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SAFETY AND SANITARY REQUIREMENTS IN THE SUGAR INDUSTRY 1/

by

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SUMMARY

The value of good housekeeping in any factory is related both to the sanitary value and also to safety of personnel.

Safety is considered in relation to personnel - operating staff and visitors on the one hand and equipment on the other.

Special mention is made of clothing worn by personnel.

Equipment protection is related mainly to mechanical conditions, electrical and fire hazards.

Special hazards with respect to hot liquids in open tanks are noted.

Sanitary requirements involve process sanitation and effluent control.

Neighbourhood pollution by solid, liquid or gaseous effluents are progressively coming under the control of national laws and regulations aimed to preserve the well being of the community and cleanliness of the environment.

The sugar industry has a civic duty and leadership responsibilities in these respects as well as legal obligations.

General Safety Factors

Good housekeeping in a sugar factory is important both from the point of view of personnel safety and also because hygeinic conditions are necessary in order to minimise sugar losses. There is adequate hot water and a good steam supply available in any sugar factory and all waste materials and surfaces can be cleaned with either one or the other. Floors, walkways, steps and all places of access should be regularly cleaned with hot water hose and brooms. Any spillages of molasses or syrup should be hosed away immediately as they can represent dangerous areas for persons walking over that area.

The inter-action of safety and good housekeeping cannot be over-emphasized. A factory which is obviously dirty and for which cleaning is inadequate is invariably one in which accidents can be expected to happen more frequently as lack of care becomes the general atmosphere.

Safety can be considered from the point of view of operating personnel themselves and also from the point of view of the equipment itself.

A sugar factory does not suffer from problems of hazards related to the handling or processing of dangerous chemicals. The product is in fact a food and all materials in process can be taken into the mouth in small quantities without being a danger to health. In fact it was the pride of old time factory managers that they could control the operations quite well simply be applying the senses of sight, sound, touch, taste and smell. All products in process are likewise of such a temperature that they do not pose a major hazard from the point of view of scalds and burns. Steam is probably the most hazardous material from this point of view.

All steam equipment operating under pressures above atmospheric require certification to assure that they meet specifications set out by appropriate engineering authorities. Design of the thickness of metals used in construction likewise need to meet specifications well defined for this purpose.

Compressed air is also generally handled under pressures requiring the certification of storage vessels and equipment used in its generation.

Falls into tanks of hot liquids can result in fatal consequences accentuated by the stickiness of sugar syrups and molasses. Adequate care should be exercised to prevent operators from being exposed to such hazards. Fortunately cold water is a very effective method of dealing with such accidents if they should happen.

Fire is something which is not common in sugar factories but nevertheless should always be anticipated as a potential hazard. Two areas are more prone to fires than elsewhere. These are the furnace area of the steam generator station and the sugar store. In sugar cane factories the bagasse storage area is always a potential hazard and dust dispersed in the atmosphere could become explosive if it is dry and in the right proportions with hot air. A fire in a heap of bagasse is difficult to extinguish once it gets a good hold. Prevention is the best way to deal with these fires. Buckets of water easily available at strategic positions help to meet this requirement. Bagasse dust is rather easily ignited and a fire can run very rapidly along a trail of dust to a neighbouring heap and so generate a larger fire.

Good housekeeping in the bagasse loft helps significantly in the prevention of potential fires. It should be axiomatic that smoking by personnel in the bagasse storage area should be prohibited or at least severely restricted.

Electrical fires are uncommon but nevertheless possible. Electrical equipment has its own safety and codes requiring a necessary standard of installation and should be carefully followed. Employees need to be instructed not only in the avoidance of contact with live electrical equipment but also in the first aid treatment of electrical casualties especially in safe release and resuscitation of a person rendered unconscious by electric shock.

Raw sugar stored in bulk has been known to burn with disastrous consequences. One major fire of this nature was believed to have been initiated by sparks from the torch of an electric welder operating on the

walkway along the top of the heap. The hot beads of weld metal fell into the heap but ignition was not immediate but delayed until after personnel had left the site. The conflagration which followed was a major disaster from the point of view of material destruction but fortunately not associated with harm to personnel.

