

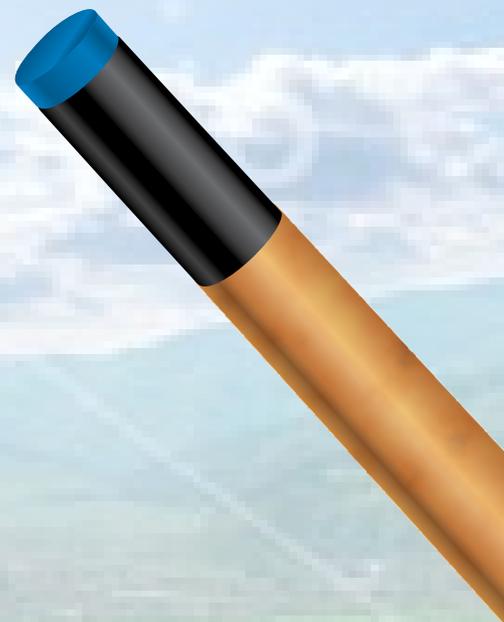
Norit

leading in purification

Activated Carbon



WAYS
DARCO[®] H₂S
ACTIVATED
CARBON IS
THE BEST
SOLUTION FOR
ELIMINATING
ODORS





DARCO[®] H₂S is not just another activated carbon.

DARCO H₂S advantages at a glance

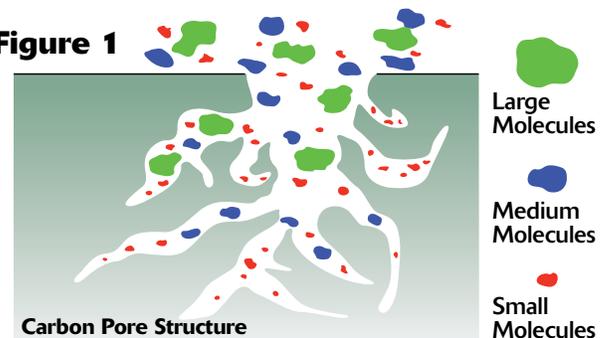
- 1 Unique physical properties
- 2 High loading capacity
- 3 Low density for reduced volumetric cost
- 4 Most cost effective
- 5 High loading capacity without impregnants or additives
- 6 Reduced risk of exotherms and bed fires
- 7 Outperforms the competition 300%
- 8 Norit backs you 100%



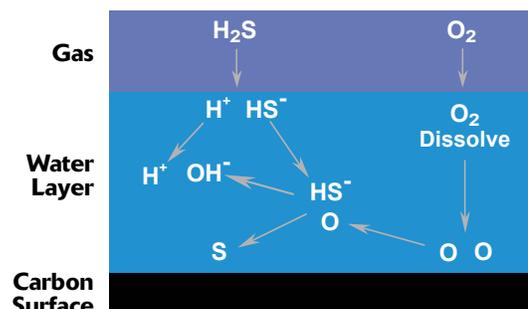
DARCO H₂S - unique physical properties

DARCO H₂S is an activated carbon specifically developed for removing hydrogen sulfide (H₂S) from air streams and eliminating "sewage odors". It is produced by steam activation of a unique raw material to provide increased pore volume for adsorption of hydrogen sulfide and mercaptan odors. The proprietary process used to activate DARCO H₂S creates an activated carbon with approximately twice the mesopore and macropore volume of traditional odor control carbons. As a result, diffusion of odor causing impurities is rapid (see Figure 1) and more internal pore volume is available to even the largest molecules that need to be removed to eliminate odor.

Figure 1



The removal of H₂S requires a thin water layer in the carbon pore structure to promote the reaction between H₂S and the carbon surface (see below). DARCO H₂S is very hydrophilic, allowing it to work well in environments with a wide range of relative humidity. DARCO H₂S has been proven effective in gas streams with relative humidity from 30% to 100% (saturated).



It's better



ways for odor removal.



