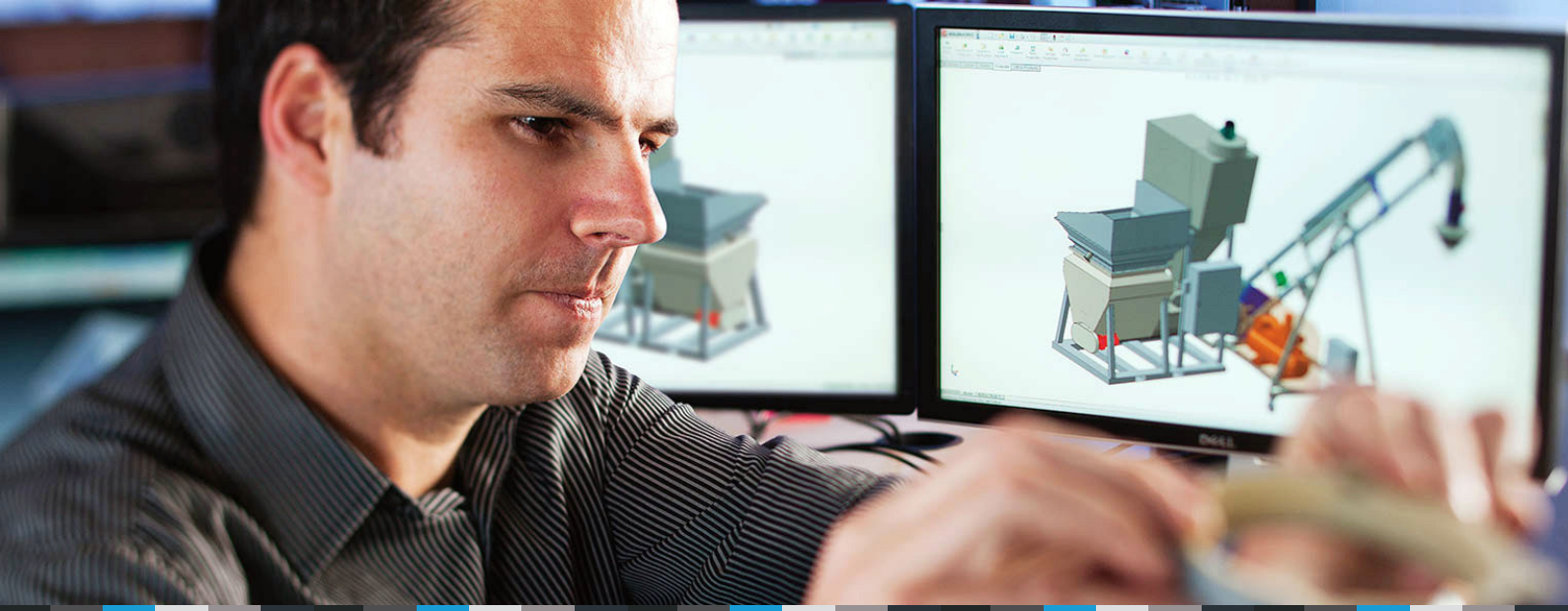

Sweet as...

aero-mechanical conveying solution for bulk sugar handling

White Paper for Sugar Applications

FLOVEYOR

'Simplicity in conveying
Integrity in everything'

Table of Contents

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Overview

Sugar gets everywhere. In powdered, liquid or granular form, it is a key ingredient in a vast array of foodstuffs and pharmaceuticals and increasingly in biofuels.

Sugar's broad application, moisture absorbing (hygroscopic) and potentially explosive characteristics make it a challenging product to handle safely and cost effectively.

Processing sugar involves transporting raw material from bulk or manually handled containers to a huge range of plant types and locations. These diverse handling requirements coupled with sugar's reactive nature make enclosed aero-mechanical conveying a highly suitable transport technology.

Aero-mechanical conveying has many advantages over alternative systems for sugar handling. It maximises throughputs while maintaining product safety and integrity. It prevents separation of blended products. It mitigates fire and explosion risk, reduces energy and maintenance costs and saves space.

This white paper discusses the suitability of the Floveyor Aero-mechanical Conveyor for safe, efficient bulk sugar handling. It aligns the Floveyor's distinct capabilities to move materials effortlessly, gently and securely to the specific needs of the sugar industry.

