Sugar Grinding Plants

Preventive & Protective Controls Against Explosion Hazards

CYBERNETIK TECHNOLOGIES
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1. Executive Summary

Preventive and constructional controls against explosion are a critical element of sugar grinding plants. Sugar dust is inflammable above 150^{0}C. Sugar grinding plants produce powdered sugar. Plus, the grinding process generates heat. A spark can easily explode airborne sugar dust at high temperature and in sufficient concentration.

While preventive measures avoid the development of explosive conditions, technically called DEA i.e. Dangerous Explosive Atmosphere, constructional controls are protective in nature and limit the effects of explosions when instituting preventive measures is not viable.

Structural controls are related to the structure of the plant and the location of various mechanisms therein. Organizational controls deal with the work practices. Both, structural and organizational controls can be either preventive or protective in nature.

Explosions at the Imperial Sugar Refinery, Georgia in 2008 underline the importance of such controls in sugar grinding plants. Unattended sugar dust accumulations at various locations in the plant set off multiple blasts. Such was the destructive force of the explosions, they dented the heavy concrete floors and pushed brick walls into work areas causing multiple casualties and severe injuries.

Establishing proper control mechanisms is only half the task. Continuously monitoring these systems to ensure they operate properly is the other half. As such, the anti-explosion measures in sugar grinding plants are a continuous process.

2. A Note on Industrial Safety

Industrial safety is an inseparable part of factory operations. It transcends the immediate goal of worker safety and facilitates the satisfaction of all stakeholders, including clients, regulators, vendors, and employees.

Manufacturing productivity rises remarkably after executing a safety program[1]! This was the conclusion drawn by a 2017 joint survey by Advanced Technology Services, a global industrial services leader, and the *Plant Engineering* magazine.

An overwhelming 83% of senior management authorities and operations personnel recorded this observation in the survey [1]. Considering that the respondents had an average 24-year experience [2], the deduction holds significant weight.

Safe industrial spaces limit the perils from physical hazards, chemical exposures, and flawed ergonomics [3]. The absence of safety related incidents translates into minimal operational interruptions, thereby ensuring on-time deliveries. Besides, it saves resources that will be otherwise assigned for costly medical and legal procedures.

More than anything else, compliance with industrial safety norms nurtures the feeling that shop floor personnel are greatly valued. A sense of belonging inspires greater employee engagement [4], a priceless asset.

Failures at the planning phase get magnified at the operational stage and require the allocation of greater funds and personnel to take care of. Prevention is, therefore, much better than cure. Such a proactive approach is particularly relevant when handling sugar, a material prone to explosion when subjected to extreme heat.

3. ATEX Directive for Explosion-Proof Equipment, Parts, & Protective Mechanisms

Atmosphere Explosible, abbreviated as ATEX, is the European Directive 2014/34/EC that lays down mandatory guidelines to ensure the explosion-proof manufacture of mechanical and electrical products (equipment, parts, and protective mechanisms) intended for use in possibly explosive environs [5].

Since explosion protection is the underlying objective, the directive also applies to those control, safety, and regulation devices, which, although located outside the explosion-prone atmosphere, are involved in the safe operation of products functioning inside the said atmosphere.

ATEX went operational on 1 July, 2003. ATEX products are available in the market only after obtaining a CE Mark and an EC Conformity Attestation. Manufacturers of ATEX products have to provide operating guidelines.

Grinding of sugar generates sugar dust and high temperatures. Sugar dust is inflammable at temperatures above 150^{0}C [6]. Consequently, adherence to ATEX is obligatory for sugar grinding plant equipment such as grinders, conveyors, silos, and hoppers.

4.0. Global Sugar Market

Food-Beverage, Pharmaceutical, and Personal Care industries are the chief customers of industrial sugar [7]. The food-beverage sector is the major consumer [8] and is further segmented into Dairy, Bakery, Frozen Desserts, Confectionary [7], Beverages, and Canned Foods [9].

Also called confectioner's sugar or icing sugar, powdered sugar is an anti-caking agent which provides a fine texture and structure to food products. It finds application in the Chocolate, Bakery, and Confectionary segments of the food industry [10]. The Pharmaceutical industry utilizes it as a medicated confectionary base, capsule and tablet diluter, viscosity booster, and agent for sweetening, suspending, granulating [11].

