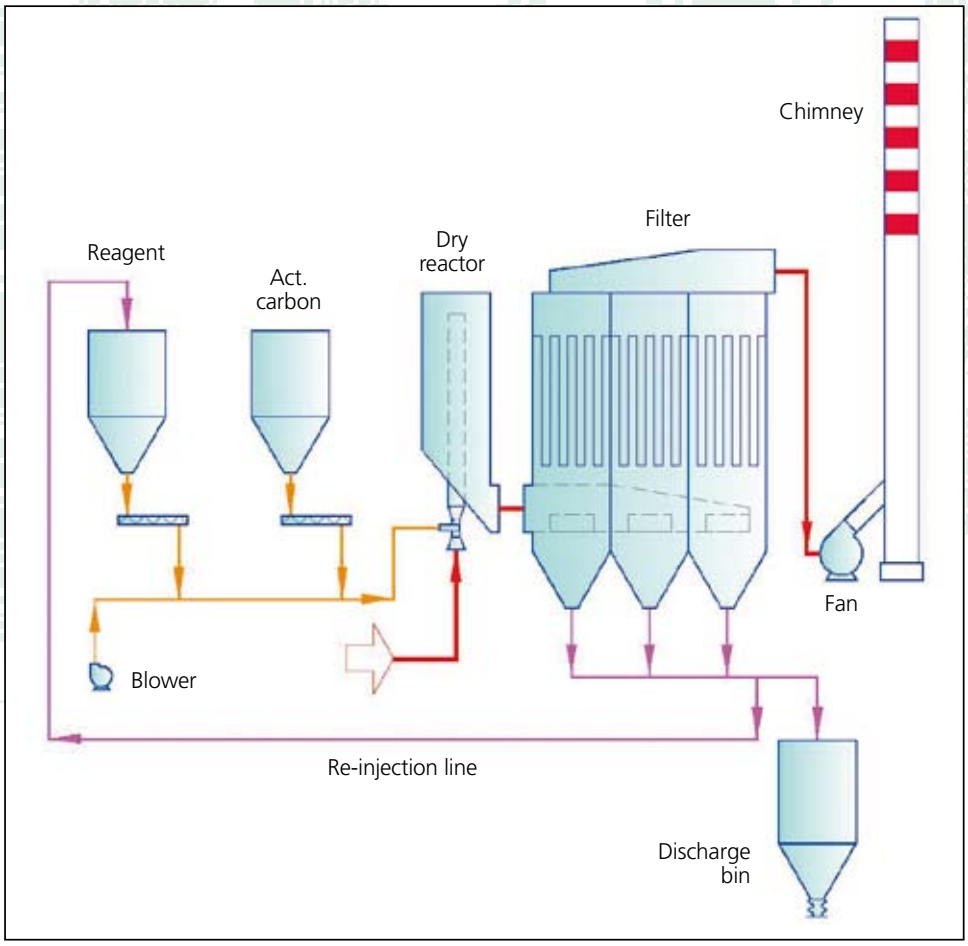
Dry scrubbing systems are used to control acid gas emissions primarily from combustion sources such as utility and industrial boilers, municipal and medical waste incinerators or industrial processes such as glass furnaces.

Dry scrubbing systems only remove acid gases and therefore must be followed by a particulate control device (ESP or fabric filter) prior to exhausting the gases to the atmosphere.

