

# Activated Alumina: The Superior Solution for Environmental Cleanup, Pharmaceutical Purification and Clean Energy Applications

Possessing a broad spectrum of useful chemical and biological properties, activated alumina is the superior adsorbent or desiccant for chromatography, separation sciences, purification and many other applications using adsorbents and desiccants. Thanks to DAI's "highest quality and consistency in the industry" alumina, and its development of specialized and customized alumina targeted to specific applications, activated alumina has become somewhat of a "miracle substance" providing the best, most cost-effective solutions for many of the most pressing environmental cleanup, pharmaceutical purification, and clean energy problems facing our planet. Applications include: removal of toxic metals and hazardous substances from water, pcb removal, gas and liquid dehydration, lithium purification, pharmaceutical purification and decolorization.

**DAI's UNIQUE "highest quality and consistency" alumina, and manipulation of alumina's pore and particle size to produce a variety of aluminas make it the ONLY company capable of using activated alumina to provide optimal solutions to the applications described below.**

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Think about some of the more pressing issues of our times; achieving sustainable environmental protection, identifying carbon neutral methods for clean energy generation and finding superior methods for purifying pharmaceutical agents from an increasingly global resource pool. A growing number of companies are recognizing that one material- activated alumina- has the potential to beneficially address all three issue areas.

Due to its unique properties, alumina possesses the utility for use in a broad range of commercial applications including:

- Cleaning up environmentally hazardous materials
- Protecting the public from the airborne transmission of H1N1 and other deadly diseases and viruses
- Promoting cleaner and safer carbon neutral energy
- Purifying pharmaceuticals and nutraceuticals

While many alternative techniques can be used in dealing with these problems, activated alumina is increasingly recognized as the superior and most cost effective choice for separation and adsorbent needs.

## What is Activated Alumina?

Activated alumina is an inorganic substance produced by the dehydration of alumina hydroxide at high temperature. The material is highly porous and exhibits tremendous surface area, resulting in superior adsorbent capabilities. It is resistant to thermal shock and abrasion and does not shrink, swell, soften or disintegrate when immersed in water.

Alumina possesses amphoteric properties allowing it to act as either an acid or a base. The ability to alter its pore or particle size provides it with a spectrum of unique biological and physical properties that can address specific desiccant and/or separating needs for the life and environmental sciences. A recent independent lab test demonstrated activated alumina to be the superior, commercially available desiccant.

## The Activated Alumina Advantage

For years, silica gel has been the mainstay desiccant agent in industrial and laboratory use. In practice, activated alumina surpasses silica gel in performance by offering a host of advantages that include:

- Greater surface area, upwards of 150-350 m<sup>2</sup>/gram
- Superior amphoteric properties
- Much higher values of pH pzc
- Greater stability over a broad pH range
- No degradation at either high pressure or high temperature in HPLC settings
- Lewis acid sites for superior bonding to acidic materials
- Strong affinity for halides

## **Commercial Applications for Activated Alumina**

### **Environmental**

Important environmental issues addressed with alumina usage include: PCB binding; adsorption and removal of arsenic, lead, copper, fluoride and other heavy metals from water; pesticides; bio-mass; dyes, color and solvent adsorption and removal.

### **PCB Removal**

Polychlorinated biphenyls (PCBs), were created as coolants and insulating fluids and used in capacitors, electrical transformers and components in early fluorescent light fittings. PCBs were also manufactured for use with items such as adhesives, paints, wax, sealants, printing inks and similar products in common usage.

The chemical was in circulation for fifty years until a causal connection to malignant disease in both animals and humans led to EPA regulatory restriction in 1979. Limited, monitored use of PCBs within industries requiring large electrical power distribution and consumption is still permitted due to indispensable benefits. Even with vigilant monitoring, however, spillage can occur, resulting in contamination of surface and ground waters.

While large scale manufacturing ceased over thirty years ago, millions of pounds of this toxic chemical still pollute our waterways, soil and air. Moreover, the polychlorinated side chains of these incredibly stable molecules resist degradation, resulting in bioaccumulation in the food chain.

Due to the threat PCB's impose, more than 100 nations have committed to a Global Program of Action to phase out PCBs. Activated alumina can play a significant role in dramatically reducing the chemical's presence in our waterways and soil.

### **Water Purification**

Contaminated water may cause a spectrum of health problems including organ failure, brain damage, cancer and even death. According to a recent report conducted by the United Nations Environmental Program, more people now die from drinking contaminated and polluted water than from all forms of violence. Activated alumina has the ability to adsorb many of the harmful contaminants found in both waste water and aquifers. Alumina can be used as part of an effective filtration system, either at the point of origin or the point of use.

### **Lead**

Chronic exposure to lead may cause irreversible damage to the kidneys, brain, nervous system and red blood cells. Water transported by lead and PVC (polyvinyl chloride) pipeline leach lead over time, creating an environmental health hazard. There are several commercially available methods for lead removal. The two most successful methods being reverse osmosis and adsorption using activated alumina. Amphoteric, activated

alumina has demonstrated superior safety and cost benefits for efficiently removing lead. As an added benefit, activated alumina can be regenerated, significantly reducing treatment cost.