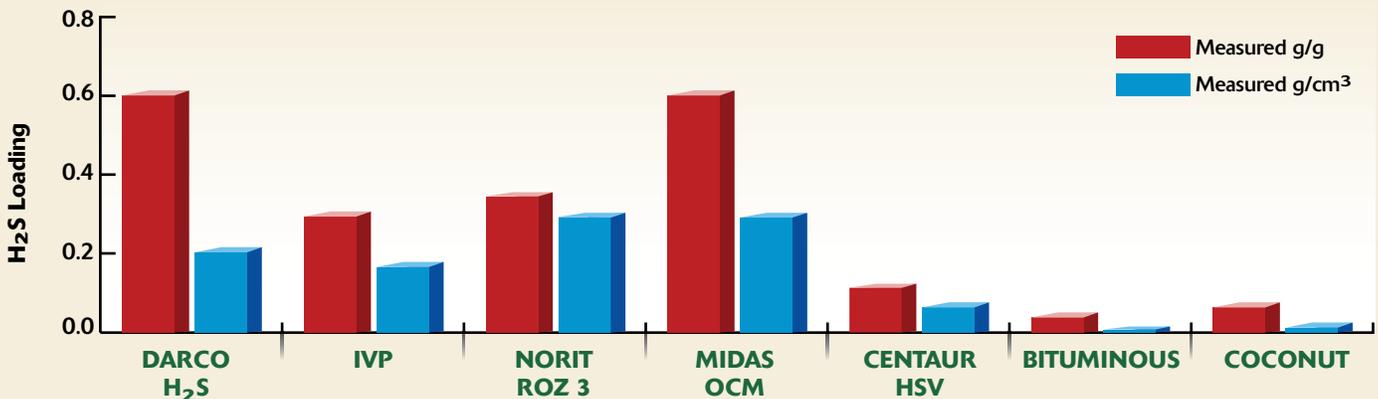
DARCO H₂S – high loading capacity

Multiple independent laboratories have measured the minimum hydrogen sulfide loading capacity of several lots of DARCO H₂S 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. In addition, the weight of hydrogen sulfide loading per unit weight of carbon was calculated using the vibrating feed apparent densities (VFAD) measured by Norit Americas Inc. Figure 2 compares the DARCO H₂S test results to the following odor control carbons:

- Midas[®] OCM (Siemens Water Technologies)
- CENTAUR[®] HSV (Calgon Carbon)
- IVP[®] (Calgon Carbon)
- NORIT[®] ROZ 3 (Norit)
- untreated bituminous coal carbon
- untreated coconut carbon

DARCO H₂S activated carbon is the most cost effective carbon based solution available for the removal of “nuisance” odors.

Figure 2 - H₂S Loading Capacity Survey using ASTM D-6646





DARCO H₂S – low density for reduced volumetric cost

The density of DARCO H₂S is lower (see Table 1) than any other carbon product used for odor control. As a result, fewer pounds of DARCO H₂S are required to fill the adsorber vessel. The density advantage of DARCO H₂S provides direct cost savings since fewer pounds of activated carbon are purchased. This advantage translates to an immediate cost savings of 20-30% on pounds alone!

Table 1. Weight Required to Fill a 470 ft³ Dual Bed Vessel

Activated Carbon Name	Density	Relative Carbon Volume
DARCO H ₂ S	25 lb/ft ³	11,750 lb
Calgon Carbon IVP	35 lb/ft ³	16,450 lb
NORIT ROZ 3	30 lb/ft ³	14,100 lb
Siemens Water Technologies Midas OCM	31 lb/ft ³	14,570 lb
Calgon Carbon MINOTAUR™ OC	31 lb/ft ³	14,570 lb
Calgon Carbon CENTAUR HSV	35 lb/ft ³	16,450 lb
Coconut Carbon, non-impregnated	32 lb/ft ³	15,040 lb
Bituminous Coal Carbon, non-impregnated	30 lb/ft ³	14,100 lb



DARCO H₂S - most cost effective

DARCO H₂S is a revolutionary non-impregnated activated carbon with a minimum hydrogen sulfide loading capacity of 0.2 g/cm³ as confirmed by three independent laboratories and Norit's lab facility. The unique raw material used for production of DARCO H₂S does not require expensive additives to the activation process to create the H₂S capacity of 0.2 g/cm³.

DARCO H₂S costs nearly the same as other non-impregnated activated carbons used for hydrogen sulfide removal and has 4-10 times the loading capacity. Other high capacity carbons are 2 to 4 times the price of DARCO H₂S.

The cost effectiveness of DARCO H₂S is illustrated in Figure 3. This graph shows the relative cost for each carbon type to remove a pound of H₂S from air. The cost calculation is based on the price per pound of carbon and the H₂S capacity for each carbon type. The illustration in Figure 3 is based on the following assumptions:

- Treatment of a 10,000 cfm air stream containing 10 ppm of H₂S
- Dual bed vessel containing 470 ft³ of carbon
- Vessel is 10 ft in diameter with 3 ft of bed depth in each bed
- Carbon change-out costs are not included
- CENTAUR cost is calculated as a single use, and not regenerated
- Calculations based on lowest referenced carbon price (please contact your supplier for current pricing on your carbon system)
- All information obtained from public bids and product datasheets published by the suppliers

DARCO H₂S cost effectiveness is evident from the example summarized by Figure 3. The second best performer, IVP, is a caustic impregnated carbon that has a 2.5 times greater cost per pound of H₂S removed. In addition, the carbon with the lowest price per pound (bituminous based) has the highest annual cost for H₂S removal due to its low adsorptive capacity. When purchase decisions are based on cost performance, DARCO H₂S is the clear choice!