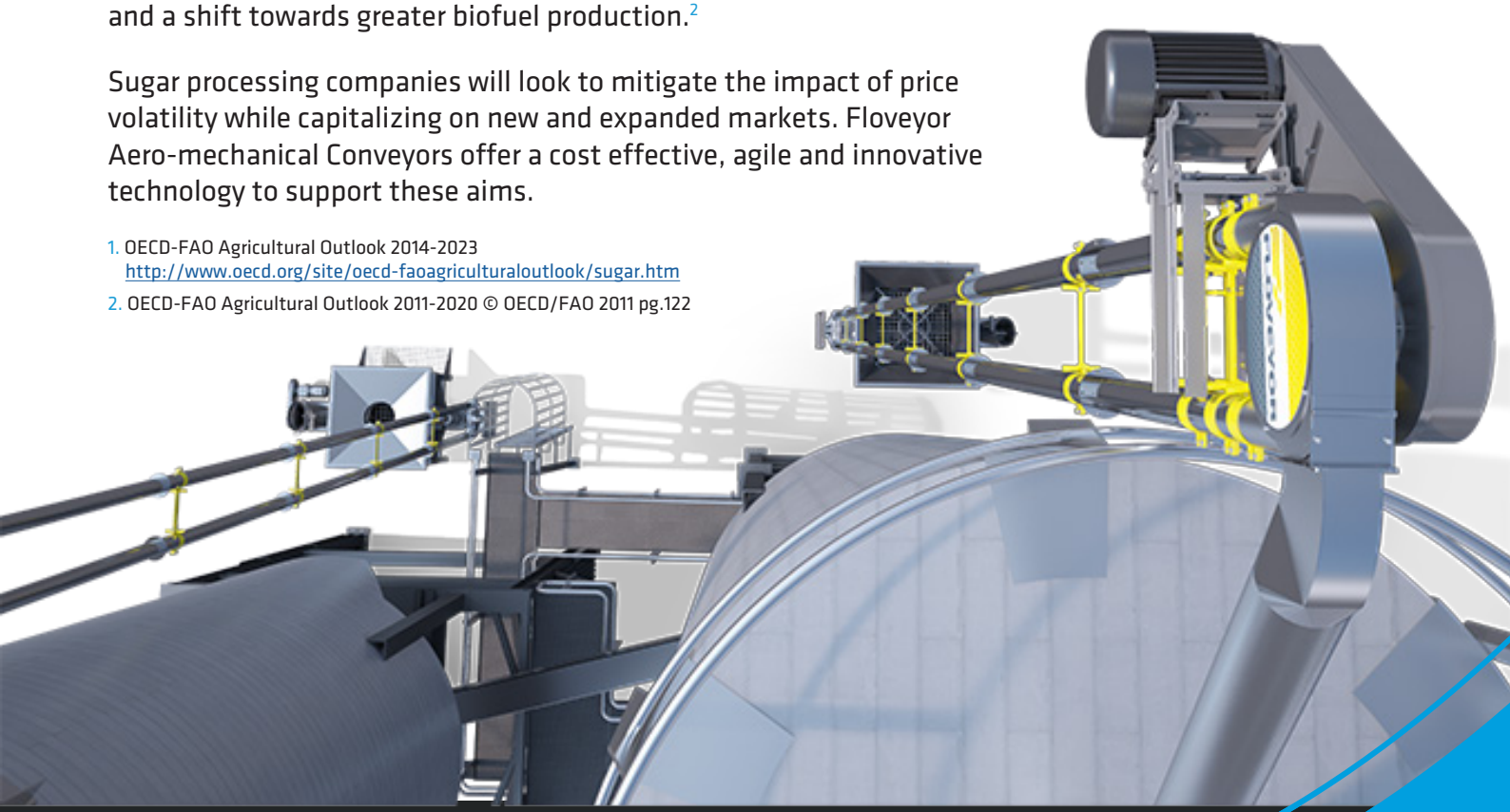
See Appendices 1 and 2 for Floveyor profiles and cost efficiencies

In the next decade global sugar consumption is expected to increase by 1.9% per annum to around 211 million metric tons annually. This increase will be greatest in Asia and Africa where current consumption rates are the lowest.[1]

World sugar prices are increasing. However they are expected to remain volatile due to a range of factors including: government policy interventions in key producing countries, the vagaries of climate and a shift towards greater biofuel production.[2]

Sugar processing companies will look to mitigate the impact of price volatility while capitalizing on new and expanded markets. Floveyor Aero-mechanical Conveyors offer a cost effective, agile and innovative technology to support these aims.