Verified Market Research placed the size of the global industrial sugar market at $41.33 billion in 2018 and forecasted it to rise to $65.35 billion by 2026 [12]. According to Grand View Research, the worldwide market for powdered sugar stood at $5.62 billion in 2018 and will steadily expand at a CAGR of 4.2% between 2019 and 2025 [10].

Urbanization, climbing disposable incomes, and modified eating habits in emerging economies are driving up the demand for sugar-based foods and beverages. Besides, the food-beverage industry is not substantially affected by economic downturns [8].

A dominant factor limiting the growth of the industry is increasing health awareness, making many people switch to sugar substitutes [7]. Moreover, the demand for sugar in the developed world remains saturated [8].

Brazil is the top producer of sugar in the world for 2019-20 [13]. Next in the list are India, the European Union, China, and Thailand [13]. India was the highest sugar producer for 2018-19 [14]. Sugarcane is the primary raw material for sugar, followed by sugar beet [8].

5. Hazards in Sugar Grinding-Processing – Why the Processes Are Explosion Prone?

Grinding generates high temperatures because a significant fraction of grinding energy gets dissipated into heat [15]. Sucrose "inverts" or decomposes into glucose and fructose at temperatures above 150^{0}C [6]. Thereafter fructose transforms to hydroxymethylfurfural (HMF) [16], a flammable compound [17] which makes sugar grinding an explosion prone process.

Size reduction during grinding means the tiny sugar particles have an enormous surface-area-to-volume ratio. For example, the surface area of 27 cubes broken down from a large cube is 3 times of the latter. Higher surface area of powder or dust particles provides more surface for combustion. It also speeds up the spread of combustion [18].

Explosions at the Imperial Sugar Refinery, Georgia in 2008 are a grim reminder of the potentially lethal nature of sugar grinding-processing. Sugar dust left unattended [19] at multiple locations in the plant set off a chain reaction of potent blasts that dented the heavy concrete floors and pushed brick walls into work areas [20] causing multiple casualties and severe injuries [21].

By itself, sugar dust does not constitute a risk. ***Explosion occurs only when all the following*** [22] ***conditions occur simultaneously and at one particular location*** [23]:

- Dust that:
    - Is inflammable.
    - Has particle size distribution sufficient to propagate the flame.
    - Is available in high concentrations.
    - Can go airborne.
- Ambience with adequate oxygen.
- Ignition source.

Primary determinants of the severity of explosion are the [23]:

- Dust's characteristic value.
- Equipment's technical design.
- Dust cloud's turbulence and expansion.
- Spatial conditions in the plant viz. relief areas, dimensions, linkages to other zones.

Hyper flammability at elevated temperatures and a large surface area make sugar dust a hazardous substance. Apart from grinding, unwanted abrasion during the transport of sugar is a source of dust. Sugar dust gets released at [23]:

- Silo and Hopper: Outlet and inlet ends.
- Conveyor Transfer Points.
- Elevators.

Both airborne and settled sugar dust can explode when present in sufficient concentrations around a hot surface or spark, both of which can spike up the temperature to inflammable levels.

Sugar dust deposits merit a separate mention:

- Finer sugar dust/particles is/are more likely to explode. At 0.063 mm, sugar particles can explode at 60 g/m^3 concentration. When available in a larger of 0.4 mm, they need at least 750 g/m^3 concentration to stimulate an explosion. Considering that the bulk density of sugar is 800 kg/m^3, any dispersed dust layer of over 0.075 mm is a potential hazard [24].

- Less than 1-mm thick sugar dust covering all the floor area can form an inflammable mixture in a plant of usual height. And because inflammable mixtures and ignition sources form concurrently, initial explosions will scatter dust and trigger secondary explosions thereby sparking off a chain reaction [23].

- Organic dust of thickness exceeding 0.8 mm creates explosion risk if it covers 5% or more of a room as per the National Fire Protection

Association (NFPA) [17]. The NFPA is an international, non-profit, and self-financed institution working to eliminate fire hazards [25].

