



Blowout during Workover Operation– A case study

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1. Introduction

An incident of gas leakage from a well took place during workover operations. Subsequently, the gas caught fire on the fourth day in which twelve persons were injured. Two contract workers, who were working with the mobile crane, succumbed to the burn injury.

2. Well history

The said well was drilled to a target depth of 700 meters seven years back with an objective to produce gas from a shallow gas reservoir. The well was drilled to the target depth, production casing was lowered cemented and hermetically tested at 100 kg / sq. cm and VSP (Vertical Seismic Profile) was recorded

Upper Object was perforated and tested. It was found to be hydrocarbon gas bearing with a flow rate of 50 thousand cubic meters per day (8 MM bean size). Average Tubing head pressure was 50 Kg / Sq. cm. The well was subdued with 1.30 specific gravity mud and isolated by placing cement plug against the perforation.

Lower Object was perforated and tested. The well ceased after flowing a little gas for few hours. The well could not be activated inspite of number of compressor applications. The well-produced mainly water with little gas. The perforated interval was then isolated with cement plug after subduing the well. Cement was cleared up to 541 meters (one meter below the bottom of upper object) and the well was put on production from the upper object interval (536 – 540 meters). It was producing with a flow rate of 25 – 29 cubic meter of gas per day.

The bean housing of this well was reported to be getting choked with wet sands frequently and ultimately production was stopped. The well was taken over for workover job for clearing sand deposition in the well, gravel pack and recompletion. Subsequently a charter hired workover mobile rig of 50 ton capacity was deployed at the well for the specific job.

3. Sequence of operations / events

- Rig building of workover rig on the well.
- Well was subdued with 1.1 specific gravity brine.
- X-mas tree was removed & BOP was installed. Released production packer & pulled out the completion string. No activity or loss observed during the pulling out process.
- Retrievable mechanical packer was lowered and set at 527 meter depth. Production casing was tested at 1000 psi and mechanical packer was released and pulled out. Annular mill was lowered and bottom was tagged at 538 meters (three meters above the cleared depth i.e. 541M). Cleared up to 542 meters. Observed no progress beyond 542 meters.
- The annular mill was pulled out, replaced with another similar annular mill, run in and tagged bottom at 542M.



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- Could not clear beyond 542.5M in spite of rotating the annular mill for several hours. Cement pieces/ cuttings and metal cuttings were observed during the operation in the return. Brine weight reduced to 1.05 from 1.1. It was increased to 1.13. Continued circulation to stabilize the well.
- After stabilizing the well, continued rotation of mill for several hours but could not drill / mill beyond 542.5M. Metal pieces / cement cuttings were observed in the return.
- The annular mill was then, pulled out of hole. Made up flat mill, run in and tagged bottom at 542.50M. Milled up to 543M only in spite of rotating mill for many hours but could not mill beyond this point. Observed metal pieces in the return.
- Stopped milling operation and pulling out string with mill started. During pulling out last stand of 4-1/8" diameter drill collars, observed gas flow from the well which became uncontrollable.
- An unsuccessful attempt was made by the rig crew to run back in the well followed by closing the blind ram against the drill collars.
- The uncontrolled flow of gas from the well continued. The drill collar stand that was stuck between the blind rams broke in two pieces and was thrown out of the well. The pipe rams of the BOP stack were replaced by blind rams under water umbrella and closed. The flow of gas from the well reduced to feeble flow but continued.
- The feeble flow of gas through closed blind rams again increased gradually to full bore flow.
- An effort was being made on 4th day to replace the BOP stack under water umbrella. During this process, the flowing gas caught fire. Due to fire, twelve persons working for replacement of BOP stack received severe burns.
- The uncontrolled flow of gas reduced to feeble gas leakage at its own on 16th day.
- BOP stack and annulus valves were replaced after killing the well by pumping heavy mud. Well was finally plugged with pumping cement in to it.

4. Analysis

4.1. Observations

- The producing interval of upper object (540 – 536) meters was open throughout the work-over operation. The well was subdued with 1.10 Specific gravity Brine; however the same interval was subdued with 1.30 specific gravity mud after testing. The specific gravity of brine could not be maintained during the entire clearing operation may be due to mixing of formation water, which was continuously entering in the well bore with gas from the open perforated interval (540 – 536) or casing cut point. Well was not stabilized. This is the primary requirement that well should be stabilized prior to carrying out any operation in the well (specially gas well). Further brine cannot stop or reduce the gas migration in the instant case due to low specific gravity and viscosity. Gas migrates and expands very fast in brine. Gas wells must be stabilized



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with drilling mud (high specific gravity and viscosity) instead of brine for carrying out milling or cement drilling operations.