1. OECD-FAO Agricultural Outlook 2014-2023
   http://www.oecd.org/site/oecd-faoagriculturaloutlook/sugar.htm
2. OECD-FAO Agricultural Outlook 2011-2020 © OECD/FAO 2011 pg.122



Meet the Challenges

Explosions and fire risk

Despite its benign reputation as a sweetener and preservative, powdered sugar dust is a potentially lethal explosive. Sugar dust shares this dangerous quality with around 70% of industrial powders all of which have the potential to combust if the following environmental and operational conditions are present: [1]

- a sufficient concentration of airborne combustible dust particles which are big enough to ignite
- an ignition source such as an electrically or mechanically generated spark, high surface temperature or electrostatic discharge
- a sufficient concentration of oxygen to fuel a fire

Historically, sugar handling has relied primarily on mechanical handling equipment, such as belt & bucket elevators, pneumatic systems and screw conveyors. These large mechanical conveying systems with high internal volumes and big external surfaces are susceptible to over loading and dust shedding. Their large number of moving and wearing parts also heightens ignition risks from mechanical impact or friction sparks. These technologies can contribute significantly to creating potentially explosive conditions.

This deadly potential of combustible sugar was realised on 7 February 2008 when accumulated sugar dust ignited, destroying the Imperial Sugar Refinery in the American state of Georgia. Fourteen people died and thirty eight others suffered severe burns.

An investigation into the Imperial Sugar tragedy by the US Chemical Safety and Hazard Investigation Board found that, inadequately vented sugar dust and lapses in regular maintenance contributed to the disaster. The report concluded amongst other things, that:

"timely housekeeping activities should have been performed to remove accumulations from elevated horizontal surfaces and spilled granulated and powdered sugar on the floors before the sugar accumulated to hazardous levels."[2]

Closer to home, several of Floveyor's clients have reported 'near miss' explosive incidents involving bucket elevators, even where significant steps to ensure workplace safety had been taken. These include a bucket elevator igniting despite being fitted with over a dozen explosive suppression and venting safety features. As a result of the explosion, caramelised sugar dust rendered the explosive suppression systems useless and the bucket elevator exploded causing the outer housing to 'peel away like a banana'. Fortunately no one was injured.

1. Carroll D. and Frost D. 'Managing explosive dust risk in sugar handling' - Schenck Process pg.2 http://www.clydeprocess.co.uk/docs/Clyde_images/BVA9065_Imperial_Sugar_Application_Report_from_Schenck_Process.pdf
2. 'Dissecting the Imperial Sugar dust explosions' Australian Bulk Handling Review: November/ December 2012 pg. 42 www.bulkhandling.com.au/pdfs/42-46-NovDec12.pdf/at.../file

Sticking clumping and lumping

Sugar is hygroscopic – it absorbs moisture. This is a troublesome property in the processing environment with significant maintenance, housekeeping and pre-processing implications.

Firstly, as a matter of 'timely housekeeping', sugar residue must be removed from external surfaces, floors and walls to ensure a safe, clean workplace free of mould and pest infestation.

Secondly, residue build up inside machinery can reduce efficiency and shorten the life of key components.

Finally, lumps found in sugar stock of up to basketball sized proportions must be crushed prior to processing.

In summary sugar's chemical characteristics present a number of challenges to ensuring workplace safety and product integrity while maximising efficient processing practices.

As a result of incidents like those described above, companies everywhere are reviewing their sugar handling practices to exclude all sources of combustion and completely mitigate any risks that may arise during processing. Innovations in highly adaptable, closed system aero-mechanical conveying are designed to address these challenges while maximising energy and production efficiencies.

Find solutions

As detailed above, sugar is a challenging commodity to transport and process and must be carefully contained to ensure safe efficient handling. Sugar dust has the propensity to explode with potentially life threatening consequences. Exposed to air and humidity, sugar's moisture absorbing properties create a sticky residue, which can clog machinery causing expensive wear and tear on components and productivity losses in time consuming maintenance. Spilled sugar residue renders work surfaces unhygienic and prone to pest infestation and mould. This creates a substantial food safety risk and an unpleasant and unsafe working environment.

Key factors in successful sugar handling include: dust and contamination free processing, effective moisture control, regular and straightforward removal of internal residue buildup in equipment and maintaining product integrity. Preprocessing sugar supplies to ensure a granulated free flowing product is also an important consideration.

Contain the problem

The Floveyor Aeromechanical Conveyor is an excellent solution for conveying hazardous materials in environments requiring intrinsically safe conveyors.

Floveyor is a fully enclosed system with low circulating air volumes. This system minimises dust emissions and eliminates the single most dangerous and difficult factor in bulk sugar handling.

Fitted with the appropriate motors, components and accessories, the Floveyor handles potentially explosive products with complete safety.

