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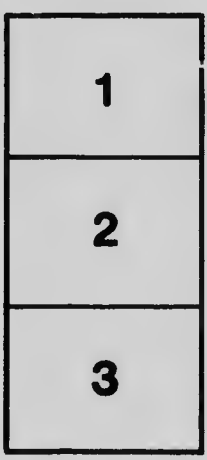

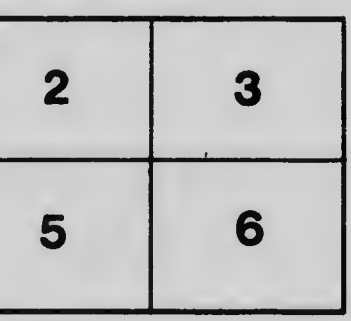

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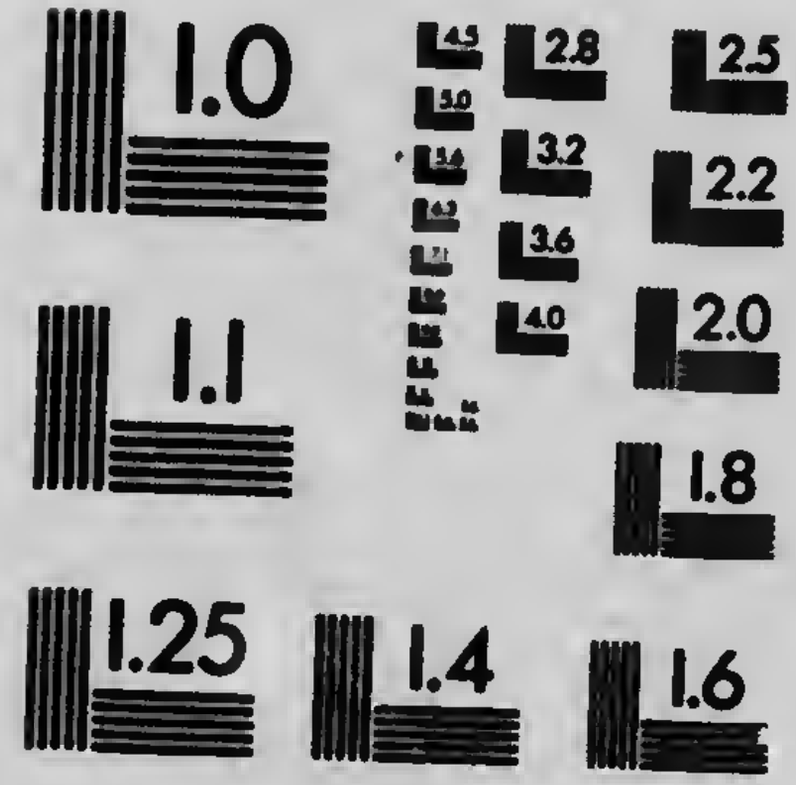

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No. 63: THE DETERIORATING EFFECT
ON STEEL RODS, AND THEIR PARTIAL
"BAKING," BY HERBERT A. BAKER AND W.

(REPRINTED FROM THE JOURNAL OF THE SOCIETY OF CHEMICAL IND

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PARTIAL RESTORATION ON
AND W. R. LANG
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DECEMBER 31, 1906.

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1906.

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Canadian Section.

Meeting held at Toronto, on Thursday, October 25, 1906.

PROF. W. H. ELLIS IN THE CHAIR.

THE DETERIORATING EFFECT OF "ACID PICKLE" ON STEEL RODS, AND THEIR PARTIAL RESTORATION ON "BAKING."

BY HERBERT A. [illegible]KER AND W. R. LANG.

It is the universal practice in wire manufacture to "pickle" the steel rods in order to remove the black scale of oxide before drawing them into wire. This has long been known to deteriorate the quality of the rods, but it has been found that, if the rods are "baked" at 250° F. for some hours after this treatment, they are in a great measure restored, and can then be drawn into wire. The following physical tests were made in order to find out quantitatively the amount of such deterioration and subsequent restoration of the rods. The work was done on samples taken in the different stages of the process of manufacture at the Imperial Steel and Wire Company's plant at Collingwood, Ontario, at the suggestion of the manager, Mr. J. A. Currie. Samples of three different coils of rods were taken in the following stages:—(1) Before treatment with acid; (2) after acid cleaning; (3) after rusting; (4) after lime coating; (5) after baking. Table I. shows the tensile strength, percentage elongation over 8 ins., and percentage contraction of the rods; the strength of the bath, time immersed, and time of baking are also given.

The tests were made with a Riehlé machine, by the kind permission and with the assistance of the staff in the Engineering Department, University of Toronto. It may be observed that the ultimate strength remains throughout the process as constant as can be expected of that kind of test. The percentage elongation over 3 ins. rather unexpectedly remains constant, but the sudden drop in the ability to contract to a small "neck," before breaking, occurs immediately after acid treatment, and remains practically constant until after "baking," when a marked recovery in this property occurs, the three rods agreeing well in this behaviour. It is important to note that on this property of "necking in," or contracting in area on stretching, depends the property of drawing well through

TABLE I.