Sugar dust is always dispersed in the atmosphere in the vicinity of sugar stored in bulk and is a potential explosion hazard. Every precaution to avoid generation of an explosion should be taken including the prohibition of smoking in the vicinity.

The safety of personnel simply walking though a sugar factory needs attention and in the more developed countries it is now an offence for any person to be walking in the factory area without a safety helmet. The author preserved a felt hat for many years as a reminder of a shower of welder's sparks which had obviously been minute pellets of molten steel.

An executive colleague narrowly missed being hit on the head by a falling hammer while walking through a sugar factory during off-season maintenance activities. These personal examples could no doubt be duplicated by others who have been engaged in operational activities in sugar factory areas. The introduction of the compulsory wearing of safety helmets is a worthwhile protective measure but for effective implementation requires the cooperation of both management and operating personnel. It is just as important for the manager to wear a safety helmet when walking through the industrial area as it is for the most junior operating personnel.

Molasses storage tanks can be a source of danger. Chemical reactions can start in molasses which are believed to be related to the reducing sugar (or hexose) and lime content and substantial gas generation develops which results in excessive frothing. Once this reaction starts it is impossible to stop.

On occasions it has been known to go with explosive violence and rupture of the storage tank. The more a molasses is exhausted of its sucrose the more likely it is for this decomposition to take place. Boiling C

massecuite under low vaccum conditions has also been thought to be the initiator of this decomposition. The molasses froth becomes brown and develops a reddish hue.

Recently another molasses decomposition reaction has been identified but is not always readily differentiated from the reaction described above. Molasses can undergo an exothermic degeneration reaction which when once initiated may proceed with explosive voilence. This reaction is the one which is also experienced in the caramelisation of sugars. It results essentially in the liberation of water vapour and carbon dioxide and the product is a highly carbonised caramel-type residue. Sucrose develops such a reaction at temperatures above about 200°C, the melting point being 186°C. Glucose and fructose likewise develop strongly exothermic reactions at temperatures above their melting points.

Molasses which is syrupy mixture of sugars seems capable of developing this reaction at a much lower temperature - possibly as low as 80°C. Explosions with fatal results have been known to occur in massecuite cut-over lines between pans which were being cleaned out with high pressure-high temperature steam. Only low pressure steam should be used for this purpose, in fact high pressure steam usage should be prohibited.

Refined sugar when stored in silos in bulk is probably the most potentially explosive material in association with the dust in the atmosphere of the silo. Refined sugar coming from a sugar drier is both hot and dusty and a potential explosion hazard. Consumption white sugar which may not be of the best refined quality is nevertheless also an explosion hazard in hot and dusty situations which are common at the exit of drying equipment. Actual explosions seem to be rare, possibly because most of the near-white sugars are handled in ambient atmospheric conditions of high humidity whereas refined sugars are more frequently manufactured under conditions of high technological development.

Equipment needs attention to protect operating and other personnel from possible harm. Moving machinery in general always requires protective measures, the following are danger points which have been observed at one

time or another in various places:-

1. Recipiocating steam engines
2. Engine fly wheels
3. Screw conveyors - death in these is very horrible
4. Unprotected conveyors of any type
5. Walkways and steps with handrail only on one side or perhaps none at all
6. Insufficiently guarded electric fans
7. Pulley sheaves for wire ropes - especially when handling cane trucks to or from the carrier
8. Ties worn by visiting dignitaries
9. Machine shop grinders
10. Hot water drips, steam leaks, syrup or molasses drips
11. Oil on floors
12. Bad illumination
13. Pieces of machinery left lying around the floor

A special item worthy of mention and of particular relevance to sugar factories in developing countries relates to the clothing worn by operatives. National costumes are very good in their right place, but that is not in a sugar factory especially in the proximity of moving machinery. Any type of loose clothing should be avoided. Even the wearing of a tie can be hazardous and has been known to result in accident in the proximity of rotating machinery in a machine shop, it could equally as well have happened elsewhere in the proximity of moving machinery.