Control moisture

Selecting the correct purpose designed conveyor will mitigate the troublesome effects of sugar's hygroscopic nature.

Floveyor Aeromechanical Conveyors are designed minimise the production and maintenance impacts of sugar's sticking, clumping and lumping propensities. The Floveyor operates without compressed air or the need for dust extraction systems. It is an unpressurised system that runs on empty without producing an air draft.

Some minimal impact from displaced air moving through the return tube occurs in humid environments or where sugar is loaded into a hot tank. Compared to the onerous requirement for dehumidifying air essential for open pneumatic conveying, the Floveyor's enclosed unpressurised system offers a simple effective solution to this particular sugar processing issue.

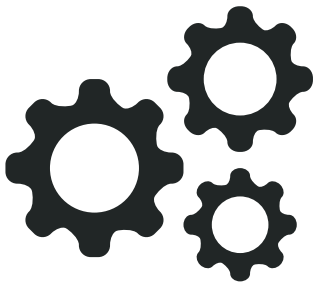
Remove internal residue

Floveyor systems accumulate minimal internal sugar residue. However, It is important to protect the rope assembly from any undue stress caused by residue blocking the discharge chute or the tube walls. This can happen if hot vapour enters the system activating sugar's hygroscopic tendency. An obstructed chute may lead to recirculating product, which can stall the conveyor.

As Floveyor custom engineers each installation, our clients have many options for mitigating and managing residue accumulation. These include manual systems and automated Clean in Place (CIP) solutions all of which are tailored to fit budget and systems requirements. In addition to the inherent moisture control and flow promoting attributes of our conveyors our design team tailors the integration and fit of every system to match its specific environmental and production conditions.

Where vapours entering the system cannot be avoided, Floveyor will fit a pneumatically operated washing plate. This is a quick, simple way to flush the system by closing the washing plate cover before hosing hot water into the feed hopper. The circulating water circulates, flushes the conveyor's internals thoroughly. Minutes later the washing plate is opened and the liquid discharges into the wet vessel for draining or via inbuilt drainage plugs. The Floveyor then can be left to dry or be quick dried using compressed air if time is an issue. Depending on the severity of build-up, we generally recommend this is done weekly.

Ensure product integrity and safety



In keeping with its contrary nature, sugar is also friable and heat sensitive. Its particles are relatively easy to reduce or damage and it can caramelise if heated excessively. As granular sugar destined for innumerable direct and indirect uses sugar particles must maintain relatively uniform shape and size.

As a key ingredient in a range of powdered foodstuffs such as cake mix, sugar must be treated appropriately to avoid degradation or clumping.

Floveyor maintains blend integrity, regardless of the material's properties, bulk density, particle size distribution, flow characteristics or moisture content. As a result of its flow promoting, fluidising process, aero-mechanical conveying is considerably gentler on products then the traditional pneumatic or mechanical alternatives.

Sugar is inherently antibacterial and it has a long history as a preservative and a wound treatment. However, sugar residue is highly attractive to bugs and prone to mould. Spillage from open conveyors coupled with poor housekeeping can contaminate products and create serious health risks. Dust and spillage issues can be eliminated by selecting equipment designed for enclosed operation and easy cleaning which is sealable when not in use.

All Floveyor conveyors supplied for sugar handling have these attributes. As a result of careful engineering, Floveyor conveyors are fully US Food and Drug Administration (FDA) and European Union approved for food safe applications.

Detect and eliminate contamination

Floveyor's aero-mechanical conveyors apply 21st century innovation to profoundly simple principles of classical pump technology.

They operate on an internally driven consumable rope assembly consisting of polymer discs fitted to stainless steel rope. The rope assembly is encased in tubing of various sizes for a range of specific applications. A small highly efficient motor drives the circulating rope assembly creating a centrifugal force. This movement suspends raw material in an air pocket and propels it rapidly but gently to a collection point.[1]

Preventing contamination from any source including: mechanical faults, worn parts, foreign objects such as nuts, bolts or knives is essential for food safety and for protecting the rope assembly.

Selecting a suitable durable rope assembly is a crucial to ensuring years of trouble free operation and eliminating contamination. Floveyor has developed a range of stainless steel rope assemblies, specifically suited for the sugar industry. These 'Metal Delectable, X-Ray Contrast and Magnetic Susceptibility Rope Assemblies' reduce potentially explosive static and allow detection of plastic contamination.

Our Stainless Steel 329 wire has four times the magnetism of standard stainless steel. An additive in the Polyurethane Disc makes plastic particles metal detectable and X-Ray downstream.

