Environmental Catalysts

HYDECAT™

Cost-effectively controlling the presence of chlorine in the environment

Johnson Matthey Catalysts

Sustainability

Sustainable Development is, in essence, a natural extension of our Corporate Environmental policies and standards, expanded to include the pursuit of economic and community benefits as well as the widely publicised environmental aspects of our business development.

At Johnson Matthey we take our corporate social responsibility seriously. We are firmly committed to managing our activities throughout the group so as to protect the environment and safeguard the health and safety of our employees, customers and the community.

The Johnson Matthey business is founded on the excellence of its people, products and technology. Our products reduce emissions, improve efficiencies and address pressing environmental and social concerns.

Johnson Matthey is committed to operating in a manner that protects basic human rights, provides real opportunities for our employees, protects the environment and makes a positive contribution to the community. We embrace a culture of continuous improvement in all aspects of our business.

Johnson Matthey

Johnson Matthey is a speciality chemicals company, focused on its core skills in catalysts, precious metals, fine chemicals and process technology. Its products are sold across the world to a wide range of advanced technology industries.

Johnson Matthey Catalysts is a leading supplier of high performance process catalysts and technology for a diverse range of market applications.

Our unique platform of experience in both precious and base metal catalysts and technologies underpins Johnson Matthey Catalysts' development of leading edge products and services for the process industry worldwide.

We offer an extensive range of products, services and technologies supported by a global network of sales offices, manufacturing facilities and research and development capability.

Chemical Catalysts

Our global Chemical Catalysts business highlights our extensive capabilities and expertise in the chemical market area. With our dynamic group of dedicated and skilled people we can meet the needs of our customers worldwide, to develop and manufacture the catalysts that optimise chemical processes. Our heritage in chemical processes further enables us to provide practical solutions to maximize the value of your business.

Today, the Johnson Matthey name remains synonymous with accuracy, reliability and integrity.

HYDECAT – the innovative solution

The Johnson Matthey Catalysts **HYDECAT** process is a catalytic method of removing hypochlorite from chlorinated caustic streams, using a heterogeneous supported nickel catalyst and a modular fixed bed reactor.

HYDECAT – One catalyst, three processes

Using the **HYDECAT** catalyst 88-2, there are three options for the positioning and the design of **HYDECAT** units to treat waste hypochlorite streams:

- **HYDECAT** TD – Total Destruction – the traditional End-of-Pipe application.
- **HYDECAT** PD – Partial Destruction usually followed by chemical polishing.
- **HYDECAT** ID – Integrated Destruction in the scrubber liquid recirculation loop.

cost-effectively controlling the presence of chlorine in the environment

Traditional treatment options

Waste hypochlorite streams are generally produced when a chlorine laden gas is scrubbed using a recirculating caustic liquor.

Traditionally two methods have been used to destroy hypochlorite in effluent streams: metal slurry catalysis and the much more common chemical reduction. Compared with **HYDECAT**, both tend to require close control (involving operator input) and comparatively complex dosing/control systems, valves and tanks.

Chlorine makes a vital contribution to the health and quality of modern everyday life: as a disinfectant and in the manufacture of plastics, pharmaceuticals and many essential products. However, there is increasing pressure to reduce the level of chlorine and chlorinated organic species released to the environment because of the potential effect on the eco-cycle.

As well as being a biocide, hypochlorite (bleach) poses two further major problems. If the stream becomes acidic, chlorine will be released. If it contains organic compounds, organo-chlorides (chloroform) can be formed. Both can occur either at the plant before discharge or following release to a water course or sewer system. It is therefore essential to clean up the caustic stream containing hypochlorite.

