NOTE ON SOME CHARACTERISTICS OF ANFEX

By N. W. Munro*, B.Sc. (Visitor)

SYNOPSIS

Certain disadvantages associated with the use of Anfex have been raised on previous occasions. This interim investigation shows that by loading at lower pressures the sensitivity to initiation of Anfex can be improved. Associated with this is a reduction in velocity of detonation and charge density which should lead to more desirable fragmentation.

The effect of lower loading pressure on other factors is also considered.

INTRODUCTION

Discussion at the Symposium on the use of Anfex in Underground Mining, conducted by the South African Institute of Mining and Metallurgy during May 1968† showed that there was considerable uncertainty and diversity of opinion on the characteristics of Anfex and its method of application.

Some of the disadvantages associated with the use of Anfex were:

Inadequate sensitivity to initiation;

Excessive fragmentation of the rock and damage to the hanging and footwalls;

Wastage as a result of blow-back;

Poor water resistance.

As a result of this, further investigations on the properties of Anfex have been carried out and, although these have not reached finality, it is considered that a progress review may be of interest and assistance to the mining industry.

EXPERIMENTAL TECHNIQUE

The work was carried out on a laboratory-scale where, for test purposes, the explosive was loaded into 1 in. (nominal) internal diameter steel pipes unless otherwise stated. Charging was conducted with a 1 in. (nominal) Schutte-Koerting eductor having a 0·2 in. internal diameter venturi nozzle, the Anfex being fed into the eductor from a conical hopper fitted directly above it. A 5 ft long copper loading tube with outside and internal diameters of $\frac{3}{4}$ in. and $\frac{5}{8}$ in., respectively, was fitted to the discharge end of the eductor. The remote end of the loading tube was inserted into the test pipe so that it was about 6 to 8 in. from the closed end of the pipe. The loading apparatus was withdrawn as the pipe filled, maintaining approximately the same stand-off distance throughout the operation.

REVIEW

Sensitivity to initiation

Sensitivity of Anfex to initiation was found to deteriorate when the dynamic pressure of the air to the eductor was increased. This was attributed to increasing charge density and it was found that at a charge density of about 1·05 g/cm^3, which

*Research Officer, A.E. & C.I. Ltd., Research Department, North Rand.

†Reported in Volume 68, No. 11, June 1968.

was attained with an air pressure of 80 lb/in.², an 8D detonator was a marginal initiator. Pour loaded Anfex with a charge density of about 0·90 g/cm³ was, on the other hand, sensititive to initiation. This finding is contrary to certain opinions expressed at the Symposium, which considered that adequate density was essential for sensitivity.

The evidence so far available indicates that, in the case of Anfex, the degree of particle breakdown does not have an appreciable effect on sensitivity to initiation. This is probably because the absorbent properties of porous prills result in a large area of contact between ammonium nitrate and fuel oil which is not increased appreciably by particle size reduction of the prills.

Moisture contents in excess of 8 per cent had a detrimental effect on initiation sensitivity of both pour and eductor loaded Anfex and, at a moisture content of 10 per cent, it was not possible to initiate the explosive even with $\frac{7}{8}$ in. × 4 in. primer cartridges. The effect of moisture contents in the range 0 to 8 per cent on initiation sensitivity has not yet been assessed.

De-coupling of both pour and eductor loaded Anfex by 10 per cent in 1 in. diameter pipes inhibited initiation even by $\frac{7}{8}$ in. × 4 in. primer cartridges. The Anfex was loaded into a polythene coated paper cartridge of appropriate diameter to produce the required degree of decoupling when inserted into the pipe. When the pipe diameter was increased to $1\frac{1}{2}$ in. and the charge decoupled by 10 per cent, detonation was initiated, but not consistently, with a $\frac{7}{8}$ in. × 4 in. primer cartridge.

Velocity of detonation

Velocity of detonation increased with increasing air loading pressure from a value of about 2,500 m/sec for pour loaded Anfex to approximately 3,500 m/sec for material loaded at a dynamic air pressure of 80 lb/in.². It was apparent that increasing charge density and degree of particle breakdown increased detonation velocity. The velocity of detonation of eductor loaded explosive decreased with increasing moisture content and initiation failures occurred when the moisture level exceeded 8 per cent. In the case of pour loaded Anfex, however, there was a small but significant increase in detonation velocity to a moisture content of 4 to 5 per cent, after which it decreased until initiation failures occurred at moisture contents in excess of 8 per cent.

Compaction

As has been shown the sensitivity of Anfex to initiation is improved at lower loading pressures. The charge density is, however, decreased so that there is a danger that the resultant charge would not be retained in a borehole. It was established that when loaded at an air pressure of 10 to 20 lb/in.², with a resultant density of about 0·95 g/cm³, the charge could not be shaken out of the pipe.

Loading rate

Lower loading pressures result in a lower loading rate. At an air pressure of 80 lb/in.² the rate was 10·6 lb/min whereas at 20 lb/in.² it was 7·5 lb/min.

CONCLUSION

While this investigation is not complete, results indicate that some of the disadvantages associated with the use of Anfex can be overcome by modifying loading

techniques. Sensitivity to initiation can be increased by reducing air loading pressure which results in a less dense charge. In practice, of course, a compromise will have to be achieved between sensitivity and compaction by loading at an intermediate air pressure. For the loading technique detailed in this review pressures of 10-20 lb/in.^{2} gave lightly compacted charges for which an 8D detonator was an adequate initiator.

Reduction of loading pressure causes a decrease in velocity of detonation and this, in turn, will produce less cracking of the rock. This, in conjunction with lower charge density, should give more desirable fragmentation and less damage to the hanging and footwalls.

Less wastage as a result of blow-back will, of course, be an attendant advantage of low pressure loading. Decreased loading rate is, however, a disadvantage, although the increase in loading time represents a relatively small proportion of the overall operational cycle.

While low pressure loading may not provide a complete solution to the problems encountered with the use of Anfex, the results appear to be sufficiently promising to warrant further investigation.

ACKNOWLEDGEMENT

Permission of A.E. & C.I. Ltd. to publish this contribution is gratefully acknowledged.