NORIT
ACTIVATED CARBON

ODOR CONTROL

Why Odor Control With DARCO® H2S LP

Most Cost-Effective

DARCO H2S LP is a revolutionary non-impregnated activated carbon with a minimum hydrogen sulfide loading capacity of 0.2 g/cm³.

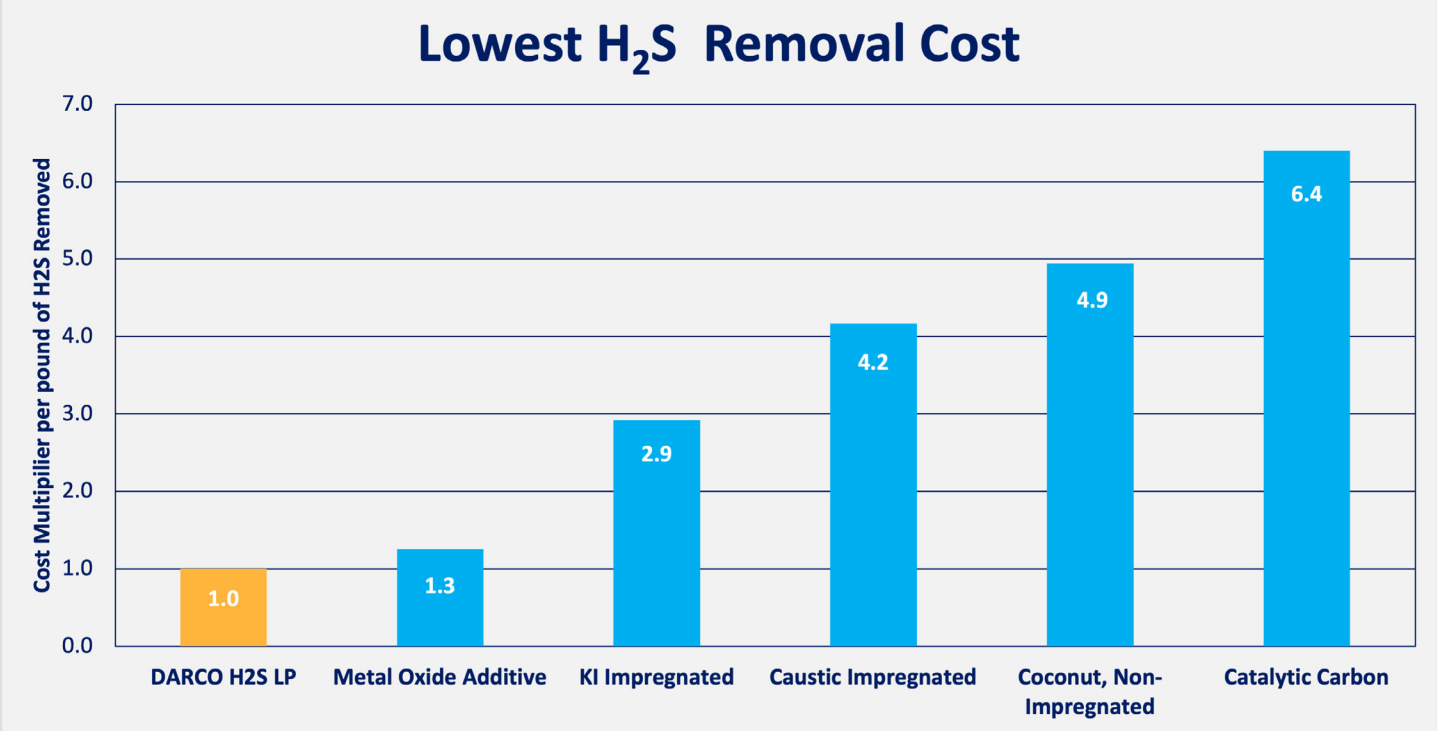
DARCO H2S LP costs nearly the same as other non-impregnated activated carbons used for hydrogen sulfide removal but has four times the loading capacity. The cost-effectiveness of DARCO H2S LP is illustrated in Figure 1. This graph shows the relative cost for each carbon type to remove a pound of H_2S from the air.

The cost calculation is based on the price per pound of carbon and the H_2S capacity for each carbon type. The illustration in Figure 1 is based on the following assumptions:

- Treatment of a 10,000 cfm air stream containing 10 ppm of H_2S
- Greater than 60% relative humidity
- Dual bed vessel containing 470 ft³ of carbon
- Vessel is 10 ft in diameter with 3 ft of bed depth in each bed
- Calculations based on the lowest referenced carbon price (please contact your supplier for current pricing on DARCO H2S LP)

The cost-effectiveness of DARCO H2S LP is evident from the example summarized in Figure 1. The second-best performer is the metal oxide additive carbon, which has a greater cost per pound of H_2S removed.

