

OIL INDUSTRY SAFETY DIRECTORATE

NOIDA

Case Study: Coker Unit Incident during un-heading operation (semi-automatic) at one Indian Refinery

V.J Rao / M. Gupta

INCIDENT

- The Delayed Coker unit of an Indian Refinery was operating smoothly at the time of incident. Coke drum was taken offline after switch over at around 3:15 AM in the night shift of previous day as a part of routine activity.
- This was followed with steaming & water cooling followed with water draining of the coke drum as per normal procedure. After completion of water draining, the un-heading operation was started at around 11:15 AM in the morning shift. After the un-heading of top cover of the coke drum, the un-heading of bottom cover was in progress.
- During the process of un-heading of bottom cover, the shot coke and hot water suddenly gushed out and spread over the platform due to which the two persons working in the same platform sustained superficial burn injuries and were discharged within 48 hours after treatment. The hot water also spilled over to the ground level due to which the two persons standing below at ground level also got about 65% burn injuries and later on succumbed to their injuries.

Analysis and Conclusion

Reconstructed sequence of events

- a) Coke drum was taken offline after switch over at around 3:15 AM in the night shift.
- b) Steaming was started and continued for around 1.5 hours followed by slow water cooling in night shift.
- c) Fast water cooling started at around 05:45 hours and continued up to 09:15 AM.
- d) The draining was started at around 09:15 AM and continued up to 11:00 AM. Based on the panel officer observation, there was only marginal built up of water level in coke maze after one hour of normal draining time. The panel officer informed field shift in-charge to check for draining of water.

- e) Due to poor visibility on that day, the completion of draining through drain to maze line could not be properly assessed by the field shift in-charge. There is no other alternate drain line to check for proper draining.
- f) During the draining process, the temperature of drain line was constant at around 98 Deg. C. As per their standard operating procedure of the refinery for DCU Reactor un-heading one of the parameter to ensure completion of draining is that the cokes drum bottom temperature should be in the range 100 to 120 Deg C. This indicates that the draining was not proper as the temperature should have risen after completion of draining.
- g) However, the operations team decided to go ahead with un-heading of the valve. As some entrapment of water was expected, the contract workers in the vicinity were verbally informed to stay away from the area.
- h) After top cover un-heading and checking of coke drum level, the field officer along with operator and contract worker proceeded for bottom cover un-heading. On unclamping of Grayloc connector and retracting of the Grayloc carriage and feed line, normal water draining was noticed which stopped after 4 to 5 minutes. Subsequently, the bottom cover was lowered. A small quantity of coke and water drained out from the 1 feet gap between the coke drum flange and water. After lowering of the bottom cover, it was latched. It was noticed that no coke was coming out from the coke drum at that time.
- i) Just in the beginning of next sequence during un-heading i.e. bottom cover swing operation, the shot coke and hot water suddenly gushed out and spread out in the switch deck platform. Some of the shot coke and water spilled over to the ground level near the staircase area adjacent to the lift.





Shot Coke and water spilled on the Switch Deck Platform

- j) Two persons at switch deck platform sustained superficial burn injuries and two persons at ground level sustained approx. 65% burn injuries.
- k) Based on the observations of operating team, there was excessive shot coke in the coke drum as compared to their previous experience, which may affect smooth draining operation due to clogging of coke drum inlet distributor. To reduce the shot coke generation, there is no mechanism to review the asphaltene content in the coker feed blend, which is one of the contributors in excessive shot coke generation along with other operating parameters like coke drum pressure, heater coil outlet temperature and recycle ratio. However, lab results show that the asphaltene content is checked only on monthly basis.
- l) The two persons at the ground level were not connected to coke drum un-heading operation and were moving in the premises in connection with other maintenance jobs. There was no barricading at the ground floor to restrict the movement of personnel in the coke drum area during un-heading operation. There were also no barriers at the switch deck to reduce the spillage. There was a hooter and warning lamp which was operated during the un-heading. However, there was no CCTV coverage in this area at ground floor.

m) The safety shower at the ground level was not available at strategic location.



Safety shower location

Root CAUSES

- The operating team could not make proper assessment of completion of draining based on the available indications. The operating team assumed that the draining has been completed, but in reality the water was not fully drained out.
- As a result, shot coke and hot water suddenly gushed out during the un-heading operation and spilled over at switch deck platform at 20M elevation and at ground floor adjacent to the lift, which resulted in superficial burn injuries to two persons at switch deck and approx. 65% burn injuries to two persons at ground floor.
- Although the hooter was operated during coke drum un-heading to alert the manpower working in other activities of the unit, the areas was not physically barricaded.
- The contract manpower workings in the unit (but not involved in jobs in coke drum area) were not properly sensitized about the critical operational activities in the unit and the significance of safety sirens and hooters.
- The spillage could not be contained at the switch deck platform at 20M elevation due to inadequate barriers and got spilled over to the ground floor

MAJOR RECOMMENDATIONS IN SEMI AUTOMATIC /MANUAL HEADING/UNHEADING IN DELAYED COKER UNIT.

- 1) Area barricading of the coke drum area at ground floor level with proper warning sign board is to be ensured during every un-heading activity in Delayed Coker Unit.
- 2) The coke drum area at ground floor level should be covered under CCTV surveillance.
- 3) The containment of coke spillage during un-heading is to be ensured by providing necessary removable type metal barriers around the chute so that any coke and hot water spillage is directed towards the coke pit.
- 4) A provision of Pressure Indication (PT) is to be made along with Temperature Indication (TI) in coke drum feed line after coke drum feed isolation valve which may assist in proper assessment of completion of water draining.
- 5) The standard operating procedure (SOP) for coke drum un-heading system is also to incorporate OHS risks like burn injuries due to steam & hot water splash, spillage of loose coke, collapse of coke bed.
- 6) It is recommended to monitor the Asphaltene content during change of Coker feed blend and to do necessary adjustments in operational parameters (higher coke drum pressure, higher recycle ratio and lower heater coil outlet temperature to reduce the chances of shot coke formation along with coke fines). Excessive shot coke formation along with coke fines is not desirable as it leads to channel blockage & clogging of coke drum inlet distributor which hinders the free draining of hot water.
- 7) As a long term measure, it is recommended to replace the semi-automatic/manual un-heading system with fully automated un-heading system having slide valve design and fixed chute arrangement.