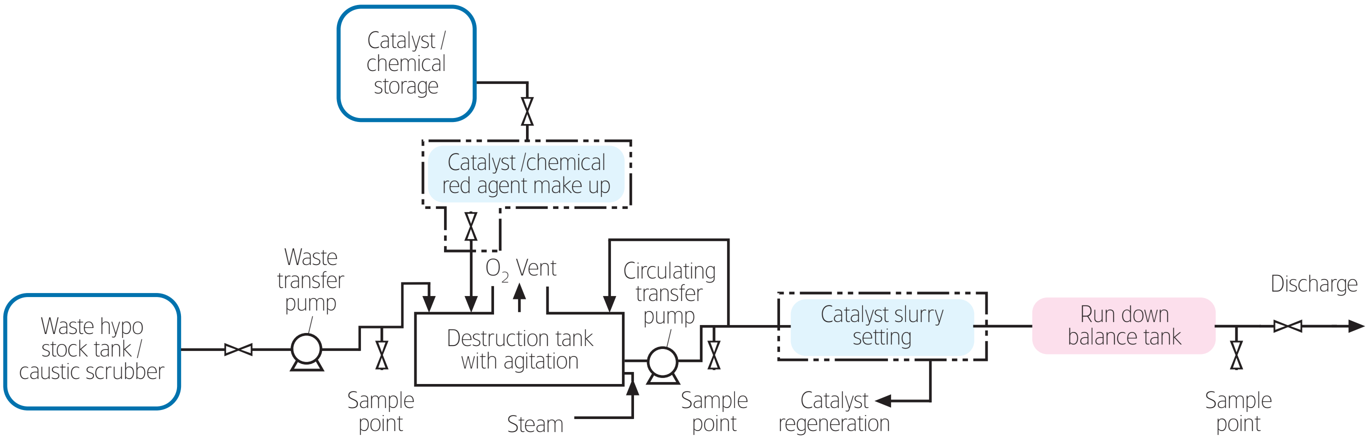
Metal slurry catalysis utilises solutions of nickel, iron or cobalt added to the waste stream in stirred or agitated tanks, causing the same basic chemical destruction of the hypochlorite as in the **HYDECAT** process.

- The high pH of the effluent causes precipitation of the metal as insoluble salt which is then removed and regenerated.

Alternatively, using a fine dispersion of an insoluble salt removes the need for the catalyst regeneration stage.

- In either case the process is very dependent on temperature, pH and hypochlorite concentration, and must be carefully controlled to avoid runaway thermal reactions.
- The reaction time combined with the settling of the catalyst slurry takes several days.
- An important environmental drawback is that the final effluent is prone to contamination by heavy metal salts.

Hypochlorite destruction using metal slurry catalysts or chemical reduction



Chemical reduction involves introducing a reducing agent to the effluent in stirred tanks. Many different agents, including sodium sulphide, sodium bisulphite, sulphur dioxide, hydrogen peroxide, urea, sodium thiosulphate and sodium metabisulphate can be used.

All chemical reaction methods for destroying hypochlorite share the same problems:

- The exothermic reaction requires careful monitoring of the chemical mix to control heat levels, particularly in solutions with a high concentration of hypochlorite.
- The reaction by-products can lead to undesirable chemical species in final effluent.
- An excess of the reducing agent to ensure complete reaction leads to discharge of reducing chemical and high chemical oxygen demand of the final effluent.
- The mechanically complex process requires a series of stock, preparation, process and rundown tanks resulting in high labour, transportation and chemical costs.

Most chemical reduction processes add chemicals to the effluent stream that may cause additional problems.

The HYDECAT option

In contrast to traditional methods of hypochlorite destruction, the **HYDECAT** process offers a simple, low cost, highly reliable, extremely efficient and environmentally friendly solution. It can also be used to improve the operability, performance and safety of an existing chemical reduction system, whilst significantly reducing the running costs.

The **HYDECAT** process is a modular, fixed-bed technology which can quickly and easily be retrofitted or integrated into the operator's existing plant. It is designed to provide maximum efficiency with minimum maintenance.

Containing no moving parts, a **HYDECAT** module requires little supervision or upkeep.

The supported nickel **HYDECAT** catalysts are extremely resistant to compounds which traditionally poison nickel catalysts. They have a long active lifespan. If performance declines after several years' service, the catalyst can easily be replaced with minimal downtime. Patented **HYDECAT** process modules are designed for easy loading, unloading and inspection, and to allow safe catalyst and effluent handling.

The **HYDECAT** process can operate continuously, decomposing hypochlorite concentrations of up to 15% wt to any required outlet concentration (<1ppmw) in a single pass. The reaction is mildly exothermic (H = 60 kJ/mol, 15 kcal/mol) and the **HYDECAT** process operates at low temperatures, 10–50 °C (50–120 °F) in the pH range 9–14. It can also lower the chemical oxygen demand of effluent streams.

Cost effective and environmentally sensitive

The key benefit of the **HYDECAT** process is that it economically produces clean aqueous effluent to meet new environmental standards for hypochlorite discharge.

It eliminates ongoing costs of alternative methods of hypochlorite destruction, requiring no large, continuing purchases of chemical reducing agents or metal salts. Minimal supervision and maintenance of the operating modules means labour costs are low. The catalyst's lengthy lifespan also reduces operating costs by increasing cycle time. The elimination of hypochlorite facilitates recycling of the brine or caustic to the process.