Figure 1



Why Odor Control With DARCO H2S LP (cont.)

High Loading Capacity

Multiple independent laboratories have measured the minimum hydrogen sulfide loading capacity of DARCO H2S LP at greater than 0.2 g/ml using the ASTM D-6646 test method. This test method is used to measure the weight of hydrogen sulfide loading per unit volume of carbon.

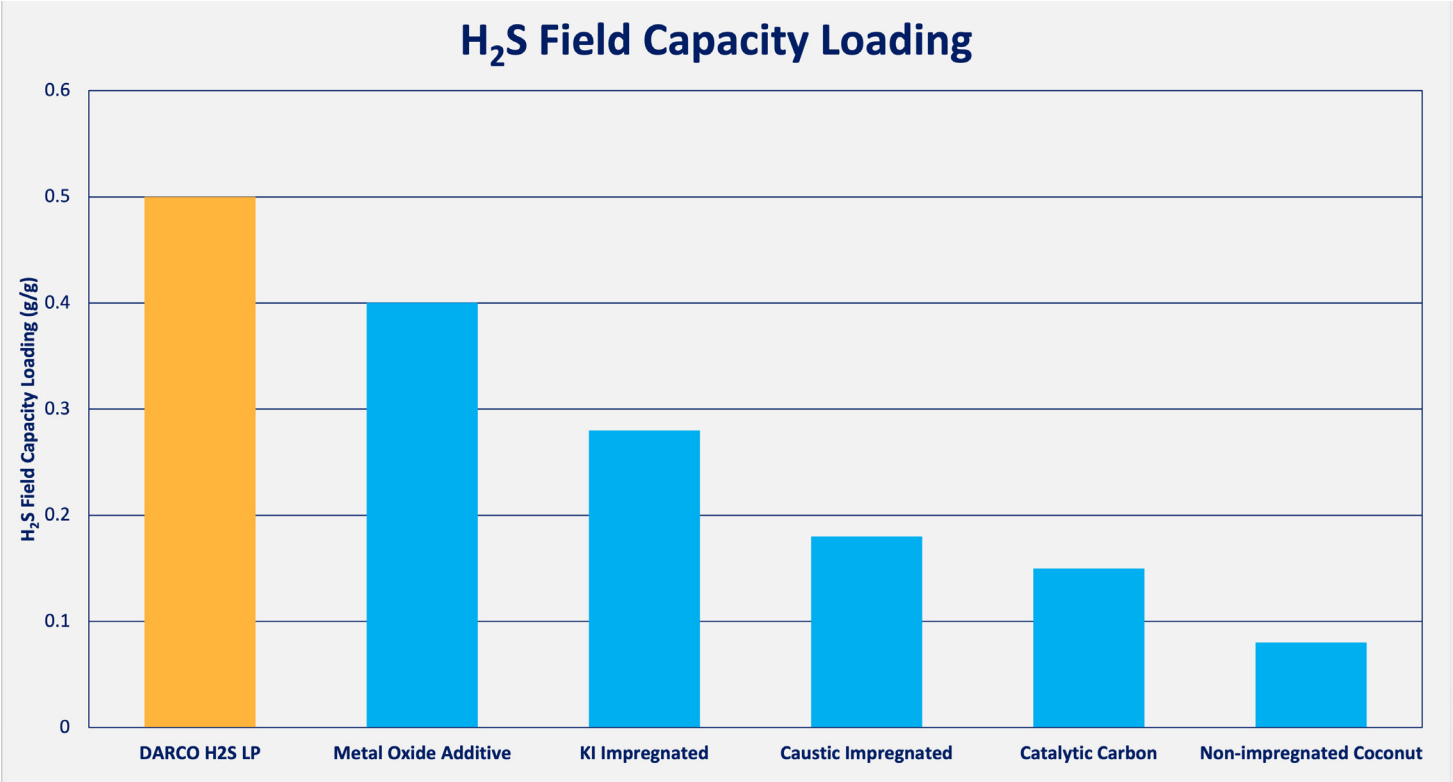
The ASTM test proves that the carbon is converting H2S to elemental sulfur, but does not fully represent how much is removed in real-life situations. The field capacity H2S loading represents what has been seen experienced by customers in their processes.