- Dust is an insulator and retards heat dissipation when settled on hot surfaces. As a result, the hot surface becomes an ignition source. The same is not possible in dust-free ambiences [23].

Factors that can trigger a spark include:

- Friction at ball bearings, electric switch, pump, and motor [17].
- Heated surfaces, foreign particles getting caught between moving contact surfaces, and electrostatic discharge [22].

Control measures target one of the conditions that can trigger a blast. These measures also focus on building equipment, parts, and safety mechanisms which can endure the impact of the blast and obstruct its propagation to other areas of the plant.

6. ATEX Classification for Zones & Equipment

ATEX classifies areas prone to formation of Dangerous Explosive Atmosphere (DEA). Zone 20 encompasses areas where sugar dust forms DEA frequently, constantly, or for longer durations. These are [23]:

- Powder Mill and its accessory Hoppers.
- Dust Extractors' raw gas end.
- Powder Conditioners.

Sugar dust occasionally creates DEA in Zone 21 that includes [26]:

- Dust and Powder Screw Conveyors working at speeds over 1m/s.
- Grade Hoppers housing fine sugar of under 250 microns.
- Elevators.
- Screening Machines.

ATEX Zone 22 is where sugar dust does not generate DEA, or does so for short durations only [23]:

- Dust and Powder Screw Conveyors working at speeds below 1m/s.
- Grade Hoppers housing coarse sugar of over 250 microns.
- Silos, Sugar Dryers, and Fluidized Bed Dryers handling crystalized sugar.
- Dust Deposit Zones.
- Dust Arrester Piping.

Safety systems and equipment employed in sugar plants where explosive dust is present fall under ATEX Group II Equipment. Such equipment is further classified into [27]:

- Category 1 for Zone 20.
- Category 2 for Zone 21.
- Category 3 for Zone 22.

7. Explosion Controls: Preventive, Constructional, Structural, & Organizational

An ever-present guideline for effective prevention and limitation of mishaps is to operate the equipment for its intended purpose [23]. Measures instituted against sugar dust explosions can be:

7.1. Preventive Controls: Eliminate one of the factors that trigger dust explosions viz. presence, concentration, and particle size distribution of inflammable dust that can go airborne; ignition sources; and oxygen-rich ambience [26].

7.2. Constructional Controls: When it is not feasible to prevent formation of sugar dust cloud and ignition sources, constructional safeguards are essential [23]. These ensure the plant withstands the expected explosion pressure. Particularly necessary in Zone 20 [26], these limit the explosion to the internal sections of the plant or equipment.

7.3. Structural Controls: Are related to the structure and location of the plant and various mechanisms / devices such as earthing system, switches, isolation techniques and devices, and lightning protection [23].

7.4. Organizational Controls: Concern work practices for the prevention of and protection from explosions [23].

7.1. Preventive Controls

Disallowing a DEA from forming is the first step. Preventive measures entail:

A. **Restricting Dust Concentration**: Machine-produced dust and dust settled in production areas, both represent potential hazards. Measures to limit dust concentration target the production, dispersion, and settling of dust [26]:

   I. Regular cleaning.

   II. Proper ventilation coupled with production rate control.

   III. Minimizing number and area of surfaces where dust can settle.

   IV. Smooth sugar handling to lower dust creation.

   V. Adequate flow velocities, optimized piping, and appropriate entry-point design to impede dust accumulation.

   VI. Dust-proof equipment to inhibit dust release.

B. **Inertization**: Introducing inert gas into the dust-proof zone around dust-carrying equipment lowers oxygen levels. This method is not popular for handling sugar dust [23].

C. **Curbing Ignition Sources**: Comprises of:

   I. **Normally Hot Surfaces**: Surface temperature of group II equipment of all three categories (1, 2, and 3) must be below 2/3rd the least ignition temperature (350 ^{0}C) of the sugar dust cloud. For dust less than 5mm thick, the maximum allowable surface temperature is 233^{0}C (2/3rd of 350 ^{0}C) [23].

   Such surfaces include drying cabinets, radiators, heating coils, and those converting mechanical energy into heat viz. mechanical brakes, friction clutches, and deficiently lubricated shaft ducts, bearings, and stuffing boxes [23].

