Explosion during primary explosive process

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1. Brief description of the accident

1.1 Date and time: Wednesday, June 12th, 2002, 8:58 a.m.

1.2 Accident location: Detonator Plant, Miyazaki, Japan

1.3 Short description: Explosion occurred during the granulating and drying process of DDNP based primary explosive. Exploded amount was approximately 2.6Kg.

1.4 Injuries: No injuries

1.5 Damage: The granulator was burned and the dry conveyor was damaged by deflagration and detonation of DDNP based primary explosive. Windows, walls and roofs of this room were also damaged. There was no damage to the adjacent manufacturing rooms and outside the plant.

2. Company

2.1 Company name: Asahi Kasei Chemicals Corporation

2.2 Office address: 12F Arca East, 3-2-1 Kinshi, Sumidaku, Tokyo, Japan

2.3 Phone & Fax: 0081-5610-6080 (phone), 0081-3-5610-6088(fax)

2.4 Contact: Takaaki Torikai, SHE Manager, Explosives Division

3. The material involved

3.1 Type: Primary explosive (Used for electric detonator)

3.2 Quantity: The quantity and position of primary explosive are as follows.

(1) Inside of the granulator: Approximately 1.0 Kg

(2) On the dry conveyor: Approximately 1.5 Kg

(3) Inside of the hopper of the measurement device: Approximately 0.1 Kg

3.3 Composition and Sensitivity of primary explosive: See Table 1.

Table.1 Composition and Sensitivity of the primary explosive

Material		Wet	Dry
		Composition (wt%)	
DDNP (Diazodinitrophenol)		42.69	49.84
$KClO_3$ (Potassium chlorate)		42.69	49.84
Water-soluble cellulose ether (Binder)		0.09	0.10
Powder for preventing static electricity		0.02	0.02
Ethanol / water (wt%: 50/50)		14.51	0.02
Sensitivity	Drop-Hammer test	Grade 1 (JIS)	Grade 1 (JIS)
	Friction sensitivity	Grade 1 (JIS)	Grade 1 (JIS)

4. Weather and Temperature of the date

4.1 Weather: Cloudy

4.2 Ambient Temp: 24.2 degrees of Celsius

4.3 Humidity: 71% RH (Nobeoka Local Metrological Observatory, 9:00 a.m.)

4.4 Site Temp: 50 degrees of Celsius inside the granulating and drying room at the accident

4.5 Site Humidity: 71% RH in side the granulating and drying room at the accident

5. Sequential outline of the accident

1. A supervisor and two operators checked the mixer in mixing room, and the granulator, the dry conveyor in the granulating and drying room. No abnormalities were found and operation was started. Operators were checking the status of machines by remote controlled TV-monitor and small windows that were located at the concrete wall.

Photo.1 Granulator

Photo.2 Dry conveyor

2. Operator A started first mixing process on that day (Approx. 3.6Kg).
   After operator A confirmed that Wet-primary explosive mixtures were removed from the distribution equipment to the granulator, and he started to operate the granulator.
   Dry- primary explosive were reached at the end of the dry conveyor and the measurement device was started. Measured primary explosive was carried to the takeout room.