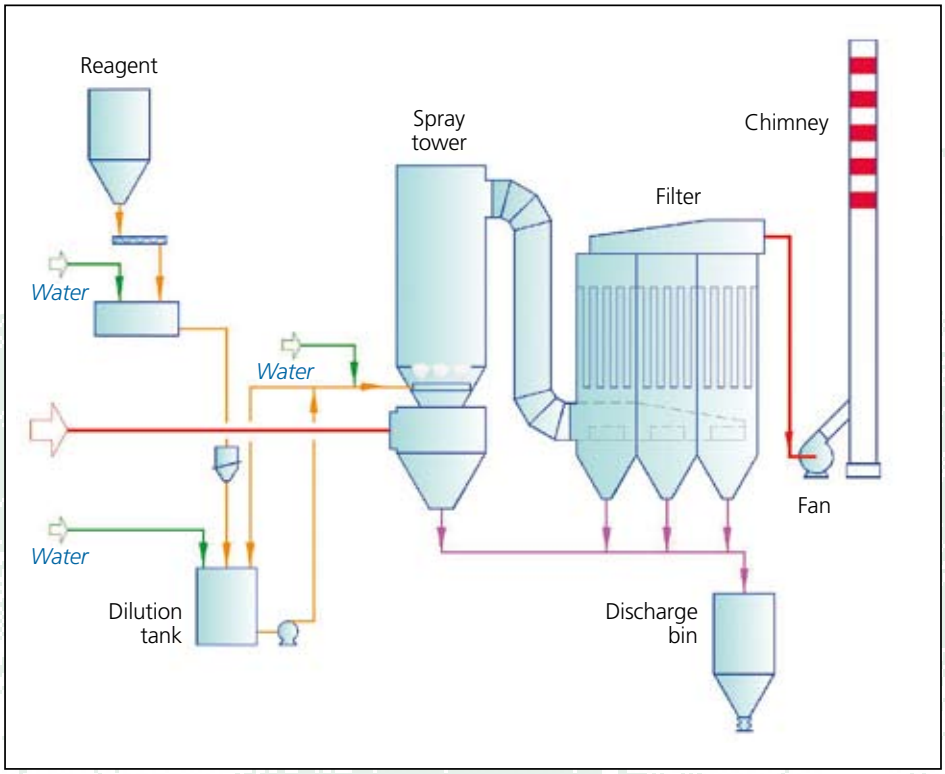
Dry sorbent injection involves the addition of a dry alkaline material (usually hydrated lime or sodium bicarbonate) into the gas stream to react with any acid gases that are present. The sorbent can be injected directly into the flue gas duct ahead of the particulate control device or into an open reaction chamber. The acid gases are adsorbed onto and react with alkaline sorbents to form solid salts which are removed in the particulate control device.

Experience available for most industrial processes, such as:

- Waste incineration
- Industrial boilers
- Biomass power plants
- Glass ovens
- Aluminium smelters



Semi-dry Process Scrubbing



In semi-dry scrubbing, the flue gases are introduced into an absorbing tower (dryer) where the gases are contacted with a finely atomized alkaline slurry : usually a calcium-based sorbent such as $Ca(OH)_2$ or CaO. Acid gases are absorbed by the slurry droplets and react to form solid salts. The heat of the flue gas is used to evaporate all the water droplets, with a non-saturated (i.e. dry) flue gas leaving the absorber tower. The effect of cooling and humidifying the hot gas stream increases collection efficiency over simple dry injection.

Wet Process Scrubbing

Wet scrubbers are gas cleaning equipment where the dirty gas stream is brought into contact with a scrubbing liquid.

Of course, the scrubber design depends on the industrial process conditions and the nature of the air pollutants involved.

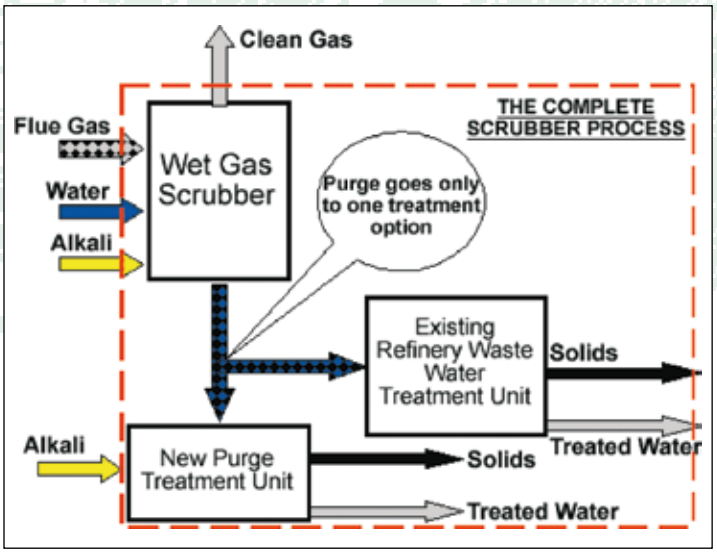
Wet scrubbers can be designed to collect particulates and/or gaseous pollutants by capturing particles in liquid droplets and by dissolving of absorbing pollutant gases into the liquid.

If the exhaust stream contains both particles and gases, wet scrubbers are generally the only single air pollution control device that can remove both types of pollutants.

