

# Deep Hole Blasting with SMS - An Excess for Better Productivity

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## INTRODUCTION

Singrauli area of Madhya Pradesh in India has been developed as the power capital expected to produce around 11000 MW in near future requiring 65 million tonnes of Coal per annum. Thermal power plants were installed considering the vicinity of coal reserves which are minable by open cast mining methods. Crisis of oil in seventies further expedited the process of planning big open-cast projects in the area varying from capacity of 3 million tonnes of coal to 14 million tonnes per annum. A separate company - Northern Coalfields Ltd. was formed to ensure meeting the rising demand of coal required for energy production. Northern Coalfields at present is producing 35 million tonnes of coal and will reach the capacity of peak demand of 65 million tonnes by the turn of the century.

Blasting plays very important role. in achieving high level of productivity in terms of better unitization factor of heavy earth moving machines. Constant feeding of good fragments of rock will help the machines running throughout reducing the idle hours. The stripping ratio in the mines is on constant increase. Mining conditions have become difficult with the increasing depth and the "fanners were left with no choice but to design big benches ranging from minimum 20 meters to 40-45 meters. Shovels and Draglines with higher bucket capacity are deployed. Bulk delivery system for blasting was introduced long back in the year 1982. In order to get desired fragmentation with minimum norms of productivity. a decision was taken to charge the blast holes with conventional type of cartridge explosive up to the limit of 10-15 percent of the total charged quantity. This process would have adverse effect as part. of the operations while charging had to be done manually. Site Mixed Slurry type of system would fail as it becomes insensitive with increasing hydrostatic pressure because of the longer depth of holes. Aty. matter of fact. this type of system will fail after 35 meters of depth. Emulsion technology which is considered to be the alternative to this problem will contribute to lower down the productivity as loading density goes up to 70 Kg. per meter against that of 55 Kg. of SMS technology.

Ministry- of Science & Technology had sanctioned a project to develop the formulation in SMS (Site-mix Slurry type of system) which could be pumped mechanically and switch over to the lighter energy formulation automatically at the upper ranges of the blast holes.

The authors have got the opportunity to conduct trials in Jayant project of Northern Coalfields to study and establish following parameters :

- (i) Elimination of charging of conventional type of explosive manually in order to bring back the depth of hole to 35 M where mechanical loading of SMS type of explosive is possible.

- (ii) To try a formulation developed indigenously which would not be effected by the hydrostatic pressure in the hole.
- (iii) To ensure better energy level at the minimum loading density (55 to 60 Kg per meter of hole) in order to get the better productivity.
- (iv) To ensure mechanical loading of the newly developed thick formulation with automatic switch over to lighter formulations.
- (v) To establish blast parameters in order to get the desired fragmentation which would be handled efficiently by the Dragline.

Successful trails were done in Jayant Project of Northern Coalfields during the period from April 1995 to December 1995. An improvement of around 25X in blast efficiency was achieved.

The paper deals with the modification brought in formulation and pump truck for efficient mechanical loading of SMS. It also covers the blast parameter introduced to get maximum productivity.

The Site-mixed-slurry system of explosive was introduced in Singrauli Coalfields in the year 1982. The stripping ratio at that time used to be in the range of 1:1 to 1:1.5 . Most of the projects were at the initial stage of development Shovel dumper combination method of open cast mining was predominant in all the projects. The bench height was restricted to within 20 meters. SMS system was found to be very successful. With enhancement of power generation capacity, the demand of coal went up and in 1986 a separate company named as Northern Coalfields Ltd. was formed. The coal production was increased from the 8.27 million tonnes in 1986 to 35 million tonnes in 1996. The removal of over-burden showed the growth from 16 M CuM to 93.92 M CuM during the same period,. (Annexure - I indicates the Year wise coal production and O/B removal figures from 85-86 to 95-96). Mining conditions in NCL became more complicated as the mines went deeper and deeper reaching to a stripping ratio of 1:3.5 as on average in most of the projects. To maintain the trend of enhancement in coal production, more quantity of O/B is required to be removed and accordingly big over burden benches varying in height from 20 Mtr. to 40 meters are planned. Bin capacity Draglines were introduced as Dragline operations do not depend upon the dumpers which is a weak link in the shovel dumper combination.