Norit Americas Inc. has developed a Cost Calculator to estimate the annual costs for odor control systems. You can enter your actual operating conditions into the Norit Cost Calculator spreadsheet to determine your carbon cost. Please visit our website at www.norit-americas.com to use the Cost Calculator.





DARCO H₂S - high loading capacity without impregnants or additives

DARCO H₂S is a revolutionary activated carbon made without additives or the use of post-activation impregnants. Norit Americas Inc. tests each lot of DARCO H₂S to ensure the minimum hydrogen sulfide capacity for this unique carbon is 0.2 g/cm³. On a volume basis, DARCO H₂S has 4 to 10 times the loading capacity for hydrogen sulfide than other non-impregnated activated carbons.

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 (NaHCO₃), sodium carbonate (Na₂CO₃), sodium hydroxide (NaOH), potassium hydroxide (KOH), potassium iodide (KI), and potassium permanganate (KMnO₄). Mixtures of these chemicals are sometimes used. Strong base impregnated carbons are considered regenerable by re-application of the strong base. However, these regenerations have diminishing returns and the overall risks with the handling of these chemicals far outweigh the benefits.

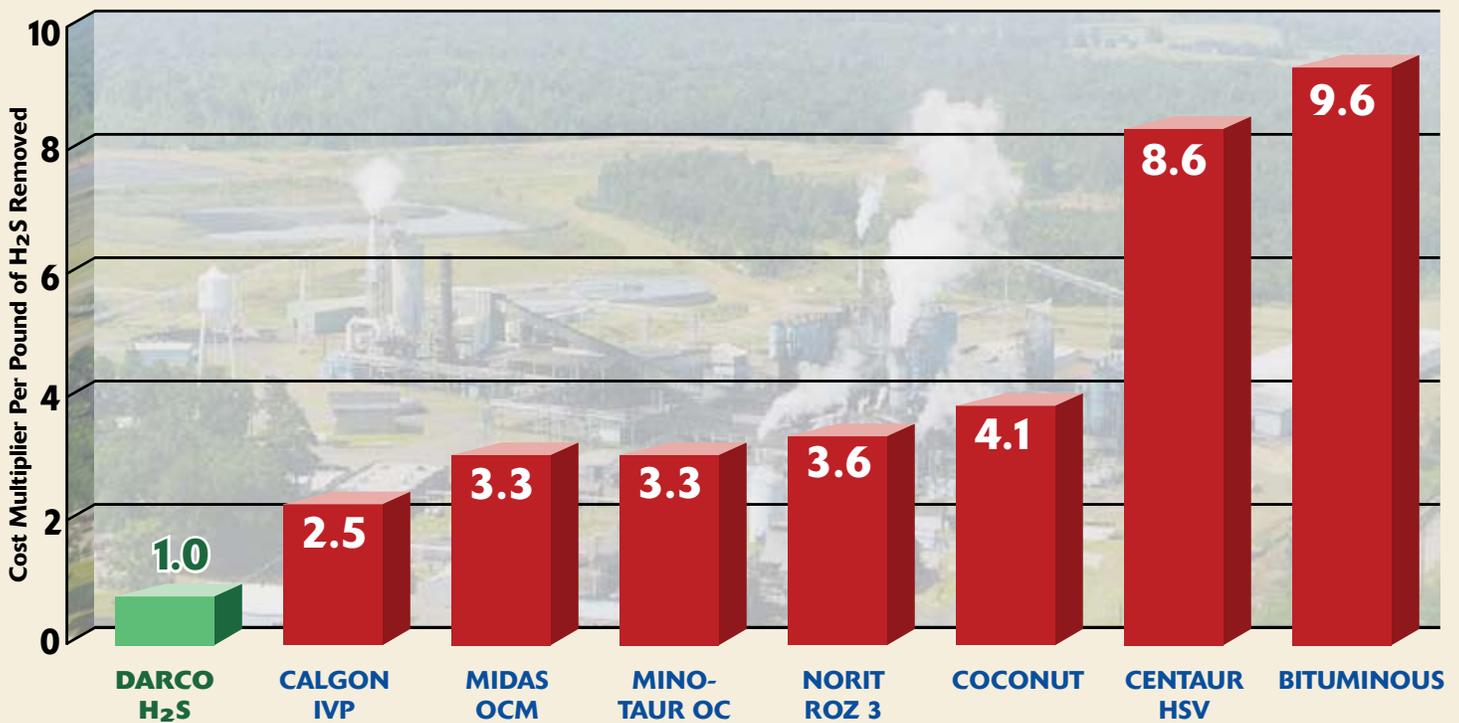


DARCO H₂S - reduced risk of exotherms and bed fires

DARCO H₂S is produced by steam activation at high temperature using a proprietary process that does not include additives or impregnants. As a result, the risk of bed fires due to exothermic reactions in an odor control system is greatly reduced. Carbons impregnated with strong bases have historically been associated with increased risk of bed fires. Bed heat-up is initiated by the hygroscopic nature of the base impregnant and the chemisorption of water and oxygen on the carbon substrate. This issue is minimized with the non-impregnated DARCO H₂S.