II. **Hot Gases and Naked Flames**: Combustion above 1000^{0}C sets up flames which produce fumes and hot gases – all three form explosive ambience. Their capacity to spread further escalates their destructive potential [26].

Instituting organizational controls viz. bans on open flames, fire, and smoking prevent naked flames formation. Welding, cutting, grinding, and burning are allowed only when following proven precautions. Sparks from cutting can fly long distances and welding beads can cover up to 10 metres [23].

To prevent flame formation during and after the completion of these operations, a fire watch is established [23]. Safeguards specific to equipment category are [26]:

a. **Category 1**: Temperature caps and isolation of flammable particles.

b. **Category 2 and 3**: Flame enclosures, surface temperature caps, and anti-flame-propagation techniques. Fire pickets surround welding and machining areas. Fires, smoking, and naked light are strictly disallowed.

Fire Watch, as defined by NFPA 101 (2018 edition), is allocation of one or multiple personnel to prevent a fire, put out small fires, informing fire fighting divisions and building inhabitants about the incident, and safeguarding public from the risks [28].

III. **Electricity / Electrical Operators**: Loose connections, closing-opening of switches, or transient currents can release electric sparks. Mechanical impact protection is necessary for light fixtures [26].

Zone 20 allows use of permitted operators (switches, motors, and connectors) only. Highest approved surface temperature in Zone 22 of sugar processing must be 75^{0}C less than smoulder temperature or 2/3rd of the ignition temperature. This works out to 233^{0}C [23].

IV. **Mechanically Generated Sparks and Hot Surfaces**: Friction, sliding movement, and impact generate sparks. Limiting relative surface velocities below 1 m/s and drive power under 4 kW hinder spark and hot surface formation [26].

Internal bearings are a liability and, if used, must be monitored for temperature and flushed as prescribed. Presence of foreign material in the equipment or machinery can form sparks [23].

Any hard material that impacts or has friction with zirconium or titanium creates sparks. Friction between aluminium and magnesium is unsafe for category 1 and 2 equipment except for alloys with less than 10% aluminium and paints with under 25% aluminium mass concentration. The same is true for iron and steel friction, with stainless steel being an exception [26].

V. **Static Electric Discharge**:

a. **Spark Discharge** does not occur if all current conducting plant equipment are linked and electrostatically earthed. Earth leakage resistance of under 10^6 ohms is helpful [23].

   Non-earthed supporting baskets within filters, isolated pipe sections inside dust separators or conveyors, and elevator buckets housed on non-conductive belts are most prone to spark discharge [23].

b. **Cone Discharge** materializes when sugar with large bulk resistivity is loaded into huge containers and silos. A discharge with potential energy greater than the least ignition energy of the air-dust mixture will ignite the latter [23].

   Bulk resistivity apart, equipment dimensions, material grain size, and flow influence the possibility of discharge [23]. Volume / bulk resistivity is the electrical resistance of a material cube of unit dimensions and is measured in ohms-centimetre or ohms-inches [29].

c. **Propagating Brush Discharge** actualizes when charge accumulates on an insulating layer in contact with a conducting layer. Using only conductive materials for making equipment prevents this discharge, which are not deemed serious enough to ignite the air-dust mixture [23].

Metal silos and pipes with insulation coating wherein sugar moves tangentially are vulnerable. Conditions enabling brush discharge are [23]:

i. Less than 9mm insulating layer thickness.
ii. Process that creates strong charges, pneumatic conveying for example.
iii. Over 4 kV breakdown voltage, and above 6 kV breakdown voltage for textile fabric.

7.1.1. Functional Solutions for Preventive Controls

Sugar plants employ the following solutions to prevent explosions [23]:

A. **Pneumatic Conveyors** work after they are totally sealed. Using them means safety engineers need to focus only on the conveyor's internals for explosion prevention actions.

B. **Mechanical Conveyors** generate dust when moving sugar crystals:

   I. **Screw Conveyor** for powdered sugar must have external bearings and mechanisms to monitor speed at the non-drive side, restrict peripheral speed to 1 m/s, and block foreign particle entry. Strict temperature monitoring of internal bearing is necessary, if used.

