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EXAMINATION OF BUTT-WELDED PIPE SAMPLES JOINED BY INDUCTION HEATING

by

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SUMMARY OF RESULTS

Twelve samples of welded 1½-inch Schedule 80 mild steel pipe were investigated by bend testing, tensile testing and metallographic examination. These welds had been made under various experimental conditions and some possessed acceptable properties.

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(8 Pages, 5 Illustrations and 1 Table)

INTRODUCTION

Twelve welded samples of 1½-inch Schedule 80, A106 steel pipe were received from Mr. M.S. Cotterell, Civilian Atomic Power Department, Canadian General Electric Company Limited, Peterborough, with the request that they be examined and the weld quality assessed. No particulars of the welding conditions were provided except the general information that they had been pressure-butt welded using induction heating. The samples were identified by numbers: 2, 6, 9, 11, 12, 13, 41, 42, 43, 44, 45, 46.

TEST PROCEDURE

Each welded pipe sample was sectioned longitudinally to yield six 3/8-inch bend test coupons, one metallographic sample and one piece from which a 1/2 in. x 1/10 in. x 2 in. gauge-length flat tensile specimen was machined. The 3/8-inch bend coupons were tested by bending around a radius of 1 inch at the welded joint. These coupons were tested in adjacent pairs - one of each pair being tested with the interior surface in tension (root bend) and the other with the exterior surface in tension (face bend).

INVESTIGATION RESULTS

1. Weld Contour

Figure 1 shows the contours of the welded joint. It is apparent that acceptable interior weld contours have been obtained in all samples.

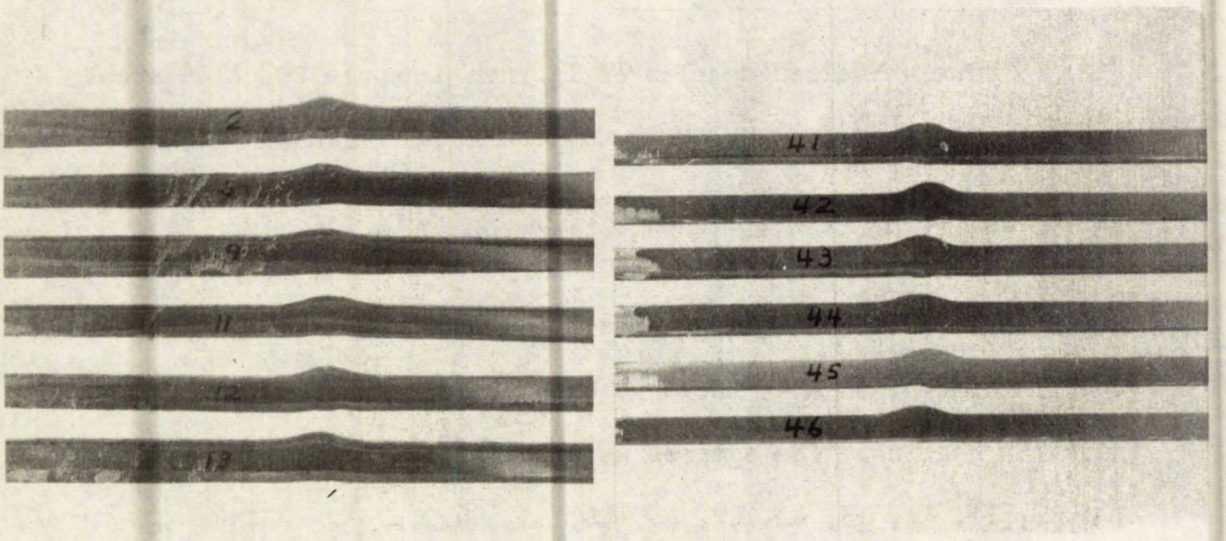


Figure 1 - Sections of the welded joints (interior surface downward)

2. Mechanical Properties

Mechanical test results are presented in Table 1.

TABLE 1

Spec. No.	U.T.S. 1000 psi	Y.P. 1000 psi	El. on 2 in.	Bend Test Results
2	65.2	49.1	21.0	150-180-180-180-180-180
6	69.8	45.7	17.0	90-45-90-90-40-20
9	75.0	56.2	16.0	45-30-40-30-100-30
11	64.8	51.2	20.0	90-90-180-180-180-180
12	65.4	47.1	19.5	All passed
13	64.4	50.4	19.0	120-180-180-180-180-180
41				All passed
42				All passed
43				All passed
44				All passed
45				All passed
46				120-180-180-180-180-180

The bend test results are presented as angles of bend at point of failure, or in coupons where failure did not occur, 180 represents a successful test. Since the weld reinforcement on all samples was very slight, it was not removed before bend testing. The surface of the fractured bend test coupons appeared dull grey with occasional brilliant crystalline facets as shown in Figure 2.

