RESEARCH & DEVELOPMENT REPORT
28HC650 WEAR TEST COMPARISON

Material Samples
Wear Test
EL 352

RESEARCH & DEVELOPMENT REPORT

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I. OBJECT

To subject a cast iron, Ni-Hard, and cryogenic[1] treated Ni-hard and chrome iron test bar to abrasive wear from a silica sand slurry in order to compare the abrasion resistance of these materials.

To determine the effect of the cryogenic treatment on Ni-hard for hardness increase and the abrasion resistance.

[1] Cryogenic treatment is the soaking of metals for several hours at a low temperature (to -300° F), followed by gradual warming to ambient temperature, to improve material properties by changing the micro structure. Treated tool steels have improved wear resistance even though the hardness is not increased. Treated Ni-hard has increased hardness, which should improve the wear resistance of that material.

II. TEST PROCEDURE

Each sample was measured and marked for identification. The mounting disc was punch-marked in a protected area to insure identification if the sample markings were lost during the test.

After the apparatus was assembled, sand and water were added to produce a mixture 40% by volume sand slurry (63% by weight) that partially submerged the test coupons in sand and completely submerged the coupons & disc with water in a static condition. The cover was installed, the slinger positioned and the test started.

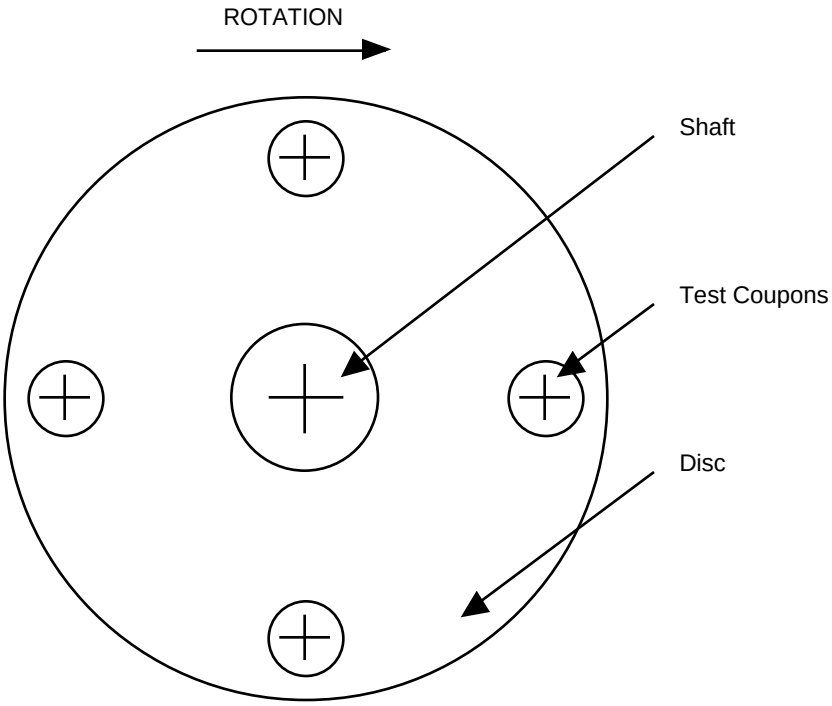
The test speed of 1475 RPM was established during the start up as the highest speed without constant low vibration. This choice of speed allowed the unit was to run unattended except for periodic checking. A cool slurry temperature was maintained with cooling water in the jacket around the base of the fixture.

A twenty hour period was selected as the first interval for inspection of the samples because vibration had been slowly increasing during the test run. Inspection of the samples showed sufficient wear to justify terminating the run.