- An annular mill was lowered with 4-1/8" round drill collars to clear the sand instead of a drill bit. This mill was not able to clear the well bore beyond 542.5 meters (bottom tagged at 538 meters). Still, it was rotated for a many hours at the same point, which may have resulted in casing cutting. This is evident from the metallic cuttings which were being observed in the return fluid continuously.
- The milling string was pulled out without stabilizing the well. Also, the well was not monitored for its behavior during pulling out operation. There is no evidence of filling trip sheet to monitor well behavior during pulling operation.
- The swabbing of gas during pulling out coupled with the gas intrusion from open perforation / casing cut reduced the hydrostatic head drastically and resulted in uncontrolled flow of gas from the well.
- The gas kick was noticed when the last stand of drill collar was being pulled out. Instead of pulling it out or dropping it in the well, the rig crew tried to connect a drill pipe and run back the same in the well, which is a wrong operation.
- Blind ram was closed against the drill collar which resulted in damage to the blind ram. This indicates that the operation personnel of the workover rig were not competent for well control operations. There was no any BOP in the BOP stack, which could be closed against 4 1/8" drill collars. It means that that there was no tested barrier when the 4 1/8' drill collars were against the BOP.
- The ram block was replaced in flowing well conditions with water spray for cooling. It could not hold the pressure. This indicates that the BOP ram cavities were damaged severely during closure of ram against drill collars or the BOP was got damaged prior to the blowout.
- There was no evidence of carrying out BOP function test, BOP Low and High pressure test.
- There was no evidence of conducting Emergency mock drills, Trip drills, BOP drills.
- Trip sheets were not being filled to monitor the well behavior during pulling out operations.
- During pulling operations, the following SOPs were not followed by the operational personnel of the rig:
 - ✓ Prior to starting pulling out, observe the well for the time at least equal to the time required for complete pulling out plus safety margin. Circulate for at least bottom up to ensure that no influx has entered in the well bore.
 - ✓ Check for self-flow intermittently.
 - ✓ Prior to pulling out BHA, observe the well for the time at lease equal to the time required for making up pup joint, putting drill collars clamps and pulling out BHA plus safety margin.



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- ✓ Circulate for at least bottom up to ensure that no influx entered in the well bore.
- ✓ Check for swabbing during pulling out.

The root cause of the incident is ignorance of basic operational practices by the operational personnel of the rig; inadequate supervision and monitoring by all concerned.

