

If the main object of the experiment is the estimation of the unknowns with the least variance, the most efficient design (for a specified value of  $N$ ) would be the one for which the minimum minimum of  $\frac{\sigma^2}{N}$  is attained for all the  $p$  unknowns. The quantity  $\frac{p}{N \sum_{t=1}^p c_{tt}}$  may, therefore, be defined as the

efficiency of a given design for providing the estimates of the  $p$  unknowns. I have used this quantity for judging the precision of the designs I have obtained.

3. By utilizing the properties of a 2-sided  $m$ -fold completely orthogonalized Hyper-Græco-Latin hyper-cube of the first order introduced earlier,<sup>4</sup> I have constructed a completely orthogonalized design for  $N=2^m$ ,  $p \leq 2^m$  (zero bias) or  $p \leq 2^m - 1$  (non-zero bias),  $m$  being any positive integer, by which each unknown is estimated with the minimum variance  $\frac{\sigma^2}{N}$ , and thus its efficiency is 100 per cent.

For  $N=2^m+1$ ,  $p \leq 2^m$  (zero bias) or  $p \leq 2^m-1$  (non-zero bias),  $m$  being any positive integer, I have obtained two types of designs. The efficiency of the first design for which

$$X'X = \begin{bmatrix} N & 1 & 1 & \dots & 1 \\ 1 & N & 1 & \dots & 1 \\ 1 & 1 & N & \dots & 1 \\ \dots & \dots & \dots & \dots & \dots \\ 1 & 1 & 1 & \dots & N \end{bmatrix},$$

the order of the matrix being  $p \times p$  if there is zero bias, or  $(p+1) \times (p+1)$  if there is bias, comes out to be

$$1 - \frac{p-1}{N(N+p-2)} \text{ for zero bias,}$$

or  $1 - \frac{p}{N(N+p-1)}$  for non-zero bias.

It is surmised that this is probably the most efficient design available for these values of  $N$  and  $p$ . For the second design, the efficiency is  $\frac{(N-1)p}{Np-1}$  for zero bias, or  $\frac{N-1}{N}$  for non-zero bias.

For  $N=2^m+r$ ,  $p \leq 2^m$  (zero bias) or  $p \leq 2^m-1$  (non-zero bias),  $r$  being any positive integer  $< 2^m$  and  $m$  any positive integer, I have worked out two designs, which are exact analogues of the two designs just discussed. For the first design of this type, the efficiency is

$$1 - \frac{(p-1)r^2}{N[N+(p-2)r]} \text{ for zero bias, and}$$

$$1 - \frac{pr^2}{N[N+(p-1)r]} \text{ for non-zero bias.}$$

For the second design of this type, the efficiency comes to be  $\frac{(N-r)p}{Np-r}$  if there is zero bias, and  $\frac{N-r}{N}$  if bias is present.

Finally, when  $N$  is at our choice, we can always obtain a completely orthogonalized design by taking  $N$  equal to a sufficiently large power of 2.

A short paper giving details of these results has been sent to Prof. Harold Hotelling and is likely to be published in the *Annals of Mathematical Statistics*.

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May 31, 1945.

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2. Bose, R. C., "The fundamental theorem of linear estimation," *Proceedings of the Thirty-first Indian Science Congress*, 1944, Part 3.
3. Radhakrishna Rao, C., "On Linear Estimation and Testing of Hypothesis," *Current Science*, 1944, 13, 154-155.
4. Kishen, K., "On Latin and Hyper-Græco-Latin Cubes and Hyper-cubes," *Current Science*, 1942, 11, 98-99.

#### D.C.-A.C. VIBRO CONVERTER (50 C.P.S.)

A VIBRO converter unit has been designed and developed at the Department of Electrical Technology of the Indian Institute of Science, Bangalore, during 1944-45 on new lines and using indigenous materials. It converts 110/220 volts D.C. (mains supply) to 110/220 volts A.C. of square topped wave form (fundamental frequency of 50 cycles/sec.). Many difficult problems like the selection of proper contact material, the determination of the suitable make to break time ratio, the suppression of high voltage surge in the transformer secondary, etc., have been solved to make the design successful. The efficiency of the machine increases with the increase of load from 50 to 75 per cent., and the vibro converter is capable of supplying current up to 2 amps. with a voltage regulation of 3 to 4 per cent. Full details of the machine will be published elsewhere.

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#### MAGNETIC ANISOTROPY OF IODINE CRYSTAL

INFORMATION regarding the magnetic anisotropy of crystals of non metallic elements is scanty. In the case of metals, studies of the magnetic properties of crystals have been possible since large cylindrical crystals can be grown by the method of slow cooling. But with non metallic elements such methods are not applicable. Other lines of approach have to be considered.

One such method is the critical torsion method developed by Krishnan.<sup>1</sup> Small crystals can be employed and using fine quartz fibres, the magnetic anisotropy of any crystal can be accurately determined. Krishnan's method has been found to be successful in the case of elements as evidenced by the work of John<sup>2</sup> and Rao.<sup>3</sup>

In the case of iodine, Krishnan's method is ideal. Resublimed iodine crystals, having masses of about 100 mg., were employed. Test experiments proved that the specimen of iodine was free from any ferromagnetic impurity. Investigations on critical torsion were

made at field strengths of 8,000 oersteds. Fine quartz fibres were used, their torsion constants being determined by separate oscillation experiments.