1. Floveyor website: The technology page https://www.floveyor.com/the-technology/

Pre process raw sugar efficiently

An efficient process for crushing lumps in contaminated sugar supply is imperative for timely cost effective processing.

This process is different for small bags, FIBC's or container handling. It can also be an intermittent problem, which may not warrant investment in permanent equipment.

Where the lump problem is significant in FIBC handling and decanting is affected due to large lumps, the Floveyor team recommends hiring a wool bale clamp to agitate the bags prior to processing through a lump breaker. It is important to assess the FIBC's condition before processing them to check that they are sufficiently robust to withstand agitation without splitting. On average this process takes anywhere between 8 and 10 minutes per bag although it can be a quick as 5 minutes.

Where preconditioning lumpy sugar is an ongoing requirement, engineering firms including Floveyor can install custom fitted FIBC conditioning stations, which will crush and churn sugar to a free flowing granulated form suitable for processing.

Container handling is more straightforward as the weight of the contained sugar generally limits the size of lumps to around 400mm in diameter. The Floveyor solution is to fit an adaptor at the unloading point to crush larger lumps and ensure unimpeded flow through the Floveyor. This allows maximum efficiency when decanting containers to minimise demurrage charges.

The final 'flow ' issue in sugar processing arises when bridging or 'rat holing' in hoppers impedes the flow of powdered sugar. Floveyor's capacity to offer a range of engineered solutions allows the integration of steep wall hoppers, screw feeders, pneumatic vibrators or aeration pads to mitigate any potential flow issues.

Conclusion

Floveyor Aero-mechanical Conveyors provide a fully enclosed, intrinsically safe system ideally suited to bulk sugar handling. They are a cost effective highly efficient conveying solution for this potentially hazardous material.

Floveyors use around a quarter of the energy required to achieve comparable throughputs from alternative conveyors. They are economical to maintain as they are filter free and only have a single consumable component. This component is a customised wire rope assembly designed to eliminate contamination in sugar handling.

Floveyor's distinctive fluidizing technology is gentler than alternative systems. It protects product integrity and prevents separation. All Floveyors are FDA and EU approved for food production and operable across a range of ATEX or IECEx zones.

The Floveyor team has over 50 years of experience in design innovation in aero - mechanical conveying. Our safe, agile, efficient conveyors are currently saving energy, time and money for major food and pharmaceutical manufacturers on every continent.

Appendix 1 - Floveyor aero-mechanical conveyor profiles

System features and applications	Throughput - Sugar	Energy consumption	Conveying distance
F3: Floveyor 3"/76mm Tubes Small, versatile and highly mobile Appropriate for: manual bag unloading, mobile and point to point plant transfer	From a trickle feed up to 12,000kgs /hr	1.5- 2.2kW motor	45'0''/ 13.7m Will maximise long term operations and minimize maintenance
F4: Floveyor 4"/102mm tubes The Floveyor workhorse Mobile and adaptable Appropriate for FIBC unloading, fixed plant installations	Up to 24,000 kgs /hr	3kW motor or upgrade to 5.5kWs for especially long or heavy applications	65'0" /19.8m Will maximise long term operations and minimize maintenance
F5: Floveyor 5"/127mm tubes The Bucket Elevator alternative used in Floveyor Tanker Loaders Moves 'mountains' with minimal structural support and small footprint Appropriate for bulk transfer, FIBC unloading and fixed plant installations	Up to 42,000 kgs /hr	5.5 – 7.5 kW motor	55'0" / 16.7m Will maximise long term operations and minimise maintenance

Appendix 2 - Ongoing cost benefits

While the initial investment in designing and installing a Floveyor can be comparable to installing alternative conveying systems. Floveyor's specific capabilities offer significant savings in ongoing costs.

Compliance	**Reduce costs for atmospheric venting and dust collection** Floveyors are intrinsically safe enclosed conveyors certified for use within ATEX 20,21,22 zones.[1]
Filtration	**Eliminate costs for installing, maintaining and replacing filters** Floveyors are filter free.
Energy	**Reduce ongoing energy costs** Floveyors deliver throughputs of 12,000 to 42,000kgs/hr. on drives of between.5 to 7.5 kW often replacing drives of up to 40kw for equivalent throughputs.
Ongoing consumables	**Achieve the lowest running costs in the industry** Floveyor's rope assembly and bearings are the only consumables. A well maintained rope assembly will run for many thousands of hours with simple, timely maintenance.

1. Explosive environments the ATEX standard
http://www.petzl.com/en/Professional/Explosive-environments--the-ATEX-standard?ProductName=PIXA-3#.VKzYx8ZINnI