   Transporting sugar crystals via screw conveyors generates dust which can drop to the ground and, left un-cleaned, intensify into a hazard. Sugar crystals containing under 3% fine dust are not a risk for screw conveying.

   II. **Elevators** dealing with sugar crystals may trickle excess sugar down and spread dust in the air around them. Monitoring their speed, belt, and slip helps. Belt or bucket must not strike the housing.

   Non-sparking material is excellent for buckets [26], as is plastic for webbing [23]. Aluminium-carbon steel is not a very safe material combination for elevator and shaft.

   III. **Belt Conveyors** drop sugar dust at transfer points. Large drop heights allow sugar dust to dispense in air. Limiting drop heights and electrostatic earthing of all the conducting parts with less than 10^6 ohms of expected earth resistance lowers the risk.

IV. **Flexible Intermediate Bulk Containers (FIBC)** also called “big bags” are exposed to explosion risk at their interior when dealing with fine sugar powder or rapidly flowing sugar.

Type A FIBCs are acceptable for handling sugar crystals. Sugar powders require using type B at the very least, but Type C and D better serve the purpose. Additionally, electrostatic earthing similar to that of belt conveyors is necessary.

C. **On-Ground Hoisting Machines** are electrostatically earthed, similar to belt conveyors to avoid risks in the tanks (transmitting and receiving) and pipes.

D. **Plug Conveyors and Dense Phase Conveyors** are electrostatically earthed, similar to belt conveyors to prevent hazards to their receiving and transmitting tanks.

7.2. Constructional Controls

When preventive measures are not feasible, constructional measures are implemented [23]:

A. **Explosion Resistance**: Involves building the plant to withstand the expected explosion pressure. Such resistance can be of two types:

   I. **Explosion Pressure Resistance**: Equipment does not deform permanently despite repeated blasts reaching up to the designed explosion pressure.

   II. **Explosion Pressure-Shock Resistance**: Equipment may deform permanently but not rupture under the action of multiple blasts which escalate to the designed explosion pressure. This is usually used in practice.

B. **Explosion Pressure Relief or Explosion Suppression**: Relief mechanism uses explosion flaps, rupture discs, or non-inflammable pressure relief tools to release the excessive pressure into a zone where it cannot damage life or property.

   Pressure relief systems allow engineers to design the equipment to a reduced explosion overpressure because the said devices disallow pressure rise above the set magnitude [26].

   Suppression systems employ infrared or pressure detectors to spot the imminent explosion and douse it rapidly (in under 5 milliseconds) via extinguisher (normally sodium bicarbonate).

C. **Explosion Isolation**: Halts the spread of explosion via:

   I. **Rotary Valves**: Shut down automatically when an explosion occurs, thereby hindering the spread of the shock wave or flame to other equipment and areas.

   II. **Extinguishing Obstructions**: Identify the flame or explosion and put if off using atomized extinguishers.

III. **Relief Vents**: Most commonly used by sugar plants for explosion isolation, these may not stop the spread of explosion, but slow down its advance to the downstream sections.

IV. **Rapidly-Closing Sliders / Flaps**: Are generally installed in pipes. These shut down rapidly and hermetically seal the pipe after detectors spot a flame or explosion.

V. **Rapidly-Closing Valves**: Shut down automatically, hermetically sealing the pipe when the shock wave speed surpasses the set velocity.

7.2.1. Functional Solutions for Constructional Control

Constructional measures against explosion include [23]:

A. **Aspiration Lines** installed between filters and relief vent are designed to the filter's explosion pressure-shock resistance. Also built to the same pressure is the explosion isolation relief vent.

   Other aspiration lines operating as collecting lines must also be constructed to endure this pressure, particularly if these link to downstream fire compartments. This is because line failure will transfer explosion to these zones.

   Such a structural control works provided the piping system does not discharge or house explosive and lethal environments. Relief vents safeguard piping only against blasts inside filters. They do not clear strategic equipment such as grinders.

B. **Vacuum System (Stationary)** is coupled with multiple devices in the plant for flexible usage and, therefore, needs proper safety design. The mechanism has its:

   I. **Raw-gas Pipes (permanent installation)** made to explosion pressure resistance for the estimated blast pressure.

   II. **Filter Housing** fabricated to the explosion pressure resistance or explosion pressure-shock resistance for the predicted explosion pressure.