DARCO H₂S will reduce your odor control cost, and you can “pocket” the savings.

Figure 3 - H₂S Removal Cost





DARCO H₂S - outperforms the competition 300%

Wastewater treatment plant

Nuisance odors occur in many wastewater plants and lift station operations where biological activity creates hydrogen sulfide (H₂S), ammonia (NH₃), and mercaptans. Human olfactory organs are sensitive to ppb levels of H₂S and therefore, the removal of the H₂S generally results in a large decrease in the odor level.

The City of Grapevine, TX Wastewater Treatment Plant (WWTP) has fugitive H₂S odor at its headworks, which is typical for most WWTPs. The highest concentration was seen after the headworks at the grit removal system where turbulent mixing occurs.

Application engineers from Norit Americas Inc. evaluated the plant and concluded that DARCO H₂S manufactured by Norit Americas Inc. would eliminate the malodor. In early 2005, DARCO H₂S, (1000 lb, approximately half the design bed depth) was installed in the existing odor control unit located near the headworks. At start-up the airflow was approximately 1100 cfm with an inlet H₂S concentration measured at 20 ppmv. The discharged effluent air contained no detectable H₂S or other odors.

DARCO H₂S eliminated the nuisance odor at the City of Grapevine, TX WWTP. Based on the H₂S concentration in the influent, the airflow rate, and the service life of the carbon bed, the calculated H₂S loading on the carbon in this plant test is 0.22 g/cm³. This high removal efficiency was accomplished using DARCO H₂S, which is manufactured without the use of any impregnant or additives.

Asphalt plant

Management at a 100,000 ton annual through-put asphalt terminal in Fernley, NV report significant reduction in operating costs for their activated carbon odor control system. This was accomplished by replacing part of the activated carbon in the system with DARCO H₂S. In addition, the plant management credits valuable technical assistance from Norit Americas Inc. for developing odor control system modifications that will reduce maintenance cost and enhance safety.

DARCO H₂S outperformed the competition by 300% in these case studies. Please see our website at www.norit-americas.com for case study details.



Norit backs you 100%

DARCO H₂S is produced at our Marshall, TX facility making it readily available to the North American market. Combined with Norit's European operation 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.

Norit Americas' engineers have expertise in the design and supply of carbon vessels, ductwork, blowers, and portable self-contained carbon treatment units. Our Engineering and Technical Service groups can provide assistance with design, operation, process analysis, system leasing, troubleshooting, testing, and piloting of your process for odor control. We can also coordinate and conduct the service to install or change-out your carbon bed, including the disposal or reactivation of your spent carbon.

The Norit organization, 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.

If you are using activated carbon for odor control our technical people can help you improve your system performance. Should you be considering activated carbon as part of your treatment, we can assist you in designing a site-specific odor control system.

TECHNICAL TIPS FROM NORIT AMERICAS



EQUIPMENT

The corrosive nature of H_2S requires appropriate materials of construction for the 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 put before the activated carbon bed. Odor control activated carbon beds typically run in up-flow mode at a few inches of water column pressure. Beds designed to run by vacuum tend to be short and wide. For systems designed to operate under pressure, the beds are relatively deep (3'- 4').

BED DESIGN

- 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 4 times the H_2S concentration on a molar basis is normally sufficient).
- Moisture is required to achieve high loading on DARCO H_2S . A minimum relative humidity of 30% (preferably higher) is recommended.

SPENT CARBON DISPOSAL

DARCO H_2S that has become loaded with hydrogen sulfide and mercaptans is not considered a hazardous material for the purpose of handling and disposal. Unique circumstances can exist, such as bacterial growth or the adsorption of a hazardous material, that will cause the spent carbon to be classified as a hazardous material. This is true not only of DARCO H_2S , but for all activated carbons.

Norit Americas Inc. strongly recommends you contact a Norit Americas Inc. representative before handling your spent carbon. Adding water or chemicals to change the characteristics of the carbon may in fact cause the spent carbon to be considered hazardous. Please contact your Norit Americas Inc. representative for consultation before proceeding with any treatment.





CALL A NORIT AMERICAS REPRESENTATIVE FOR ALL YOUR CARBON NEEDS.

For specific information and recommendations, contact your Norit Americas Inc. sales representative or call **(800) 641-9245** in the continental United States, or visit the website at www.norit-americas.com.

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