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COMPARISON OF BRIQUETTING ROLL SHELLS

by

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SUMMARY OF RESULTS

The longer service life of the AHTS roll shells, which did not break in service, was due to the higher hardness level of these rolls. The lower matrix harness of the ALAH steels resulted in preferential wear of the softer matrix over the harder massive carbides. The results of the examination indicate that the ALAH steels were hardened.

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INTRODUCTION

A request for the examination of four broken briquetting roll shells was received from Mr. H. A. Timm, Plant Metallurgist, Dominion Magnesium Limited, Haley, Ontario, on May 8, 1961. These shells were similar in composition to the AISI type D2 steel shell, the examination of which was reported in Mines Branch Investigation Report IR 60-102.

The roll shells designated as AHTS type were noted to have been giving superior performance to those designated as ALAH type. A list of the shells supplied and their service lives is given in Table 1. The service lives of two other ALAH roll shells were reported as similar to those of the shells supplied, and that of another AHTS was short due to breakage.

TABLE 1

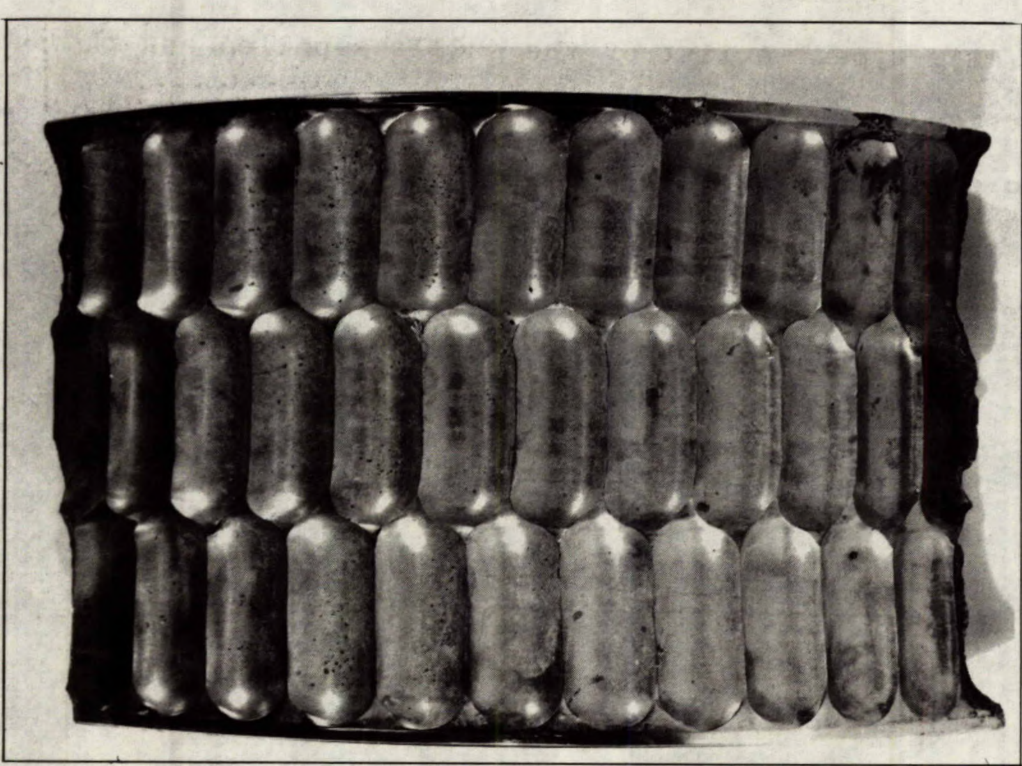
Service Lives of Shells Supplied

Shell Number	Life (hours)
JA-298-1-AHTS	>2000
A-298-2-AHTS	>2000
JA-582-3-ALAH	607
JB-427-5-ALAH	792

A metallurgical examination was requested to determine the reasons for the difference in behaviour.