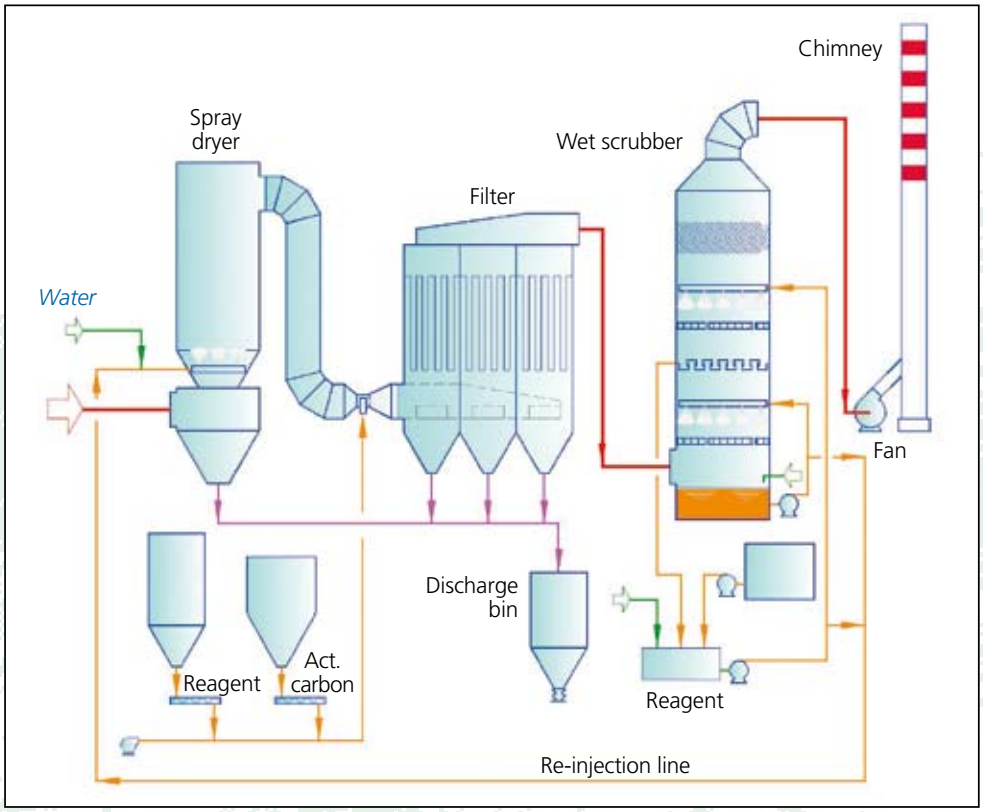
Wet gas scrubbers for petrochemical industry

Hamon Research-Cottrell Inc. and ExxonMobil Research & Engineering Company (EMRE) have signed an exclusive licensing agreement to provide Wet Gas Scrubber and Purge Treatment Unit as an air pollution control technology for Refinery Fluidized Catalytic Cracking Unit (FCCU).

The ExxonMobil Wet Gas Scrubber System as provided by Hamon Research-Cottrell is a simple system consisting of an "on-site" WGS (Wet Gas Scrubber) and typically an "off-site" PTU (Purge Treatment Unit).



Combined Flue Gas Treatment



Waste incineration is probably the most severe demanding application for the Flue Gas Cleaning field.

Control of several pollutants such as SOx, HCl, HF, heavy metals, dioxins and furans, as well as NOx, must be accomplished with integrated air pollution control systems which combine different treatments to provide the highest efficiency of removal in respect of the best available technology.

Heat recovery and gas re-heating is being part of the more complex problems in control of pollution, as demonstrated in a number of waste incineration plants which have been equipped by Hamon Environmental flue gas cleaning systems.

NOx Reduction Technologies

Selective Catalytic Reduction (SCR)

Selective Catalytic Reduction (SCR) is the most effective method of controlling nitrogen oxide emissions (NOx) from combustion sources. It is a commercially proven flue gas treatment technology that has been demonstrated to remove over 90 percent of the NOx contained in combustion system exhaust gas. Nitrogen oxides contribute to acid rain and smog.

Elimination of NOx creates a healthier environment and meets highest stringent reduction requirements. SCR technology is widely used on different types of combustion systems such as coal fired boilers, simple and combined cycle gas turbines, process boilers, hydrogen reformers, etc. Virtually any hot flue gas containing NOx can be treated effectively with the SCR process as a retrofit or on new equipment.

The catalyst is at the heart of the SCR process. It creates a surface for reacting the NOx and ammonia, and allows for the reaction to occur within typical flue gas temperature ranges. The active ingredient in most NOx catalyst is vanadium pentoxide (V_2O_5) of various concentrations. For higher temperatures zeolites, tungsten or titanium matrices may be utilized as well. Catalyst configurations can be homogenous honeycomb, coated honeycomb or plate type catalyst.

