

ammonia precipitate flocculates. Filter the precipitate and insoluble residue on a washed, dried, and weighed filter; wash thoroughly with hot water, dry at 100° to 105° C., and weigh. The difference is the weight of insoluble residue and ammonia precipitate.

To the percentage of insoluble residue and ammonia precipitate a small correction for moisture, *M*, must be added. This correction is from 0.02 to 0.05 per cent for pure stones, up to 0.15 per cent and even 0.20 per cent for those containing considerable amounts of insoluble residue.

A clayey insoluble residue contains more moisture than a sandy one, and its character should be noted as a guide to the worker in the assumption of moisture correction.

From the titration calculate the calcium carbonate (CaCO_3) equivalent of the acid neutralized by the stone, as per cent CaCO_3 , *A*. The percentage of insoluble residue and ammonia precipitate, *B*, having been determined, and the moisture, *M*, assumed, we are able to use Equations 4 and 5 as stated above.

The moisture was determined on the samples in Table I subsequent to the assumptions, except in Nos. 2, 3, and 4 as noted, and in no case was the difference more than 0.03 per cent and in a large majority only 0.01 and 0.02 per cent, from which it is evident that, with due regard to the character of the insoluble residue, the moisture may be assumed without material error.

Colloiding Agents for Nitrocellulose^{1,2}

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WHEN colloided straight nitrocellulose powder is exposed to a moist atmosphere, it takes up moisture for two reasons, because of the hygroscopicity of the colloid itself and because of the considerable hygroscopicity of the ether-alcohol that is still retained in the material of the powder grain. Since the moisture so taken up impairs the ballistic properties of the powder, a study of the mechanism of the process by which it is absorbed and of the means by which that process may be regulated or prevented is of obvious interest.

We have shown³ that the absorption of moisture by colloided straight nitrocellulose powder produces precipitation of the nitrocellulose and is accompanied by the production of minute cracks or pores in the surface of the grain. If the powder, after exposure to moisture, is now desiccated, the moisture held in these cracks by capillary action is driven off, the cracks give access to the residual ether-alcohol in the interior of the grain and some of this is also driven off, with the result that the desiccation of the powder actually drives off more volatile matter than the powder had taken up during its exposure to the moist atmosphere. By repeated exposure to moisture and subsequent desiccation, the powder soon reaches a condition of being *perfectly porous*; it no longer contains any ether-alcohol, and the gains and losses on successive exposures and dryings are equal. The amount of moisture which the powder now takes up is a measure of the true hygroscopicity of the ether-alcohol-free material of the powder grain, and, naturally, is considerably less than would be taken up under similar conditions by the original powder grain.

In certain coated or *progressive burning* powders, the exterior of the grain has been toughened and slowed down in its rate of burning by treatment with some colloiding agent.

Certain nonvolatile solvents for nitrocellulose, either incorporated throughout the mass of the grain or applied to the exterior as a surface coating, are used in the manufacture of colloided smokeless powder. Their value lies in the fact that they reduce the amount of volatile solvent needed in the manufacture, and that they influence the rate of burning of the finished powder and determine its attitude toward moisture. The present paper is a report of a study of the solvent action of a number of ureas, urethanes, and sebacic and phthallic esters. Results are such as to permit inferences regarding the relation between structure and solvent action.

Centralite, or sym-dimethyl diphenylurea, has been much used for the purpose. Suitable colloiding agents are nonvolatile or high-boiling substances, they are nonhygroscopic and capable of forming with the surface of the powder grain a skin of reduced hygroscopicity which protects the ether-alcohol of the interior

of the grain from taking up the moisture which it would otherwise attract.

In a study of coated powders it has seemed proper to determine the amount of the various colloiding agents necessary for the complete gelatinization of a given amount of nitrocellulose. The results are such as to permit certain generalizations concerning the relation of the structure of the organic compound to its solvent action for nitrocellulose. We find also—a fact which does not seem to have been noted heretofore—that the amount of the colloiding agent necessary for complete gelatinization is in general different when different solvents are used for applying it to the nitrocellulose.

DISCUSSION OF EXPERIMENTS

The experimental procedure was one suggested by Marius Marquoyrol,⁴ Inspector General of Powders of France, who has used it, with alcohol, for studying the action of a large number of colloiding agents on the soluble and insoluble nitrocotton that are used by the French for the manufacture of smokeless powder. We have worked in general with different colloiding agents and have studied the *pyrocellulose* which is standard for United States powder—a nitrocellulose containing 12.60 per cent nitrogen and completely soluble in ether-alcohol. When we have worked with the same materials, our results have been in close agreement with those of M. Marquoyrol for soluble nitrocotton.

Half-gram samples of dry finely pulped pyrocellulose were weighed into 30-cc. beakers, and to each sample a known weight of the colloiding agent previously dissolved in an appropriate amount of solvent (15 to 30 cc.) was added.

⁴ Recently published, Marquoyrol et Florentin, *Mémorial des Poudres*, 18 (1921), 150, 163. These investigators worked at 35° C.

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³ Army Ordnance, II, 9. July–August 1921.