Figure 2 compares the H2S LP field capacity loading test results to the following odor control carbons:

- Metal Oxide Additive
- KI Impregnated Carbon
- Caustic Impregnated Carbon
- Non-Impregnated Coconut Carbon
- Catalytic Carbon

DARCO H2S LP activated carbon is the most cost-effective carbon-based solution available for the removal of "nuisance" odors

Figure 2



Why Odor Control With DARCO H2S LP (cont.)

Unique Physical Properties

DARCO H2S LP is an activated carbon specifically developed for removing hydrogen sulfide (H_2S) from air streams and eliminating "sewage odors." Produced in North America, DARCO H2S LP is a 4 mm pellet that has less dust while reducing pressure drop in your process.

The proprietary process used to activate DARCO H2S LP produces an activated carbon with approximately twice the mesopore and macropore volume of traditional odor control carbons. It also creates the catalytic surface properties necessary for the removal of H_2S and other odor compounds.

In addition, the diffusion of odor-causing impurities is rapid, and more internal pore volume is available to adsorb even the largest odor-causing molecules.

The unique surface and pore structure of DARCO H2S LP allows it to store sulfur within its pores, unlike impregnated carbons that store most of the sulfur on the surface of the carbon. In Figure 4, lignite, DARCO H2S LP's base material, has more meso and macropores than other material types for the loading sulfur.

DARCO H2S LP converts any H_2S from moist air streams into elemental sulfur through a catalytic process. This sulfur is retained in the carbon's pore structure (see Figure 5). DARCO H2S LP is very hydrophilic, allowing it to work well in environments with a wide range of relative humidity. It is most effective in gas streams with relative humidity from 60-100% (saturated).

The majority of competitive products perform by generating a high conversion to sulfates, which form sulfate salts on the carbon surface. These salts can solidify the carbon bed drastically, increasing pressure drop and service costs for media change out.

DARCO H2S LP removes sulfur with a very low sulfate conversion, eliminating bed solidification and maintaining a consistent pressure drop throughout its life cycle.

Figure 3

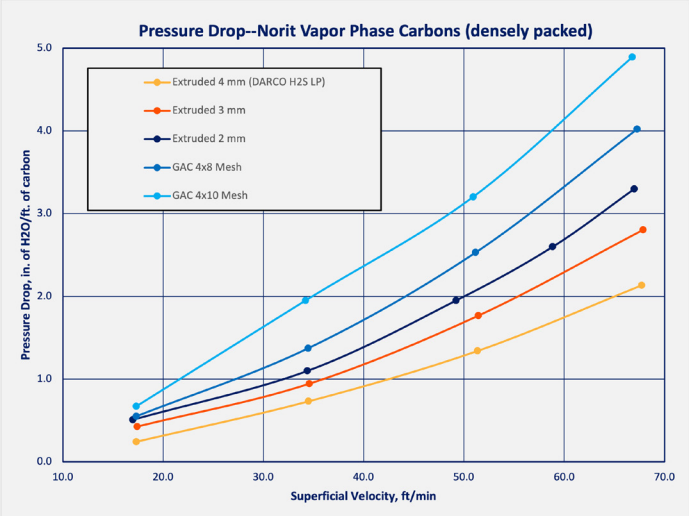


Figure 4

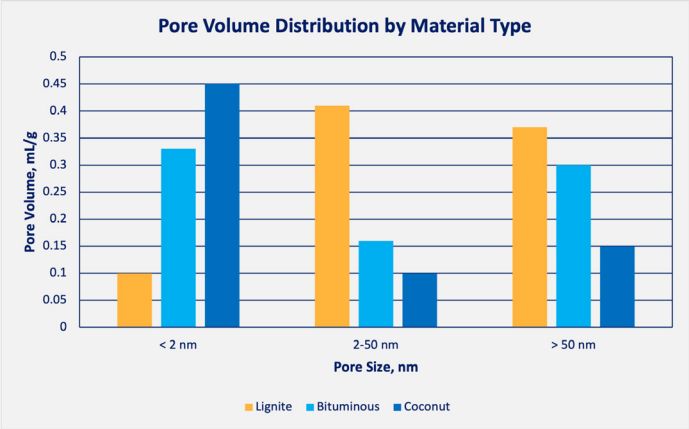
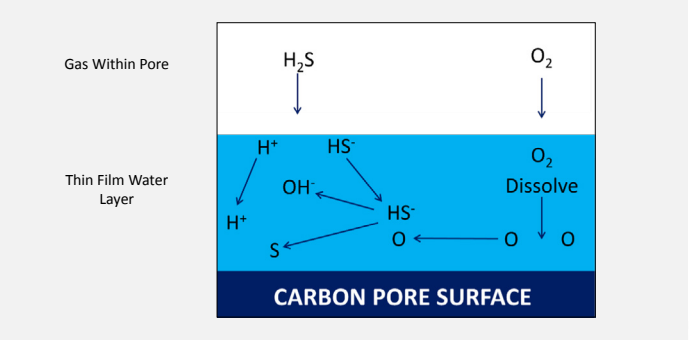