A. Sanitary Measures

Sugar is a substance which decomposes very easily under the influence of bacterial infection. This is particularly the case with juices and low concentration solutions. Harvested cane and cane juices are probably more liable to infection than beet under corresponding conditions owing to the generally higher ambient temperatures. Sugar cane becomes infected with leuconostoc bacteria as soon as it is cut. Mechanical "chopper" harvesting has accentuated this effect.

Cane should be transported to the factory with the minimum of delay. Sometimes delays may run to 7 or 8 days which can account for a loss of as much as 10% of the sugar initially in the cane and is believed to be one major reason for the apparently low sugar content of cane in developing countries.

Juices during the extraction operations are not only infected themselves but also infect surfaces they contact. Hot inhibition if properly carried out helps to minimise this infection, but it is still necessary to disinfect.

Leuconostoc grows along milling trains, in juice gutters and pipes and especially on and under juice screens. The steam hose is one of the best means for keeping these surfaces clean, but it must be used regularly and frequently. Disinfection should also be meticulously carried out during shut-down maintenance periods, for which formalin or hypochlorite solutions are effective.

The tendency to extend the time between shut-down periods is not in the best interests of good sanitary conditions.

The wet wastes flowing in drains from a sugar factory represent a source of pollution elsewhere unless measures are taken for treatment. The amount of sugar they contain may not be enough to make it an economical proposition to recover it as sugar, but it is enough to become very unpleasant as soon as fermentation sets in. It may be disposed of by aerobic or anaerobic treatment. In the former case it is treated in much the same way as town sewage in an aerated sludge plant and activated sludge from sewage is a very useful catalyst. The sewage from factory employees and neighbouring housing units can serve as a source for this purpose. In fact there is merit in associating a town sewage disposal unit with a sugar mill liquid waste disposal treatment plant.

If anaerobic treatment is to be used this must be done in closed tanks operating in much the same manner as septic tanks or household sewage. Again the addition of sewage is an aid to decomposition.

B. General Housekeeping

Brass-work around evaporator bodies and pans should be kept well polished. The evaporator operator should have ample time to look after his area and pansmen can usually do likewise. To a certain extent brass-work is being replaced by stainless steel mountings which require less polishing, but should still be kept clean.

Engine-drivers should keep their engines clean and plant operators in general should be responsible for the cleanliness of the equipment they are handling. This is all part of good housekeeping.

One of the most difficult areas around a sugar factory to keep clean is the lime mixing area and special provision needs to be made for this by way of adequate hosing facilities and recognition of responsibility for cleanliness by carrying out the operation.

C. Sugar Factory Effluents

The effluents from a sugar factory are:-

1. Cane fibre or beet pulp
2. Defecation mud
3. Carbonatation and/or sulphitation muds
4. Waste active carbon sludge
5. Ion exchange resin regenerant and wash fluids
6. Molasses
7. Condenser water
8. Floor washings
9. Stack gas from steam generator furnace
10. Stack gas from lime kiln
11. Bagasse ash from furnaces

Any one factory may not produce all eleven listed effluents but most will be represented, and some may have others. Cane fibre or beet pulp are mostly put to good use, as also is molasses. Defecation mud should be put to good

use as fertilizer. Floor washings are possibly the most difficult to deal with because of their relatively high sugar content and their intermittent and largely unpredictable character. Condenser water represents by far the largest volume of effluent but its effect can be minimised by recycling with appropriate treatment. The pollution from stack gases from bagasse fired furnaces is too often overlooked. This does require arrestors or soot and fly-ash separators.

Because sugar cane factories are usually located away from more populated areas there is a tendency to turn a blind eye to much of their polluting effects. As population densities increase this becomes more objectionable, and also factories are themselves becoming larger in size and hence producing more polluting effluents. There are no effluents which cannot be dealt with by spending money on appropriate equipment and many of the effluents can be made to more than pay for their processing.