## Uranium

Radioactive waste from uranium enrichment plants leaks into our groundwater. The following environments and items have been contaminated with uranium:

- Groundwater
- Surface water
- Surface soils
- Legacy waste
- DOE material
- Burial grounds

Activated alumina can effectively elute uranium from polluted sites by adsorption and filtration. Specialty designed, activated alumina captures uranium with high affinity, and the alumina particles can then be safely disposed, safely removing the radioactive hazard.

## Copper

Copper is produced as a byproduct of many industrial processes. Significant amounts of copper invariably escape into the water supply through unintentional leaks. As with other heavy metals, copper is not biodegradable and will cause harm unless absorbed and removed before discharge for consumption. Costly disposal techniques such as ion exchange, chemical precipitation, ultra-filtration and electrochemical deposition are being replaced by adsorption with activated alumina. The amphoteric benefits provided by specialty activated alumina eliminate the requirement for co-precipitation and pH adjustment; thus providing a seamless method for affordable copper removal.

## Fluoride

Fluoride is a waste product associated with glass manufacturing, electroplating, the production of steel and aluminum, pesticides, fertilizer and semiconductor manufacturing.

Removal of fluoride from municipal and industrial waste water can be achieved through precipitation, membrane or adsorption processes. The maximum contaminant level for fluoride established by the EPA is 4 parts per million. Activated alumina can reduce the concentration of fluoride to 1 part per million or less.

The advantage of using activated alumina for fluoride removal is due to fluoride extraction being partially dependant on the pH of waste water components. With some methods, if the effluent stream is highly alkylotic, the wastewater may need to be pretreated prior to reaching the proper pH level. Activated alumina performs optimally in a pH range of 5.5 to 8.5. When using activated alumina, the "pretreatment" step can be skipped entirely, providing greater efficiency and reducing cost.

## Arsenic

Arsenic is the 20th most abundant metal of the earth's crust and continuously leaks into the soil and water supply. Excess exposure increases the risk for lung, bladder, skin, liver and kidney tumors. The EPA most recently reduced the acceptable level of arsenic in the public water supply from 50 to 10 parts per billion. The previous standard of 50 parts per billion gave a 70 year old person a 1:100 chance for developing cancer solely on the basis of drinking water. This is the same statistical odds for being killed in a motor accident.

Activated alumina has proven to be the superior sorption material for removal of arsenic from ground and surface water. When using an adsorption technology, which is currently the preferred method for arsenic removal, it is best to use a material which is non leachable. The arsenic should remain chemically bound to the adsorbent media such that the material is able to pass the EPA criteria for Toxic Characteristic Leaching Procedure Levels (TCLP). This will allow the arsenic bound adsorbent material to be removed in a cost effective, non hazardous fashion. Ideally, there should be no sludge for disposal and the adsorbent selected should be effective over a wide range of temperature conditions and pH, and be resistant to both microbial growth and oxidation.

## **Energy**

Foreign energy dependence directly impacts the American economy. For our national security, we need to develop alternative energy resources like natural gas and electricity. Many people are not yet aware that generous supplies of energy resources like natural gas and lithium, used to make electric and hybrid car batteries, are domestically accessible. Activated alumina plays a role in bringing these energy sources to the marketplace through its role as an adsorbent and a desiccant.

## **Gas and Liquid Dehydration**

Trends in energy demand and concerns over our increasing trade imbalance have made natural gas the fastest growing source of domestic energy production. New natural gas fields from the Appalachian Basin and our western states all have access to natural gas lines that can sustain the United States with its energy needs for at least 100 years. As these new production fields are commercially developed, it is essential that the gas be transported or stored devoid of water vapor and other liquids that can corrode and, over time, destroy the transport infrastructure.

Liquids left in natural gas lines will disrupt continuous gas delivery. Most of the liquids associated with extracted natural gas can be removed by simple separation methods at or near wellheads. Water extruded along with natural gas is removed through the process of direct cooling - reducing temperatures in order to decrease the saturated vapor content of the natural gas. The temperature must be reduced to the lowest value that gas will encounter at the prevailing pressure in order to prevent further condensation of water.

The direct cooling method is not the most effective way to ensure that the liquid component is fully removed from natural gas lines. The complete removal of water vapor existing in natural gas requires a superior desiccant or drying agent.

Activated alumina will most efficiently ensure the future energy needs of North America by keeping natural gas lines void of all liquid. It is essential for natural gas to be dry at both points of use and origin. Companies have designed specialized activated alumina that can adsorb the most amount of liquid from natural gas at both points of use and origin, making alumina the superior method ensuring the protection of the local energy source.

## **Lithium**

The global demand for lithium is increasing 20% annually and is on the rise. Lithium is being used to power laptops, digital cameras, cell phones and has recently become a prime energy source for powering hybrid and electric motor vehicles. By switching to carbon-free transportation, the pace of global warming will be altered. Lithium is truly part of the global movement of "going green."

