

## Summary of the investigation report

<p>Accident</p>	<p>Explosive detachment of a pulp storage tank roof at a fluting mill in Kuopio on 4 November 2024</p>
<p>Summary of the accident and the results of the investigation</p>	<p>Mondi Powerflute Oy is a semi-chemical fluting mill with a production process based on ammonia. A similar process is not known to be used elsewhere in Finland. An extensive upgrade was carried out at the mill between 2021 and 2023, and it was completed in November 2023. The mill is subject to Tukes's supervision. Approximately 230 employees of its own and employees of several subcontractors work at the mill.</p> <p>The mill's board machine had operational issues in the morning on 4 November 2024, and the machine stopped. It was decided to interrupt and shut down pulp production for the duration of the downtime. At 11:56 a.m. on the day of the incident, an explosion and an uncontrolled increase of pressure occurred in the pulp storage tank at the end of the shutdown of the fibre line. As a result of the explosion, the pulp storage tank's roof was detached, and it landed on to the roof of the adjacent mill building, causing damage. Loose pieces also landed on to the ground around the mill area. The accident did not cause any personal injury.</p> <p>The immediate cause of the accident was gas combustion and sudden pressure increase within the pulp storage tank. Hydrogen was formed in the tank during the process, and it reached an explosive concentration in the gas mixture with ammonia. The gas mixture was most likely ignited by a static spark. The changes to process chemistry after the mill upgrade and the microbiological conditions in the white water system increased the formation of hydrogen and hydrogen-ammonia gas mixture in the process. The accident was also affected by the shutdown conditions of the fibre line and the structures of the white water system and pulp storage tank.</p>
<p>Measures proposed by the investigating team to avoid similar accidents</p>	<p>The investigating team proposes the following measures to avoid similar accidents. The recommendations are general, concerning the entire sector.</p> <p>Recommendations related to technical systems:</p> <ul style="list-style-type: none"> <li>- In pulp processing in the paper and board industry, the risks associated with microbial activity and the possibility of the occurrence of bacteria producing flammable gases (such as hydrogen) must be identified and assessed.</li> <li>- From the viewpoint of the normal operation of the mill, process safety and explosion risk assessments may not apply in exceptional situations such as during a downtime. In exceptional circumstances, situation-specific risk assessment may be needed.</li> </ul>

	<p>Recommendations related to the organisation:</p> <ul style="list-style-type: none"><li>- The chemical plant must have sufficient information on the material properties of chemicals and the reactions between chemicals that are essential for process safety.</li><li>- As part of its risk assessment, the operator must also identify the process safety risks caused by chemical and biological hazards and microbiological conditions.</li><li>- Significant changes in the technical and operating methods of the chemicals plant must be handled through a systematic change management procedure. Disruptions occurring in the implementation of changes and their causes must be determined systematically.</li><li>- If it is possible for an explosive gas mixture to form in a space or a storage tank, preparation for the risk of explosion should be taken into consideration in the construction of the space or the tank.</li></ul> <p>Recommendations related to measures taken by a public authority:</p> <ul style="list-style-type: none"><li>- SFS-käsikirja 59 "Räjähdyksvaarallisten tilojen luokittelu. Palavalt nesteet ja kaasut" (SFS, 2022, English: SFS Manual 59: "Classification of explosive atmospheres. Flammable liquids and gases") does not comment on microbiological gas formation as a source of the risk of explosion. The matter should be examined when the manual is next updated.</li><li>- Tukes's supervision should pay attention to assessing the process safety risks caused by microbiological conditions in the paper and cardboard industry.</li><li>- Tukes's supervision should pay attention to recurring disruptions and unplanned shutdowns of the plant after significant changes and to investigating their causes.</li></ul>
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