Questions:

1. What safety measures are considered minimal for a sugar factory?
2. In what ways do safety and good housekeeping inter-relate?
3. How should polluting effluents be dealt with?
4. Should a safety code be formulated specifically for use in the sugar industry?

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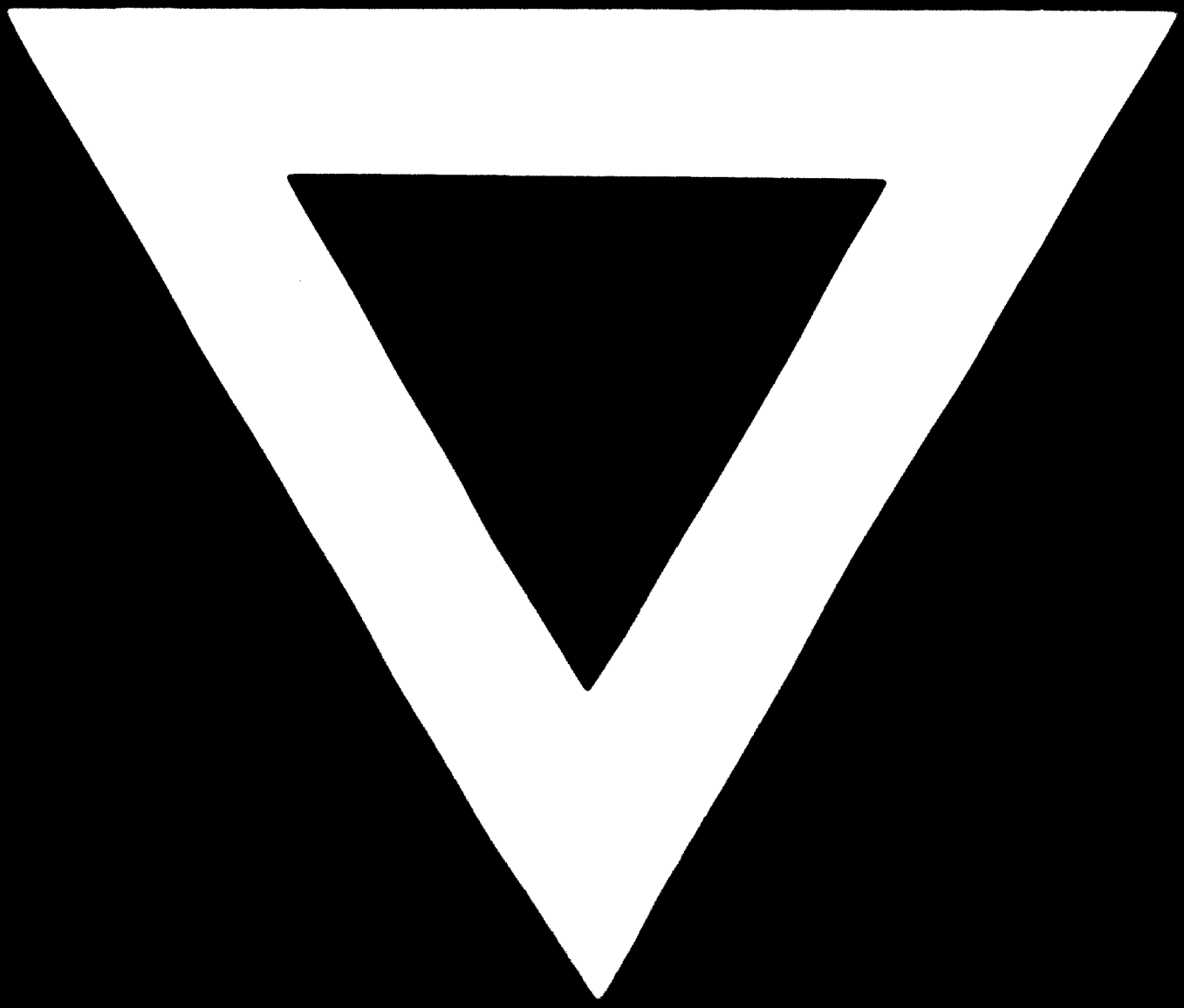

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