The catalyst opening, composition and volume are determined by components of flue gas chemistry, treatment temperature and amount of flue gas to be treated.

Selective Non-Catalytic Reduction (SNCR)

The process works by injecting a reagent (ammonia or urea) into the radiant and convection regions of a furnace to treat the flue gases, so the reduction reaction can take place.

The key to the SNCR process is having the reagent come in contact with the flue gas within a specific temperature window. For urea this window is approximately 980°C-1 150°C. For ammonia, range is slightly lower at 850°C-980°C.

Typically these temperatures include the latter part of the radiant section and most of the convective section of the boiler. The products of the SNCR reactions are benign, nitrogen, water vapor, and carbon dioxide (CO_2 only when using urea).

Selective Non-Catalytic Reduction has low cost capital equipment, and is extremely versatile. It offers competitive economic advantages to large SCR installations when combined with other technologies. SNCR can be used in many industries including power, steel and other metal production, pulp and paper, petrochemical, waste to energy, glass and many others.

NOx Reduction

The best type of technology for NOx reduction at a particular site is very application and site specific. Many factors affect the cost / benefit analysis, such as, application size, NOx output, current NOx regulations, planned future NOx regulations, reagent selection / cost / availability, fuel changes and retrofit space limitations. This type of planning can be very difficult and Hamon Environmental has the experience and process knowledge to help customers make the most economical and effective decision.

SCR (Selective Catalytic Reduction) offers technically superior NOx reduction capabilities (>90%). In addition, SCR traditionally offers lower ammonia slip than SNCR. For extremely high reduction requirements this may offer the only choice. However, SNCR (Selective Non-Catalytic Reduction), combined with burner modifications, can enable some sites to meet regulations while minimizing capital cost. Also, in some cases, NOx reduction and capital cost minimization can be optimized by utilizing a hybrid SCR / SNCR system. A hybrid SCR / SNCR system reduces the amount of catalyst required and can be considerably cheaper than a traditional SCR system.

U_2A™ process - On site ammonia generation

SCR NOx removal process requires ammonia, either anhydrous or aqueous, which is a toxic substance. The hazards from exposure vary from minor discomfort to toxic poisoning and asphyxiation.

To counter this risk and ensure the safety of plant personnel and the surrounding community, Hamon Environmental offers a patented on site Urea-to-Ammonia generation system, U_2A™, that produces ammonia by a method that avoids the hazards of its transportation, transfer, and storage.

In addition, there are economic benefits versus using unregulated lower concentrations of aqueous ammonia.

Benign dry urea is transported to the site and mixed with water to form an aqueous solution of varying concentration (typ. 40-50%) depending on the application. The solution is then fed to an in-line hydrolysis reactor, where heat is applied to the entering solution. Both steam and electric heat are available as design options depending on site availability and application requirements.

The heat is applied to maintain a constant ammonia pressure. The ammonia production is exponentially proportional to the temperature of the urea solution. As more ammonia is required, more heat is added to increase the production and maintain the reactor pressure. Ammonia generation begins at 116°C. The reactor is designed so that throughout the operating range of a particular application the temperature range is typically 138°C-154°C.

The product gas is a mixture of ammonia (NH_3), carbon dioxide (CO_2) and water vapor (H_2O) and may be used in SCR's application.

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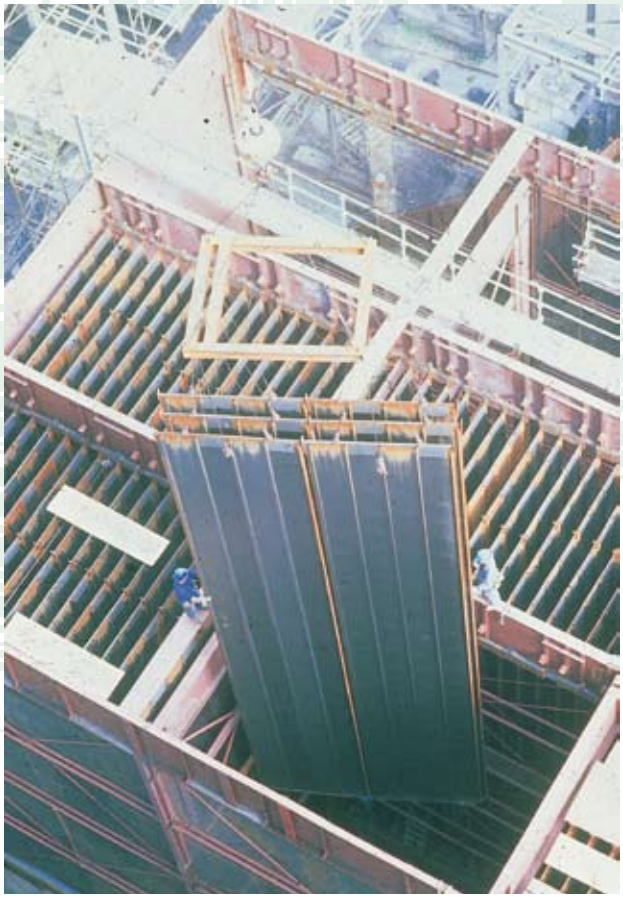
Customer Service



