

Incident of a MEMU Truck (Multiblend Truck) during a loading of ANFO : causes, analysis , evolution

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DATE AND TIME OF INCIDENT

19th June 2012 at 9h30 am

INCIDENT LOCATION

EPC – Belgium, subsidiary of EPC Group – in a quarry in Belgium

DESCRIPTION OF INCIDENT

In a Limestone quarry in Belgium, during the loading of ANFO with a multi-blend truck, an emission of fumes and glowing particles had been discovered at the bottom of the vertical auger.

The driver of the MEMU truck used the extinguisher and water under pressure to stop the incident and cool the auger and the bearing.

Fortunately, there were no injuries and the damage to the truck was minimal.

This paper will describe the causes, the analysis and the modification made on the MEMU truck.

Raw material used

In the MEMU Truck of EPC-Belgium (see Picture n°1), the raw materials are technical grade ammonium nitrate (porous prill), emulsion (Matrix), aluminium, and fuel-oil.

During a loading of heavy ANFO, the ammonium nitrate prills are mixed with the aluminium particles in the bottom of the horizontal auger. The product then moves through the vertical auger. In the top horizontal auger, the emulsion-matrix (which is pumped through the large blue pipe) and the fuel oil (injection by the small blue pipe) are mixed together with the ammonium nitrate and aluminium.

During a loading of ANFO, the ammonium nitrate prills are mixed with fuel oil (injection by the small blue pipe) in the top horizontal auger. The explosive is then fed into the borehole.



Picture 1 : EPC-Belgium –Multiblend truck (Tradestar unit)

Description of the loading – timeline of the incident

- ❑ At 7:00 Arrival of the Multiblend truck in the quarry
- ❑ 8:15 Start of production of heavy ANFO with aluminium in each borehole
- ❑ 8:40 Start of the ANFO production
- ❑ Up to 9:30 Normal production with many stop/starts due to the blast design.
- ❑ Time zero= 9:30 (Still 18 boreholes to complete) Operators hear a *bang/ clatter similar to “wet banger”*. David Jacquet and the Multiblend Operator (driver) saw fumes and glowing particles from the bottom of the Multiblend truck’s vertical auger.
 1. It took approximately 5 to 10 seconds to cut power to the engine and the augers
 2. It took approximately 1 to 2 mn *time to extinguish the fire with 1 extinguisher present on the truck body, which was easy to extinguish. There was time lost in finding the extinguisher due to stress. Quarry employees left the area during the extinguishing phase. Therefore, the 2 EPC Belgium employees were alone to operate the Multiblend truck and handling the fire extinguisher.*
 3. It took approximately 30 seconds *to move the truck away from the loading area at 50 meters distance in order to secure the area-*
 4. *It took approximately 5 min to cool the bottom of the vertical auger with water under pressure.*
- ❑ 9:38 The alarm was given by phone to EPC Belgium

The picture n°2 shows the part of the vertical auger directly after the intervention with the extinguisher (powder blue on the picture)



Picture n°2 : vertical auger with the bearing after the use of the extinguisher

IMPACT OF THE INCIDENT

Fortunately, we had no injuries. The miners got a fright. The damage to the truck was minimal – replacement of a bearing, a seal and an extinguisher.

LIKELY CAUSE OF INCIDENT

The principal cause of this incident was a lack of tightness of the seal in the vertical auger. This lack of tightness comes from the design of this auger, but also we have to note a lack of good housekeeping and preventive maintenance rules.

An accumulation of fine particles (aluminium, nitrate) in contact with grease in the confined chamber had been discovered in the bearing. This confinement has increased the friction and reduced heat dissipation. Heat source by friction was located inside the bearing (ball bearings) at the bottom of vertical auger.

The presence of the shaft guard on the bearing and the lack of cleaning allowed the accumulation of energetic product within the bearing.

Fortunately, with this design of truck, the product in the vertical auger is only technical ammonium nitrate **without** fuel and the product isn't in direct contact with the bearing (spacing of 5 cm). So the fumes and glowing particles were confined below the auger with ammonium nitrate.



The combustion was situated at the bottom of the vertical auger just above the bearing and below the flange. No particular smell (neither ammonia nor rubber smell) was noticed only just light blue colour fumes.

The gasket seal located below the flange and above the bearing on the bottom of the vertical auger must guarantee the tightness of the auger. After the disassembly of the auger, we noticed that the seal (picture n°3) was deformed which allows solids to fall down onto the bearing.



Picture n°3 : gasket seal deformed (inside circle with the diameter of the shaft)



The dismantling of the bearing has yielded other important facts and findings. The remainder of the grease was found at the peripheral of the bearing but not with the balls inside the bearing. The picture n°4 shows the bearing after the incident together with a new bearing



Picture n°4: ball bearing after the incident and a new ball bearing

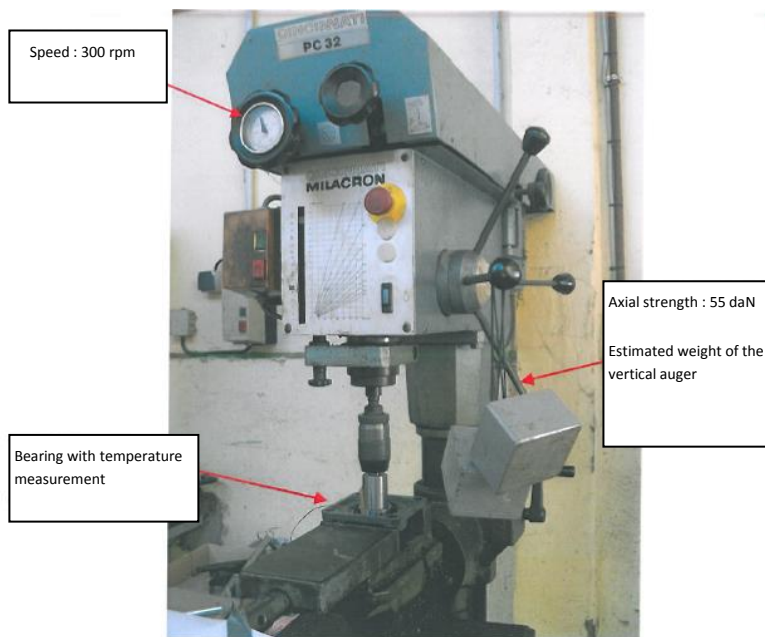
We also noticed that the balls were oxidized and without grease. Normally, this type of bearing is greased for life (sealed for life)



