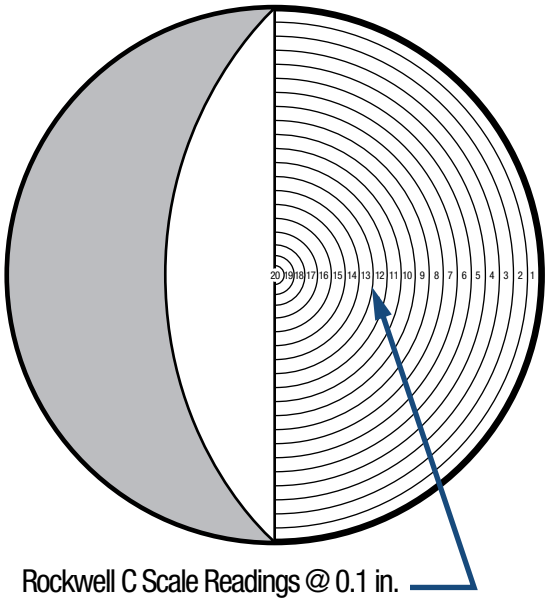
TECH TOPICS

Average Volumetric Hardness Calculations compare overall hardness of different grinding balls

AVH gives more meaningful single hardness value

"Average Volumetric Hardness" (AVH) is a computed value which weighs the importance of each hardness value on the grinding ball cross section. The result is a meaningful single hardness value. The AVHs can then be used to compare the overall hardness of different grinding balls. This permits more effective grinding ball evaluation for the most efficient production, because the higher the volumetric hardness, the better the resistance to abrasion throughout the entire life of the ball in any grinding operation.



Average volumetric hardness calculation for 105mm dia. ball.

Calculation

Hardness values are taken at intervals from the surface through to the centre of the grinding ball. The ball volume present at each of these depths is depicted by an imaginary shell as shown in the following figure. The percentage of total ball volume present in each of these shells has been computed, and is shown in the "% Volume" column of Table 1.

TABLE I

PORTION OF BALL NO.	% VOLUME	AVG. R_C READING
1	14.26	64.0
2	12.84	63.5
3	11.49	63.5
4	10.21	63.0
5	9.01	63.0
6	7.89	63.0
7	6.84	62.5
8	5.86	61.0
9	4.96	60.0
10	4.14	58.0
11	3.39	56.0
12	2.71	55.0
13	2.11	55.0
14	1.59	54.0
15	1.14	54.0
16	.76	52.0
17	.46	52.0
18	.24	51.0
19	.09	50.0
20	.01	50.0

Average volumetric hardness 61.7R_C

TABLE II
HARDNESS CONVERSION TABLE*

Rockwell C Hardness Number	Vickers Hardness Hv 30	BRINELL NUMBERS 10mm Caribide Ball, 3000kg Load
68	940	...
67	900	...
66	865	...
65	832	739
64	800	722
63	772	705
62	746	688
61	720	670
60	697	654
59	674	634
58	653	615
57	633	595
56	613	577
55	595	560
54	577	543
53	560	525
52	544	512
51	528	496
50	513	481
49	498	469
48	484	455
47	471	443
46	458	432
45	446	421
44	434	409
43	423	400
42	412	390
41	402	381
40	392	371
39	382	362
38	372	353
37	363	344
36	354	336
35	345	327
34	336	319
33	327	311
32	318	301
31	310	294
30	302	286
29	294	279
28	286	271
27	279	264
26	272	2858
25	266	253
24	260	247
23	254	243
22	248	237
21	243	231
20	238	226

*Reference: ASTM E140-67, Table 2

The AVH of the grinding ball is then computed by multiplying the % volume of each shell by its shell hardness, summing these products, and dividing by 100. The example computation is for a 105 mm grinding ball. However, grinding balls of other sizes will require computation of the individual "% Volume" in each of their shells.

Rockwell C Scale hardness determinations are made on Donhad Grinding Balls. At the high-hardness levels of Donhad Grinding Balls, absolute Brinell determinations are not reliable although they are calculated for reference.