Release of SO_2 from a cellulose factory caused by an electrical power failure.

16 August 2006

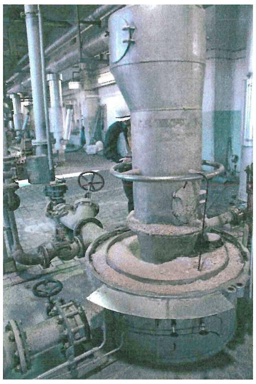
Germany

Realease
SO2
Electrical power failure
Alarm system
Modifications
Safety management system

THE FACILITIES INVOLVED

The facility involved in this incident is a cellulose manufacturer, producing cellulose by the sulphite-process in which wood chips are boiled in a cooking acid consisting of a combination of free sulphur acid and sulphur acid bound as magnesium bi-sulphite.

The unit involved was one of the reactors in which wood chips were treated with cooking acid.



Hubert Kerber, TÜV-Süd

THE ACCIDENT, ITS CHRONOLOGY, EFFECTS AND CONSEQUENCES

The accident:

The consequences of an electrical power failure at a cellulose manufacturer show the importance of understanding how particular processes and installations depend on specific infrastructure elements and utilities. This requires a systems-based approach to hazard identification.

The installation produced cellulose from wood chips by the sulphite process in which the wood chips are heated in a reactor containing sulphurous acid which is enriched with SO_2. (sulfur dioxide). The reactor was charged with wood chips at the top of the reactor. After charging the lid was closed, the acid added and the reactor heated. During the heat-up phase the lid of the reactor was kept sealed using water pressure maintained by an electric pump. Once sufficient pressure had been built up within the reactor the seal system could be switched over to "self-sealing" using the reactor pressure.

The incident occurred when a reactor was in the heat up phase and there was a complete power failure on the whole site. This meant that the water pressure could no longer be maintained and the seal of the reactor failed; this lead to a release of SO_2 into the cellulose boiler house. The release of SO_2 to the atmosphere was sufficient that it was noticed by a passing motorist who alarmed the police and fire brigade.

Fortunately the reactor was at sufficient pressure to maintain the seal under its own pressure and the actions of an employee to switch over to "self-sealing" mode reinstated the seal.

The investigation of the accident showed that there was a lack of awareness about how vulnerable the electrical power supply was to power-outages, and in particular that one failure could cascade through the whole system. It also showed the need to be aware of how infrastructure and utilities are linked together and that individual failures can lead to the breakdown of whole systems.

The consequences drawn from the accident are to modify the sealing system so that nitrogen is used to maintain the pressure. In addition the emergency planning should take account of the potential release from the cellulose reactors as previously only the SO_2- storage had been considered as a potential source of a SO_2 release. Generally improvements needed to be made in the company to improve the handling of hazardous incidents.

Consequences of the accident:

The failure of the reactor seal due to the electrical power failure led to the release of ca. 100 kg SO_2. No injuries were reported, There was no damage to property recorded, however the costs to the company of dealing with the incident were put at around € 170 000.

The European scale of industrial accidents

By applying the rating rules applicable to the 18 parameters of the scale officially adopted in February 1994 by the Member States' Competent Authority Committee for implementing the '*SEVESO II*' directive on handling hazardous substances, and in light of the information available, this accident can be characterised by the four following indices:

The parameters composing these indices and their corresponding rating protocol are available from the following Website: http://www.aria.developpement-durable.gouv.fr

The "dangerous materials released" index is rated at 1 due to approximately 100 kg SO2 released (parameter Q1).

The accident had no human, environmental or economic consequences.

THE ORIGIN, CAUSES AND CIRCUMSTANCES SURROUNDING THE ACCIDENT

The causes of the accident lie in two areas: a) the electrical power supply and b) the means of maintaining the seal of the reactor.

a) Electrical power supply

The 110 kV power supply from the power supply company was transformed to 20 kV and transferred to the works' distribution bus via 5 earth cables in two channels (2 cables and 3 cables). The distribution bus was separated into a supply and a demand side, also it was divided into two stations corresponding to the two channels of 20 kV supply. Additional energy was produced by a number of steam turbine generators; two attached to Station1 and one attached to Station 2.

Under normal operating conditions both sides of the distribution bus were coupled and there was a balanced supply and demand situation. If the machines connected to Station 2 were not operational then the supply from the steam turbine attached to this station was supplied via the two (supply and demand) 20 kV busses to the machines connected to Station 1. However this meant that the meters for determining the power supplied by the power supply company (which were attached to the supply side of the bus in both station 1 and 2) gave false readings in favour of the energy supply company. Thus, under these operating conditions it was necessary to open the connection in the supply side between Stations 1 and 2.

Modifications and enlargement of the production machines on a large scale (e.g. 3 new 900 kW motors) had been carried out. On the day the power failure occurred production was running from Station 1. There was an increased demand on Station 2 due to the start-up processes taking place and the extremely large current demand for these very large units. This led to a rapid increase in demand and the triggering of the circuit breaker and the supply point for Station 2. This meant that the complete demand was placed on the supply point for Section 1. This demand could not be met and the circuit breaker was triggered, which meant that the supply from the power supply company was cut off. The company's own supply via the steam turbine generators then collapsed due to too low frequency and voltage, resulting in the whole facility being without power.

The preventative maintenance and the highly developed load shedding system, which could not react fast enough, were unable to prevent the total blackout.

The changes in the power demand due the enlargement of the facility were not considered within the management of change

b) Maintaining the seal of the reactor

The reactor was charged with wood chips at the top of the reactor. After charging the lid was closed, the acid added and the reactor heated. During the heat-up phase the lid of the reactor was kept sealed using water pressure. Once sufficient pressure had been built up within the reactor the seal system could be switched over to "self-sealing" using the reactor pressure.

The incident occurred when a reactor was in the heat up phase and there was a complete power failure on the whole site. This meant that the water pressure could no longer be maintained and the seal of the reactor failed; this lead to a release of SO_2 into the cellulose boiler house.

The method chosen for maintaining the seal in the heat-up phase was dependent on the electrical power-supply to drive the pumps which maintained the water-pressure. The possibility that the electrical power-supply could fail completely during the heat-up phase had not been considered. The interdependence of utilities for the safe operation of the process was beyond the scope of the hazard identification process.

ACTIONS TAKEN

An immediate decision was that the coupling between the supply busses for Stations 1 and 2 should remain closed. This no longer presented a metering problem as the metering was now carried out at a point not connected to the supply busses.

The method used to maintain the reactor seal was converted to be completely nitrogen based. A nitrogen generator with a storage tank was installed together with an additional gas bottle supply for the event of a technical defect or electrical power failure.

Modifications were also made to the alarm system to take account of a potential SO_2 release in the reactor hall. Previously to the event only SO_2 releases from the bulk storage of SO_2 had been considered. The procedures for notifying the emergency services in the event of a release were also improved.

The safety management system was also amended to take account of the experiences gained during this event.

LESSONS LEARNT

Utilities (water, gas, steam, electricity) may be highly interdependent. The failure of one of these, particularly electrical power may have knock on effects in other systems. Only a systematic approach to hazard identification together with an understanding of how the utility supplies actually function will enable an operator to identify the potential for any further consequences.

The reliability of the electrical power supply for facilities handling large quantities of hazardous substances is often not considered as a safety relevant aspect.

Modifications in one area of the facility may have consequences in quite separate parts of the site. Start-up of large equipment places extraordinary demands on the utilities and possibly other resources.