Reproducibility of the incident

Using the Lab facilities of EPC-France (EPC-Group), we have tried to reproduce this incident on the bearing. The report CTL 12-13¹ from EPC France is partially used in this paper. For these tests, many samples are used with a percentage of aluminium, ammonium nitrate and grease and also with 2 types of bearing.

The lab uses drill equipment with temperature measurement as illustrated with picture n°5



Picture n°5: reproducibility of the incident with the drill equipment – EPC-France

This equipment was able to reproduce the incident and characterize the mechanical performances of the bearing.



With a mixture of 50% ammonium nitrate and 50% aluminium, without grease, we noted, after 8 minutes of rotation, a violent fire with glowing particles. The temperature is about 150°C. The pictures n°6-7-8 came from the video of the experiment.



Pictures 6-7-8: reproduction of the fire in the lab – bearing SKF

The analysis from the tests to reproduce this incident within the Lab of EPC-France, show 2 essential factors: The presence of an energetic mixture of aluminium and ammonium nitrate on/in the bearing and the use of a bearing with a polyamide structure.

ACTIONS TO PREVENT RECURRENCE

The incident allowed us to understand the effect of the lack of preventive maintenance on our fleet of MEMU Trucks and a problem in the design of the sealing arrangement of the auger.

Now, once a month, visual inspection of the gasket seal and the bearing is carried out. At 12 months, the gasket seal and the bearing are replaced.

With the contribution of our technical service EPC-Innovation, a new design of the auger was made. The modification on the truck was implemented in January 2013. The modification of the auger has also been implemented to improve the sealing arrangement.



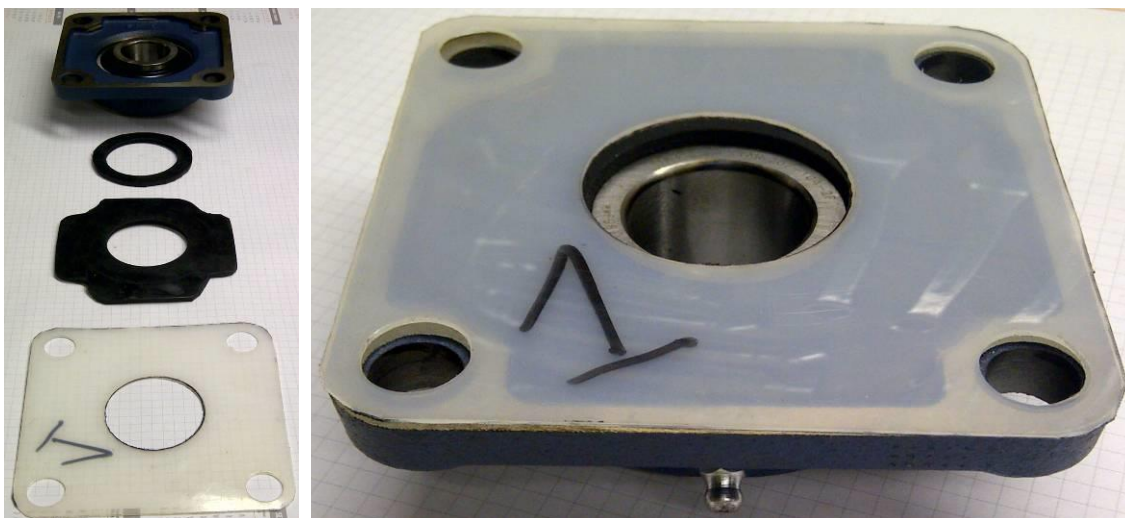
With this design (Picture 9), new lip seals and a V-ring are added on the shaft to improve the sealing of the auger.



New piece with lip seal and circlips

Picture 9 : Additional element to improve the sealing of the auger.

Also to reduce the quantity of ammonium nitrate and aluminium in case of failure of the seal on the bearing, there is a layer of protection of Ertacetal on the bearing as shown in picture 10



Picture 10 : layer of Ertacetal on the bearing – (additional protection)



From the results of the tests from the EPC-France Lab, we have changed the type of bearing by using a bearing with structured steel (which cannot burn in case of overheating).

The team from EPC-Belgium (drivers, miners and maintenance operators) have been made aware of this problem.

A presentation explaining the causes of the incident and corrective actions was shown to the miners and the manager of the quarry.

TAKE HOME MESSAGE

This incident reminds us that the MEMU truck is a mobile explosive plant. The operator/driver has to be vigilant on a regular basis regarding the corresponding danger. Being unprepared for such an incident, and our reactions to it, are areas we can improve.

Personally, being present near to the auger during the incident, I was unable to find the fire extinguisher which was only 1 m away from me. Due to the stress, we lost 80% of our abilities. I estimate that 1 or 2 minutes were lost trying to locate a fire extinguisher.

I recommend to train the team (driver, MEMU operator, shotfirer, miners ...) to know the locations of the emergency STOP and the position of the nearest extinguisher and how and when to use it.

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