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**In 1982, the name of the International Superphosphate Manufacturers' Associations (ISMA) was changed to International Fertilizer Industry Association (IFA).*

International Fertilizer Industry Association - Secretariat: 28 rue Marbeuf - 75008 Paris - France
Tel. +33 1 53 93 05 00 - Fax +33 1 53 93 05 45/47 - ifa@fertilizer.org - www.fertilizer.org

THE INTERNATIONAL
SUPERPHOSPHATE MANUFACTURERS' ASSOCIATION

AGRICULTURAL COMMITTEE
1, AVENUE FRANKLIN D. ROOSEVELT
PARIS (8E)
TEL. BALZAC 57-25

CENTRAL OFFICE
44, Russell Square,
LONDON, W.C.1.
TEL. MUSeum 8927.

LE/762 (2d)

TO ALL MEMBERS:

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MOISTURE CONTENT AND THE HARDNESS OF GRANULES

by A. T. BROOK

(Messrs. Fisons Limited)

Various methods of determining the hardness of granules have been published, and all employ some form of crushing or abrasion of the granule, followed by some method of assessing degredation of the granule.

Compound fertiliser granules, having a heterogeneous structure, cannot be expected to have consistent physical characteristics.. Granules formed by agglomeration of superphosphate and salts in a rotating tube-type granulator vary both in structure and shape, even when sieved between close mesh sizes. This fact makes any test on individual granules liable to wide errors, and as a result we have found crushing tests on individual granules to be inconsistent.

Soft granules show no definite point of fracture when loaded between flat steel plates, as their plastic nature produces an increase in area of contact as the granule deforms under load. A hard compound granule, such as is formed by drying to a low moisture content, requires a much higher compressive load to start the fracture, but it is difficult to obtain a good correlation between moisture content and true crushing loa

In our investigations into the setting characteristics of granular compounds, moisture content was found to be a major factor, and a reduction in setting with moisture contents below 2% led us to believe this could be due to a corresponding increase in hardness - the latter point being obvious from quite simple tests.

After investigating various methods of employing single granules as well as larger granules, the most consistent results have been given by subjecting about 100 grms. of a closely screened sample to a direct compressive load for a given time, and then measuring the amount of sub-size material (i.e., crushed granules and dust) resulting from the breakdown of granules.

Fig.1 illustrates graphically the relation between moisture content of granules and percentage breakdown.

The test is similar to that described by Hardesty and Ross in 1938*, and the following procedure is adopted:

A quantity of the granules to be tested is sieved between B.S.S. 6 & 7 mesh sieves, sufficient to give at least 100 grms. of test material

* Hardesty & Ross, Ind.Eng. Chem. June 1938, page 671

the mean size of granules then being 2.7 mm. 100 grms. are then weighed out, and placed in a shallow steel vessel having a cross-sectional area of 3 sq. ins. (19.2 cm^2). After settling the granules in the vessel, a load is applied to the surface by means of a steel piston sufficient to produce a pressure of 150 p.s.i. (10.5 Kg/cm^2). This pressure is far higher than would be obtained in any normal pile in practice.

The depth of granules in the vessel is approximately 2 ins. (5 cm.)

The load is applied for 15 mins. after which the granules are re-screened and the weight below B.S.S. 7 mesh noted. It is the value of this weight which forms the abscissa of Fig.1.

The ordinate of Fig.1 is the moisture content of the screened (- 6 & 7 B.S.S.) material, as determined by loss in weight in vacuo at 50°C for two hours. This method of determination gives the free water content, and is usually about 2/3rds of the value of the figure obtained by drying at 100°C for 4 hours.

Most of the points on the graph represent tests on a 9-9-15 compound but figures for 0-16-16 and 7-7-7 compounds and for granular T.S.P.*(triple-superphosphate) are also given.

Considering the variability of the granule structure, the straight-line relationship between the two factors is noteworthy.

In Fig.1 the line has been drawn through the mean of points given by the 9-9-15 compounds of relatively low age (about 1 month).

Points above the line represent materials harder than average and points below the line are softer than average.

Points 1 and 2 represent samples of granular T.S.P. of widely different moisture contents, and show that the material has quite different hardness/moisture characteristics from N-P-K compounds, as would be expected from its uniform structure and method of manufacture.

Neither of the above samples of T.S.P. tended to set in the bag, and all points to the feft of the dotted ordinate drawn through the intercept at 1% moisture do in fact represent materials which had been found free of setting tendencies.

Point 8 represents a fairly old 9-9-15 compound, but points 9,11, 12 & 13 represent 7-7-7 compounds of varying ages, with point 11 the oldest (8 days) and point 12 the newest (freshly made).