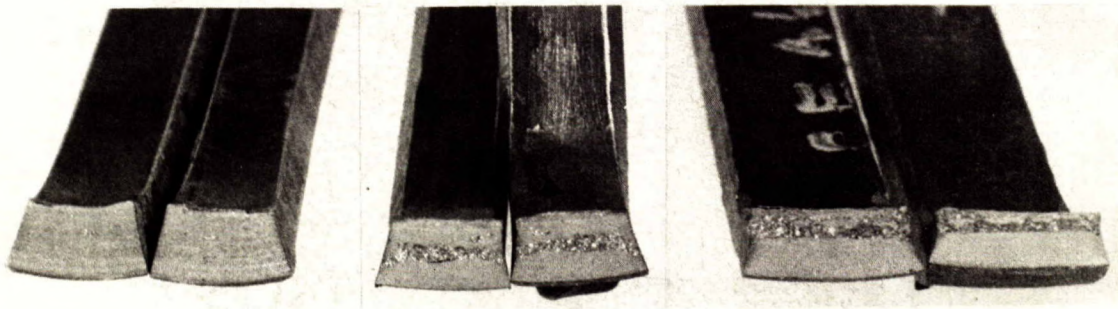
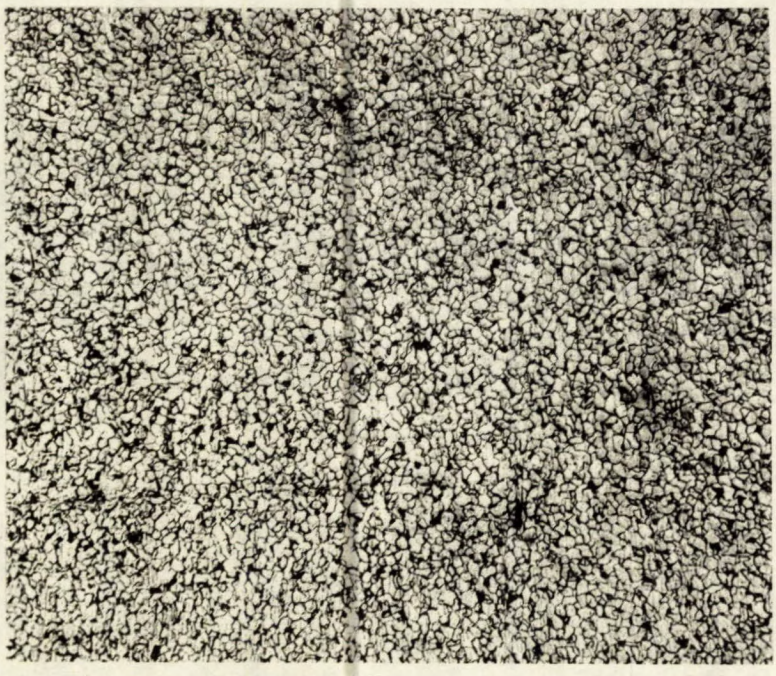


Figure 2 - Typical fracture surfaces.

In the tensile tests the yield point was determined by the observable drop in load on the tensile testing machine. None of the tensile specimens broke along the weld plane or in the heat-affected zone. Unfortunately pipe samples 41 to 46 inclusive were inadvertently sectioned in such a fashion that a tensile specimen could not be obtained. It appears, however, on the basis of the other samples' results that they would have shown equal or better mechanical properties.

3. Metallographic Examination

Sections were taken from each pipe weld and examined metallographically. Figure 3 is typical of the original normalized pipe structure away from the heat-affected weld zone.

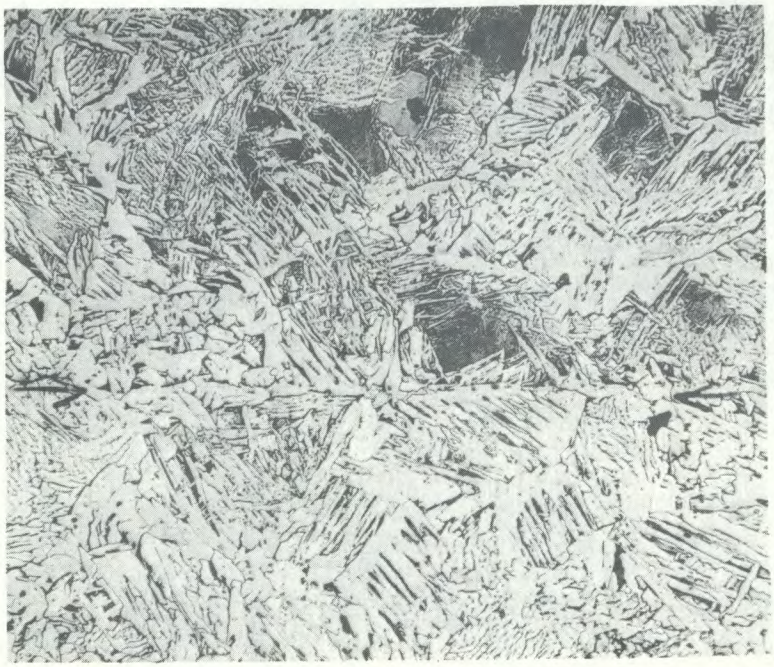


Mag. x200

Figure 3 - Normalized pipe structure.

Mag. x200

Figure 4 - Photomicrograph of weld interface from Sample No. 6



Mag. x200

Figure 5 - Photomicrograph of weld interface from Sample No. 12

Figures 4 and 5 are micrographs of the weld interface from samples No. 6 and 12, respectively. Sample No. 6 (which failed to pass the bend tests) exhibits a band of fine ferrite grains and a few black specks (presumably oxide inclusions) along the weld plane. In Figure 5, the weld plane is hardly discernible except for the fact that the carbon content is slightly different in the two pieces joined which results in more pearlite on one side of the weld plane. Weld interfaces such as this, which were free of oxide and fine ferrite grains, were typical of the welds which successfully passed the bend tests. It should also be noted that considerable grain growth has occurred in the heat-affected zone (compare Figure 5 and 6 with Figure 4).

CONCLUSION

Samples No. 12, 41, 42, 43, 44, 45 may be considered as acceptable in accordance with A.S.M.E. Section IX, Welding Qualifications, 1956 edition.

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