   III. **Isolation Equipment** such as Ventex valve positioned inside the clean air pipe.

   IV. **Raw Gas Collection Line** is disconnected, using a rapid-closing valve for example, before it gets inside filter housing.

   V. **Hoses** made of conducting material.

C. Filters are built to pressure-shock resistance for reduced explosion overpressure. Isolation techniques include employing:

I. Puncture-proof rotary valves for product release.

II. Extinguisher hurdles or relief vents for raw air take-in.

Either an explosion suppression system is incorporated into the filter chamber, or the explosion pressure is passed into open air directly or through non-flame pressure relief devices such as the Q-pipe.

Filters do not require structural protection systems if risk assessment certifies that they are immune to penetration by ignition sources. Design pressure is lower for silo-conditioning filters as the air circulates in a closed loop denying access, even unintentional, to ignition sources.

D. Powder Mills / Grinders have their grinding chambers particularly vulnerable to explosions on account of the presence of high temperatures and inflammable material (sugar dust). A spark formed out of friction between moving parts can easily set off a blast.

Design parameters are:

I. **Housing** built to maximum overpressure for explosion pressure-resistance.

II. **All Inlets and Outlets** with technical explosion isolation.

III. **Downstream Reservoir** is depressurized and made to reduced overpressure for explosion pressure-shock-resistance.

7.3. Structural Controls

Such measures relate to the building that houses the plant and the various mechanism therein. These include [23]:

A. **Fire Isolation** divides the building into numerous segments to check the spread of fire between them.

B. **Spatial Pressure Relief** such as building masonry of sufficient strength or prohibiting workstations in certain areas is necessary if constructional controls become irrelevant.

C. **Surface Design** with a 60^0 gradient to the horizontal precludes dust accumulation. When such design is not practical, the surface must allow easy cleaning.

D. **Isolation Devices** are essential for connecting conveyors that link separate / isolated building segments.

E. **Lightning Protection Measures**

F. **Earthing Systems** to pass all electrostatic discharges safely to the ground.

G. **Permanent Socket Arrangement** should have a non-detachable flap covering when unplugged. Their insertion port must be downward and not make more than a 30^0 angle with the perpendicular.

H. **Zone-compatible Electrical Equipment** that functions without creating blast or fire hazard in the zone of its location-operation.

7.4. Organizational Controls

Maintaining excellent safety practices is essential to curb the development of DEA and restrict the consequences of explosion. Organizational controls are geared towards [23]:

A. **Identification** of dangerous zones as per the relevant regulations.

B. **Maintenance & Cleaning Schedules** describe the nature, timing, and frequency of these operations. Cleaning timetable defines:

   I. Method (vacuuming or mopping) to use for cleaning the identified areas.

   II. Exact time of cleaning.

   III. Frequency of cleaning.

   Maintenance itinerary is related to:

   IV. Efficacy of technical systems for dust removal.

   V. Operation of the protective mechanism.

   VI. Avoiding mechanically created sparks.

   VII. Sealing the dust covered plant.

   VIII. Elimination of friction between moving parts.

C. **Inspection & Repair** is mandatory at three stages for equipment, regulation or control devices, and protective or safety mechanisms located in hazardous zones and those that require monitoring. These three stages are before commissioning, after repair, and periodic.

   All inspections conducted as per the inspection concept are documented. The inspection-monitoring concept specifies the type, depth, scope, and interval of inspection.

   I. **Before Commissioning Inspection** includes:

a. **Plant Inspection** by an Approved Inspection Body (AIB) or Qualified Personnel (QP) to check equipment installation, assembly, and operation. Plants that are considerably modified also need this check-up.

   QPs possessing special knowledge inspect new plants for a second time before commissioning to evaluate the utility of the explosion-protection concept and its proper execution.

b. **Workspace Inspection** by QPs having particular expertise scrutinizes how safe the workstation is from the impact of a blast by checking if the explosion-protection concept is:

   i. Factually correct.

   ii. Properly applied in the specific local zone.

   iii. Correctly mentioned in the document for explosion-protection.

   iv. Rightly followed by related organisational and technical controls.