III. TEST EQUIPMENT

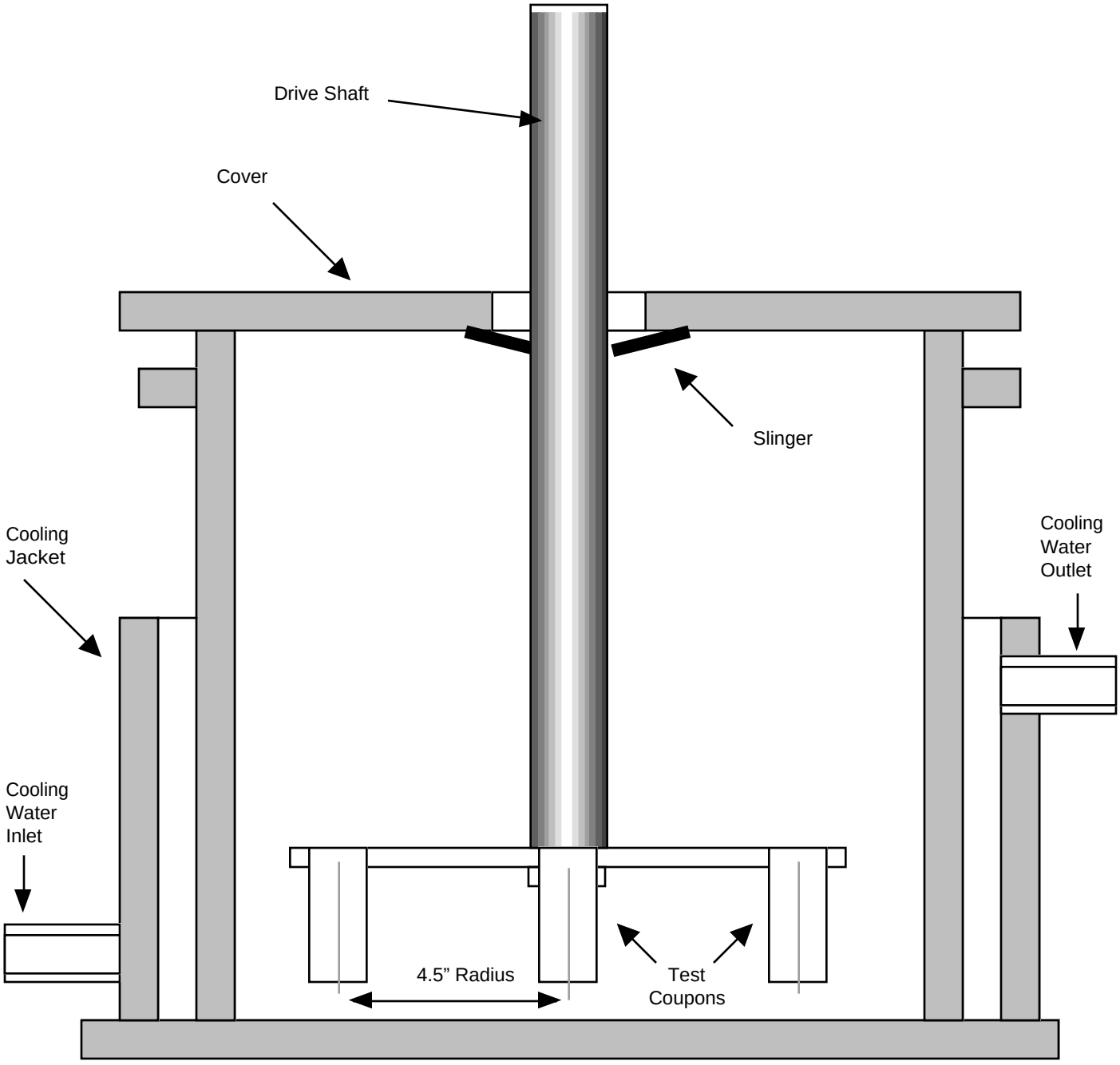
The wear test apparatus was adapted to a vertical shaft assembly (see figure 1). It was driven by a 25 HP, 0-3600 RPM variable frequency drive (VFD) motor connected to the shaft assembly with standard commercial flexible couplings.
An electric pulse generator and a counter were used to measure the RPM. A vibration pickup was attached to the bearing frame for observing vibration levels during the testing operation.