5. Root cause

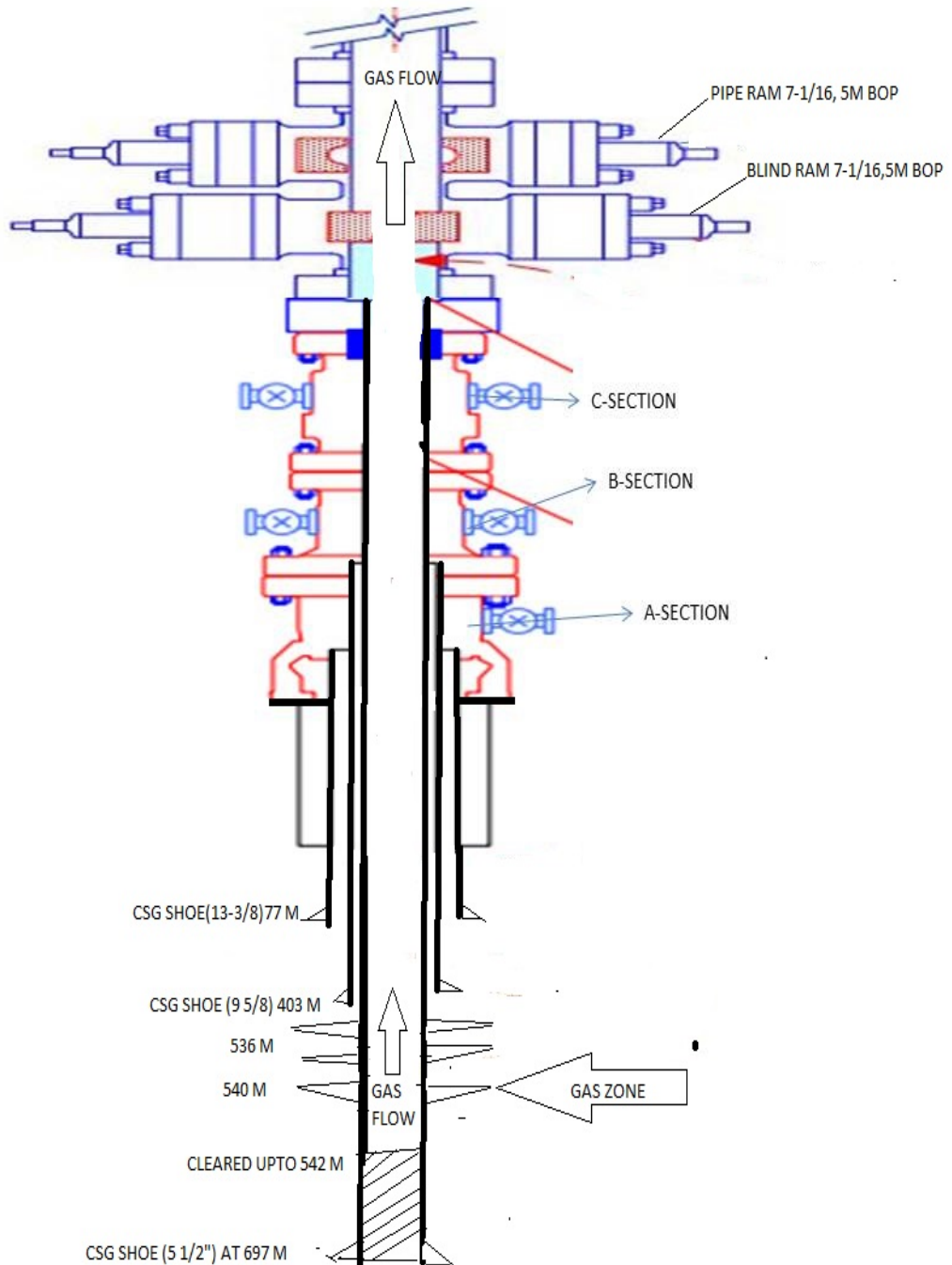
The root causes of the incident are enumerated below:

- Well was not stabilized during the entire operations with the brine. String was pulled out without ensuring the stability of the well. During pulling out, the well was not being monitored for its behavior.
- Use of brine itself is inappropriate instead higher density mud should have been used.
- The mill was not able to clear beyond 542.5 meters. Still the milling tool was rotated continuously at the same point. This might have resulted in damaging the casing.
- The blind ram was closed against the drill collars which was a wrong operation.
- BOPs were not tested at the desired level of pressure.
- The reason of fire may be development of spark inside the cabin panel, battery terminals of the mobile which was stationed near the cellar pit area and was being used for BOP replacement job.

6. Recommendations:

- The responsibilities of Operator and Contractor must be clearly mentioned in the Bridging document in respect of handling emergency situations viz. operations, well control operations etc.
- Competency criteria for key operational personnel of charter hired rigs must be developed considering all the specific requirements and associated jobs.
- Competency of work-over operational personnel must be enhanced by training, retraining including regular assessments.
- Level of supervision should be increased for work-over in gas wells.
- It must be ensured that only persons having adequate experience and competency in workover operations be deployed in workover of gas wells.
- The workover operations in gas wells must be carried out using drilling mud only.
- Before designing String, it must be ensured that the BOPs of BOP stack is suitable for closing on its tubular components.
- All BOP function tests, BOP low and high pressure test must be carried out in accordance with the requirements of OISD-RP-174. Trip drills for all the three scenarios mentioned in OISD-RP-174 shall be carried at regular intervals in the presence of senior officers. Reports of the tests / drills to be signed by concerned in charge and witnessed by the senior officer of work-over department.

- It is recommended that blind cum shear ram in place of Blind ram and 2-7/8" to 5" variable ram should be provided for workover operations in gas wells.
- Use of 'Trip Tank' must be made mandatory to monitor well behavior of well during pulling out operations in work-over of gas wells. Trip sheet must be filled during pulling outs.



WELL DIAGRAM OF ONGC ANKLESHWAR WELL#OLPAD-31