David Hewitt Pottery

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Raw Materials - Do you know what you are buying? By David Hewitt

My recent experiences with **Black Iron Oxide** and **Talc** have made me realise that, as buyers of pottery materials, we should be given much more precise information as to what we are being offered. How often have we made up a glaze mix from a well tried recipe only to find that it has not come out as expected. Did we make a mistake in the weighing or was it the latest purchase of one or more of the ingredients that was different?

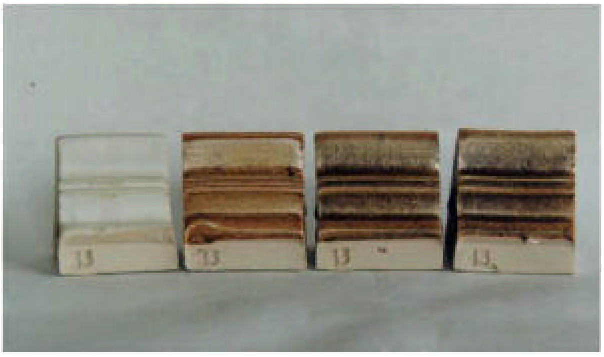
Ideally we should get an analysis sheet with each purchase. This would not only tell us what we are getting, but we could also see if it was different from what we had before.

If we use a Glaze Calculation Program of any type, then it is even more important that we know that the data is applicable to what we are buying. My Glaze Workbook Program, for example, is based on the materials that I get from Bath Potters' Supplies.

Suppliers' catalogues, in general, give limited information on glaze materials, but Bath Potters' Supplies are going to add material analysis data to their Web Site later this year. This will also include analysis data on their Clays. At present only data on their Fritts is included. It would seem to me that the Internet provides the easiest way by which Suppliers can give this information to us and keep it up-to-date

I would encourage all potters to press their Suppliers for this information.

Black Iron Oxide



Left to Right
Base Glaze O1 - see Recipe below
O1 + 6% W G Ball Black Iron Oxide
O1 + 6% Potterycrafts Black Iron Oxide
O1 + 6% Potclays Black Iron Oxide

Do you know what you are getting when you buy black iron oxide? Until recently I had always assumed that I would get a material with the composition of FeO (Ferrous oxide), but I now find that you are more likely to get Fe3O4 (Ferrosic oxide or Magnetite). It might even be something quite different like a Synthetic Iron-manganese mixed oxide (Fe, Mn)2 O3.

This all started because my glaze program, 'The Glaze Workbook' is a spread sheet file, and hence one can see all the formulae used in any calculation. A sharp eyed Chemist from Holland, Ruud Ruijgrok, pointed out to me that in using black iron oxide in oxidation my % weight analysis did not take into account the fact that FeO would, in fact, take in oxygen and change to 0.5Fe2O3.

Through the Clayart discussion group, Michael Banks commented 'Are you sure that you are getting FeO when you buy black iron oxide? I think that you are most likely to be supplied with Fe3O4 (Magnetite or Ferossic oxide)'. This, of course, opened up a whole new aspect to this enquiry.

On Ruud's suggestion, it was decided to obtain some black iron oxide from WG Ball, Potterycrafts and Potclays and heat a weighed and dried quantity in oxidation to 1000 C and see what weight increase was obtained. A quick and easy test to carry out. While not the same as a full chemical analysis, this should indicate whether or not we were getting FeO or Fe3O4 as the weight gain would be different. See Theoretical Weight Gain Table below.

Mike Bailey of Bath Potters' Supplies was good enough to do these tests as he has some very accurate weighing equipment. The results were all different in weight and physical appearance. None tallied with the theoretical weight increase for FeO, one showing no increase at all. So, while all three suppliers were giving us what they called 'black iron oxide', there were clearly some differences, and so we requested each to supply an analysis sheet from their suppliers. The W G Ball analysis, which had shown no increase in weight, indicated that the material was a synthetic iron-manganese mixed oxide. The Potterycrafts and Potclays was largely Fe3O4, but there was still some doubt about the exact composition of the Potclays material. Details of the analyses received are given below together with results of the heating tests.

The important thing is, do these differences in composition matter when mixed in a glaze? To show what these variations might make in a glaze, a 6% of each was added to a well established matt cone 8 glaze. The W G Ball test showed typical yellowish manganese colouring while the other two showed black streaking and were very similar and more what one would expect from adding black iron oxide. All three had a slight fluxing effect on the glaze, making it a nice satin matt.

