

A solution for removing acid gas from glass

Dry sorbent injection (DSI) with engineered hydrated lime sorbents, such as Sorbocal SP/SPS, offers a cost-effective method for acid gas compliance states Jerry Hunt*.

DSI systems are a relatively low capital cost technology that has successfully demonstrated the capability to control acid gas emissions in the power industry and in a multitude of industrial applications, including glass production. DSI systems offer an acid gas emission control solution that is relatively easy to retrofit at existing facilities and provides a high degree of flexibility.

While each DSI system generally consists of a motive air system, storage silo, dosing system, piping/portioning device and injection lances, each end user may require some customised DSI design features (**Fig 1**).

Evolution of Engineered Hydrated Lime Sorbents

In the past, hydrated lime (i.e. $\text{Ca}(\text{OH})_2$) was produced for a variety of applications unrelated to acid gas abatement and as a result, material properties were not optimised for a reaction with acid gases.

In these so-called 'standard hydrated lime' sorbents, surface area and porosity – the key properties that govern acid gas capture – were not explicitly controlled in the manufacturing process.

In order to more efficiently capture acid gases, first generation engineered hydrated lime sorbents (EHLS) were manufactured with increased surface area coupled with a smaller particle size to provide a performance enhancement over 'standard hydrated lime'.

Additional research demonstrated that increased pore volume would also boost acid gas removal efficacy.

This led to the development of second generation EHLS, Sorbocal SP, which had a higher pore volume ($> 0.2 \text{ cm}^3/\text{g}$) as

well as a higher surface area ($> 40 \text{ m}^2/\text{g}$), resulting in properties two to three times greater than 'standard hydrated lime'.

The third generation EHLS, designated as Sorbocal SPS, utilises a chemical activator to accelerate acid gas kinetics coupled with the optimised physical properties of Sorbocal SP for an even more reactive sorbent.

Furthermore, the chemical activator used for Sorbocal SPS reduces the sorbent's resistivity, which has demonstrated improved response in electrostatic precipitators compared to other, non-activated hydrated lime products.

Fig 2 illustrates the evolution of hydrated lime products specifically engineered for acid gas abatement.

Acid gas abatement

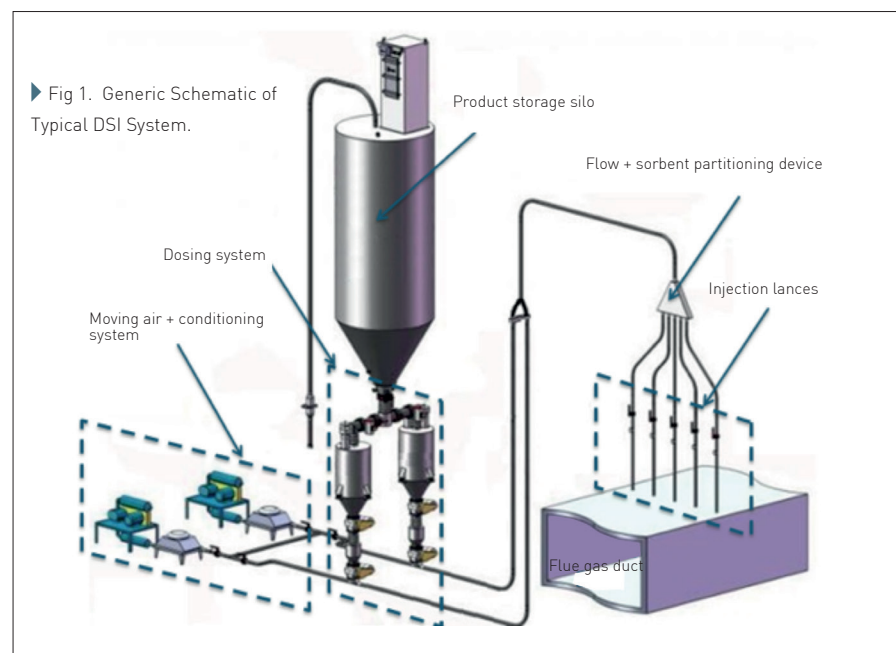
Today, DSI with Sorbocal SP and Sorbocal SPS are currently being utilised by dozens of facilities for removal of SO_2 , HCl , $\text{SO}_3/\text{H}_2\text{SO}_4$ and HF .