Figure 1



ROTATING DISC COUPON HOLDER

Figure 2



WEAR TEST APPARATUS

III. TEST RECORDS

TABLE 1

Location	Material	BHN	Net. Weight Start	Net. Weight Finish	Wt Loss %	Rel Wear 2	Observations
1	Ni-Hard Cry	652	95	85	10.53	0.444	Moderate wear
2	28HC650	652	92.1	85.5	7.17	0.303	Minimum wear
3	Ni-hard	512	95.6	85.7	10.36	0.436	Moderate wear
4	Cast Iron	179	89.3	68.1	23.74	1	Significant wear

* Radius from center of rotation to center of test coupon is 4.50 in.

* Wear test speed was 1475 RPM

* Test coupon centerline velocity was 57.9 ft/sec

* Test coupon exposed surface was .75 in. diameter X 1.75 in. long with surface ground to 32 RMS[3]

* The percent weight loss is based on the exposed weight of the test coupon. The portion of the test coupon protected by the disc holder is deducted prior to calculations.

[2] Cast iron is used as the control. Cast Iron baseline comparison = 1.00

[3] RMS-Root Mean Square

V. TEST DATA

TABLE 2

Chemical Composition & Mechanical Properties of Test Materials

Symbol	Description	Cast Iron	Ni-hard	28HC650
C	Carbon	3.25 - 3.35*	3.00 - 6.00	2.30 - 3.00
Si	Silicon	1.70 - 1.90*	.80 max	1.00 max
Mn	Manganese	.40 - .70*	1.30 max	.50 - 1.50
Cr	Chromium	-	1.40 - 4.00	23.0 - 28.0
Ni	Nickel	-	3.30 - 5.00	1.50 max
Mo	Molybdenum	-	1.00 max	1.50 max
Cu	Copper	-	-	1.20 max
P	Phosphorus	.07 max*	.30 max	.10 max
S	Sulfur	.09 max*	.15 max	.06 max
PSI	Tensile Strength in lbs/in2	35,000	40-50,000*	70,000*
BHN	Brinnel Hardness Number	196-228*	550 min.	650 min.*
ASTM Number		A 48	A 532	A 532
ASTM Type		Class 35	Class 1 Type A	Class III Type A

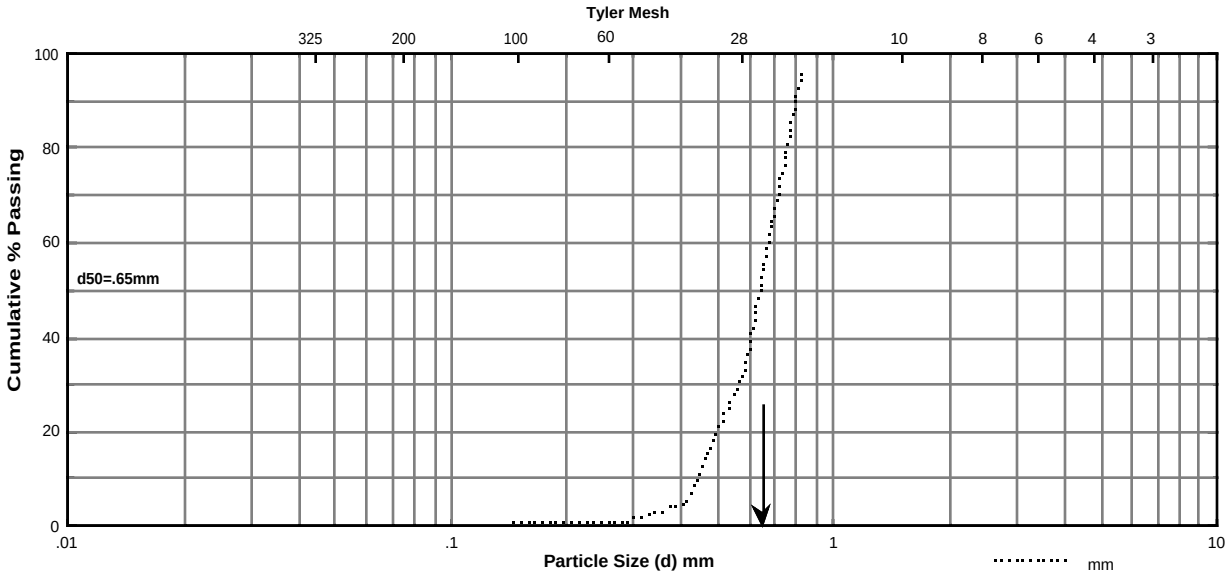
*** Values are typical and are not listed in ASTM specifications**