Point 10 represents a 0-16-16 compound of high superphosphate content and fairly uniform structure.

With the arbitrary method of test we employed, it would seem that materials giving less than 12% of material below 7 B.S.S. mesh size after crushing do not set, but from our experience of the various fertilisers in practice, we would have expected a more pronounced difference in hardness at moistures above and below 1%. However, the correlation obtained indicates that, for N-P-K compounds based on superphosphate, moisture content is the overriding factor in determining granule hardness.

By comparison with the results obtained by Hardesty and Ross in their tests on mass granules, our method as described above gives a better and more consistent correlation.

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* Dorr Process.

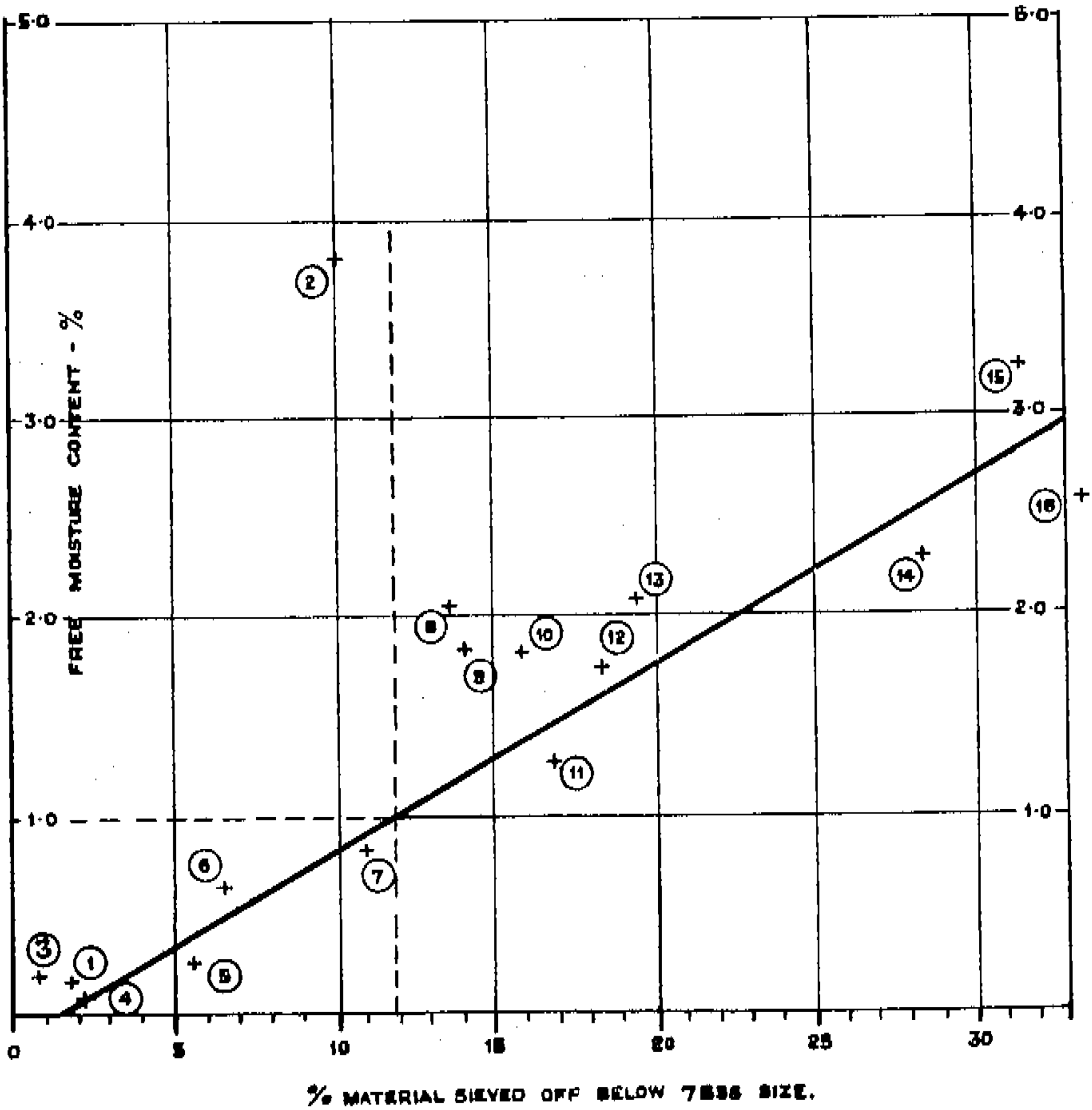

FIGURE I.

CORRELATION FOR MOISTURE v GRANULE HARDNESS.