Iodine crystallizes in the orthorhombic system.<sup>4</sup> Molecules of I<sub>2</sub> have their axes on the *ac* plane, these axes making angles of  $+\phi$  or  $-\phi$  with the *a*-axis. The atoms in an iodine molecule are 2.70 Å apart. Between neighbouring molecules, the separation is 3.54 Å in the *ac* plane and 4.35 Å in adjacent planes. Cleavage takes place, therefore, easily along the *ac* plane.

With the cleavage face of an iodine crystal horizontal, it is easy to locate the *a* and *c*-axes. Investigations on five crystals gave the following average values for the principal specific susceptibilities.\*

$$\chi_a = -0.354, \chi_b = -0.331 \text{ and } \chi_c = -0.366.$$

Since the iodine molecules lie in the *ac* plane, the specific susceptibility normal to the axis of the molecule becomes  $\chi_b$ . With this simplifying assumption a calculation of the specific susceptibilities of the iodine molecule parallel and perpendicular to the axis, gives  $\chi_{\parallel} = -0.389$  and  $\chi_{\perp} = -0.331$ . The corresponding gram molecular susceptibilities are 98.74 and 84.03 respectively. The angle  $\phi$  works to 51°. The axes of the iodine molecules in the crystal are thus found to be inclined to the *a*-axis of the crystal at angles of  $+51^\circ$  or  $-51^\circ$ . The available X-ray data do not appear to be specific on this issue.

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July 10, 1945.

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1. *Phil. Trans. Roy. Soc.*, 1935, A 234, 265. 2. *Zeits. Krist.*, 1939, 101, 337. 3. *Jour. Mysore Univ.*, 1945, 5, 69. 4. Wyckoff, *The Structure of Molecules*, 1931, p. 210.

\* The susceptibility values are given in  $10^{-6}$  unit.

#### 'KYANOPHYLITE'—A NEW MINERAL OF THE HYDROUS ALUMINIUM SILICATE GROUP, DERIVED FROM KYANITE, FROM MAVINHALLI, MYSORE

ABOUT a mile and a half W.S.W. of Mavinhalli, in the ground consisting of the composite series of kyanite graphite schists, talc biotite schists, sillimanite quartz schists and other types of granulitic rocks, are found some loose bits and small lumps of an apple-green mineral which looks like some variety of talc or chlorites. It is, however, much harder than any of these minerals, and contains a large percentage of alumina and practically no magnesia at all. On chemical analysis, one of the specimens gave the following percentages:—  
SiO<sub>2</sub>-45.20; Al<sub>2</sub>O<sub>3</sub>-41.04; CaO-3.72; MgO-0.0; K<sub>2</sub>O-0.73; Na<sub>2</sub>O-3.84; Loss on ignition (mostly H<sub>2</sub>O)-5.00.

The data show that it is essentially a hydrous aluminium silicate.

In thin sections the mineral forms feather-like aggregates, and shows fairly low refraction (about 1.58 to 1.60) and low birefringence,—the interference tints being low greys and hardly rising above yellow and red of the first order. In its physical and optical properties it does not correspond to any of the known varieties of the group of hydrous

aluminium silicate minerals. The mineral forms a new type possessing its own individual characters, and will be described in detail in the next volume (XLIII) of the *Records of the Mysore Geological Department*.

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May 23, 1945.

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#### MIXTURES OF TETRYL AND T.N.T.

ACCORDING to Giua,<sup>1</sup> and Taylor and Rinckenbach,<sup>2</sup> tetryl (trinitrophenylmethylnitramine) and T.N.T. form a compound which melts at 67.6° C. and which contains the tetryl and the T.N.T. in the molecular proportion 1:2 respectively. Their conclusion is based on the presence of a very flat maximum in the melting-point diagram for tetryl/T.N.T. mixtures at a point which corresponds to the above proportions and melting-point. Efremov and Tikhomirova,<sup>3</sup> using a similar technique, reported that they could find no evidence for the existence of a compound.

As an alternative method of investigation we have determined the molecular weight of the alleged compound by measuring the depression of the freezing-point produced when it is dissolved in benzene. With three separate samples, prepared by melting the tetryl (m.p. 129.1° C.) and T.N.T. (m.p. 80.3° C.) together, figures of 233, 232 and 233 were obtained taking 51.2° C. as the molecular depression for benzene. These figures are, approximately, what would be expected from a mixture. The compound would have a molecular weight of 741.

In addition, it is possible to separate the tetryl and the T.N.T. by treatment with carbon tetrachloride at 0° C.<sup>4</sup>

Clearly, then, tetryl and T.N.T. in the molecular ratio 1:2 do not behave as a compound in solution at about 0-5° C.

We wish to thank the Director of Armaments for permission to publish this observation.

Inspectorate of Military  
Explosives, Kirkee,  
May 24, 1945.

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J. VERGHESE.

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#### A CHEMICAL METHOD FOR THE ESTIMATION OF ALKALOIDS PRESENT IN ARGEMONE OIL AND ITS APPLICATION TO A MIXTURE OF ARGEMONE AND MUSTARD OILS

ON account of its supposed role in causing epidemic dropsy argemone oil has received considerable attention in recent years. The theory is that when argemone oil is present in mustard oil as adulterant the ingestion of such mustard oil would produce epidemic dropsy in man. Lal *et al.*<sup>1</sup> were not able to substantiate this theory by isolating any toxic substance from this oil. The present authors<sup>2</sup> have, however, been able to isolate at least two toxic factors of alkaloidal nature from argemone oil. Whether they are responsible