Figure 5



Why Odor Control With DARCO H2S LP (cont.)

High Loading Capacity Without Impregnants

DARCO H2S LP is a revolutionary activated carbon made without the use of impregnates. NORIT tests each lot of DARCO H2S LP to ensure the minimum hydrogen sulfide capacity for this unique carbon is 0.2 g/cm³. On a volume basis, DARCO H2S LP has four times the loading capacity for hydrogen sulfide than other non-impregnated activated carbons.

Hydrogen sulfide is classified as an acid gas with a very low odor threshold and can be dangerous even at very low levels. There are a number of reaction pathways for H_2S.

Impregnated carbons are those to which a solid or liquid chemical has been mixed with the carbon substrate before, during, or after activation. The main chemicals used as impregnants are magnesium oxide (MgO), sodium bicarbonate ($NaHCO_3$), sodium carbonate (Na_2CO_3), sodium hydroxide (NaOH), potassium hydroxide (KOH), potassium iodide (KI), and potassium permanganate ($KMnO_4$). Mixtures of these chemicals are sometimes used.

Catalytic carbons can be produced by a number of different manufacturing techniques. Most often, catalytic carbon is created using a post-activation amine treatment, but the H_2S capacity is low. These catalytic carbons can be regenerated by water washing, but the regeneration process produces very low pH effluent and has diminishing returns, with only a maximum of three regenerations being practical. Disposal of the carbon bed may be difficult due to low pH.

Some strong base (KOH or NaOH) impregnated carbons are considered regenerable by reapplication of caustic. However, these regenerations have diminishing returns, and the overall

risks associated with the handling of these dangerous chemicals and byproducts far outweigh the benefits. In addition, strong base impregnated carbons are very susceptible to self-heating, which can result in bed fires.

Metal oxide additive products can achieve a minimum H_2S capacity of 0.3 g/cm³. While these additives can increase the ability to remove H_2S from a vapor stream, they can cause crystal formation downstream in the piping and cause “bricking” within the carbon bed.

Table 1

	Specified H_2S Capacity (ATSM D6646) (g/ml)	Conversion to H_2SO_4 at 800 ppm H_2S Inlet (%)	Elemental Sulfur Loading on Carbon (mass%)
DARCO H2S LP	0.20	4.3	30
Catalytic Carbon	0.09	47	5.2
Metal Oxide Additive Carbon	0.30	17	10

Why Odor Control With DARCO H2S LP (cont.)

Consistent Performance With Low Upset Risks

DARCO H2S LP is a unique product that exhibits low sulfate conversion compared to other high-capacity products. Over time, the buildup of sulfate salts in most other H_2S removal products will solidify the media bed, gradually increasing the pressure drop during operation. As a result, additional resources and equipment are necessary to remove the spent media.

The low sulfate conversion of DARCO H2S LP and its reduced risk of bed fire means consistent, safe, and reliable operation can be expected for the duration of its useful life.

NORIT Backs You 100%

DARCO H2S LP is produced in North America. We are considered the world's most complete source for activated carbons, carbon installation assistance, and technical support for the effective use of activated carbon.

We can coordinate and conduct the service to install or change out your carbon bed, including the disposal of your spent carbon. NORIT, combined with the world's largest selection of carbon grades, will give you the best performance and the most cost-effective solution for your odor control application.

Easy to schedule, fast, turnkey media exchange with experienced technicians and strong technical support

Technical Tips From NORIT

Equipment

The corrosive nature of H_2S requires appropriate materials of construction for treatment equipment. Fiber-reinforced plastic (FRP) vessels and ducts are common. Some equipment suppliers use FRP-coated blowers and impellers, especially when the blower is placed before the activated carbon bed. Odor control activated carbon beds typically run in up-flow mode at a few inches of water column pressure. While carbon vessel dimensions tend to vary, low length-to-diameter (L/D) is a common characteristic of units operated under vacuum conditions. For systems designed to operate under positive pressure, the beds are relatively deep (3-4').