There is no need for cooling towers or other thermal processing, as the technology operates at low temperatures. Whenever environmental constraints require an increase in treatment volume or a decrease in treated effluent contaminant concentration, you can easily and inexpensively expand destruction capacity because the **HYDECAT** process is modular.

The end-products can conveniently be discharged into aqueous effluent on site, being environmentally compatible – simply brine and oxygen gas vented to the atmosphere. You can rely on the environmentally sound credentials of the **HYDECAT** process.

Comparative operating costs for partial treatment for a catalytic system and chemical destruction

Inlet hypo concentration	Hypo concentration after treatment	Flow (m^3/hr)	Typical catalyst cost/annum	Additional annual depreciation for retrofits* *based on 10 years linear depreciation	Typical chemical cost/annum (H_2O_2)
10%	0.1%	5	GBPk 80-90	GBPk 15	GBPk 850-950
5%	0.1%	10	GBPk 90-100	GBPk 15	GBPk 800-900

Investment costs for a grass roots unit for ***HYDECAT*** *or chemical destruction are in the same order of magnitude. Maintenance and operator costs are much lower for the* ***HYDECAT*** *system.*

How HYDECAT catalysts work

The active component in the **HYDECAT** catalysts is nickel dispersed and fixed to a highly porous ceramic support to achieve high activity and stability under the highly alkaline conditions. The process decomposes sodium hypochlorite into brine and oxygen gas by the following reaction:

$$2NaOCl \longrightarrow 2NaCl + O_2$$

Catalyst surface effect

The hypochlorite ion is adsorbed onto the catalyst surface where it is broken down to give a chloride ion with the oxygen atom remaining on the catalyst surface. Because of the potential for competition for active sites, the complete composition of the effluent stream needs to be characterised to allow optimum design (ions such as hydroxide and carbonate will not react on the catalyst surface but will chelate and diffuse in competition with the hypochlorite ion and thus block active nickel sites).

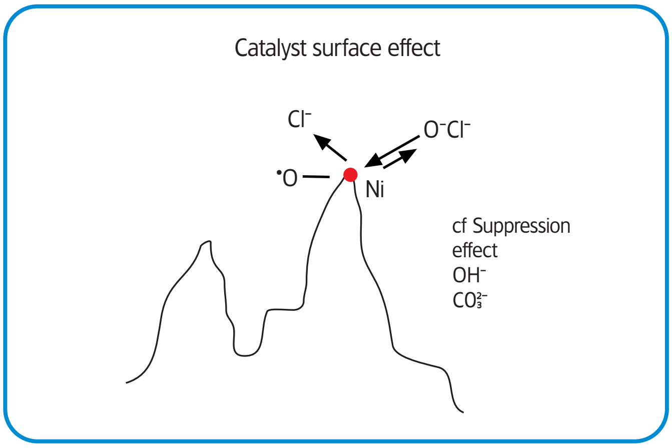
Catalyst surface reaction

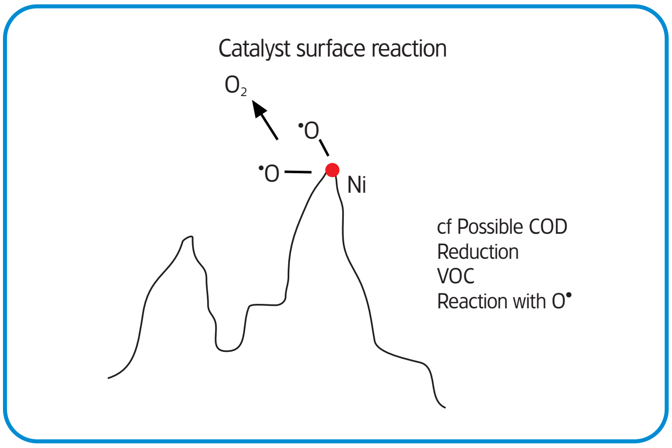
The oxygen atom on the catalyst surface can combine with an adjacent oxygen atom to form an oxygen molecule, which is vented to the atmosphere. There is the potential for reaction with another molecule other than a second oxygen atom, such as a volatile organic compound (VOC). Thus the total VOC content of the final effluent can also be lowered, reducing its chemical oxygen demand (COD).

The reaction products occur naturally and the catalyst itself can be recycled when exhausted. Therefore, adopting the **HYDECAT** process will improve the environmental performance of any industrial process using or producing chlorine.