Rod	Strength in lb. per sq. in.			Elongation over 8 ins.			Percentage contraction.		
	A	B	C	A	B	C	A	B	C
				per cent.	per cent.	per cent.	per cent.	per cent.	per cent.
Before treatment	65,700	59,700	69,100	16	13	12	63	66	67
After acid cleaning	61,400	59,700	64,200	16	13	13	38	44	47
" rusting	62,800	57,000	64,700	17	14	11	38	47	44
" lime coating	65,700	59,700	67,000	16	14	—	37	47	41
" baking	65,700	58,000	67,600	16	13	—	57	66	56

The strengths of acid used, at 100° C., were: A, 38 per cent.; B, 11 per cent.; and C, 10 per cent.; and the times of immersion in the baths: A, 1 hr.; B, 45 mins.; C, 1 hr. 10 mins. All the rods remained in the "baker" for about 4 hours.

the die, which is a conical hole in a block of tungsten steel.

This deterioration and recovery at the same stages in the process is also well shown in the following bending tests, which corroborate the contraction tests :—

TABLE II.

Bending tests on the rods.

	Before treatment.	After acid cleaning.	After rusting.	After lime coating.	After baking.
Rod A.	100	70	64	64	100
,, B.	100	60	56	57	99
,, C.	100	71	55	53	100

These figures are relative, of course, and express the ability to bend a certain number of times through a definite angle before breaking. They are the result of averaging eight or ten tests in each case. The highest number was taken as 100, and the rest calculated proportionately. The results show a break in the bending properties of the rod immediately after acid treatment, and a recovery after "baking," thus corresponding to the effect on the rods as indicated by the contraction tests.

Shearing tests were also made, but the differences were so small that no conclusions could be drawn from them.

An examination of the wires of different diameters drawn from these rods (correspondingly marked A, B, C) was also made in the same manner :—

TABLE III.

Tensile strength and percentage contraction of wires.

1. *Tensile strength.*

		Wires A.	Wires B.	Wires C.
	Diam. in.	lb. per sq. in.	lb. per sq. in.	lb. per sq. in.
(*a*)	0·175	72,900	93,700	93,700
(*b*)	0·142	112,600	113,900	113,900
(*c*)	0·112	117,300	122,400	122,400
(*d*)	0·091	—	138,400	131,000
(*e*)	0·072	137,000	150,000	150,000

2. *Percentage contraction.*

		per cent.	per cent.	per cent.
(*a*)	0·175	52·0	54	47
(*b*)	0·142	45·0	38	36
(*c*)	0·112	28·5	31	32
(*d*)	0·091	—	36	33
(*e*)	0·072	20·0	37	30

It will be observed t
tensile strength than wi
tensile strength on dra
fall in contraction are
the wires tested decrea
it is in A. This mean
be drawn through tw
would be necessary, wh
stand no more drawing
better wires. The only
rods was that rod A
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longer than usual—an
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that only weaker acid
Table IV. gives the
the wires: this also wo
the better.

Bendin

	Wir
Diam. in.	
(*a*) 0·175	9
(*b*) 0·142	9
(*c*) 0·112	8
(*d*) 0·091	—
(*e*) 0·072	8

Many superintender
terioration to the prese
renders steel "cold sho
highly improbable, as
in the sulphur conten
before and after treatr
that a "hydride" of
suggested. Several t
obtained, but not
publication. The inv

observed that wires B and C have a higher
gth than wire A. Incidentally the increase of
ngth on drawing out will be observed. The
traction area percentage, as the diameter of
ested decreases, is not so great in B and C as
This means that these wires could probably
through two more dies before annealing
ecessary, while wire A would, in all likelihood,
ore drawing. Thus B and C appear to be the
s. The only difference in the treatment of the
that rod A was cleaned in 38 per cent.
cid, while rods B and C were cleaned in 10 per
They were all "baked" about four hours—
n usual—and are probably restored as much
The results indicate that strong acid causes
sary amount of deterioration in the rod, and
veaker acid should be employed.
V. gives the comparative bending abilities of
this also would indicate that wires B and C are

TABLE IV.

Bending tests on the wires.

	Wire A.	Wire B.	Wire C.
. in.			
5	91	100	100
2	90	97	100
2	89	100	83
1	—	100	80
2	86	100	94

uperintendents of plants have attributed the de-
to the presence of sulphur, knowing that sulphur
el "cold short." This appears to the authors to be
probable, as careful analyses show no difference
phur content, which was 0·051 per cent. both
after treatment. It seems much more probable
hydride" of iron is formed, as has often been
. Several tests confirmatory of this idea were
but not sufficiently conclusive for present
n. The investigation is being continued.