SILICA SAND DESCRIPTION

TABLE 3
Silica Sand Size

Tyler Mesh	mm	Particle Size %	mm
20	0.833	95.30%	0.833
28	0.589	32.60%	0.589
35	0.417	41.70%	0.417
48	0.295	40.00%	0.295
65	0.208	30.00%	0.208
100	0.147	2.00%	0.147

TABLE 4
PARTICLE SIZE DISTRIBUTION PLOT



Mohs Hardness 6-7

d50 - - - - - - - - - - - .65 mm

VI. TEST RESULTS AND CONCLUSIONS

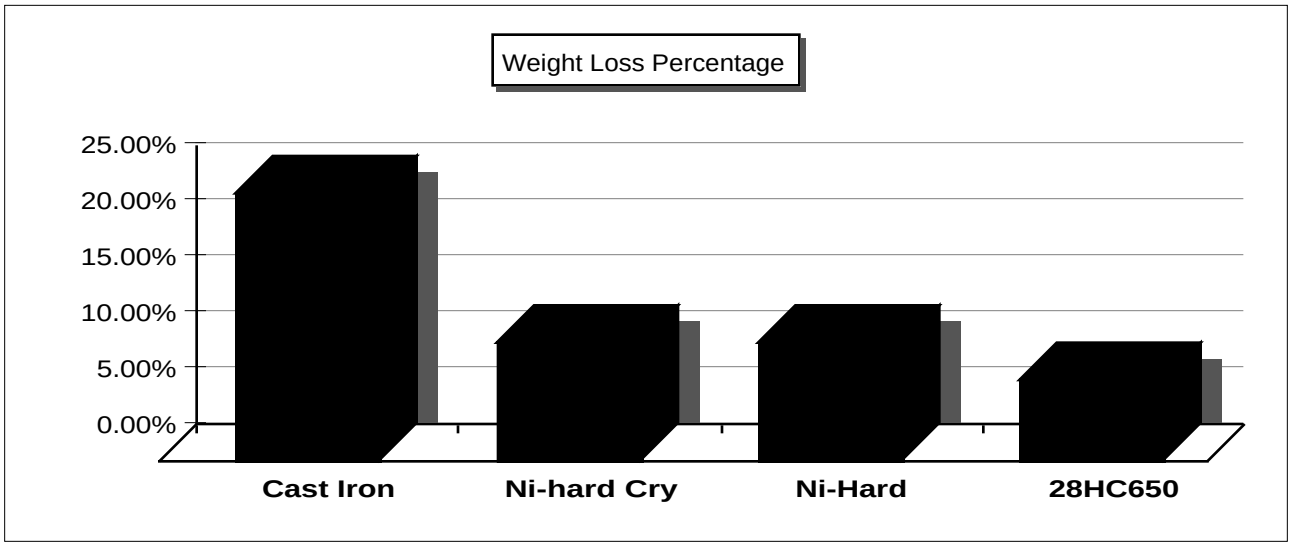
This test shows that hardness is not the only criteria for resistance to abrasive wear. The 28HC650 test coupon (652 BHN) had the same hardness as the cryogenic treated Ni-hard test coupon (652 BHN) but only had a 7.17% weight loss compared to a 10.52% loss for the treated Ni-hard. This is attributed to superior carbide dispersion in the 28HC650, which also has superior tensile strength.