VISUAL INSPECTION

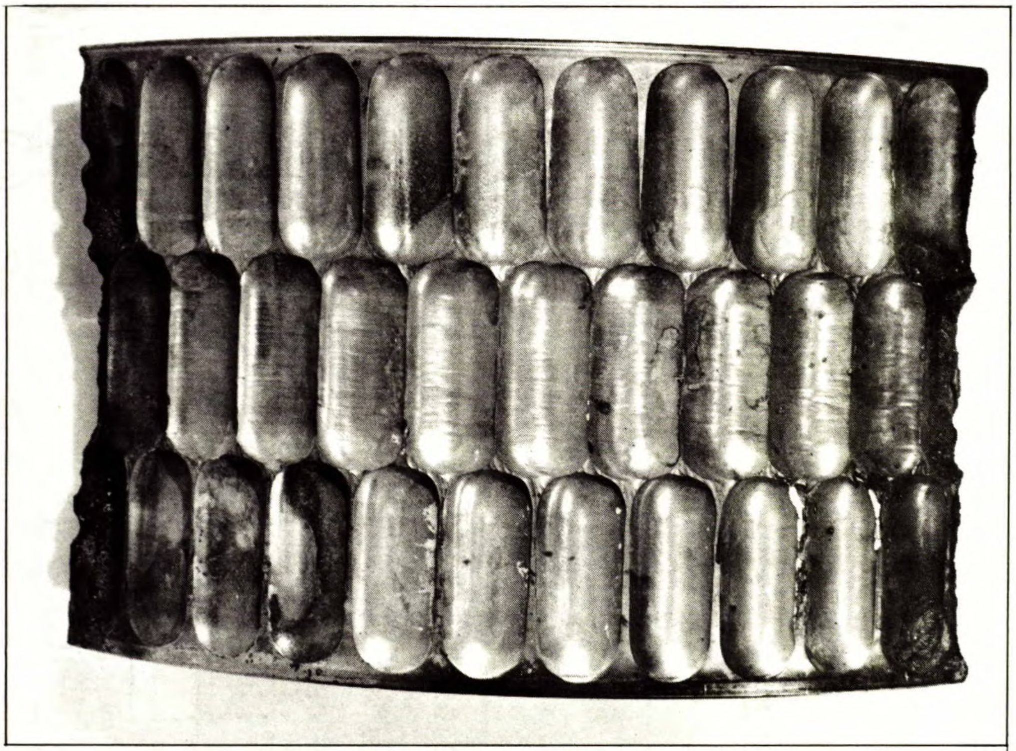
The wear of the AHTS type shells (long life) was fairly uniform, whereas the pockets of the ALAH shells exhibited ridge-type wear, particularly in the central pockets. This condition is illustrated in the photographs shown in Figures 1 and 2.



(Approx. 0.4 x actual size)

Figure 1 - Photograph of JA-298-1-AHTS

Illustrates the uniform wear of the rolls which had a satisfactory service life.



(approx. 0.4 x actual size)

Figure 2 - Photograph of JA-582-3-ALAH

Illustrates the ridge-type wear of the roll shells which had a short service life.

CHEMICAL ANALYSIS

Samples of each of the roll shells supplied were annealed, and drillings were taken for chemical analysis. The results are given in Table 2.

Table 2

Per Cent Chemical Composition of Shells

Shell Number or Target Analysis	C	Mn	Si	S	Cr	Ni	Mo	V	Co
JA-298-1-AHTS	1.56	0.61	0.65	0.028	11.64	0.32	0.83	0.56	0.81
A-298-2-AHTS	1.54	0.50	0.54	0.027	11.20	0.24	1.38	0.28	0.77
JA-582-3-ALAH	1.55	0.48	0.43	0.024	11.44	0.26	1.20	0.39	0.81
JB-427-5-ALAH	1.55	0.52	0.65	0.025	12.08	0.28	1.23	0.42	0.77
AISI-D2	1.50	-	-	-	12.00	-	0.90	0.50	0.75
AISI-D2(Mo)	1.50	-	-	-	12.00	-	1.20	0.50	0.75

There appears to be no significant difference between the chemical compositions of the ALAH and AHTS roll shells that would account for the difference in wear life. As both the AHTS steels had wear lives greater than 2000 hours, there appears to be no evidence of an advantage for the use of AISI-D2(Mo) rather than AISI-D2. However, the amount of evidence here is scanty, and advantages for the use of increased contents of molybdenum have been cited in the literature.

HARDNESS TESTING

Hardness surveys, involving fourteeen impressions at varying depths from the surface, were taken on microspecimens of the shells, using a Tukon Hardness Tester. There was no hardness gradient across the samples. Other samples were quenched in liquid nitrogen for two hours. This treatment made no difference in the hardness values.

