Issue 15: Bud's Take on Ball Manufacturing and Resultant Accuracy

Ball Manufacturing and Resultant Accuracy

I was recently doing some training and was thrown an unexpected curve ball. I was discussing the precision of bearing clearance. In bearing manufacturing prior to ball selection each raceway surface curvature is measured. The measured dimensions are fed into a computer which determines the ball size necessary to achieve the required internal clearance. The machine then drops the required number of balls, all of the exact same size….

At this point my nemesis pounced, "No way the balls are exact!"

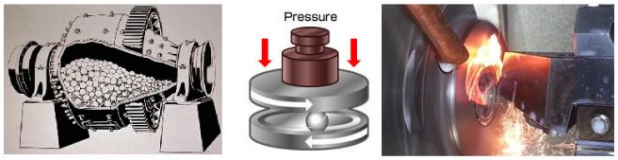
Ball Manufacturing Process

To best dig into the exactness of the ball size I felt it appropriate to look at the ball making process.

The process starts with wire that is cut into slugs of the required length. They are then cold headed resulting in a ball with the approximate size with flashing (resembles a Saturn ring).

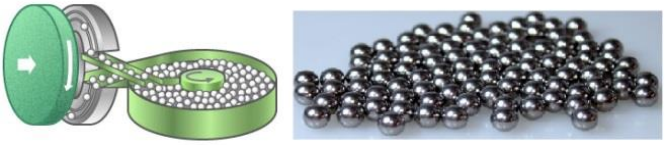
Pic 1: Blank, heading, ball with flashing.

The next steps are a series of grinding and tumbling operations, depending on manufacturer, to remove the flashing and followed by heat treatment.



Pic 2: Tumbling, flashing machine, heat treatment.

After heat treatment the balls will go through additional grinding, could be a series of rough and finish grinding. The final steps include lapping. In some cases a second lapping step is used to achieve the final tolerance and surface finish.



Pic 3: Lapping Machine and finished balls.

Standard Grade for Balls used in Electric Motor Bearings

I will use ABMA (American Bearing Manufacturers Association) figures for my comparison.

Grade tolerances for inch sizes[3]

Grade	Size range [in]	Sphericity [in]	Lot diameter variation [in]	Nominal ball diameter tolerance [in]	Maximum surface roughness (Ra) [µin]
3	0.006–2	0.000003	0.000003	±0.00003	0.5
5	0.006–6	0.000005	0.000005	±0.00005	0.8
10	0.006–10	0.00001	0.00001	±0.00005	1.0
25	0.006–10	0.000025	0.000025	±0.0001	2.0
50	0.006–10	0.00005	0.00005	±0.0002	3.0
100	0.006–10	0.0001	0.0001	±0.0005	5.0
200	0.006–10	0.0002	0.0002	±0.001	8.0
1000	0.006–10	0.001	0.001	±0.005	

Pic 4: ABMA Grade Tolerances for inch sizes.

For electric motor bearings, in most cases the ball grade is 25 or better. Let's assume we have a 0.500" diameter ball, grade 25. The ball tolerance is 0.4999 in to 0.5001 in.

Now the true kicker is that you must look at lot variation. Let's say your lot size hits that 0.5000" on the button. So the ball variation within the lot will be 0.000025" according to Grade 25 tolerances. So if the smallest ball is 0.5000", the largest in the lot could be 0.500025".

What is Exact?

How big is that variation? Let's look at some common items for comparison:
Contact Lenses: 0.1575"
Human hair: 0.0040"
Paper: 0.0039"
Grain of sand: 0.0008"
Standard aluminum foil: 0.0006"

Bud's Take (or opinion)

Going back to my nemesis' statement, "No way the balls are exact!"

If you want to split hairs he would be right. By splitting hairs we aren't in the ball park! Human hair is 0.0040". If you split it we are still at 0.0020". That is 80 times larger than the 0.000025" variation of a Grade 25 ball!

In most cases you round at 4 digits. Round 0.000025" to four digits and we get 0.0000".

Note: In checking on ball grades with two manufacturers, both stated that they used better than Grade 25 tolerance balls for their standard ball bearing product.

Ok, by the book maybe he is correct, but in theory they are exact. I mean how many spaces can you accurately measure?

You get to decide who is right!