In the year 95-96, the contribution of Dragline was 38%. The industry introduced the bigger diameter drill machines with expended blast design in order to get maximum productivity, Deep mining conditions bring heavy water column in Dragline benches which again has to be takled carefully to get maximum operational efficiency. The SMS system, which was found to be the best suited for heavily mechanized mines, started behaving adamantly under new conditions of 30 M - 40 M deep holes with minimum 20 meters of water column. The basic problems encountered with SMS-system for deep hole blasting were :-

- (i). SMS is charged at a cup density of 0.6- 0.7 . The density at the bottom increases with the hydrostatic pressure replacing the water if there is any. In deep holes the final density lesser than 1 (One) is arrived within about 45 seconds. The Gel starts floating and is not in position to replace the water.
- (ii). The Gelling of the product is achieved within about 2-3 minutes. If the travelling time to reach the bottom of hole is more, it will create the problem in jamming the hose pipe.
- (iii). SMS system has the tendency of netting disintegrated when sleeps with water for a longer period.

NCL had to switch over to the conventional type of cartridge explosive in order to cover 20% of the bore hole, there after SMS-type of explosives were being used ie bottom 20% of the hole depth used to be charged with packaged explosives.

This whole process would lead to delay the charging and blasting process resulting in to the idleness of HEMM. The manual process of charging the bottom of the deep holes become hindrance in achieving better utility factor of the machines. The R&D center of IBP Co. Ltd. took up this challenge to develop the formulation under the guidance of Ministry of Science and technology which could over come the above mentioned short comings. The scopes of the study undertaken were :

- (i). In order to have easy and effective placement of SMS Explosives specially during bottom charging, it is considered necessary to decrease the passing and gelling rate(s) while processing SMS Explosive.
  - (a). Gassing rate is required to be retarded to an extent that the SMS density above 1.0 is maintained up to about 2.5 minutes when equilibrated cup density of the product is set in the range of 0.6 - 0.7 . The overall gassing time of about 12 minutes is considered satisfactory.
  - (b). Gelling rate is also reduced. It takes 4-5 minutes for completion of gelling. Fast gelling will have detrimental effect on SMS properties specially under the condition of slower gassing rate.

In order to achieve the above parameters, some chemical changes have been effected in the manufacturing process. This basically relates to process temperature of oxidiser solution which is required to be reduced by 2 C ie it is now kept at 68 C. It does not create any problem since fudge point is 60 C. pH value of the oxidiser solution after mixing with Gaur Gum should be maintained at 5.6 .

Cross linking agent which normally keeps all the ingredients together to release maximum energy on initiation has been modified with 3% of Nitric Acid and 28% of Sodium Dichromate. The above mentioned modification have resulted in achieving the desired gassing and gelling pattern while manufacturing and placing the SMS explosives in the bore

holes.

Major achievements with the changed formulation are :

- (a). Density of SMS is maintained above 1.0 value up to about 3 minutes at the equilibrated cup density of 0.7
- (b). In the bottom charging gelling process is completed in about 12 minutes or in other words various ingredients forms explosive product in the bore hole after 12 minutes of pouring or charging.

Number of experiments/Trials were conducted in Jayant project of NCL to find out the effectiveness of the modified formulation. It has been observed that the improvement in blast efficiency went up by 21.4 percent. This could be achieved because of the following behaviors of new formulation :

- (i). Better placement of explosives in deeper watery holes, water in the holes get replaced as the solution is poured at a density more than 1 immediately which later on is gassed after an interval of about 3 minutes.
- (ii). The product remains in fluid state for a reasonable duration of time and hence it is in position to achieve 100% bore hole coupling. This is the most important parameter required to be achieved for best blast productivity. Fluid takes the final shape of the explosive product after 10-12 minutes. This is very good time to fill and block all the cracks/cavities and will lead to the maximum utilization of the energy.
- (iii). While charging the hose pipe is required to be lowered down in the hole right-up to the bottom and then withdrawn at the predetermined speed matching the rate of charging. This method will lead to the best placement of explosives in the bore hole.
- (iv). Proper placement of explosive in deeper watery holes could be able to eliminate the charging of conventional type of cartridge explosive which happened to be more costly and time consuming and thus lead to better productivity in explosive efficiency and improved utilization factor of the HEMMS.