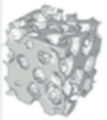
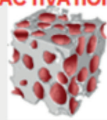
In many applications, greater than 90% removal of the previously mentioned acid gases has been demonstrated using DSI with Sorbocal SP or Sorbocal SPS at facilities with electrostatic precipitators as well as baghouse filter units.

Sorbocal SP is currently also being used in conjunction with Tri-Mer's ceramic filter technology in more than two dozen glass furnaces for multi-pollutant control, one of which is SO_2 .

To achieve high acid gas removal rates, system design and sorbent selection

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Sorbent	Standard hydrated limes	High quality standard hydrated lime	2nd generation EHLS	3rd generation EHLS
Figure				
Typical available Ca(OH)_2 - [%]	92-95	93	93	93
Typical surface area [m^2/g]	14-18	20	40	40
Typical pore volume [cm^3/g]	~0.07	0.08	0.20	0.20
Typical D_{50} - [microns]	5-7	5-7	8-12	8-12

▲ Fig 2. Comparison of Various Hydrated Lime Sorbent Physical and Chemical Properties.

require careful consideration. Below are some of the fundamental conditions that drive acid gas capture efficiencies and resultant sorbent consumption rates.

In general, DSI performance is impacted by the gas temperature, particulate control device, gas moisture and sorbent dispersion.

- Gas temperature – DSI chemistry is non-linearly impacted by gas temperature. Understanding the role that gas temperature plays for each acid gas is critical to selecting the ideal sorbent injection location.

Specifically, each acid gas has a different optimal injection temperature for a reaction with hydrated lime.

- Particulate control device – Whether a site has an electrostatic precipitator or filtration unit (e.g. fabric filter, ceramic filter) will also have an impact on DSI performance.

The filter cake that builds up across the filtration unit also provides a medium for additional acid gas scrubbing. Optimising filter cake thickness and residence time can also impact DSI system performance.

- Gas moisture – The applications with the peak sorbent utilisations tend to be the sites with the highest gas moisture content. Full scale DSI testing specific to SO_2 removal indicates that DSI performance is typically directly correlated with gas moisture content.

- Sorbent dispersion – Appropriately designing the injection grid to ensure that the sorbent and acid gases mix well is imperative to ensure that the necessary acid gas removal is achieved as well as the

optimisation of sorbent consumption.

New improved sorbent dispersion technologies are commercially available and have demonstrated the ability to improve DSI performance and/or reduce sorbent consumption.

Below is a case study from an industrial facility using Sorbocal SP coupled with a filtration unit over the past few years to provide control of several pollutants, including SO_2 .

This site has relatively low moisture content in the flue gas stream (< 5% by volume moisture) and injects Sorbocal

SP at > 600°F with multiple standard injection lances.

The DSI system doses Sorbocal SP with a loss-in-weight feeder system and the SO_2 emissions are periodically measured using temporary gas analysers.

Fig 3 shows recent DSI performance data indicating that with Sorbocal SP dosage rates at just under 140 lb/hr, this facility is able to achieve greater than 95% SO_2 removal efficiency.

Benefits

Engineered hydrated lime sorbents such as Sorbocal SP and Sorbocal SPS often provide the following benefits:

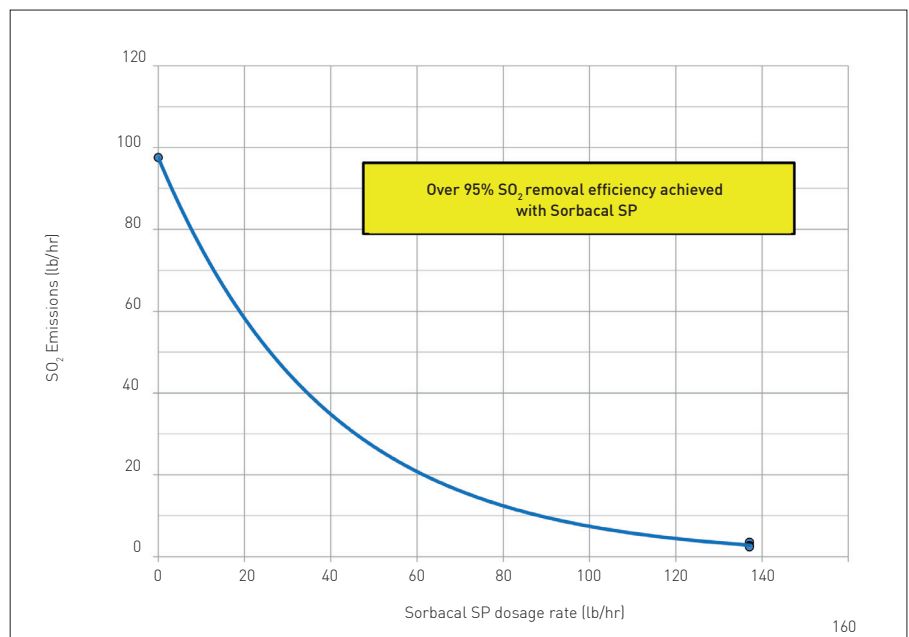
- Sorbent cost savings – Sorbocal SP/SPS typically reduces sorbent consumption by 30-50% over standard hydrated lime sorbents, usually resulting in a lower annual sorbent spend.

- Disposal cost savings – Reducing sorbent consumption with Sorbocal SP/SPS will generate less residue (i.e. less in = less out), resulting in a residue of disposal savings.

- Reduced impact on particulate collection devices – Reduced sorbent dosing into an electrostatic precipitator may directly impact particulate collection efficiency and in a baghouse it could impact the bag cleaning cycle frequency.

In particular, Sorbocal SPS is optimised for electrostatic precipitator applications compared to standard hydrates; the chemical activator in Sorbocal SPS not

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▲ Fig 3. DSI Performance with Sorbocal SP for SO_2 Removal from Industrial Application.

only improves acid gas reactivity, but also reduces sorbent resistivity.

Combined with a larger particle size, this combination of properties results in reduced potential for detrimental impacts to the electrostatic precipitator.

- Flexibility – Opportunity fuels or raw materials with higher sulphur and/or chloride contents may offer an attractive lower cost option; Sorbacal SP/SPS can provide the higher acid gas removal necessary in order to operate with these fuels/raw materials.

- Simplified logistics and supply – Reducing sorbent consumption with Sorbacal SP/SPS increases the number of available storage days in a fixed silo volume. Lower consumption will also reduce the number of deliveries required.

Total cost of ownership (TCO)

Deciding which sorbent is the optimal solution for each acid gas removal application is not necessarily as simple as comparing the lowest delivered cost.

The most cost-effective solution overall is determined by the sorbent, which provides the lowest TCO.

While delivered cost is important, it is also necessary to factor in the sorbent performance to determine the total annual sorbent expenditure.

The DSI performance for each sorbent may also play a role in the residue disposal costs as well.

For example, if using Sorbacal SP or SPS results in a 30-50% lower sorbent consumption, it will result in less generation of residue and therefore have a lower annual cost for disposal.

Disposal costs can be a significant consideration; especially if sodium sorbents are considered - sodium sorbents potentially result in increased heavy metals leaching (i.e. selenium and arsenic), which may cause residue to be classified as a hazardous waste.

It is also important to consider other factors, especially when retrofitting a DSI system to an existing facility, such as impacts to the particulate control device (especially for an electrostatic precipitator) and the waste handling system.

Conclusion

DSI is a reliable acid gas control technology that has been installed at numerous glass production facilities in order to control acid gas emissions that are generated from the raw materials and/or fuels.

Development of engineered hydrated lime products such as Sorbacal SP/SPS have paved the way for new and less costly acid gas compliance solutions.

Sorbacal SP/SPS has demonstrated the capability to achieve > 90% acid gas (e.g. SO₂ and HCl) emissions reduction while using 30-50% lower consumption rates, in contrast to standard hydrated lime sorbents.

In addition to providing savings on sorbent expenditures, Sorbacal SP/SPS can also provide reduced disposal costs, simplified logistics/supply, as well as increased flexibility.

Ultimately, the best sorbent for each site may not be the lowest delivered cost, but rather proper consideration of TCO which takes into account the sorbent cost, sorbent consumption rate, disposal cost, as well as the balance-of-plant impact. ■