The flexibility of the process allows easy retrofitting to existing plants. It is robust and requires little monitoring or maintenance and provides a simple, efficient and effective means of environmental compliance.

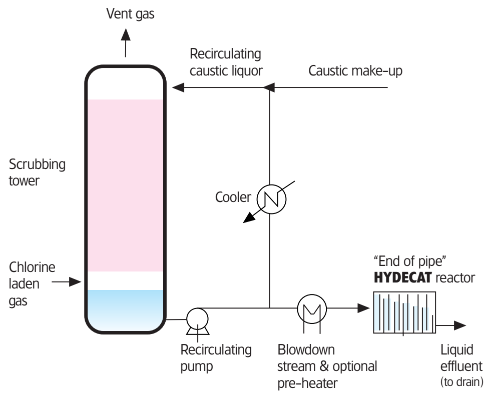
The configuration and the positioning of the **HYDECAT** vessel can be designed to replace or complement existing systems and so achieve the most economical effluent treatment solution for the customer.



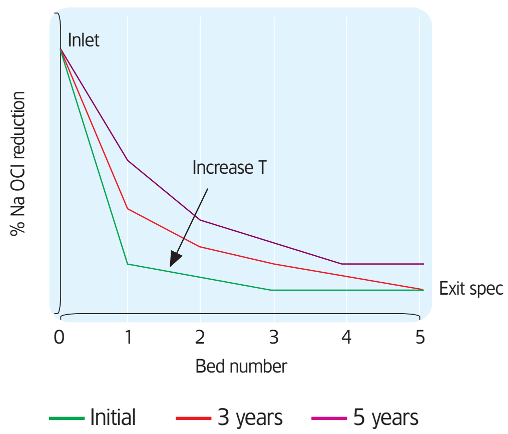


The **HYDECAT** Processes

HYDECAT TD



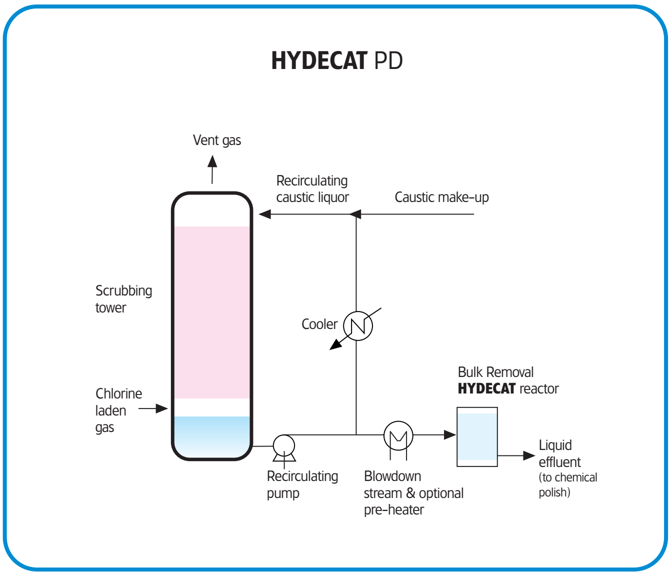
HYDECAT reaction profile

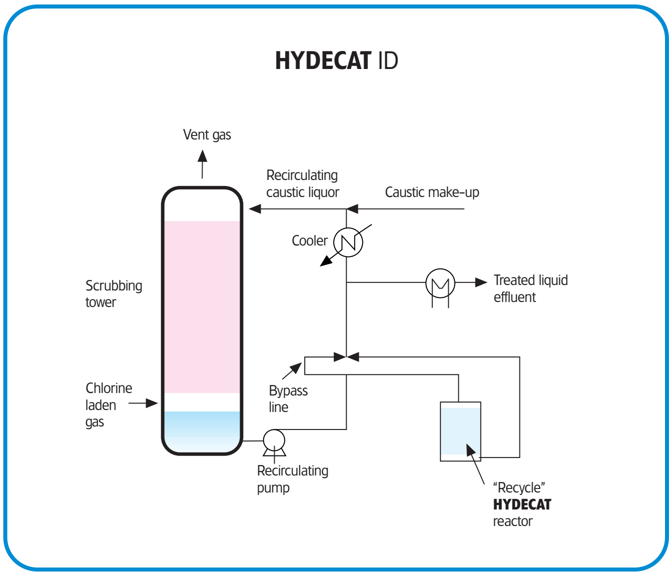


The process consists of a multi-bed catalyst reactor through which the effluent passes.