Average hardness values were obtained for the four as-received samples, using the Rockwell Hardness Tester. These are shown in Table 3.

Table 3

Average Hardness of Roll Shells

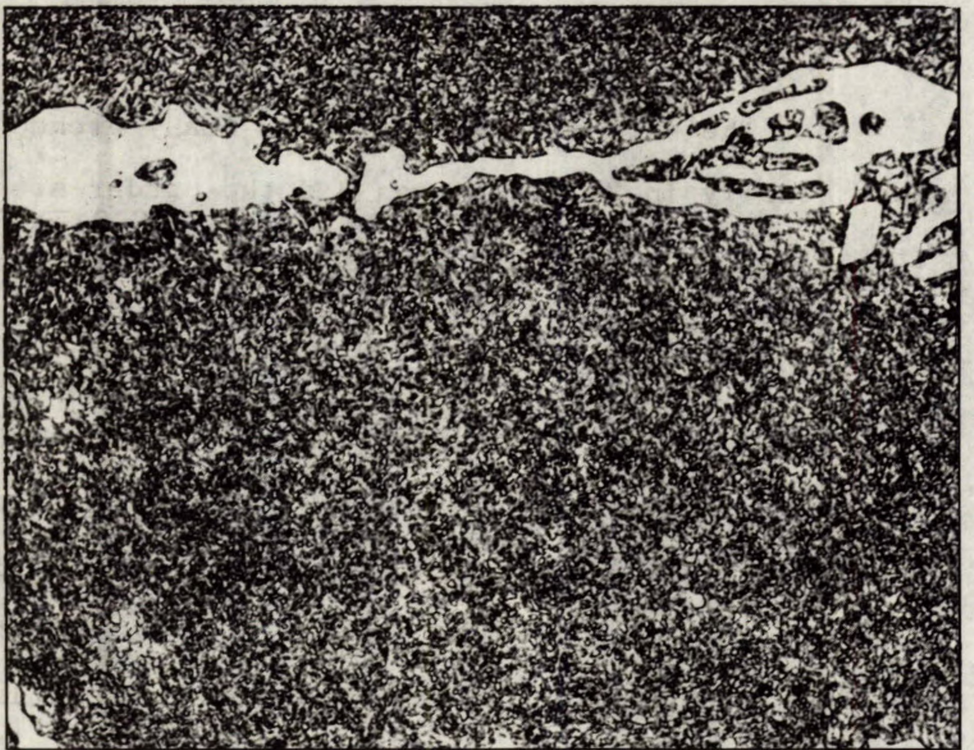
Shell Number	Rockwell 'C' Hardness
JA-298-1-AHTS	61
A-298-2-AHTS	62
JA-582-3-ALAH	54
JB-427-5-ALAH	56

The average hardness of the matrix (exclusive of the primary carbides) was determined for one each of the AHTS and ALAH steels, using the Tukon Hardness Tester, Knoop indenter, 500 g load and the 10.25 mm objective. The matrix hardness of JA-298-1-AHTS was 761 Knoop (Rc 61) and that of JA-582-3-ALAH was 603 Knoop (Rc 53).

MICROSCOPIC EXAMINATION

The microstructures of both AHTS steels were similar, as were those of the ALAH steels. Consequently, the examination of only JA-298-1-AHTS and JA-582-3-ALAH is reported.

The softer steel (JA-582-3-ALAH) etched much more readily in 2% nital than did the harder steel. It is felt that the rate was greater than normal for the proper condition of heat treatment and for the amount of retained austenite that should be associated with the recommended hardening temperature, 1850°F (1010°C). The presence of a great number of fine carbides in the matrix is indicative of hardening from too low a temperature, of the order of 1700°F (930°C). The microstructure of the ALAH steel is illustrated in Figure 3.