So where does this leave me with my glaze program? I am going to assume that the most likely analysis for black iron oxide is Fe3O4 and make the calculations accordingly. As with all glaze programs, the user can alter the analysis if they do find that their supply is different. In altering my program I have, of course, make the correct theoretical oxygen gain when used in oxidation, which was of course Ruud's original point. The calculations are made on the following basis:-

FeO in oxidation gives 0.5*Fe2O3
Fe3O4 in oxidation gives 1.5*Fe2O3
Fe2O3 in oxidation gives Fe2O3

FeO in reduction gives FeO
Fe3O4 in reduction gives 3*FeO
Fe2O3 in reduction gives 2*FeO .

Heating Test Procedure

Five 100g samples of each supply were weighed and then dried by heating to 100 C and then re-weighed. The dried samples were then heated to 1000 C and re-weighed. The gain/loss was then averaged over the five samples from each supplier. The results were as follows:-

	Weight after drying	Weight after heating to 1000 C	Gain/Loss %
W. G. Ball	98.6g	98.6g	no gain or loss
Potterycrafts	99g	101.42g	2.44% gain
Potclays	99.5g	106.7g	7.23% gain

Theoretical Weight Gain on 100g assuming material is 100%

FeO if oxidised gives 0.5* Fe2O3 (100/72)*(0.5*160) = 111 or 11% increase
Fe3O4 if oxidised gives 1.5* Fe2O3 (100/232)*(1.5*160)=103 or 3% increase
Fe2O3 if oxidised gives Fe2O3 (100/160)*(1*160) =100 or no increase
(MW FeO = 72, MW Fe2O3 =160, MW Fe3O4 = 232)

The W. G. Ball lack of any weight increase is consistent with it being a Fe2O3 + Mn2O3 mixture.
The Potterycrafts weight increase would seem to be consistent with it being 89%- 92% Fe3O4 as given in its analysis.
The Potclays weight increase would suggest that it may well be a mixture of Fe3O4 + FeO.

W. G. Ball Black Iron Oxide

Analysis

Synthetic Iron-manganese mixed oxide (Fe, Mn)2O3

Fe2O3 58 - 60%
Mn2O3 16 - 30%
SiO2 + Al2O3 3 - 5%
Water soluble salts (%) 0.7 max Loss on heating at 1000 C 2.0 max
Sieve residue (on 0.045 mm mesh) % 0.005 max
pH value 7 - 10
Tampered apparent density (g/cm3) 1.1 - 1.5

Sample before and after heating to 1000 C

Coarser than the others as supplied. Stayed black after heating and quite clinkery

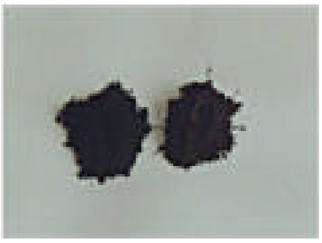
Potterycrafts Black Iron Oxide

Analysis

Magnetite

Fe3O4 89 - 92%
Fe2O3 1 - 2%
Fe (Metallic) 0.2%
C 0.1%
SO3 0.5%
Tampered bulk density 2.3 - 2.5
SG 4.8 - 5.0 % > 40 µm 90%

Sample before and after heating to 1000 C



Black as supplied but after heating was powdery and a slight mauvish colour.

Potclays

Analysis

Assumed Fe3O4 or FeO and Fe3O4 mix After much trouble Harry Fraser was unable to get a definitive analysis from his supplier with which he could be wholly satisfied. The above is his best advise to me. I am very grateful to him for the trouble to which he went to help me in this enquiry.

Sample before and after heating to 1000 C

Finer powder than the others as supplied. Stayed black but formed a soft 'biscuit' after heating

Glaze Recip - O1	
Cornish stone	500
China clay	220
Dolomite	230
Whiting	60
Talc	100
Total	1100

Talc

Not long ago I bought some talc from another supplier and confidently used it in two well tried glaze recipes. The results, however, were something quite different. On checking with each supplier I clearly found the reason for this as the analyses of the two materials shows.

	New Talc	Original Talc
SiO2	31.41	59.78
TiO2	0.01	0.02
Al2O3	0.43	0.54
Fe2O3	6.56	0.33
MnO	0.1	-
MgO	33.9	31.97
CaO	0.25	0.57
Na2O	0.01	0.01
K2O	0.01	0.03
P2O5	-	0.07
LOI	26.38	6.0

The effect of these differences can clearly be seen in the following images. The pot on the left in each case is using the original talc and the one on the right is using the new talc. The new talc glaze is darker and, on close examination, is shinier. The recipe for the glaze on the two pots in the left hand image is **O1** as given above.

The information detailed above was first published in Ceramic Review No. 186 in 2000