Lithium must be purified to its natural state in order to be effectively used. If the impurities in lithium are not removed, devices that are powered by lithium batteries like motor vehicles and cell phones could explode. Due to stability in a high alkaline setting, activated alumina has proven to be an outstanding agent for the purification of lithium.

## Biopharmaceuticals

Biopharmaceuticals and nutraceuticals are referred to as phytochemicals or functional foods. They are natural bioactive chemical compounds that promote health, prevent disease or have medicinal properties. Many nutraceutical products are of herbal origin and their active chemical properties are based on plant alkaloids that require the use of activated alumina for isolation and purification..

## Pyrogen Removal

Pharmaceutical products produced using bacteria as cellular factories are virtually always contaminated with lipopolysaccharides (LPS), endotoxins that can cause systemic inflammatory reactions. These can run the spectrum from effecting tissue energy, to endotoxin shock and death when injected into patients.

Due to its amphoteric properties, specialty activated alumina with surface modified chemical moieties provide a superior tool for the removal of endotoxins. No other commercially available agent can provide such a rewarding pH response or offer a better method for the removal of chemical pyrogens from a protein or peptide solution.

## Antibiotics

Antibiotics that are isolated compounds produced by large scale fermentation broths can benefit from the use of activated alumina. As an example, glycopeptides such as vancomycin (used for the treatment of methicillin resistant Staphylococcal aureus (MRSA) as well as for treating other gram positive bacteria resistant to penicillin) are produced from the genus Actinomycetes. The fermentation process is run through an activated alumina column to decolorize this antibiotic, the most important drug agent in the treatment of a MRSA epidemic.

## Alkaloids

There are more than 420,000 distinct plant species in the world and less than 10% of them have been fully analyzed. Almost all alkaloids are toxic and most display pharmacologic activity. The isolation and purification of these distinct alkaloid species is a major goal of the pharmaceutical industry. Each of the sundry classes of plant alkaloids have been successfully isolated and purified using activated alumina as the sorbent of choice in TLC and flash chromatographic systems.

## Conclusion – Making the Right Purchasing Decision with DAI

**Only Dynamic Adsorbents makes the quality and variety of alumina that make it the "miracle substance" - providing the best solutions available for so many applications.**

While there are a number of products to consider when dealing with environmental cleanup, clean energy and biopharmaceuticals, activated alumina is the superior choice for almost all applications. The compound surpasses its competitors in the critical categories of:

- Efficiency
- Cost effectiveness
- Versatility

Now that you are aware of alumina's capabilities, the next step is to make the right purchasing decision - to purchase from the only company manufacturing the highest quality and most consistent alumina, and widest variety of specialized and customized alumina targeted to the widest range of applications.

Dynamic Adsorbents, Inc. specializes in the production of specially designed and customized activated alumina for a wide range of applications. When it comes to using alumina for any of the applications in this article, there is only one company whose team of researchers and scientists wrote the book on alumina. For the past 30 years, the Dynamic Adsorbents (DAI) team has set the standard for how alumina is graded and used, as well as quality and breadth of product.

DAI is the only company whose mission is to find the best solutions to meet your company's needs, and deal with some of the most pressing health and safety issues facing our planet, and not just sell off the shelf products. It is the only company producing activated alumina capable of providing the best, most cost effective solutions to such a wide variety of applications.

How? By being the only company:

- Whose team wrote the book on alumina - setting the standards for how alumina is graded, manufactured and used today.
- Manufacturing activated alumina using standardized procedures, producing the highest quality alumina according to independent lab tests, along with the highest quality control and lot to lot consistency.
- Producing more than 20 varieties of alumina through manipulation of particle and pore sizes, to meet the widest range of applications and solutions in the industry.
- Customizing alumina to best meet company and lab needs
- Having a team of experts – scientists, researchers, environmentalists and medical specialists - always striving to find the best solutions for our clients and problems facing our planet.

DAI specialized products include:

### **For Chromatography**

- Super Activity I
- Standard Activity I
- Activity II and III
- Dry column chromatography alumina

### **For Cleanup, Drying and Purification**

- Alumina C - removal of PCB's
- Dyna-Aqua™ Lead
- Dyna-Aqua™ Copper
- Dyna-Aqua™ Uranium
- Dyna-Aqua™ Fluoride
- Dyna-Aqua™ Arsenic
- DynaPharma™ Pyrogen
- Drysphere™ - Gas and liquid dehydration
- Alumina for Pilot and Process
- Alumina R - Radioactive materials removal
- AL 2100 - Scavenger alumina for process cleanup
- AL 2300 - Bio-Mass clean-up
- AL 5005 - Decolorization
- AL 5788 - Dioxin analysis
- AL 5900 - Activated wide-pre alumina
- Alumina for Solvent Purification

In the end, there is only one company, DAI, with the history, mission, expertise, product quality, and full commitment to you.

Activated alumina should be the first choice for environmental remediation, separation, desiccant and purification needs and applications. DAI should be your only choice for purchasing it. You will be pleased that you have chosen wisely. It not only makes perfect environmental sense, but perfect business sense.