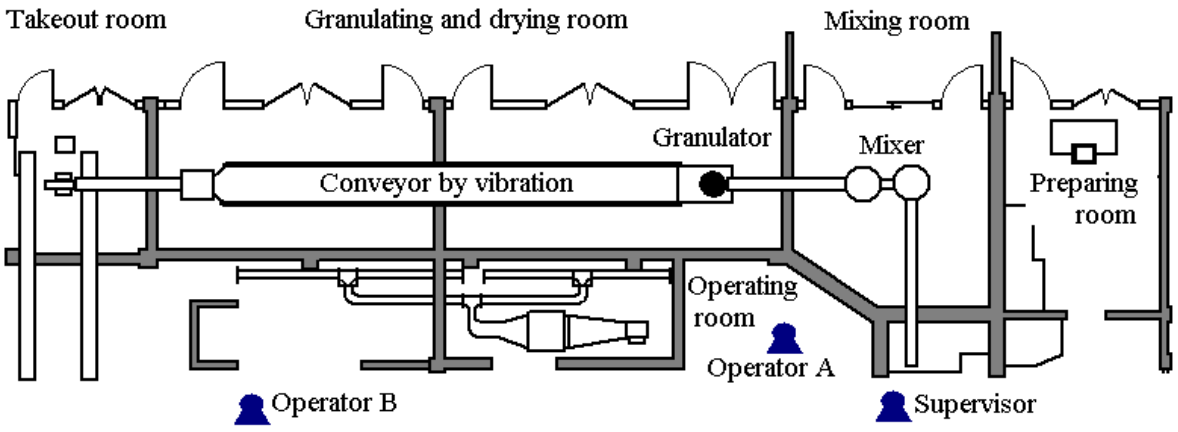

Figure.1 Layout view of the accident place

3. When a series of the process was smoothly going on, an explosion occurred in the

granulating and drying room at 8:58 a.m.

At that time, a supervisor was going from preparing room to operating room, operator A was checking the status of granulator through a small window, and operator B was carrying Dry-primary explosive to the temporary storage place.

6. Injuries / Damages

6.1 Injuries: No injures

6.2 Damages: The granulator was burned by the combustion and the dry conveyor was damaged by detonation of primary explosive. Windows, walls and roofs of the granulating and drying room were also damaged.

(1) Neighboring district: None

(2) Granulating and drying room: Partially destroyed (See Photos 3 and 4)

Photo.3 Granulator

Photo.4 Outside view of the granulating and drying room

7. Analysis and reason for the accident

7.1 Analysis of explosion beginning point

Various facts and inspection data of the accident were checked, and the analysis was performed to obtain explosion-beginning point because the accident occurred continuous production process of primary explosive.

As a result of the analysis, we estimated that Wet-primary explosive ignited around the granulator, then the fire propagated to primary explosive on the dry conveyor. The state of combustion was changed to deflagration, and finally detonation was occurred.

(1) Three detected signals were remained in control unit and there were time lag approximately 170 milliseconds. First signal was detected by fixed safety device under the granulator. Another two signals were detected by prepared response switch for measurement device at the end of dry conveyor and response switch in a crossing barrier between drying room and next takeout room.

(2) Wet-primary explosive in granulator burned out. The surface of equipment around the granulator and on dry conveyor near granulator was caked with soot.

The soot decreased at the center of the dry conveyor, and there were marks caused by

deflagration and detonation on the center and end of dry conveyor. The dents of plate at the end of conveyor (near measurement device) were bigger than the plate of dry conveyor around the granulator.

(3) Wet-primary explosive can detonate by large shock (e.g. 6-cap detonator) even if a proportion of water content is 20 weigh percent.

7.2 Result of analysis

The Fault Tree Analysis carried out to determine the cause of the accident. Moreover, various kinds of test data have been obtained and evaluated under the instruction of experts with static electricity outside the institution (H. Izumi, Technology Institution of Industrial Safety).

In order to analyze, the continuous production process in granulating and drying room was divided 7 parts and we had verified all factors.

In consequence of analysis in detail, two possible causes were presumed.

(1) One of parts of the dry conveyor was made by polyvinyl chloride (PVC), and the crack was generated during the long-term operation for about 37 years. The residue of primary explosive was remained inside the crack even though the cleaning with water after each manufacturing operation was done.

In the bended part, the crack of PVC gradually grew and finally one piece of PVC was separated and became two pieces. The residue of the explosives charge was ignited by the impact and friction between the two pieces of PVC and the combustion, deflagration and detonation occurred.

(2) The stopper of the equipment to supply Wet-primary explosive mixtures was made by iron and synthetic resin, and the environmental condition with high temperature and humidity during the long-term operation corroded iron. Generated rust fell in bowl for granulator, and was mixed with primary explosive. Because the sensitivity of primary explosive contained rust became higher, the ignition by impact and friction between primary explosive and the rusts occurred in the granulator, and the combustion, deflagration and detonation occurred.

The daily check and cleaning of equipment was done, but the thorough check from the superannuated point of view was not enough.

8. Action to prevent recurrence of the accident

The actions are carried out to prevent recurrence of the accident as follows.

(1) The part made by PVC was eliminated and replaced with the stainless steel. It is made with just only one plate, not using adhesive part.

(2) The parts that can be the cause of rust were improved.

(3) Improvement of inspection system for equipments was done.

(3) Reeducation to operators concerning the dangerous potential of primary explosive powder residue inside the parts and the importance of thorough cleaning of equipments.