Currently, utilities and industries are facing extraordinary challenges in the efficient use and upkeep of their pollution control equipment: aging, significant preventive maintenance and emergency repairs, process changes, and demanding new regulations.

Dealing with these issues becomes even more difficult when many companies do not have the in-house personnel to perform their much-needed maintenance and engineering services.

Hamon Environmental has been responding to these challenges for almost a century by:

- delivering proven solutions to your most difficult compliance and operating requirements
- offering a complete line of replacement parts; each product has been carefully chosen for its quality, performance and value
- providing the entire range of cost-effective maintenance strategies, from routine repairs, upgrades to parts, outage planning, project management to cost containment plans.

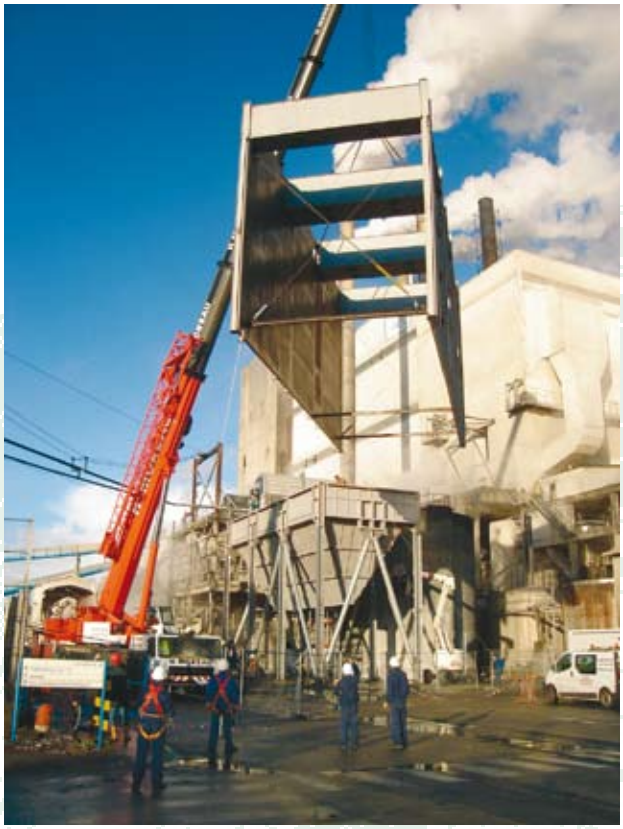
With offices throughout the world to perform condition assessments, performance evaluations, and unit enhancements, Hamon Environmental meticulous services contribute to the extended life of your plant.

Repair and maintenance

- Troubleshooting
- Performance analysis
- Inspections and training
- Life extension
- Repair supervision
- Emergency repairs
- Outage maintenance

Parts and customer service

- Discharge electrode wires and weights
- Rigid discharge electrodes
- Collecting plates
- Insulators
- Rappers and rapper components
- Microprocessor control systems
- Transformer-rectifier sets
- Electrical and mechanical auxiliaries



Field and Engineering Service

Hamon Environmental offers a wide range of field and engineering services including:

- Inspection
- Repair and maintenance supervision
- Rebuild and upgrade
- CFD and physical modelling
- Dust resistivity test

Upgrade, rebuild and performance enhancement

Many of the units in operation today were sized and designed to meet performances that are far below current requirements. Time has also taken its toll on the robust machines built many years ago. Most of them can be upgraded, repaired or rebuilt to extend their life and improve their performances. Hamon Environmental has the design and construction experience to insure that modifications meet the objectives of today's market operators. Hundreds of systems have been modified to meet more stringent performance requirements. Units built in the 1960s and 70s can often be modified to provide 15% to 20% more collecting surface without increasing their footprint. The size of European design precipitators (Compact) can be increased by 30% and more.

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