   It also delineates possibly explosive regions and examines the propriety of zone plan enforcement as well as the appropriateness of equipment for the zone of its location-operation.

II. **After Commissioning Inspection** by the manufacturer, recognized QP, or an AIB is performed after repair to investigate if the equipment, regulation or control devices, and protective or safety mechanisms possess adequate explosion protection characteristics.

III. **Periodic Inspection** with the interval and exact procedures based on the manufacturer's guidelines, risk assessment, and operating conditions. These inspections review if:

i. Equipment, regulation or control devices, and protective or safety mechanisms are in the prescribed state and appropriately linked to each other as well as with other plant elements via acceptable out-fittings.

ii. Control, safety, and regulating apparatus operate as per relevant standards.

D. Training & Operational Guidelines are premised on the risk assessment, and educate personnel and operators on:

I. Conditions that cause explosions.

II. Operational practices for the zones with DEA.

III. Strict prohibition of flames and smoking in areas exposed to DEAs.

IV. Forbidding unauthorized personnel from entering such zones.

E. Work Clearance is essential when conducting operations that can set off an explosion. Such operations include welding, grinding, and cutting. Clearances are provided only after complying with stringent conditions as mentioned under section 7.1.C.II. “Curbing Ignition Sources.”

F. Documentation for Explosion Protection is a broad document, not restricted in scope for protection only against dust explosions. It outlines:

I. All measures to safeguard against all types of explosions based on all the identified threats.

II. Areas classified into various zones as per identified intensity of explosion risk.

III. Locations for which minimal controls apply.

Created during the planning phase, it is revised whenever fresh knowledge is available and new developments take place. Its revamp is also necessary when work-related equipment, environment, or process is altered, converted, or expanded.

8. Cybernetik Technologies Pvt. Ltd. (CTPL) Equipment for Sugar Grinding

Cybernetik Technologies Pvt. Ltd. (CTPL) has been offering customized and turnkey automation solutions to the food industry since 1989. Starting from definition and design, our technicians proceed to deployment and support for a seamless and professional experience.

Integrating safety in all aspects of its functioning, CTPL offers the following equipment for sugar grinding parts (all of SS304 and/or SS316 make):

- Fine Grinders
- Screw Conveyors
- Bag Tipping / Dumping Stations
- Storage Silos
- Silos with Feeder

Fine Grinders (100 to 2000 kg/hr. capacity) are ATEX- and cGMP-compliant. The housing is built to withstand 12 bar pressure. Designed for dust-free, silent grinding of explosion prone (high kst) material, the grinder can deliver up to 30 µm fine powders while retaining flavour.

Screw Conveyors (100 to 6000 kg/hr. capacity) adhere to ATEX and cGMP norms.

Bag Tipping / Dumping Stations (max. 3000 kg/hr capacity) have a de-dusting mechanism to prevent sugar dust from forming a dangerous explosive atmosphere (DEA). The equipment complies with ATEX and cGMP benchmarks.

Storage Silos (0.5 to 50 m^3 capacity) conform to cGMP guidelines.

Silos with Feeder (0.25 to 1 m^3) observe cGMP standards and have an agitator with gear motor to mix material in the silo.

Magnetic Grills bar metallic particles from entering fine grinders and silos. Fine particles trapped between moving surfaces can set off a spark.

9. Final Comments

Conventional wisdom says eternal vigilance is the price for liberty. It is also the price for safety. Although safety is an integral component of all manufacturing processes, it becomes even more important when handling explosive material such as sugar dust.

Setting up preventive, constructional, structural, and organizational controls is necessary but not sufficient. What makes them sufficient is continuous scrutiny to examine their efficacy – eternal vigilance.

As such, organizational controls must be interpreted in the widest possible sense, for it is these measures that create a safety-first work culture.

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CYBERNETIK TECHNOLOGIES
AUTOMATION

Contact Us

Cybernetik Technologies – Automation

Gat No. 365, Urawade, Mutha Road,

Opposite Indo-German Technology Park

Pune, India – 412108

+91 20 679 09600

sales.automation@cybernetik.com

automation.cybernetik.com