Operational Parameters

- Empty Bed Contact Time (EBCT) of 3-6 seconds
- Linear Velocity of 10-60 ft/min (5-30 cm/s)
- Minimum Bed Depth ~2 ft

Oxygen is required for effective performance (more than four times the H_2S concentration on a molar basis is normally sufficient). A relative humidity range of 60% to saturated is recommended to achieve high loading on DARCO H2S LP.

Spent Carbon Disposal

DARCO H2S LP that has become loaded with sulfur from the removal of hydrogen sulfide and mercaptan is not considered a hazardous material for handling and disposal. Unique circumstances can exist, such as the adsorption of a hazardous material, that will cause the spent carbon to be classified as a hazardous material. This is true for DARCO H2S LP and all activated carbons.

NORIT strongly recommends contacting a NORIT representative before handling your spent carbon. Adding water or chemicals to change the characteristics of the carbon may cause the spent carbon to be considered hazardous. Please consult your NORIT representative for consultation before proceeding with any treatment.

Table 2.

NORIT Product Portfolio

	Extruded Pellet	Granular
Odor Control of H_2S and mercaptan (Typically <100 ppm H_2S, high CFM)	DARCO H2S LP	DARCO H2S G
H_2S and VOC Removal	DARCO VOC	
VOC Removal	NORIT RB-4S	NORIT GCN 48
Ammonia Removal from Vapor Phase Streams	NORIT RPA4	
Wastewater Digester Gas* (H_2S removal up to 9000 ppm)	NORIT BG1P	NORIT BG1
Siloxane Removal	NORIT SILPURE	

** See NORIT Biogas Brochure for more information.*

Wastewater Digester Gas

Wastewater Digester

H_2S is a common contaminant related to wastewater digester biogas applications, both of which are relevant to wastewater treatment plants (WWTP). H_2S concentrations can vary considerably across these use cases, as well as site to site. DARCO H2S LP is designed to suit a wide range of H_2S concentrations and air/gas flow conditions. In addition to H_2S, activated carbons are an effective technology used to address a wide range of contaminants. See Table 2 for Norit's Product Portfolio developed to address an array of challenges encountered at WWTPs.

Siloxane Removal

Siloxanes comprise a class of organo-silica compounds originating from synthetic consumer products (cosmetics, hair care products, etc.) that enter wastewater streams. Due to their tendency to form silica deposits in pistons and other engine and turbine components, siloxane moieties must be removed from biogas streams prior to combustion or pipeline injection. NORIT SILPURE removes siloxanes from vapor streams.

Ammonia Removal

Ammonia (NH_3) is another common culprit behind odor complaints. NORIT RPA 4 is an impregnated activated carbon suitable for chemical adsorption and removal of ammonia.

NORIT® Activated Carbon — Purity for Life

Helping our customers meet their specific purification needs

Building on our greater than 100-year history of innovation in manufacturing and product development, NORIT Activated Carbon is the world's most experienced and one of the largest producers of activated carbon.

Our products are used to remove pollutants, contaminants, and/or other impurities from water, air, food and beverages, pharmaceutical products, and other liquids and gases in an efficient and cost-effective manner.

In addition to our unparalleled product portfolio, we offer a full range of activated carbon, carbon reactivation, bulk delivery and changeout, some types of carbon evaluation, as well as technical service and support to help our customers meet their specific purification needs.

We provide our customers with a worldwide network of sales and service support. In fact, we manufacture activated carbon and reactivate carbon in multiple plants around the world. Whether you have one operation or many facilities around the globe, we have you covered.

NORIT
ACTIVATED CARBON

Our sales, technical service, and customer service teams are well prepared to serve customers around the world.

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www.norit.com

EMEA REGIONAL OFFICE
Norit Nederland B.V.
Astronaut 34
3824 MJ Amersfoort
THE NETHERLANDS
T +31 33 464 8911
E info.emea@norit.com

AMERICAS REGIONAL OFFICE
Norit Americas, Inc.
3200 University Avenue
Marshall, Texas 75670
USA
T +1 903 923 1000
E info.americas@norit.com

ASIA/PACIFIC REGIONAL OFFICE
Norit Singapore Pte. Ltd.
101 Thomson Road
United Square #16-04
Singapore 307591
Singapore
T +65 6631 9386
E info.ap@norit.com

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