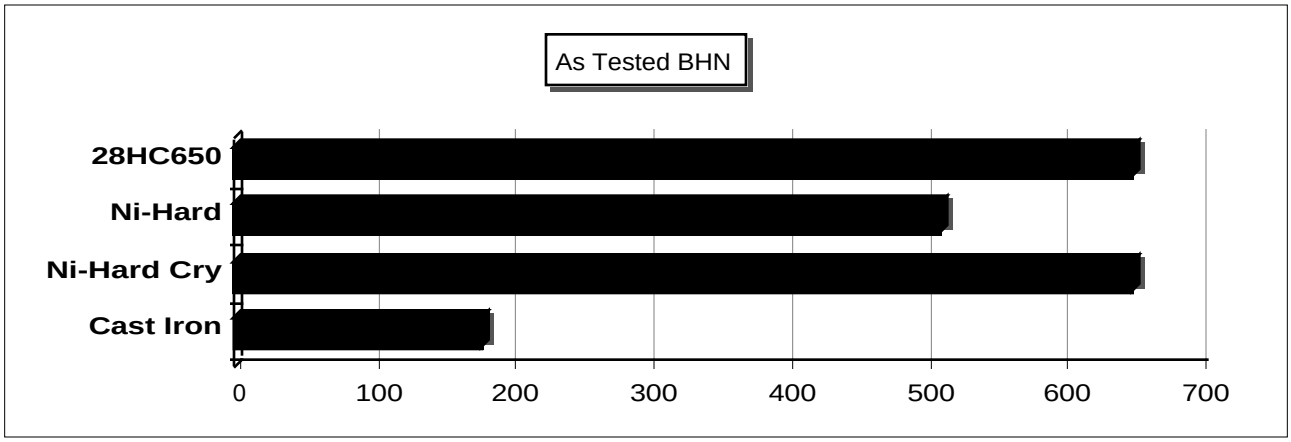
The cryogenic treated Ni-hard test coupon (652 BHN) was 140 BHN points higher than the untreated coupon (512 BHN), but had slightly more metal loss; 10.52%, compared to 10.35% for the untreated Ni-hard coupon. It is possible the gain in hardness causes a loss of toughness for no actual gain in abrasion resistance.

This test showed Ni-hard to have a wear life 2.28 times longer than cast iron, and 28HC650 3.30 times longer than cast iron. The 28HC650 has an indicated life 44% longer than Ni-Hard for the same amount of wear.

This apparatus can be refined to collect comparative wear data for other materials and also determine velocity effects to establish abrasivity indexes for slurries.


Relative Wear Rate of Test Coupons
28HC650
Ni-hard
Ni-Hard Cry
Cast Iron
0
0.5
1
1.5
2
2.5
3
3.5


Weight Loss Percentage
25.00%
20.00%
15.00%
10.00%
5.00%
0.00%
Cast Iron
Ni-hard Cry
Ni-Hard
28HC650


As Tested BHN
28HC650
Ni-Hard
Ni-Hard Cry
Cast Iron
0
100
200
300
400
500
600
700

VII. RECOMMENDATIONS FOR FUTURE TEST

1. Develop a baseline test procedure which would give qualifiable results in 4 hours by running at higher RPM speed.

2. Repeat this test using a new set of Ni-hard samples.

3. Make sure there is a sufficient quantity of this sand to run a complete test program using a precise amount of new sand and water for each test.

4. Repeat this test using test coupons of CD4MCu, PACE, and 316 with control samples of cast iron and 28HC650.

5. Establish a program for testing at various speeds to measure speed effects on wear using a constant speed times running time.

For further information about Morris Pumps' Series 6100 Type CT Severe Duty Recessed Impeller pumps constructed of 28HC650, contact your local authorized Morris Pumps Sales representative or contact the factory at:

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