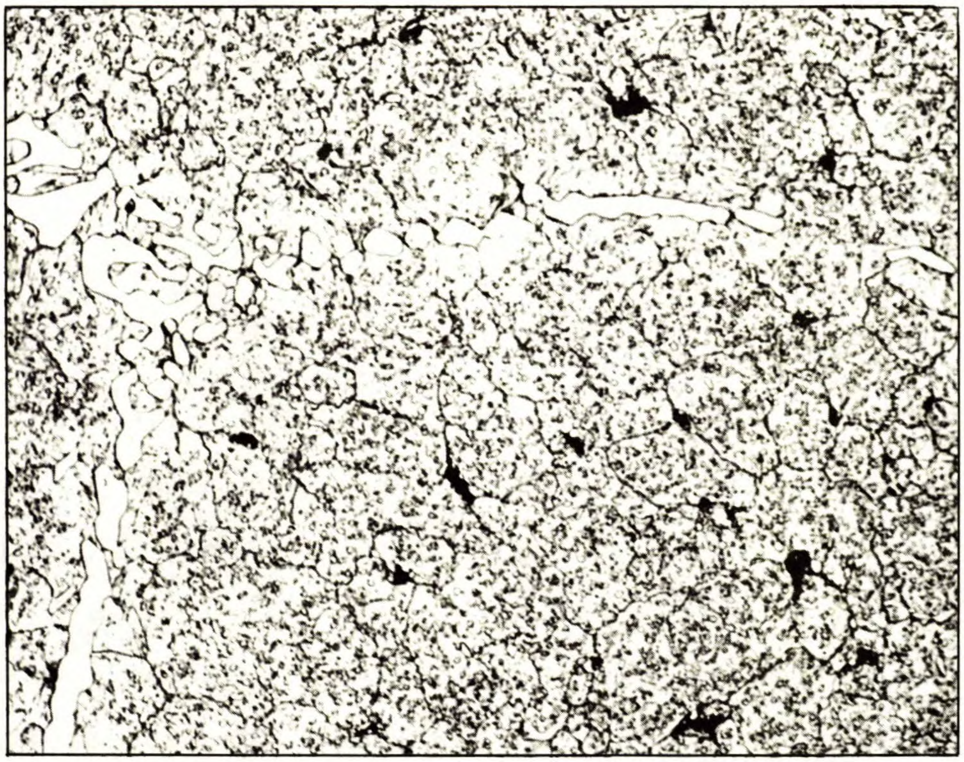


(X 1000 - Etched 10 sec in 2% Nital)

Figure 3 - Microstructure of JA-582-3-ALAH

Illustrates the massive primary carbide, many fine carbides in the matrix, and a dark-etching martensitic matrix.

The harder steel (JA-298-1-AHTS) had a more normal microstructure and hardness for this grade of steel under the recommended conditions of heat treatment. The photomicrograph shown in Figure 4 shows massive carbides, as in the softer steel, but fewer matrix carbides, which are of a larger average size, are seen. The grain boundary etching effect is normal for this grade when hardened from the proper temperature, as is the lighter-etching matrix.



(X 1000 - Etched 10 sec in 2% Nital)

Figure 4 - Microstructure of JA-298-1-AHTS

Illustrates massive primary carbide, fewer and coarser carbides in the matrix, a lighter etching matrix, and traces of spheroidized pearlite.

The darker patches of grain boundary phase are traces of spheroidized pearlite formed during cooling past the nose of the "S-curve". The formation of this phase is covered fully in the literature. The amount present in this case is too small to have a real effect on the hardness of the material.

X-RAY DIFFRACTION TESTS

Samples of JA-298-1-AHTS ɔd JA-582-3-ALAH were prepared and tested by X-Ray diffraction techniques. The former had an estimated retained austenite content of 25% ± 5, whereas the latter had approximately 8% ± 5. This is a definite indication that the softer steel was hardened from too low a temperature.

CONCLUSIONS

The wearing characteristics of the rolls supplied were controlled exclusively by their hardness levels. Both roll shells that had satisfactory wear life had hardnesses of at least Rc 61. At this hardness level there is a sacrifice in ductility, as evidenced by the fact that one of the AHTS shells was reported to have broken in service. The importance of the hardness level is also seen in the case of the ALAH steels. The greater the hardness of the ALAH steels, the longer was the life.

The appearance of the worn shells is also linked with the hardness. The lower matrix hardness of the ALAH steels caused noticeable preferential wear of the matrix over the massive carbides. The wear of the AHTS steels was much more uniform due to the higher hardness level of the matrix material.

Chemical analysis of the roll shells revealed no significant differences. Although there was a variation in the molybdenum content, the two shells with long life encompassed the range of molybdenum content.

Microscopic and X-Ray evidence indicates that the lower hardness of the ALAH steels is due to hardening from too low a temperature.

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