- Able to reduce any inlet concentration of hypochlorite to any required outlet concentration.
- The most environmentally acceptable option, as the only by-products are salt and water, as opposed to chemical destruction.
- Can also reduce VOCs in final effluent.

The diagram above shows the destruction profile for hypochlorite through each bed of a five bed system over a period of 5 years. Towards the end of the run, the performance of the unit can be improved to meet final effluent specifications by increasing the temperature (T).





Partial, or bulk destruction, with a multi-bed **HYDECAT** reactor retrofitted before an existing chemical treatment for polishing offers a number of advantages:

- Potentially much cheaper running costs than chemical destruction alone.

In certain cases a single-bed **HYDECAT** reactor can be used, which gives minimum capital investment with rapid pay-back in possibly only a few months.

- Robust and simple.
- Typically used for retrofit, when a chemical destruction system already exists.

A further option is to integrate a single-bed **HYDECAT** reactor in the liquid reactor in the liquid recirculation loop of a chlorine scrubber which offers a number of benefits:

- Improved process safety by reducing concentration of recirculating hypochlorite and total available chlorine;
- Reduced cost of treating resulting hypochlorite stream blow-down stream;
- Most cost-effective use of catalyst in batch and semi-batch scrubbers.

HYDECAT in action

The simple, low cost and environmentally friendly **HYDECAT** processes offer unique ‘fit and forget’ technology to chlorine producers and users alike. Any industrial process including the absorption of vent gases containing halogen (chlorine or bromine) in caustic scrubbing towers is a potential **HYDECAT** user.

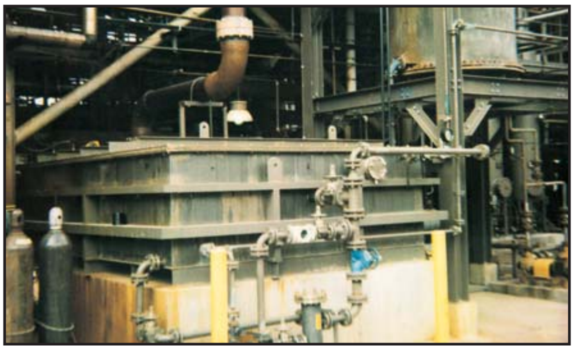
Processes include: chlorine, caustic soda, CFC replacements, pharmaceuticals, magnesium metal, vinyl chloride monomer (VCM), chlorinated solvents, organic dyes, inorganic pigments and sodium metal. Other potential chlorine consumers include: municipal water treatment plants, paper mills, commercial laundries and public swimming pools/water parks.

Coalite Chemicals UK*

Flow rate (l/h)	270
Temperature (°C)	15
Inlet Hypo Concentration (% wt)	4
Exit Hypo Concentration (ppmw)	<1000

Polifin, South Africa*

Flow rate (l/h)	4000
Temperature (°C)	50
Inlet Hypo Concentration (% wt)	0.5-3
Exit Hypo Concentration (ppmw)	<10



Allied Signal, Baton Route, USA*

Flow rate (l/h)	1150
Temperature (°C)	50
Inlet Hypo Concentration (% wt)	9
Exit Hypo Concentration (ppmw)	<1

Monsanto, Antwerp, Belgium*

Flow rate (l/h)	1600
Temperature (°C)	25
Inlet Hypo Concentration (% wt)	1-4
Exit Hypo Concentration (ppmw)	<100

Cabot Carbon, Barry, UK*

Flow rate (l/h)	2500
Temperature (°C)	50
Inlet Hypo Concentration (% wt)	0.6
Exit Hypo Concentration (ppmw)	<10

'The **HYDECAT** process was immediately attractive to us since it offered the most environmentally-friendly solution with low operational capital investment. We believe that (the **HYDECAT** process) not only represents the Best Practical Environmental Option, but it is also a good example of what BAT-NEEC should be about'.

Dr Ken Shelton, Head of Environmental Quality & Safety, Coalite Chemicals.*

'The degree of supervision and monitoring of the **HYDECAT** process performance has amounted to little more than daily sampling of feed and discharge liquors. It has been a particularly straightforward system to operate'.

Adam Bennion, Technical Engineer, ICI Chlorchems (Runcorn Site).*

* Company names and personnel at time of installation

For further information on Johnson Matthey Catalysts, contact your local sales office or visit our website at www.jmcatalysts.com

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